SINDH IRRIGATION AND DRAINAGE AUTHORITY

Sindh Water Sector Improvement Project Phase-I (WSIP-I)

PREPARATION OF REGIONAL MASTER PLAN FOR THE LEFT BANK OF INDUS, DELTA AND COASTAL ZONE

Phase – III

Main Report

Final

Volume I –PRESENT SITUATION

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Development Plan

The Louis Berger Group Inc.
In Association with
Indus Associated Consultants (Pvt.) Ltd.

March 2013

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Letter of Transmittal

18 March 2013

Dear Mr. Junejo,

We are pleased to submit the Phase III Final Report of the Study "Regional Master Plan for the Left Bank of Indus, Delta, and Coastal Area". The Phase III draft report was submitted to SIDA in December 2012 that included the comments of the Panel of Experts.

This Phase III Final Report has been prepared with a stakeholder consultative approach involving a wide array of stakeholders, and represents their aspirations and expectations, and detailed feasibility studies were undertaken with the objective to assist with the timely and safe drainage of effluent and storm flood waters. Accordingly, this report presents the details of 9 feasibility studies.

We would like to place on record our appreciation for the guidance and support extended by Engineer Ehsan Leghari (MD SIDA), Mr. Nazir Essani (GM Transition) and Engineer Mr. Habeeb Ursani (Director AWB Badin), and yourself in the preparation of this report.

We would also like to place on record the support provided by Mr. Fateh M. Mari, PhD, Project Coordinator, PCMU, and Engineer Ylli Dedja, PhD, FAO Project Management Consultant (PMC/A), and Mr. Mohammed Ehsan, The World Bank Consultant. We would also like to express our gratitude to the Honorable Ministers, Mr. Murad Ali Shah, (former Minister of Finance), Mr. Jam Saifullah Dharejo, (former Minister of Irrigation), Mr. Nadir Ali Khan Magsi, (former Minister of Food), and Syed Raghib Abbas Shah (Chairman Water, WAPDA). Special thanks are due to the Panel of Experts (PoE) for their instructive comments. We take this opportunity to acknowledge the encouragement and guidance received from the Chairman PoE, Dr. Asad Kazi.

We would also like to mention here the appreciation and concurrence of the President of Pakistan on the perspective plan, who desired that the people of Sindh do not undergo this level of misery, in the event of similar unprecedented rainfall.

Sincerely yours,

Assuring our best services and cooperation,

Carlos A. Gandarillas,
Team Leader

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Acronyms

ADB	*Asian Development Bank*
DCO	*District Coordination Officer*
DDMA	*District Disaster Management Agency*
DERA	*Drought Emergency Relief Assistance*
EIA	*Environmental Impact Assessment*
ERC	*Emergency Relief Cell*
FFC	*Federal Flood Commission*
GoP	*Government of Pakistan*
LGO	*Local Government Ordinance*
NWFP	*North Western Frontier Province*
NA	*Northern Areas*
NCMC	*National Crisis Management Cell*
NDMA	*National Disaster Management Agency*
NDMF	*National Disaster Management Framework*
NDMO, 2007	*National Disaster Management Ordinance of 2007*
NEAP	*National Environmental Action Plan*
NEC	*National Economic Council*
NEQS	*National Environmental Quality Standards*
NFFB	*National Flood Forecasting Bureau*
O&M	*Operations and maintenance*
P&D	*Planning & Development*
PCMC	*Provincial Crisis Management Cell*
PID	*Provincial Irrigation Department*
PDMA	*Provincial Disaster Management Agency*
PPA	*Participatory Poverty Assessment*
PSDP	*Public Sector Development Program*
SUPARCO	*Space and Upper Atmosphere Research Commission*
TOR	*Terms of Reference*
TMA	*Tehsil Municipal Administration*
UNDP	*United Nations Development Programme*
UWP	*Urban Works Program*
VC	*Village Council*
WAPDA	*Water & Power Development Authority*
WMO	*World Meteorological Organization*

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1 Introduction

1.1 Introduction to the Project and this Report

The present document is a Regional Master Plan document for the Left Bank of Indus covering the strategy for ensuring safe disposal of the drainage effluent, storm water, and riverine floods to mitigate damages from water hazards and to agriculture and livestock, productive, physical, and communication infrastructure, vital installations, and most importantly human lives and livelihoods in the left bank of Indus encompassing the command areas of Guddu, Sukkur, and Kotri barrages, and the coastal areas. The report also outlines a phased investment plan, and detailed feasibilities of the selected core projects that were identified and prioritized in consultation with the stakeholders at large. This report is being submitted as the Phase III of the Regional/Master Plan Study, and will be followed by the submission of detailed designs and tender documents for the core projects as the final deliverable.

1.2 Context and Rationale

1.2.1 The World Bank Country Assistance Strategy (CAS)

According to the World Bank Project Appraisal Document 2007[1]the infrastructure challenge is particularly acute with respect to water as Pakistan relies on the largest contiguous irrigation system in the world to provide basic food security (90% o f food production and 25% o f the Gross Domestic Product GDP). Agriculture is the single most important source of employment and exports (two thirds of employment and 80% of exports) and irrigation represents more than 95% of the total consumptive use of water. However, this massive infrastructure is deteriorating and in need of rehabilitation along with reforms to improve the allocation of water as well as the efficiency o f its use. Moreover, competition for water is growing among the provinces and across the varied needs for irrigation, industrial and domestic use, and the environment.

In irrigation the Bank is to support a combination of institutional reforms and investments throughout the system including major investments in rehabilitation of critical assets and reforms to improve the quality, efficiency, and accountability with which irrigation services are delivered. The Project fits extremely well in the CAS and it is a major element of Bank's assistance to Pakistan in the water sector.

1.2.2 Project Objectives

The World Bank identifies three inter-linked and mutually reinforcing pillars of the CAS

i. *¨sustaining growth and improving competitiveness;*
ii. *improving government effectiveness and service delivery; and*
iii. *improving lives and protecting the vulnerable¨*

The World Bank further indicates that the Sindh Water Sector Improvement Phase-I (WSIP-I) Project supports all three pillars o f the **CAS** by:

> *(a) ¨rehabilitating/improving the hydraulic and irrigation infrastructure on which the irrigated agriculture is fully dependent and thus avoiding social and environmental disaster in case of I&D infrastructure collapse;*
>
> *(b) deepening and widening the reforms already underway in Sindh's I&D sector and thus improving the efficiency, quality, accountability and sustainability of I&D services, supporting the second pillar of **CAS** and,*
>
> *(c) improving the agricultural production, employment in rural areas o f Sindh which is one o f the poorest regions in the country, leading to improving the lives of vulnerable.¨*

[1] World Bank. Project Appraisal Document. WSIP-I. Report No: 37923-PK. August 2007

1.2.3 Context

Government of Sindh started the reforms of the management of the entire irrigation system with the approval of SIDA Act 1997, shifting the responsibilities for the management of irrigation and drainage infrastructure from the governmental centralized provincial Irrigation and Power Department (IPD) to autonomous bodies: the Sindh Irrigation and Drainage Authority (SIDA), Area Water Board (AWBs) and Farmers Organization (FOs). The Sindh Water Management ordinance 2002 replaced SIDA Act 1997.

The immediate goal of reforms in Sindh is to restore equitable and reliable water delivery to the farmers. The ultimate goal is, of course, the improvement of agricultural production. At present Sindh Irrigation and Drainage Authority (SIDA) is executing the World Bank funded Water Sector Improvement Project Phase–I (WSIP-I) The overarching objective of WSIP is to improve the efficiency and effectiveness of distribution of irrigation water in three Area Water Boards (Ghotki Canal AWB, NARA Canal AWB, Kotri Left Bank Canals AWB), particularly with respect to measures of reliability, equity and user satisfaction. This will be achieved by:

1. Strengthening and fast tracking the institutional reforms that are already underway in Sindh[2].
2. Improving the irrigation system in a systematic way covering key hydraulic infrastructure, main and branch canals, and distributaries and minors;
3. Enhancing long-term sustainability of the irrigation system through participatory irrigation management and developing institutions for improving operation and maintenance (O&M) of the system and cost recovery

The project also has a component[3] to support detailed studies and preparation of a Regional Plan for the area on the Left Bank of the Indus River, for rehabilitation and improvement of collection and safe disposal of drainage effluent, flood and storm water in the left bank of Indus, and rehabilitation of wetlands and the coastal zone; considering the environmental importance of the region and its economic potential drawing upon international experience. The various components of the WSIP-I project are shown in Table 1.1.

Table 1.1: Components of the World Bank Funded WSIP-I Project

WSIP-I Component	Description of Component
A	Community Development and Capacity Building
B	Improvement of Irrigation and Drainage System
C	Management Plans for Major Irrigation and Drainage Infrastructure
	Preparation of Regional Plan to Deal with Floods & Drainage Issues on Left Bank of Indus River and Designing Measures for Improvement of the Indus Delta and the Coastal Zone *[This Study]*
D	Project Monitoring, Evaluation and Supervision of Environmental Management Plan
E	Project Coordination, Monitoring, Technical Assistance and Training

[2] Sindh Irrigation and Drainage Authority (SIDA) has established a total of 345 Farmer Organizations (FOs), in three Area Water Boards (AWB) - as legal entities under the Sindh Water Management Ordinance of 2002 (SWMO 2002)

[3] The sub-component C-2 of SWIP-I deals with the provision of these studies

1.2.4 Background to the Project

Sindh Province has a vast irrigation and drainage network and it is one of the primary beneficiaries of the Indus Basin Irrigation System of Pakistan (IBIS). The IBIS is considered as one of the largest contiguous irrigation systems in the world. Of the total 14 barrages of the IBIS, Sindh has three major barrages on the Indus River that divert approximately 48 million acre feet MAF (59.0 billion cubic meters- BCM) of water annually to the 14 main canal commands in Sindh Province. These canal systems have an aggregate length of 13,325 miles (21,445 Km), which serve a gross command area (GCA) of 14.391 million acres (5.8 million ha). There are also about 42,000 watercourses (tertiary channels), which have an aggregate length of about 75,000 miles (120,000 Km). The water diversion in the study area (Table 1.2) is approximately 11.6 MAF for eight canal commands.

Table 1.2: Major Barrages on the Indus River in Sind Province

Barrage Name	Year constructed	Diversion Quantity Left Bank (MAF)
Guddu	1962	3.484
Sukkur	1932	5.532
Kotri	1955	2.577

A plan showing this extensive barrage, canal and drainage system is shown in Figure 1.1

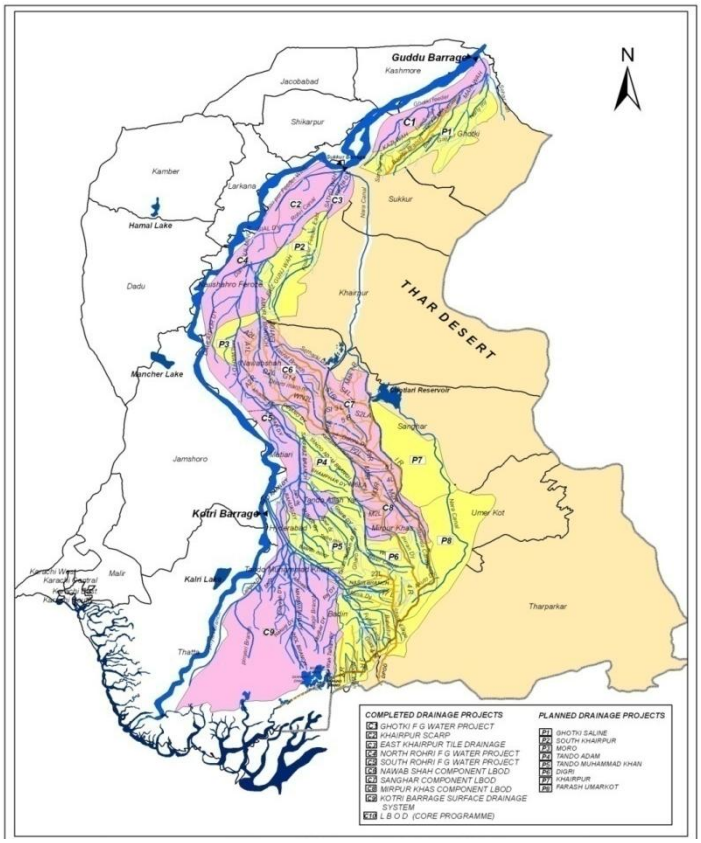


Figure 1.1: **Barrage wise irrigation network system of Left Bank Indus Region**

1.2.5 Salinity and waterlogging

Around 78% of the area in Sindh Province is underlain by saline groundwater which is unsuitable for irrigation and other uses. Surface and sub-surface drainage systems are inadequate, resulting in much of the drainage effluent being either retained in the basin or disposed of into rivers, canals, and through a drainage network. There are 13 existing surface drainage systems in Sindh, which serve a total area of over 6.2 million acres (2.5 million hectares) and have an aggregate length of about 3.8 thousand miles (about 6.1 thousand Kms). In addition, there are two sub-surface drainage systems, which serve an area of 0.10 million acres (0.04 million ha).

Due to an inadequate drainage network and the flat topography of the basin, nearly one-fifth of the canal command area is affected by water logging and salinity – widely referred to as the *twin problems* or *twin menace*. A map showing the surface areas of water logging and salinity is given in Figure 1.2.

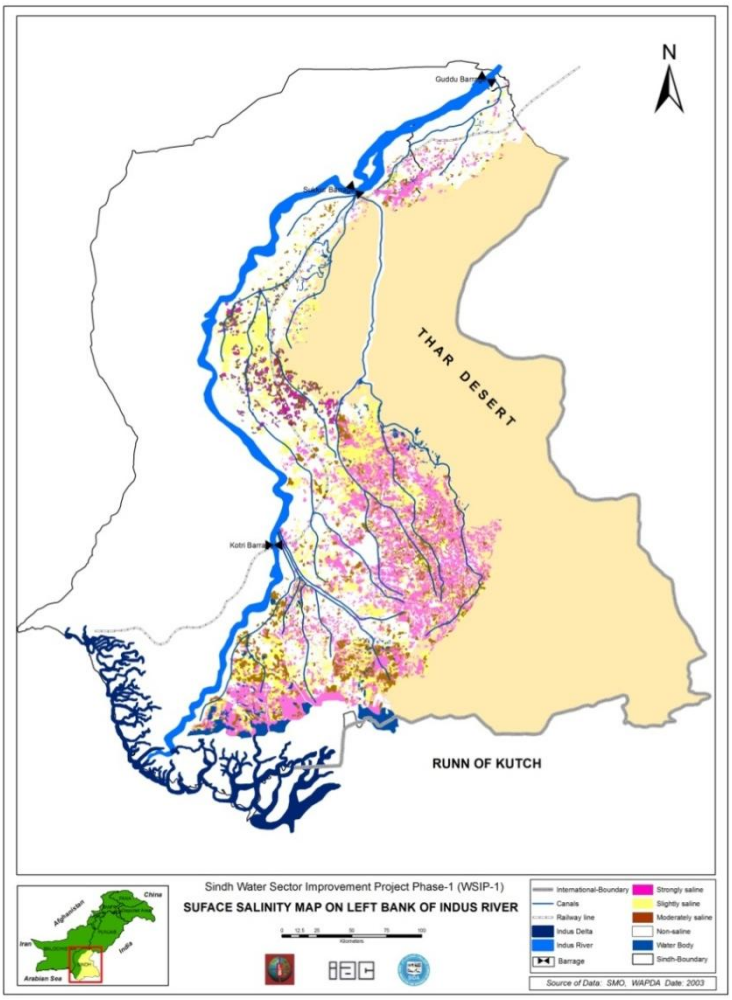


Figure 1.2: **Waterlogging and Surface Salinity Status Left Bank of Lower Indus Region**

To address the problems of water logging and salinity in the Left Bank of the Indus River, the Left Bank Outfall Drain (LBOD) was constructed. The LBOD collects drainage water from the three districts of Sukkur Barrage command area (Shaheed Benazirabad, Sanghar, and Mirpurkhas) and drains to the sea through a Tidal Link drain constructed as part of the LBOD project. LBOD has performed well and the upper part of the LBOD area has benefited from the drainage. However, there are several issues unresolved in the outfall area and coastal zone.

A chronological history of the development of irrigation and drainage, and a genesis of the salinity and drainage problems in the study area are shown in Fig-1.2. These twin problems, combined with increased development in the region, demand the preparation of a comprehensive Regional

Plan for the handling of flood and drainage problems of the area on the left Bank of the Indus River, the River Delta and its Coastal Zone.

1.2.6 Project/Study Area

The project study area includes the areas in Sindh Province lying on the Left Bank of Indus River, including the river delta, associated wet lands, and adjacent coastal zone. In particular, it covers the irrigation areas served by the Indus River canals off-taking from the left bank of Guddu, Sukkur and Kotri barrages; the area covered by the Left Bank Outfall Drain (LBOD), and its catchment and backwash areas.

The delineation of the project areas for the study is shown in Figure 1.3.

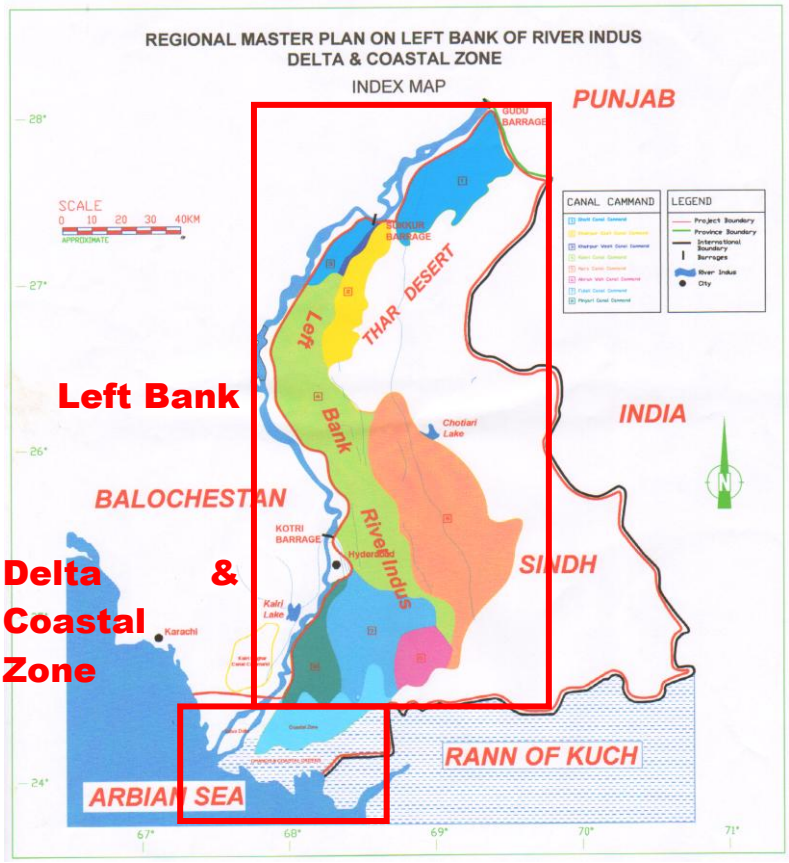


Figure 1. 3: Map Showing the Study Area: Left Bank of Indus, River Delta and Coastal Zone

Figure 1.4: Extent of Indus River Delta and Coastal Zone During 2010

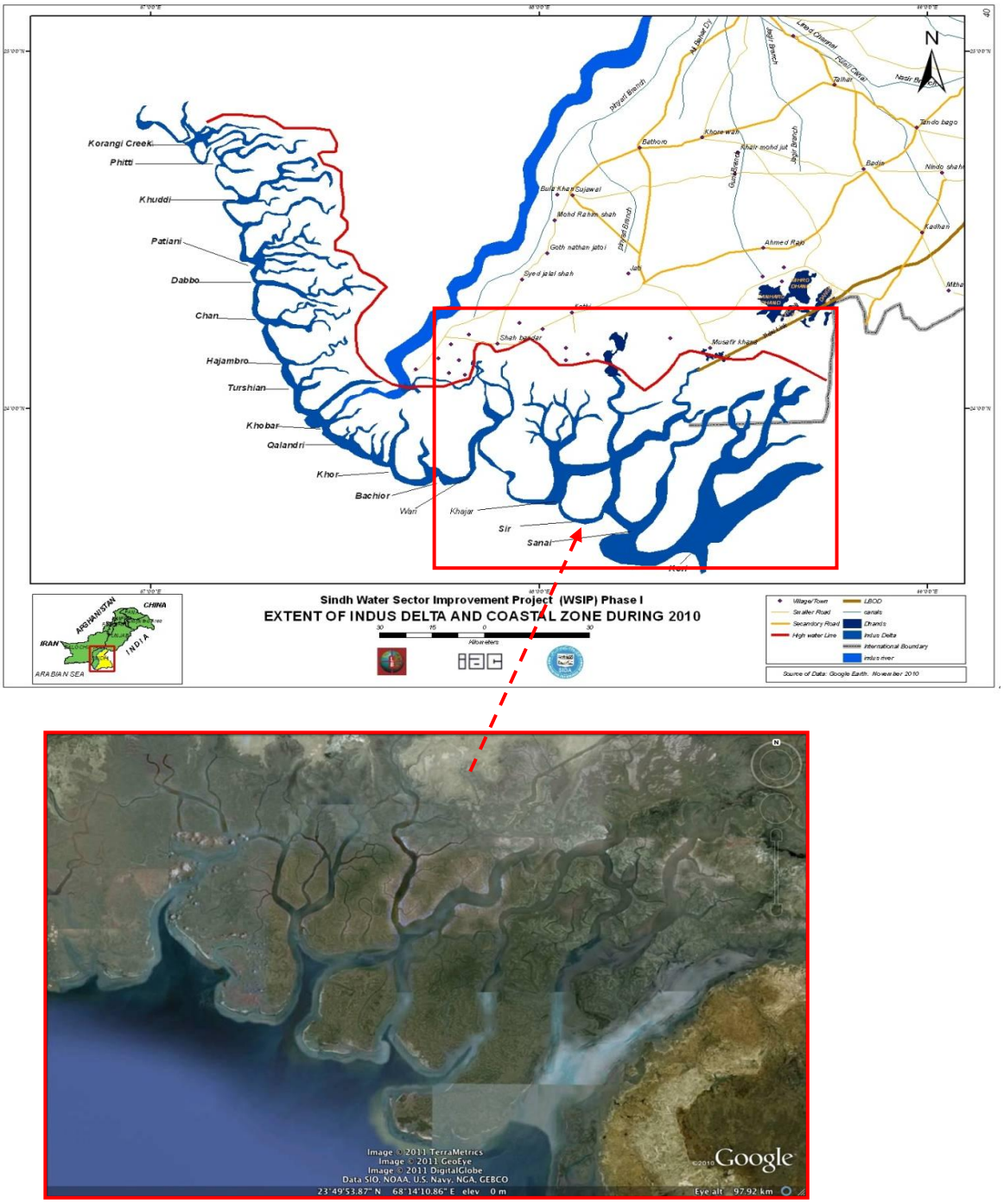


Figure 1.5: Google Earth Photo of Indus River Delta and Coastal Zone in the Study Area

Originally it was expected that it would be possible to consider the Indus River Delta and Coastal Zone separately, and to develop different Phase-I issues and problems for the two areas. However the complex nature of the morphology and the interaction of tides and river morphology in the two areas shown in Figure 1.4 and Figure 1.5 make it impossible to separate out drainage and flooding effects in the Delta and Coastal Zone. For this reason, the two areas are taken as one morphologic regime in the study.

1.3 Objectives of the study

The objective of consultancy services is to prepare for the Government of Sindh (GoSindh) a Regional Plan for addressing the flooding issues and providing proper drainage to the area on the Left Bank of the Indus River - including the River's Delta and Coastal Zone - through appropriate structural and non-structural measures, including remedial measures for any outstanding deficiencies in the Left Bank Outfall Drainage (LBOD) system; measures for retention and/or safe disposal of drainage; storm and flood water; improvement of wetlands in the delta area and in the coastal zone; recognizing their environmental importance and considerable economic potential for local communities.

These studies have been carried out in consultation with the stakeholders starting from the beginning to the end of the process covering the identification of the issues, and an analysis and detailed design of the solutions selected. The work has been performed in a phased manner. Each phase was conducted through consultations and shared understanding with the stakeholders leading to key decision necessary for carrying out further work under subsequent phases of the study.

The World Bank (2007) emphasizes that the detailed design would be prepared and made ready for implementation of the priority works identified under the master plan under a future investment project that Sindh may undertake with the assistance o f i t s development partners.

1.4 Scope of Work and TORs

In order to achieve the objectives of WSIP-I and also the Regional Master Plan objectives, the assignment was designed to be performed in four phased studies as defined below:

***Phase-I*:** Inventory and assessment of existing conditions and identification of issues and problems, preparation of a report that will form the basis of consultations with all stakeholders to reach an agreement on definitions of issues and problems. This will also cover issues related to supply of water and management of drainage & waste water effluent expected to be generated by development of the Thar Coal mines and power complex in the future as planned by the government. The Phase-I report will be finalized through extensive consultations with the population, water users and stakeholders in area on the Left Bank of the Indus River, delta and coastal zones; and should help identify and prioritize issues for which the solutions have to be developed during the Phase-II study.

***Phase-II*:** Identification of solutions covering structural and non-structural options, and institutional and management measures and their technical, environmental and social feasibility, approximate cost, workability and ranking based on pre-feasibility level studies and analysis. Development of a comprehensive Regional Plan to address the problems of flooding and drainage composed of an optimal mix of improved structural, non-structural, institutional and management measures selected to enhance developmental objectives in the study/project area. This phase will also include consultations with stakeholders in order to identify solutions for which detailed feasibility is to be carried out under Phase-III studies.

***Phase-III*:** Preparation of detailed feasibility including technical, economic, environmental and social viability and implementation/institutional arrangements for the solutions identified under Phase II as high priority. This phase will also result in consultations based on the feasibility studies, and identification and prioritization of structural and non-structural solutions and their ranking for which detailed designs will be prepared.

***Phase-IV*:** Preparation of detailed designs and bidding documents for the most preferred solution for implementation according to international standards and implementation manuals, and institutional arrangements for non-structural solutions.

1.5 Study Approach and Methodology

General Strategy

The strategy followed for the preparation of the Regional Master Plan is summarized in the following points:

- Prepare for the Government of Sindh a Regional Master Plan for addressing the flooding issues and providing proper drainage to the area on Left of River Indus through structural and non structural measures.
- Suggest remedial measures for any **outstanding deficiencies** in the LBOD.
- Suggest measures for retention and / or safe disposal of drainage, storm and flood water.
- Suggest improvement of wetlands in the delta area and coastal zone recognizing their environmental importance and considerable potential for the local communities.
- Studies to be carried out in consultation with the stakeholders starting from beginning to end, covering **identification of the issues, analysis and design of solutions**.

Methodology

A summary of the characteristics of the WSIP-I project and its Preparation of a Regional Plan for the Left Bank of the Indus, Delta and Coastal Zone sub-project is given in Table 1.3.

Table 1.3: Summary of Water Sector Improvement Project Phase-I (WSIP-I) for the Lower Indus River Basin

Period	Sponsor	Project and component name	Abbreviation	Objective	Methodology
Dec 2007 – April 2013	World Bank	*Project*: Water Sector Improvement Project – Phase I[4]	WSIP-I	Improve the efficiency and effectiveness of distribution of irrigation water in three AWB[5]s (Ghotki, Nara and Left Bank), particularly with respect to measures of reliability, equity and user satisfaction.	(a) Deepening and broadening the institutional reforms that are already underway in Sindh; (b) Improving the irrigation system in a systematic way covering key hydraulic infrastructure, main and branch canals, and distributaries and minors; (c) Enhancing long-term sustainability of irrigation system through participatory irrigation management and developing institutions for improving operation and maintenance (O&M) of the system and cost recovery

[4] Project Implementing Agency is the Sindh Irrigation and Drainage Authority (SIDA)

[5] AWB are Area Water Boards – There are 345 Farmer's Organizations in three Area Water Boards in the Lower Indus River Basin

Period	Sponsor	Project and component name	Abbreviation	Objective	Methodology
April 2010 - April 2013		*Subproject*: Preparation of a Regional Plan for the Left Bank of the Indus, Delta and Coastal Zone	LBG	Prepare for the Government of Sindh (GoSindh) a regional master plan for addressing the flooding issues and providing proper drainage to the area on the left bank of the Indus River through appropriate structural and non-structural measures, including remedial measures for any outstanding deficiencies in the Left Bank Outfall Drainage system, measures for retention and/or safe disposal of drainage, storm and flood water, improvement of wetlands in the delta area and in the coastal zone recognizing their environmental importance and considerable economic potential for the local communities.	*Phase-I*: Preparation of Inventory, Assessment of Existing Conditions, Identification of Issues , and Methodology and Plan for consultations and Stakeholders participation *Phase-II*: Development/Identification of Options, Formulation of a Regional Master Plan, preferred solutions and their ranking. *Phase-III*: Preparation of the Detailed Feasibility Studies for Selected the Options/Solutions. *Phase-IV*: Preparation of Detailed Design and Preparation of Bidding Documents and Implementation Manuals and Standard Operating Procedures for non-structural and improvement management measures.

Summary of the Project

The key components of the Regional Plan Study are given in Table 1.4. In addition, the following requirements of the project Terms of Reference were followed in undertaking all aspects of the study:

1.1. The Client for the Regional Plan is the Government of Sindh, and all of its administrative components. However implementation of the Regional Plan is to be designed and to be implemented by a wide range of actors and civil society.

1.2. The beneficiaries of the Regional Plan are the populations on the Left Bank of the Indus River; and the population in the Delta and Coastal Zone. Other areas in Sindh, including the Right Bank of the Indus River, were not part of the study area.

1.3. The development sectors that the Regional Plan was to focus on drainage and flooding only. Other development sectors such as irrigation and or social sectors are being considered in other components of the WSIP-I and are not a part of the Master Plan study.

1.4. Particular interest has been directed to the assessment of deficiencies in the Left Bank Outfall Drain System (LBOD). This was further divided into assessment of drainage collection, drainage conveyance and drainage disposal.

1.5. The study considered combined collection, transport and disposal of both drainage water and excess flood water. This is similar to studies in urban areas where combined collection of waste water and storm water require remediation before the combined polluted water flow can be safely discharged to existing water courses.

1.6. Particular attention was directed to improvement of the wetland environment in the Indus River Delta and Coastal Zone.

1.7. Any remedial measures selected to address issues and problems were to include both structural and non-structural options

1.8. The study was based on an assessment of Issues and Problems; to be followed by proposed Options and Solutions.

1.9. All work efforts were to be based on extensive consultations with stakeholders: i) to identify issues and problems; ii) to analyse options and solutions; to design remedial measures;

Consultations and a shared understanding with stakeholders were required before work on a primary phase of the study could be completed; and the successive phase of the study could be started.

Table 1.4: Summary of Study Requirements

Study Characteristic:	Study Requirement
Client:	Government of Sindh Province
Beneficiaries:	Sindh Province: 1. Population on Left Bank of Indus River 2. Population of Delta and Coastal Zone
Sectors to be considered:	1. Drainage 2. Flooding
Executing Agency:	Planning & Development Department, Government of Sindh Province
Implementing Agency:	Sindh Irrigation and Drainage Authority
Sponsor:	The World Bank

1.5.1 Study phases and outputs (tasks)

1.5.1.1 Brief Overview of Phase I Study

The Phase study commenced in April 2010, and a draft was submitted in December 2010. The phase I study report, after a series of reviews and incorporation of comments was finalized and approved in the June 2011. This Phase of the study was dedicated to the identification of issues and problems associated with the impacts of spreading water logging and salinity; institutional breakdown for management of water delivery, drainage, floods, and disasters; environmental

problems and resultant spread of poverty and deteriorating livelihoods among the growing population.

The main activities during the preparation of the study Phase-I were i) review of available relevant reports and interaction with staff of relevant agencies, ii) field visits to assess the performance of existing infrastructure, wetlands, and coastal areas and improvements and revival needs; iii) preparation of technical, descriptive and analytical reports on area description, inventory of existing irrigation and drainage infrastructure and issues related to its operation and maintenance, impact of seawater intrusion, institutional issues, disaster management etc.; iv) scoping sessions and intensive consultation with the stakeholders at the village, district, regional, and provincial levels.

About 5,000 persons were consulted/participated in the workshops. The objective was to solicit the perceptions about issues related to safe disposal of drainage, flood and storm water, and impact of these infrastructures on poverty and livelihoods.

The Phase I report was organized in eight thematic areas detailing of the work and findings that addressed the requirements of the scope of work mentioned in the contract. The thematic areas included: i) overview and development of planning for drainage and flooding; ii) water resources and water usage for drainage and flooding; iii) impacts of drainage and flood on environment and wetlands; iv) flooding, disaster management and mitigation; v) structures for irrigation drainage and flood protection; vi) overview of current agriculture, livelihood, and economic aspect of drainage & floods; vii) social issues of drainage operation and flooding; and viii) review of capacities of provincial agencies involved in execution of the irrigation and drainage projects and its management.

1.5.1.2 Brief Overview of Phase II Study

Following the submission of Phase 1 study report, as a proactive strategy, the Consultants embarked on the preparation of pre feasibilities for solutions for intervention aspired by the stakeholders. This was based on review of available studies, field studies, surveys, procurement of satellite imagery, and ongoing process of consultation with the stakeholders. The near finished pre feasibilities, that were technically feasible and economically viable were presented to the stakeholders, along with the selection criteria, at the district and Area Water Board (AWB) levels. Based on feedback from the stakeholder workshops, 19 pre-feasibilities were presented at the national stakeholder workshop, held on 14 January 2012 in Karachi. The participants agreed with the Consultants selection and advised to submit the pre-feasibilities for approval and final selection of interventions for detailed feasibilities.

During the course of preparation of pre-feasibilities, the unprecedented rains and havoc thereof, provided an opportunity to monitor the performance of the drainage system to cope with the strain and weaknesses in the system, and its damage to the human lives, agriculture, livestock, private properties, irrigation, drainage, and physical infrastructures, miseries of the flood displaced persons including their constrained access to social services, and livelihoods. This required reallocating Consultants focus and resources to closely evaluate the systems' capacity and alternatives options and interventions to ensure safe disposal of storm water in the event of future similar extremes.

During the preparation of the report sufficient Consultants resources were reallocated to provide support and assistance to SIDA and the Core 5 Engineers, and providing information and analysis to the irrigation department and senior politicians, including the President and at the provincial Cabinet level. This also included preparation of a plan of emergency works to restore the capacity of the drainage system, and measures to ensure safe disposal through natural waterways in the event of similar rains.

During the Phase II of the Study, pre-feasibilities were prepared for eight structural, six quasi-structural, and two institutional interventions that were selected and agreed in the national workshop. In addition to this three position papers were developed to address and recommend actions required to the identified relevant issues.

The Phase II report was organized in five thematic areas detailing of the work and findings that addressed the requirements of the stakeholders at community, district, and regional levels. The stakeholders` perceptions about the drainage disposal related issues and problems and their perceived solutions and aspirations and identification of priority interventions lead to the formulation of regional plan and action/implementation plan.

The five thematic areas included: i) Safe and timely disposal of surplus drainage effluent, and storm water flood, ii) Combating waterlogging and salinity in non-LBOD areas, iii) Environmental mitigation, iv) Institutional Strengthening and capacity building of SIDA and, v) Livelihood support to water hazard affected communities. During the Phase II of the Study, pre-feasibilities were prepared for eight structural, six quasi-structural, and two institutional interventions that were selected and agreed in the national workshop. Please refer to Chapter 9 for the list of pre-feasibility studies.

The phase II study report was initially submitted in March 2012 and after a series of reviews and incorporation of comments was finalized and a final version was submitted in May 2012, to be approved in September 2012.

1.5.2 Participatory and Consultative approach

A brief summary of consultative process to i) identify the issues and problems related to the drainage sector; ii) identification of solutions and selection of interventions, iii) preparation of pre-feasibilities; iv) ranking and prioritizing and phasing of core interventions; and vi) review and approval of the detailed feasibilities of the core projects.

1.5.2.1 Participatory Approach

A central point in the preparation of the WSIP Regional Plan is preparation of the Plan in consultations with communities and other major stakeholders. One of the key '*lessons learnt*' (see PAD, WB, 2007) has been to make participatory approaches to development crucial to project design based on social considerations.

The participation and meaningful involvement of the community and other relevant stakeholders are essential throughout the planning, design and implementation phases of the Project. The emphasis in genuine community participations is on fostering a sensitive and mutually beneficial dialogue. The stakeholders' and community participation encourages ownership of the Project and its outputs, provides improved visibility and education regarding the complex issues as well as the activities initiated by the Government of Sindh and SIDA to identify and solve the problems.

Often marginalized and underrepresented groups such as women, disabled, ethnic minorities, landless and poor are included and empowered through the participation process. The method encourages the active involvement of local people with own perspective and valuable knowledge of the area's conditions, traditions, local values and social and cultural structure. With its specific tools, the participatory approach allows community/ stakeholders' concerns to be voiced, identified and adequately addressed. In addition, a genuine participation generates alternative solutions as seen by the communities and stakeholders and improves transparency and accountability.

It is essential that all major stakeholders are identified and given the opportunity to be involved and informed regarding the Project, the irrigation and drainage issues and potential structural and non-structural solutions for the current issues/problems. Open public consultation sessions, workshops and other systems for receiving comments are indispensable for encouragement and opportunity for any interested parties to access information about the Project and to express their opinions, suggestions and recommendations relevant to the Project.

A meaningful community and stakeholders' engagement goes beyond formal dissemination of the Project information or people's bare voicing their opinions. It should build trust, rapport and understanding between the stakeholders and to ensure that the perspectives and realities of the Project beneficiaries are developed into longer term strategies and concrete actions.

Participatory methods and techniques used tend not to follow a standardized procedure. The tools used are often creative and generative and are often considered less important than the attitudes and beliefs of those carrying out the investigation. In particular, facilitators need skills for facilitation and negotiation, as well as a range of personal qualities, attitudes and behaviors which are appropriate for designed intervention with communities.

The community consultations are imperative in addressing social concerns and fostering participation and community support for the Project. People should be correctly informed of the issues and potential solutions and allowed to voice their comments and concerns – which should in turn feedback into the planning and design process. It is especially important when the reality of the Project is not perceived in the same way by those who implement the Project, and by the communities who should benefit from it.

In order to ensure the stated principles of the adopted participatory approach, the Consultant has taken a range of steps during the preparation of the stakeholders/ community participation plan. The early drafts of the stakeholders/community participation plan were shared at numerous meetings with the SIDA's social team and the field staff, working in the Area Water Boards.

1.5.2.2 Consultative Approach to the Studies

Since phase I to phase III, all the issues and problems had been identified through the participatory and consultative process with the stakeholders of the project area; the identification of solutions and selection of interventions have also been ensured through participatory approach and with the consultation of project population of left bank of Indus and coastal area; similarly, ranking and prioritizing and phasing of core interventions are being taking place with the same techniques of conducting consultations with the stakeholders and finally same techniques are being considered with priority in order to take review and approval of the detailed feasibilities of the core projects.

To address the diverse requirements and outcomes required in the 34 tasks of Phase I of the Project, the Consultant grouped tasks under eight themes and carried out the work of each thematic area in four steps:

Planning process

- Secondary data collection, review, critical evaluation and analyses
- Primary data collection, review and critical analyses
- Collation of findings and identification of resultant problems and issues for presentation to stakeholders.

Each sub-team planned the activities and approaches according to the particular task groups assigned. Sources of required data were identified, followed by informational meetings with concerned departments, reconnaissance surveys, and specially developed interaction with communities and other major stakeholders. Stakeholders associated with each topic were identified and consulted during the process of data collection. Stakeholders included beneficiaries, affected communities, NGOs, influential local people, and staff of government line departments.

1.5.2.3 Conceptual Approach of community consultations

During the phase I of the project, participatory approach was adopted and community consultations were made with the stakeholders in order to identify the issues and problems.

Community consultations were the venue for collection of most of the raw data and information for all themes and issues of phase I of the study. An important objective of this phase of the project was to identify, together with communities and other stakeholders, relevant issues and problems. The community consultations involved the collection of primarily qualitative data from primary sources at sample village/district/ Area Water board level, as well as the collection of data from relevant secondary sources. Information gathered through consultations with stakeholders, open consultations with communities, key informants' interviews and focus group discussions were complemented by related information derived from government population censuses and relevant studies and reports.

The Consultant established the Study Team consisting of four experienced sociologists/ anthropologists (three local and one international). The Team planned to conduct 15 workshops out of which 12 were be conducted on the Area Water Board or/and district level, two for SIDA's social team and field staff and one for other major stakeholders. In addition, during October-December 2010, the Consultant conducted community consultations in 36 sample villages in 14 districts in the Project area.

The consultations process outlined in the set methodology and the set objectives require workshops for main stakeholders, open consultations for men, focus group discussions with women in selected villages and key informant interviews in each selected village. A female group facilitator and a note taker were available at each consultation with women. The Consultant used pre-prepared discussion guidelines for group facilitators.

The main objective of community consultations during phase I was to identify project relevant issues/problems and get communities' views and opinions. In accordance with the objectives of stakeholders' consultations, the data collection and analysis required a primarily qualitative approach. The corresponding sample methodology involves a non-probability sampling as it does not aim to produce a statistically representative sample or draw statistical inference. The targeted phenomenon/issue needs only to appear once in the sample. Nevertheless, relevant quantitative data on the village level were also collected and analyzed in this study.

The major related issues within communities had been pre-identified and grouped. The pre-identified issues were served as the platform for discussions with communities. To identify the most severe issues, the Consultant pursued practical steps and gathered information from numerous sources.

Methodology during Phase II

In addressing the tasks and objectives stated in the Terms of Reference, the Consultant formulated the methodology which would realistically cover the project area and issues relevant to the Project. In order to cover a large geographical area and a number, diversity and complexity of issues, a three-dimensional methodological approach was adopted. The approach focused on: a) location, b) persisting issues and c) current flooding issues.

Primary data were collected in two stages. The first round of consultations was done by the Consultant's social team comprised of three local sociologists/ anthropologists and one international sociologist. The consultations were conducted in October 2010 in ten villages. Five workshops with stakeholders were organized in selected districts and two with SIDA field staff.

The second round of consultations was subcontracted and conducted in November – December 2010. The consultations included seven workshops at district level/area Water Board and consultations with men and women in twenty six sample villages. The consultations were supervised by the Consultant's social team members and SIDA. In total, 12 workshops at Area Water Board/district level were planned.

The primary data collection included workshop consultations with stakeholders, open community consultations with males, focus groups discussions with female adult groups, and key informant interviews in selected villages. Before commencing the consultations at workshops with stakeholders and in villages with the local population, the Consultant conducted one information session. The objective of the sessions was to inform the participants about the scope and objectives of the Project, the objectives of the community consultations, and to discuss issues and concerns relevant to the Project objectives. A Power Point presentation or A1 flip charts used at workshops. A verbal introduction to the Project and the purpose of consultations were used in the sample villages. The team encouraged the participants not only to list the problems and issues relevant to the Project but to express their perception and to give their suggestions and recommendations about the implementation of the Project.

1.5.2.4 Participatory and consultative workshops with stakeholders

The preparation of the Master Plan followed the consultative process at all stages of the study, namely, identification of the issues and options and preparation of pre feasibilities, and detail designing. The consultations with communities and other main stakeholders were organized at multiple levels.

Phase I: During the phase I of the study, in order to cover a geographically large Project area, the Consultant organized and conducted 12 stakeholders' workshops at the district/Area Water Board level. The stakeholders were invited from a variety of organizations and groups such as farming communities, fishermen, villagers, urban populations, non-government organizations (NGOs), water user groups, groups interested in environmental and social issues, women's groups, civil society organizations, universities, local media and others. All interested parties were given an opportunity to express their concerns and opinions and to access information relevant to the Project. Each workshop lasted for a minimum of three hours.

To achieve transparency, continuity in stakeholders' participation and encourage ownership of the Project, the Consultant shared the workshop records, notes, and photographs with participants and asked them to review the records, fill in the gaps in information recorded and give additional comments and opinions. The received individual feedbacks were incorporated into workshop records and the final analysis of the stakeholders/community consultations.

Preliminary findings from the first round of community consultations were shared with the numerous stakeholders at the workshop which were organized by the Consultant at the end of the first round of consultations. The workshops' outcomes were analyzed and used for fine tuning the stakeholders/community participation strategy, refining of the methodology and tools used at the consultations and focusing on under-represented community issues and problems in the Consultant's approach.

Phase II: During the Phase II of the study, 12 workshops were organized at the district level, 3 at the Area Water Board (AWB) level, and one regional/national level, The Consultants supported by fifteen local partner NGOs and a consortium of six organizations/NGOs, strived hard to bring relevant stakeholders into the workshops, attended by about a little over one thousand participants, of which 121 were women. The main purpose of the workshop was to present solutions proposed during the consultations with communities and stakeholders in the Phase-I, and to solicit additional suggestions and solutions if any; and their endorsement of the proposed solutions, mainly to resolve issues related to drainage, flooding, environment, natural resources, socio-economic and institutional issues, and to prioritization the proposed interventions.

To ensure full and equal involvement of men and women of all ages, backgrounds and social status, a wide range of stakeholders were invited to participate in the workshops in project area based on fifteen districts of Sindh, three area water boards including national potential stakeholders. Several interventions were proposed and presented to the stakeholders for the identified problems related to drainage, flooding, environment, and socio-economic issues.

The main objective of this process of community consultations was to identify structural and non-structural environment friendly solutions/interventions, ranking and detailed designing of selected interventions. The solutions to the problems/issues identified during the phase I, have been compiled, discussed, ranked and endorsed by the stakeholders at intensive Phase II consultations.

Overall, the phase II consultations were comprised of the workshops organized at three levels i.e.: i) twelve district level workshops; ii) three Area Water Board level workshops; and iii) one national/regional level workshop. The workshops at the district level were organized in the following districts: Ghotki, Sukkur and Khaipur, Noushero Feroze, Shaheed Benazirabad, Mirpurkhas and Tando Allahyar, Sanghar, Hyderabad and Matiary, Badin, Thatta, Tando Muhammad Khan, Tharparkar and Umerkot. In addition, one workshop was organized for each of the three Area Water Boards (Ghotki Feeder Canal AWB, Nara Canal AWB and Left Bank Canal AWB). The final wrap up workshop was conducted in Karachi with participation of regional and national stakeholders.

The participants included representations from the farming communities, fishermen, villagers, urban populations, and line agencies, such as departments of agriculture, livestock, fisheries, forestry, farmer organizations (FOs), Abadgar Board, (AWBs), SIDA, civil society. Women were especially encouraged to participate. These workshops were organized in coordination with fifteen local partner NGOs and Consortium teams. Based on these consultations and stakeholders' suggestions, the Consultants have formulated several interventions to mitigate the issues and problems mainly pertaining to drainage, flooding, environment, natural resources, socio-economic and institutional issues in the left bank of Indus, delta and coastal area. The stakeholders were given the opportunity to discuss, endorse or reject those interventions with adding alternative solutions according to their opinions.

In these workshops, the stakeholders were facilitated to express their aspirations and apprehensions vis-à-vis the possible solutions and interventions proposed by the Consultants. Based on the stakeholder consensus and agreement, 16 interventions were selected for preparing the pre-feasibilities. The conceptual outline of the selected pre-feasibilities was presented in a regional/national workshop, held on 14 January 2012 in Karachi, for the final selection and approval of the stakeholders.

The participatory consultative approach was used throughout all consultations. During the phase II of the study, the stakeholders were given detailed presentations on issues and problems identified during the first phase of the project. The Consultants have identified several interventions as solutions of the issues and problems and were presented in the phase II workshops.

The total number of participants in the workshops held during the two phases was 9,077, of which female participants were 2,455 (about 27 percent). Out of these women 229 were women active in the professional fields. In the district level workshops held during the second phase of the study, 1,442 stakeholders were invited. Of them 1,014 (70 percent) participated in the workshop. Of those who attended, twelve percent were women (121).

Based on the participatory approach, during and after the 2011 storm water floods, the social team visited each district in the project area, assessed the situation and consulted with the flood affected communities. The team visited 89 villages in fifteen project area districts and consulted with 1,740 persons in order to assess the losses/damages of villages, crops destruction, people and livestock affected, chicken and fish farms destroyed, diseases spread, government/private assistance provided, source of income available etc. In each district, the team has a partner NGO that gave us the first hand information about the situation on the ground, suggested villages, and communities to be visited and accompanied our team on each visit.

Information sharing through print and electronic media

In order to disseminate the preparation of master plan process, project fliers in local languages were distributed prior to the community consultations. About 10,000 project pamphlets each in Sindhi and English languages were distributed, along with 81 news cuttings published in the local media in English, Urdu and Sindhi languages. In addition to this, six TV programs about the preparation of the master plan and related issues were organized local TV channels. In order to reach a wider community, a questionnaire to identify problems and solutions was published in the Sindhi and English newspapers. The feedback received from stakeholders indicates stakeholder's satisfaction and keen interest in the participatory process. This also helped the consultants in understanding the perceptions and aspirations of the stakeholders.

***Phase III*:** During phase III of the study, consultations were conducted with the stakeholders by the team of consultants and in cooperation with the local Partner NGOs. The consultations were aiming at assessing the social impact assessment of the proposed dhoras revival, potential resettlement need, environmental assessment study and economic assessment study with the stakeholders living in settlements in the location of natural Dhoras. The objective of the study was to assess the socio-economic conditions of the people, beneficiaries, who would be affected by the development process and proposed revival of natural Dhoras, to assess the level of community involvement and kind of support of the beneficiaries and to assess the benefits and negative

impacts of the proposed interventions. In order to foster participatory dimension of the process and developing the local ownership, the assessment studies in phase III were conducted in collaboration with local NGOs working as partner organizations. These partner NGOs worked at district level with the Consultant's social since the project phase I.

The team was comprised of sociologists and anthropologists (two local and one international) in order to conduct social impact assessment study along with the focal person of the partner NGO in each affected district. As per plan, the team conducted separate open consultations with male and female groups; interview with head of households, (male and female member) and collected village profile data from the key informants in each sampled village having agriculture land in the area of natural Dhoro.

The team conducted consultative sessions in the location of six natural dhoros and proposed drain D4 covering 543 households from 91 sampled villages of 32 talukas and seven districts. In the whole process of consultation, 2815 people were consulted with the ratio of 1,482 females and 1,333 males. For primary data, through the consultative process, qualitative and quantitative data were collected by designing guidelines and data collection tools. During the field work, the primary data collected were included the open community consultations with males and females and key informant interviews in sampled villages.

In order to foster and enforce the ownership of the project, informal sessions were also conducted with local people especially with community leaders, influential, political personnel, and landlords and with partner organizations. In the sessions, people were informed about the scope of the work, intervention proposed, government's initiative and importance of the community consultations. The main objective of the sessions was to assess the people's willingness, issues and concerns, commitment, endorsement and ownership with the proposed intervention. During the consultative sessions, people were encouraged for discussion on any issue, concern, suggestion, and recommendation for the development process.

Knowledge sharing, the level of the community involvement and different kinds of support with full or partial cooperation from community, were also brought under consideration. Indigenous knowledge sharing process was supported and emphasized by the local people.

The consultants working on the environmental issues of the project conducted field visits and consultations in 40 villages located in the critical areas and met with the stakeholders and discuss the environmental issues, impacts of interventions/ proposed projects on the overall environment with respect to flora, fauna, archeological sites and other aspects.

1.5.3 Collection and review of primary and secondary data

1.5.3.1 Methodology for Planning Studies

Each major study conducted in the preparation of the Regional Master Plan under the Consultancy was executed according to the objectives of the particular subject. Generally, all studies and approaches followed the main criteria outlined as follows:

1. Identifying existing legal, budgetary and other official documents
2. Identifying existing relevant studies/reports/maps
3. Identifying different parameters/indicators, ideas and applications used in the studies/ reports
4. Identifying the main methods and techniques used in the analysis and design of the reports
5. Understanding and rationalizing the significance of the problems, solutions and structures
6. Synthesizing and developing own professional judgement.
7. Developing appropriate approach, methodology and tools

1.5.3.2 Secondary Data Collection, Revision and Critical Analysis

In accordance with the outlined planning criteria, the Consultant collected, reviewed and analysed extensive secondary data, publications consulted are listed in the bibliography of the different phases of the Study. Each study/task required review of selected literature, relevant reports and

existing studies as well as contacts with relevant agencies and organizations involved in the specific area.

The first step was identification of stakeholders for each area of interest and introductory meetings with them during the process of data collection. These included beneficiaries, affected communities, NGOs working in respective areas, and local influential people. Government line department officers were contacted at the Meteorological Department, Forestry Department, Coastal Development Authority, Agricultural Department, Cane/Production Managers of Sugar Mills, civil society representatives, AWBs, CBOs, FOs, WUAs, Abadgar Water Board, Environmental agencies, representatives and technocrats including personnel from PCMU, SIDA, IPD, WAPDA and Water Experts, just to name a few.

Information about relevant organizations and NGOs were assessed through the local networks and the internet. Follow up for information was accomplished by visits and telephone and email contacts. Personnel, equipment and transport capacities and legal and financial standing of NGOs were secured for use during implementation to facilitate short listing. The Consultant established a database of relevant NGOs working in the Project area.

The next step was collection of data (reports, literature, maps, data on rainfall, water table depth, relevant revenue, provincial budget, barrages, siphons, side weirs, cross-regulators, head regulators, drains, canals, irrigation, geotechnical data, soil parameters data, environmental data, environmental impact assessments, available statistics on population and economic indicators etc). Library resources of SIDA, local universities, private consulting firms and individuals were accessed. Information gained was complemented by the Web search on various subjects such as environmental and wetland problems of the project area, pollution of surface and underground water, socioeconomic and poverty characteristics of the project area, flood etc. Each Consultants sub-team gained considerable information and perspective through revision of these documents and reports.

Revision of literature and other relevant data were assessed and used for the planning by each Consultant's sub-team. It formed a solid base for familiarization with and understanding of the project area and relevant components of the Regional Master Plan. In addition, it served as the base for a variety of specific assessments, critical analysis and evaluations of existing situation, identifications of strengths and gaps of relevant past and ongoing projects and other relevant structural and non-structural interventions in the project area. Furthermore, the secondary sources were of the utmost importance for identification of the core issues as well as for setting the appropriate communication strategy and methodological tools for interaction with communities and stakeholders.

1.5.3.3 Internet Web Sites

Web search was conducted basically on all subjects of the planning. Substantial consultations were on environmental and biodiversity problems of the project area with special reference to pollution of surface and underground waters. Literature on Water disasters and measures taken to mitigate the effects of flood and drainage challenges was reviewed. The consultants reviewed reports of the national and international renowned organizations working on the issues of the communities locally and globally. Copies were collected of up-dated progress reports, completed and on-going development projects, issues and problems to manage them, lessons learnt, activities undertaken to develop and monitor the resources.

1.5.4 Investigation Surveys and Studies

During the phase-III of the Regional Master Plan Study a number of diagnostic and design related surveys and investigation studies were undertaken as an input to the preparation of the feasibility studies and assessment of the likely impact of the interventions that are likely to be included in the Regional Master Plan. A brief scope of the studies/surveys is presented below.

1.5.4.1 Physical Condition Survey

A survey of drainage system and outfall structures was undertaken to observe and document the number of size of breach sections, weak and vulnerable points, condition of embankments and inlets etc. and areas that were ponded and its length of stagnation.

1.5.4.2 Current Metering for Discharge Measurement

The discharge levels in the main drains and outfall drains were periodically monitored to estimate the actual flow, and to monitor the drain out rate immediately after the rainy season was over. The consultants procured a boat for the purpose and staff guages were fixed at appropriate points to record the levels and estimate drainage flows.

1.5.4.3 Farm Household Damage Assessment Survey

A survey of farm household was conducted to estimate the damages from rain to crops, livestock, stored grains, agricultural machinery and equipment, irrigation turnouts and ditches, and injuries or loss of human life.

1.5.4.4 Water Quality Monitoring in the Drains and Sugar Mills outlets

Water quality was monitored to estimate the pollution in the drains and coastal wetlands mainly caused by the sugar mills effluent. Both physical and chemical parameters were assessed. The quality of disposed-off from sugar mills was also mentioned to determine the extent of pollution. In addition about 100 water bodies use for drinking in the project area were sampled to determining the water quality.

1.5.4.5 Resettlement Surveys

A resettlement survey was conducted along the dhoras covering all the likely affected people (census) to document the value of land to be acquired, standing crops, household effects, and livelihood means.

1.5.4.6 Topographic surveying

The topographic surveying of selected representative sites of the dhoras and the full length of the LBOD are being conducted for establishing and constructing the bench marks, and to record the cross sections and long section measurements, earthwork requirements, profile plane, and to prepare the detailed topographic maps and overall natural features to locate the main structures.

1.5.4.7 Geotechnical Investigations

Site and laboratory investigations are planned in the Left bank of Indus River at selected representative sites where main structures are proposed along the dhoras and also the LBOD, including the tidal check structure, where the soils are predominantly silty clay; clayey silt and silty fine sand. The explorations are to determine the ground geotechnical properties to depths up to 100 feet below the ground surface.

The site investigations are required to collect suitable samples for laboratory testing and for undertaking field tests, geotechnical investigations, and analysis. All sampling, testing and reporting are in strict accordance with ASTM/BS protocols.

1.5.4.8 Tubewell Surveys

A survey of SCARP tube wells are being planned to i) prepare an inventory of fresh ground water tubewells that will be divested; and ii) to prepare an inventory of functional and nonfunctional saline groundwater tubewells that need to be rehabilitated, repaired, and replaced.

1.5.4.9 Environment Assessment Studies

Following environmental assessment related studies were undertaken: i) baseline survey of fauna and the impacts on environment; ii) baseline survey of flora and impact on the environment; iii)

baseline survey of archaeological sites in the study area and impacts of project interventions on these sites

1.6 Constraints and limitations of the study

The title of the Contact Agreement signed by SIDA and the Consultants is: *"Preparation of Regional Plan to Deal with Floods & Drainage Issues on Left Bank of Indus River and Designing Measures for Improvement of the Indus Delta and the Coastal Zone"*, where it refers the study as a regional plan. The World Bank Project Appraisal Document (2007) defines the study as: "*Preparation of Master Plan for Left Bank of Indus, Delta, and Coastal Zone*," but describes it as: "regional master plan."

There are a number of definitions of what a master plan and a regional plan are, mainly according to the objective of the plan itself. A search on the Internet has rendered the following definitions of a Master Plan:

i. A plan giving comprehensive guidance or instruction.
ii. A plan giving overall guidance
iii. A comprehensive long-term strategy
iv. And a more elaborated: "The master plan is the orderly planning of a system's future improvement program; it's the initial step before specific designs of parts of the system." Nassar, I.S. The importance of Master Planning SAWEA 2007.

The same exercise on Internet about the definition of a Regional Plan was conducted. According to the Webster's on-line dictionary: *"Regional planning is the science of efficient placement of infrastructure and zoning for the sustainable growth of a region"*

The contractual tasks of the TORs were grouped into four phases, the total being close to 150 tasks. The tasks range is very broad, from health, education and cash transfers to contract documents for the implementation of the designs, with a vast variety of topics in-between. Some of the tasks could be independent projects by themselves. Others lack clarity and/or cohesion. In some cases there is duplicity of phase wise tasks and at times they are contradictory.

The title of the Contact Agreement directs the study *to Deal with Floods & Drainage Issues*. However, the Terms of Reference tasks constantly mix irrigation topics with drainage and flooding issues, which even though are related, they are conceptually different. During the meetings with the Sindh Irrigation and Drainage Authority the two concepts were often mixed and obviously irrigation issues were often referred to by the stakeholders in the consultative exercises, along a number of subjects not related to the study.

The extraordinary climatological phenomena observed in 2011, comparable only to a tsunami and/or earthquake of significant magnitude, changed the whole scenario and actors of the drainage and flooding issues, affecting significantly the work approach. The 2011 flooding unveiled the lack of outlet (outfall) for the rain waters to be evacuated. The natural water ways created by nature in millions of years had been in some cases partially and entirely blocked in others by agricultural fields, roads, and housing and also by the LBOD. The dhoras became an essential component of the Plan.

The Agreement calls to Select appropriate areas for detailed studies representing various agro-climatic, topographic, irrigation and drainage, and socio-economic conditions in the project area so that they can serve as a representative of sub-project area for the engineering designs, water use and water balance, cost and benefit estimates, and assessment of environmental and social conditions. The TORs also instructs to prepare terms of reference for the consulting services for designing the remaining project works during the project implementation period. The Plan puts emphasis on the activation of the dhoras and in the rehabilitation of LBOD including the green protection proposed to control the Tidal Link.

1.6.1 Critical Risks

The World Bank Project Appraisal Document (2007) appraised the overall risk as "Substantial". Here below is duplicated what the Bank says:

> *"SIDA, AWBs and FOs may not function in a coordinated manner to make the system responsive to the farmers' needs and Irrigation and Power Department which is still the technical arm of SIDA for operations of the canal system may be threatened by the reforms and retard the process."*

The Bank also proposes some risk mitigation measures, which would need to be revised before the implementation of the Plan.

1.7 Report Outline

The first two chapters present and introduction to the report and description of the study area. The chapter 1 introduces the report, scope and objectives of the study, approach and methodology adopted, and limitations of the study. Chapter 2 describes the project area, including physical features and social and institutional setup, livelihood opportunities, incidence of poverty and social protection approaches, and role of gender in the development and planning of the drainage infrastructure ,

The next six chapters describe the present situation vis-à-vis the resource base and its use, performance of the irrigation and drainage subsectors, environmental issues, and present practices of disaster management. More specifically, Chapter 3 outlines the resources base, including land use, water resources, agricultural, livestock, and fisheries subsectors, and wetlands. Chapter 4 presents an overview of present state of irrigation and drainage, and flood protection infrastructure and its performance, and potential for water harvesting. Chapter 5 highlights the environmental issues, including impact of reduction in downstream Kotri flows, and impact of seawater intrusion, degradation of water bodies, and water quality in the drains and sugar mills, and impact of climate change. Chapter 6 describes the disaster management approaches and the need for better protocols to cope with the water hazards. Chapter 7 reviews the present institutional arrangements for safe disposal of drainage effluent, storm and flood waters.

The following chapters outline the stakeholder's perceptions of issues, problems, and possible solutions, perspective plan, its strategy, and feasibilities of the proposed interventions. Chapter 8 presents the strategy adopted for the formulation of regional plan, stakeholder consultation process in the identification of issues, problems, and suggestions for interventions, and basis of screening and prioritization of interventions. Chapter 9 outlines the perspective plan, specific interventions, their output and impacts, plan period, financial outlay, implement arrangements, and policy and regulatory pre-requisites. Chapter 10 describes the water balance and estimates of drainage surpluses, water use efficiency, and characteristics of drainage flow routings. Chapter 11 presents the technical aspects of feasibilities/intervention, their objectives, outputs, impact, and safeguards. Chapter 12 outlines the yardsticks for O&M of the drainage infrastructures, institutional arrangements, and pricing policy.

Chapter 13 presents the summary and recommendations of the regional plan, and recommendations for sequencing of interventions, policy issues to be considered, compliance of environmental protection laws and regulations, and pricing policy.

2 Project Area

2.1 Location and Area

The Indus River bisects the Sindh province into left and right bank. The right bank consists of irrigated plain and dry land along the foothills of the Khirthar mountain of Sulaiman range. The left bank consists of irrigated plains, and flanked in the eastern belt by arid Nara and Thar Desert, delta, Halar range (Karonjhar), and the coastal zone.

The project study area includes all areas in Sindh Province lying on the Left Bank of Indus River, including the river delta, associated wet lands, and adjacent coastal zone. In particular, it covers the irrigation areas served by the Indus River canals off-taking from the left bank of Guddu, Sukkur and Kotri barrages; the area covered by the Left Bank Outfall Drain (LBOD), and its catchment and backwash areas. The districts covered are Ghotki, Sukkur, Khairpur, Naushahro Feroz, Shaeed Benazeerabad, Sanghar, Mirpurkhas, Umerkot, Matyari, Hyderabad, Tando Muhammad Khan, Tando Allah yar, Tharparkar, Badin and left bank of Thatta.

The study area is bordered by India towards eastern side, the Punjab province in the north, Indus River in the west, and a coastline along the Arabian Sea in the south. The Study area is also linked to upcountry with inter district and interprovincial road network, and a railroad.

The left bank of Indus, for the purpose of this report is delineated into three sub-regions. These include i) Guddu sub-region in the north irrigated by Guddu barrage; ii) Sukkur sub-region (middle) mainly irrigated by Sukkur barrage, and iii) the Kotri sub-region irrigated by Kotri barrage, including delta and coastal areas, which is generally outside the canal command. The Ghotki sub-region includes districts of Ghotki and Sukkur. The Sukkur sub-region include districts of Khairpur, Naushero Feroze, Shaheed Benazirabad (formerly known as Nawabshah), Sanghar, Matiari, Tando Allahyar, Hyderabad, Mirpurkhas, Umerkot, and parts of Tharparkar and Tando Mohammed Khan districts. The Kotri sub-region comprises parts of Tando Muhammad Khan and Badin district, and eastern part of the Thatta district. The Delta and coastal sub-region include southern parts of the above two districts. The delineation of the project areas for the study is shown in Figure 2.1.

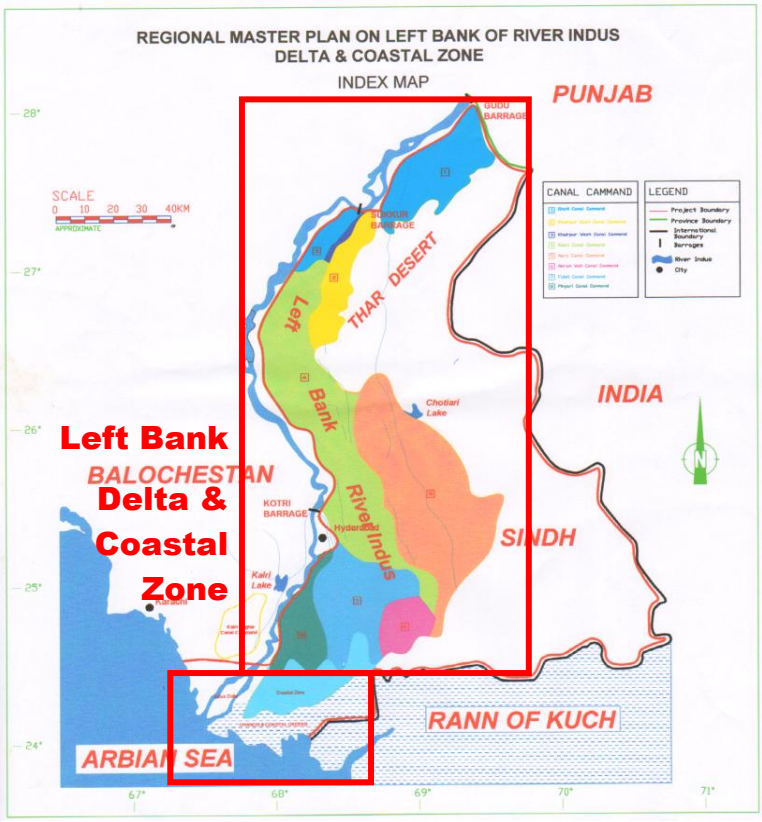


Figure 2.1: Map Showing the Study Area: Left Bank of Indus, River Delta and Coastal Zone

2.2 Topography and Physiography

2.2.1 Topography of the Study Area

The general slope of study area is flat and is considered as level to nearly level with an average gradient 0.75 ft per mile. The contours are almost at right angles to the river from Guddu Barrage to Nawabshah, and this has been the zone of the most persistent movement of the river course in the past. In Guddu barrage left command there are number of drainage lines, especially in the desert fringe, running south-west wards, towards the head reaches of Nara Canal. South of Nawabshah the valley broadens and general slope is to the south-east, towards Nara and eastern flanking trough of the valley. Likewise the old river courses fan out in this direction with several drainage lines between them, the most important drainage line is the Dhoro Puran, which runs south-east of from Mirpur Khas to the old Nara bed (Dhoro Nara), and eventually into Rann of Kutch. However, the Nara itself does not run along the lowest line for its entire length, as the ground level continues to fall eastwards, towards the Thar Desert, resulting in several lakes between the sand hills. On the left bank the old bed of Nara was utilized as a canal as early as 1859 and was connected to Sukkur barrage in 1932. Further south the alignment of the Fuleli canal runs on the ridge caused by the change of slope of the ground from south east to south.

2.2.2 Physiography of the Study Area

The study area is divided into three ecosystems viz. agricultural tract irrigated by three barrages Guddu, Sukkur and Kotri, desert ecosystem parallel to agricultural tract and coastal/ deltaic ecosystem. The great Thar desert form an equally well defined shape, the sand hills in the south are strongly aligned along a north east to south west axis and reach an elevation of about 200 feet. The greatest aggradations occur near the river, which consequently flows along a slight ridge of its own making. In Past River has flowed across most parts of the region and the meander plain represent the strips of slightly elevated alluvium with comparatively rough surface topographically features lying along these early courses. Between these lie the cover flood plains, shallow basins of very smooth topography, where floods used to accumulate.

The cover flood plain extends in the lower reaches of the study area towards the lateral margins of the valley and delta. The delta flood plain is distinguished principally by its extensive cover flood plain and narrow meander flood plain, the former deltaic distributaries. The Nara canal is aligned along the bed of an old river that formerly had no direct connection to Indus system. South of Sukkur it cuts off a portion of Thar Desert, and then flows along the eastern margin of the region into the Rann of Kutch.

Within the boundary limits of study area, the Indus enters from the north at an elevation of 240 feet (amsl) above mean sea level, and the level of flood plain falls south wards at an average rate of seven inches (Inches “) per mile. The overall slope is somewhat less than as compared to the northern region (Punjab). The modern course of Indus River is at a comparatively recent delta. It began to flow through the gap in the Rohri hills at Sukkur only about fifteen hundred years ago and adopted its present course west of the Ganjo Takkar out crop at Hyderabad as late as 1758 AD. Elsewhere the slight projections in the contours indicate the various courses; the river has followed across the region.

2.3 Climate

2.3.1 Climatic regions of Sindh

Sindh is divided into three climatic regions: Siro (the upper region, centered on Jacobabad), Wicholo (the middle region, centered on Hyderabad), and Lar (the lower region, centered on Karachi). The thermal equator passes through upper Sindh, where the air is generally very dry. Central Sindh's temperatures are generally lower than those of upper Sindh but higher than those of lower Sindh. Dry hot days and cool nights are typical during the summer. Central Sindh's maximum temperature typically reaches 43–44 °C (109–111°F). Lower Sindh has a damper and humid maritime climate affected by the southwestern winds in summer and northeastern winds in winter, with lower rainfall than Central Sindh. Lower Sindh's maximum temperature reaches about

35–38 °C (95–100 F). In the Khirthar range at 1,800 m (5,900 ft) and higher at Gorakh Hill and other peaks in Dadu District temperatures near freezing have been recorded and brief snowfall is received in the winters.

2.3.2 Delta and Coastal Zone in Sindh

The Sindh coastal region is located in the south-eastern part of the country between the Indian border along the Sir Creek on the east, and the Hub River along the Balochistan coast on the west. The Sindh coast can be subdivided into the Indus Delta/creek system and the Karachi coast. The Indus Delta (2,560 sq. km) is the most prominent ecological feature of the coast and covers 85 percent of the coastal belt. The coastal morphology is characterized by a network of tidal creeks and several small islands with scattered mangrove vegetation.

Situated between the Indus Delta on the southeast and Hub River on the west, the Karachi coastal belt is about 100 km in length. Most of which, with the exception of scattered patches of mangroves, is devoid of any kind of vegetation and consists of shallow lagoons, sea cliffs, stacks and terraces, wave cut platforms, sea caves and notches.

The coastal waters have high salinity (Hein Van Gils, 2006) due to high evaporation rates, combined with negligible rainfall. Oxygen-poor water layers sometimes rise to the surface along the coast, leading to fish mortality. The wildlife along the Pakistani coast consists of both marine and terrestrial species.

Cyclones on the Sindh coast are not common but do occur periodically causing considerable damage to coastal villages. After 1947 (post partition), major cyclones occurred in June 1948, November 1993, and in May 1999.

2.4 Soils of Study Area

The soils of the Left Bank area are mainly formed by alluvial sediments deposited by Indus river. Only the old dissected desert on eastern border of Left bank contains an admixture of aeolian sand transported from Rann of Kutch, later on dissected by river Indus. The extreme lower Southern part of Badin area is a mixture of river alluvial and sea deposits.

Soil Textural classification

Soil survey in past has been conducted by different Govt/ Semi Govt agencies. The latest survey conducted by soil and Reclamation Directorate SCARP Monitoring organization WAPDA during 2005 by following the criteria used for appraisal was the same as given in Soil Survey Manual Agriculture Hand Book 18. The Textural groups and their corresponding five soil series recognized and mapped by WAPDA and updated by consultants selecting the sample representative sites within the study area are listed as under Table 2.1.

Table 2.1: Soil Textural Groups

S.No	Textural Group	Soil Series	Textural Classes	Characteristic
1.	Coarse	Jhang	Sand and Loamy sand	Soils are excessively drained and have very low nutrient and Water holding capacity.
2.	Moderately Coarse	Farida	Sandy loam and Fine sandy loam	Fairly retentive of moisture for plant nutrients. Potentially productive and capable of producing normal yields of crops under good management. Not advised for raising high delta crops.
3.	Medium	Buchiana	Loam, Silt loam and Silt	Soils are moderately permeable and well retentive of moisture for plant nutrients, these have a high productivity potential and can grow wide variety of crops.
4.	Moderately	Chuharkana	Sandy clay	Soils are moderately permeable and retain

	Fine		loam, Clay loam and Silty clay loam	good quantity of moisture for plant nutrients. These are suited to grow high delta crops.
5.	Fine	Nokhar	Sandy clay, Silty clay and Clay	These soils have low permeability and develop cracks on alternative drying and wetting and pose difficulty in workability. These are mostly used for high delta crops.

The investigations carried out throughout the Left Bank of Indus depend upon approximately one to two sites per square miles. These locations or sites were augured up to 180cm depth for textural classification. For mapping purpose, the data of previous survey by LIP & MP&RD WAPDA has been utilized and updated by consultants, selecting the representative sites for verification and maps showing soil textural groups have been prepared by using GIS technology.

Overall and command wise acreage and their percentages of five (5) textural groups are given in Table 2.2

Table 2.2: Command wise & total area of Left Bank under different Textural Groups

S. No	Main Canal	Area in Acres	Percent of each Textural Group					Miscellaneous	Total	Remarks
			Coarse Texture	Moderately coarse texture	Medium Texture	Moderately Fine texture	Fine			
1.	Ghotki Feeder	304286	8.0	11.0	26.0	46.0	-	9.0	100	The miscellaneous Land type mostly covers the urban areas, grave yards, canal, drains and other Linear features.
2.	Nara Canal	1286746	3.0	20.0	43.0	29.0	-	5.0	100	
3.	Rohri Canal	998588	5	11.0	46.0	32.5	-	5.5	100	
4.	Khairpur Feeder East	506000	18	11.0	49.0	18.0	-	4.0	100	
5.	Khairpur Feeder West	300000	1.0	44.0	25.0	18.0	5.0	7.0	100	
6.	Pinyari	548672	3.0	23.0	31.0	29.0	-	14.0	100	
7.	Fuleli	74726	1.0	14.0	38.0	42.0	-	5	100	
8.	Lined (Akram Wah)	339108	0.5	11.5	36.0	39	-	13	100	
	Total Left Bank Command area	9708725	5.0	18.0	37.0	32.0	-	8	100	

It is obvious from the table that as a whole the dominant textures within the study area are medium (37.0% Buchiana Series) and moderately fine textured (32.0% chuarkana) soils, where as minor part of area is covered by moderately coarse (18% Farida) and coarse textured (5.0% Jhang) soils.

2.5 Water logging and Salinity

Command wise surface salinity status was observed during the S&R studies conducted by WAPDA Water wing (SMO) South in 2005. These are the latest studies conducted by this organization, later on such type of studies have not been conducted by any organization. Hence data is collected, processed and presented by consultants after rechecking and updating the study area on reconnaissance level for each canal command and on over all basis the statistical status of Left Bank area is presented in table 2.3

Total four categories namely Non-saline, slightly saline, moderately saline and strongly saline have been recognized and mapped. The categories criteria for classification are according to the soil survey manual Agricultural Hand Book 18. These classes are briefly described as under.

Table 2.3: Left Bank Command Wise Salinity Status of the Area

S. No	Main Canal	Area in Acres	Salinity Class- ECe dS/m at 25° C (% of area)				Miscellaneous area	Total
			Non Saline 0-4	Slightly saline 4-8	Moderately saline 8-15	Strongly Saline more than 15		
1.	Ghotki Feeder	984795	73	6.0	3.0	9.0	9.0	100
2.	Nara Canal	2431394	29	23	10	33	5.0	100
3.	Rohri Canal	998588	57	22	6.0	9.5	5.5	100
4.	Khairpur Feeder West	300000	72	13	4.0	4.0	7.0	100
5.	Khairpur Feeder East	506000	61	17	7.0	6.0	9.0	100
6.	Pinyari	981207	22	19	5.0	40	14	100
7.	Fuleli	1045651	44	21	10	20	5.0	100
8.	Lined Channel Akram Wah	531965	27	23	15	22	13	100
9.	Total area of Left Bank Command	9708725	48	18	7.5	18	8.5	100

Non Saline

There are no visible salts on the soil surface and plant growth is not affected by salinity, this type of area covers about 48 percent of the total area in Left Bank.

Slightly Saline

Plant growth is uneven patchy, salts are mostly present in patches and cover about 18 percent of the total area.

Moderately Saline

Salts are fairly visible on the soil surface and growth of plants is affected and covers 7.5 percent of the total area.

Strongly Saline

There is no cultivation except some salt loving natural vegetation. Mostly this area is lying abandoned and covers about 18 percent of the total area.

Miscellaneous Land type

This is most important unit and includes built up area like cities, town, road, railway, canal drains and Industrial areas. It covers about 8.5 percent of the area.

2.6 Demography, Literacy and other Indicators of study Area

2.6.1 Project Area

The project area is located on the left bank of Indus comprising of 15 districts namely, Ghotki, Sukkur, Khairpur, Naushahro Feroze, Nawabshah (Shaheed Benazirabad), Hyderabad, Matiari, Sanghar, Mirpurkhas, Umerkot, Thatparkar, Badin, Thatta (left bank), Tando Muhammad Khan and Tando Allahyar. The data for area for Hyderabad includes newly created districts namely Matiari, Tando Muhammad Khan and Tando Allahyar as in 1998 these districts were part of Hyderabad. The total area of the project is 102,984 sq. kms Table 2.4.

Table 2.4: The district-wise area

Name of District	Area (sq. kms)
Ghotki	6,083
Sukkur	5,165
Khairpur	15,910
Naushahro feroze	2,945
Shaheed Benazirabad	4,502
Hyderabad/Matiari/T.A.Yar/ T.M. Khan	5,519
Sanghar	10,608
Mirpurkhas	2,925
Umerkot	5,608
Tharparkar	19,638
Badin	6,726
Thatta including right bank	17,355*
Total	**102,984**

* Thatta district falls on both sides of Indus, Ref: 1998 Population Census

2.6.2 Project Area Population and other social/demographic details

Following parameters of all the project districts have been studied and analyzed:

1. District-wise population for men and women
2. Sex ratio
3. Population density (urban/rural)
4. Average household size
5. Literacy Ratio Sex-wise
6. Population -1981
7. Average Annual Growth Rate (1981-1998)
8. Total Housing Units
9. Pacca Housing Units
10. Housing Units having Electricity
11. Housing Units having Piped water
12. Housing Units using gas for Cooking
13. Administrative Units (Towns, Talukas, Union Councils and number of Villages

Table 2.5: District Wise 1998 Census Information of Left bank of Indus (Project Area)

Details	Hyderabad	Khairpur	M / khas	Tharparkar	Umerkot	Badin	Ghotki	N / feroze	Sanghar	Sukkur	Thatta	Nawabshah
Area (Sq.km)	5,519	15,910	2,925	19,638	5,608	6,726	6,083	2,945	10,608	5,165	17,355	4,502
Population - 1998 (Person)	2,891,488	1,546,587	905,935	914,291	663,095	1,136,044	970,549	1,087,571	1,421,977	908,373	1,113,194	1,071,533
Male	1511025 (52.26 %)	810448 (52.40 %)	471096 (52.00 %)	499859 (54.67 %)	349754 (52.75 %)	597573 (52.60 %)	511363 (52.69 %)	568574 (52.28 %)	746127 (52.47 %)	483251 (53.19 %)	589341 (52.94 %)	555677 (51.86 %)
Female	1380463 (47.74 %)	736139 (47.59 %)	434839 (48.00 %)	414432 (45.33 %)	313341 (47.25 %)	538471 (47.40 %)	459186 (47.31 %)	518997 (47.72 %)	675850 (47.52 %)	425122 (46.80 %)	523853 (47.06 %)	515856 (48.14 %)
Sex Ratio (males per 100 females)	109.50	110.10	108.30	120.60	111.60	111.00	111.40	109.60	110.40	113.70	112.50	107.70
Population Density (Per Sq. km)	523.9	97.2	309.7	46.6	118.2	168.9	159.6	369.3	134.0	175.9	64.1	238.0
Urban Population	1469101 (50.81 %)	365216 (23.61 %)	300175 (33.13 %)	39827 (4.36 %)	111464 (16.81 %)	186488 (16.42 %)	158501 (16.33 %)	192404 (17.69 %)	331316 (23.29 %)	462105 (50.87 %)	124739 (11.20 %)	282359 (26.35 %)
Rural Population	1422387 (49.19 %)	1181371 (76.38 %)	605760 (66.87 %)	874464 (95.64 %)	551631 (83.19 %)	949556 (83.58 %)	812048 (83.67 %)	895167 (82.31 %)	1090661 (76.70 %)	446268 (49.12 %)	988455 (88.79 %)	789174 (83.19 %)
Average Household Size	6	6.1	6.1	5.6	5.4	5.3	505	5.8	5.8	6.6	5.1	6
Literacy Ratio (10 +)	44.20%	35.50%	36.00%	18.30%	24.80%	24.60%	29.01%	39.10%	31.00%	46.60%	22.10%	34.13%
Male	52.63%	49.70%	45.99%	28.33%	36.32%	35.07%	44.21%	24.27%	42.88%	59.83%	31.58%	47.62%
Female	34.97%	19.70%	25.05%	6.91%	11.94%	12.90%	11.85%	22.60%	17.45%	31.32%	11.40%	19.62%
Population - 1981 (Person)	2,059,026	981,190	287,570	540,985	383,018	776,614	562,105	829,051	893,047	560,566	761,039	813,534
Average Annual Growth Rate (1981 - 98)	2.02%	2.71%	2.37%	3.13%	3.28%	2.26%	3.26%	1.61%	2.77%	2.88%	2.26%	1.63%
Total Housing Units	476,321	255,261	148,470	163,147	122,335	211,354	177,432	187,988	245,479	138,553	220,068	177,522
Pacca Housing Units	259973 (54.58 %)	53751 (21.05 %)	46395 (31.25 %)	11509 (7.05 %)	15945 (13.03 %)	34201 (16.18 %)	53072 (29.91 %)	40017 (21.29 %)	69264 (28.22 %)	53926 (38.92 %)	36841 (16.74 %)	47339 (26.67 %)
Housing Units having Electricity	145838 (56.55 %)	168173 (65.88 %)	82814 (55.78 %)	11011 (6.75 %)	47857 (39.12 %)	74268 (35.14 %)	105301 (59.35 %)	130311 (69.32 %)	127255 (51.84 %)	101853 (73.51 %)	57069 (25.93 %)	134053 (75.51 %)
Housing Units having Piped Water	53399 (20.71 %)	40796 (15.98 %)	45140 (30.40 %)	3757 (2.30 %)	14797 (12.09 %)	27485 (13.00 %)	25589 (14.42 %)	30257 (16.09 %)	51636 (21.00 %)	52190 (37.67 %)	32274 (14.66 %)	41835 (23.57 %)
Housing Units using Gas for Cooking	7476 (2.90 %)	24927 (9.76 %)	1722 (1.16 %)	788 (0.48 %)	734 (0.59 %)	7184 (3.40 %)	8995 (5.07 %)	16682 (8.87 %)	23799 (9.69 %)	41230 (29.76 %)	6000 (2.72 %)	23197 (13.07 %)
Administrative Units												
Talukas	8	8	3	4	4	4	5	4	6	4	9	3
Union Councils	102	89	40	44	29	49	34	51	69	46	55	50
Villages	410	382	369	166	228	505	284	231	412	251	652	310

2.6.3 Project Area Population

According to population census 1998 the total population of the project area located on left bank of Indus is 14,630,637 million. Since 1999 to date no census has been carried out in the project area. Thus in order to estimate the population the average growth rate of the previous census (1981-1998) has been used to estimate the population till 2011. The average annual growth rate of population from 1981 -1998 census is 2.52%. Applying this average growth rate the population in 2011 works out to about 30 million.

2.6.4 Other Parameters of Demography

The average literacy ratio (10+) as per 1998 census is 32.11%. At present this ratio is estimated to 44% at country level. Like- wise other parameters/indicators have literacy also changed over a period of more than 13 years (from 1998 to 2011).

2.7 Social Services

Pakistan is facing low economic development that has badly damaged the rural development process of the country and the conditions in rural Sindh are getting worse. In Sindh, the health, education, drinking water supply and sanitation facilities need a proper re-thinking in order to fulfill the basic necessities of the rural population. The lack of safe drinking water is the main problem facing the rural people. Due to this problem, water-borne diseases have badly affected the health of people. The problems of food security and deficiency of hygienic food has raised the ratio of undernourished and malnourished children. Similarly, in addition to pure drinking water and nutritional problems, the unavailability of formal education system in hard-to-reach areas has produced illiterate generations. In order to solve the problems of basic needs, people spends on acquiring needs whatever they earn. As a result, poverty level has risen in rural areas of Sindh.

According to an article "National Finance Commission Award and social services in Sindh" of DAWN newspaper (www.dawn.com) written by Abdul Samad Channa, "The satisfaction of basic human needs is an essential element for poverty reduction. Overall emphasis for adequate social investment, particularly in human capital development, through education and health is the need of time. Inadequacies in relation to meeting such basic needs as nutrition, health, water and sanitation, education, housing and participation in social and cultural life must be featuring prominently in virtually all action plans of the provincial government for poverty reduction."

(Source: http://archives.dawn.com/archives/51056)

In the same article, he has recommended some major steps to be taken urgently. He has written that, the government of Sindh should, therefore, formulate a roadmap for sustainable prosperity of the poor of the province. The following areas merit priority of the government for more investment.

i. Improvement of nutrition especially for children and youth of rural areas
ii. Extended facilities of healthcare.
iii. Extension of universal and quality education right from primary education with one syllabus for haves & have-nots.
iv. Creation of employment opportunities in the agriculture sector through research and modern technology.
v. Extended technical trainings, especially for urban poor.
vi. More investment for micro-credit both in rural and in urban areas for creating self employment by the poor and unemployed youth.
vii. Development of the energy with special reference to the Thar coal project.
viii. Improvement of the irrigation system

In order to observe the low social indicators of Pakistan, Asian Development Bank has been offering financial support to Pakistan Government for years.

During 2003 – 2007, Asian Development Bank (www.fsindh.gov.pk) had provided financial and technical support to Government of Sindh in implementing "Sindh Devolved Social Services

Program". The goal of the program was to improve education and health services, and access to water and sanitation, thereby, helping to reduce poverty and gender imbalances. The principal objectives of the Program were to: (i) increase primary and middle school enrolment of children; (ii) increase immunization coverage; (iii) increase the proportion of pregnant women who are able to deliver their children in hospitals; (iv) increase the proportion of households with access to safe drinking water; and (v) increase the proportion of households with proper sanitation facilities.

Source: (www.fdsindh.gov.pk/sdssp/SDSSP%20RRP%20final.pdf)

Similarly during 2012, Asian Development Bank continued its support for social services program and provided financial support for implementing "Sindh Devolved Social Services Program" (DSSP). The overall goal of the DSSP is to improve people's education and health, thereby helping to reduce poverty and gender imbalances. The broad purpose is to increase school enrolment, and coverage with health and clear water and sanitation services. These objectives are to be primary achieved by improving governance and financial situation of social services that should result in increased access to basic social services, in particular for women; and improved quality, efficiency, affordability and sustainability of services. The Program has 5 principal policy outcomes, namely: 1) to further administrative devolution of social services, 2) improve social sector financing and flow of funds, 3) promote participation, linkages, and public accountability, 4) rationalize services and set minimum standards, and 5) encourage public-private partnership. The DSSP covers all 16 districts and 102 taluka/town municipal administrations (TMAs) of Sindh for a time slice of 3 years for the program loans and 4 years for the TA loan.

Source: (http://www.adb.org/projects/34337-013/main)

2.7.1 Education Sector

Education plays the important role in development of the human dignity, personality, vision, life stability with persons' strong economy by using knowledge for his/her earnings in applying his/her physical / mental role within the different sectors of life; for example, engaging oneself in public or private sectors so that his livelihood would improve.

The Studies on the earnings of education have shown that income increases by 2.7 percent with every additional year of primary school and by 4 percent with every additional year of secondary school. Currently, adult literacy rate shows that there is a gap between males and females in literacy role and enrolment ratio. Recently literacy rate was 58.6 percent for male and 36.3 for female during the period 2007. The table below shows that there is incomparably lower number of educational facilities available to girls than to boys. The number of Degree schools for girls has fallen or stagnates between years 2004 and 2007, while training institutions for girls do not exist at all.

(Source: Development Statistics of Sindh 2008, Bueru of Statistics GOS)

2.7.2 Education Performance

Due to the poor governance, the education sector is still in the state of crises. The factors responsible include lack of access to education facilities and poverty that prevents families from bearing the cost of education. Moreover, unsatisfactory quality of education arising from absent or poorly trained teachers, shortage of school supplies and inadequate infrastructure (Shelter-less school, 1-2 room schools, school without drinking water and sanitation facilities), lack of accountability of school's management and service users weak monitoring and evaluation of performance.

2.7.3 Education Status of Left Bank Districts

The present Status of Left Bank (Study area) education stage wise i.e. Primary, Middle, Secondary school, Intermediate collages, Degree collages, Post graduate collages and Commercial Institutions are presented in the following table 2.6:

Table 2.6: Educational facilities in Sindh

Number of Education Facilities Available in Sindh Province 2004-05 to 2006-07 Bureau of Statistics 2008 Government of Sindh							
		2004-05		**2005-06**		**2006-07**	
S.#	**Status**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
1	Number of Primary Schools	34,573	6,642	35,902	7,116	37,048	7,452
2	Number of Middle Schools	1,754	785	1,834	814	1,916	816
3	Number of Secondary Schools	1,204	521	1,229	527	1,250	246
4	Number of Intermediate Schools	25	13	22	13	22	13
5	Number of Degree Schools	113	97	127	83	127	83
6	Number of Post Graduate Institutions	6	2	6	2	6	2
7	Number of Training Institutions	14	__	14	__	14	__
	Total	**37,689**	**8,060**	**39,134**	**8,555**	**40,383**	**8,612**

2.7.4 Field Observations

During the extensive field work performed for the Project, a numerous consultations with local communities and studies were conducted. The consultations and the studies revealed local perception of education, access to educational services, quality of education offered and prevalence of cultural values which determine local perceptions and attitude towards education. Some of the most typical statements are given in the following paragraphs:

'We don't have enough food for our children, how can we send them to schools. Therefore, we like them to work with us into field', Budho Uner village, Dhoro Puran, Badin

'Teachers are not sincere with their profession. They remain mostly absent from schools in our area and do their personal activities at school time', Dhano Kolhi village, Bhai Khan Dhoro, Badin

'There is no any basic facilities available like drinking water, electricity, latrines and so on in the schools of our area therefore, there is no benefit of sending children to school' , Kaloiabad village, Dhoro Puran, Tharparkar

'There are so many people in our area who are educated and passing useless life because they are jobless. Therefore, it will be again useless to send more children to schools', Long Khan Gurgez village, Dhoro Naro, Tharparkar

'We are already passing poor life, our children are good source of our income. They don't like to go school', Misri Khaskheli village, Dhoro Puran, Mirpurkhas

2.7.5 Health Sector

Health plays a main role in the lives of human beings; it is a famous proverb that 'health is wealth'. According to the 1948 universal declaration of Human Rights, everyone has the right to a standard of living adequate to health and well-being of himself/ herself and his / her family. As it is correct to say that human development is a basic right of any individual and health is a prerequisite for its development. Poor health can directly influence individual's opportunities, earning capacity, performance at school, ability to care for children, participation in community activities and so on.

In the perspective of above facts it is observed that health indicators of Study area and overall Sindh, lag behind of many low- income countries. According to analysis done in the late 1990s, applicable to this province, priority should be given to the basic preventable and readily treatable diseases. Government of Sindh (GoS) has taken the lead in preparing and announcing a comprehensive Health Policy covering long term targets and addressing all the impediments hampering progress. The Government is committed to continue all efforts including the following actions:

- Implementation of the health policy
- Re- Invigorating the immunization and tuberculosis programmes.
- Improving health sector governance,
- Promoting public -private partnership by inviting NGOs.

2.7.5.1 Health Organization

The health Institutions are administratively governed by Director General Health Services in the province and this institution maintains the records of hospitals and health centers provided by offices of the District Health office. Table 2.7 shows the number of health facilities in each district distributed by the number of Union councils. The data shows that there is on average at least one health facility on the Union Council level. However, the local population has a vast reservation on type and quality of services available in these facilities.

Table 2.7: Government Health Facilities in the Project Area

No	District	Number of Taluka	Number of Union Councils	Number of heath Facilities
1	Hyderabad	4	48	50
2	Matiari	3	31	31
3	Tando Mohammad Khan	3	20	20
4	Tando Allahyar	3	20	20
5	Thatta	8	86	86
6	Badin	5	62	79
7	Mirpurkhas	6	84	88
8	Umerkot	4	53	54
9	Tharparkar	4	76	77
10	Sanghar	6	91	95
11	Sukkur	4	49	51
12	Ghotki	5	47	51
13	Khairpur	8	155	155
14	Naushahro Feroze	5	90	93
15	Benazirabad	4	79	80
Total		**72**	**991**	**1,030**

Field Observations

During the extensive field work performed for the Project, a numerous consultations with local communities and studies were conducted. Some of the most typical statements are given in the following paragraphs:

'We need proper health facilities in our area with full operating facilities and qualified doctors', Bacho Khan Tangri village, Naro Dhoro, Mirpurkhas

'Doctors mostly remain absent from hospital in our area therefore in emergency we face treatment problems and we travel for long distance to city hospital', Haji Sultan Tangri village, Dhoro Naro, Mirpurkhas

'Here we face big problem of timings in hospitals. Doctors used to go away after lunch time and don't come back', Mir Allah Bachayo village, Sohni Dhoro, Mirpurkhas

'Hospitals are not clean and have dirty basic facilities like drinking water and latrines for the patients. Even now buildings are very close to get down and still repairing is not being done', Piru Fiqir Shoro village, Sohni Dhoro, Sanghar

2.7.6 Water and Sanitation

F. H. Mughal Reported that, in Sindh, water and sanitation scenario is pathetic. Almost all cities in Sindh are getting unsafe water. Similar is the case with sanitation which does not exist in many towns of Sindh. Even schools in Sindh have no proper water and sanitation facilities. Ingredients for improving water and sanitation facilities in Sindh include robust institutional framework; policy guidelines; rational strategic approach to the choice of water and wastewater treatment technologies; and sense of ownership.

Source: http://archives.dawn.com/archives/49216

The recent floods of 2010, 2011 and 2012 in Sindh province ruined the system of water and sanitation badly especially in rural areas where the system was already burdened with weaknesses. "Access to a basic water requirement is a fundamental human right implicitly and explicitly supported by international law, declarations, and State practice. Governments, international aid agencies, non-governmental organizations, and local communities should work to provide all humans with a basic water requirement and to guarantee that water as a human right. By acknowledging a human right to water and expressing the willingness to meet this right for those currently deprived of it, the water community would have a useful tool for addressing one of the most fundamental failures of 20th century development."

Source:http://www.huffingtonpost.com/peter-h-gleick/the-human-right-to-water_b_671175.html

2.8 Physical Infrastructure

2.8.1 Roads

Background

Road and railways are the main source of communication in the Study area. During past days long before the partition of Indo-Pak the main source for transport and trade was the Indus which provided the main communication and trade route between the hinterland and parts of the Arabian Sea. With the passage of time and development of Karachi as a port and the buildup of Railway facilities, the Indus river route declined in usefulness and as the Barrages were built, it ceased to be important.

Development & Extent of Roads

After Indo-Pak partition, National Highway was the only source of main transport within the province which served as a trunk road connected with the small metalled / weathered roads of major cities on Left bank like Hyderabad, Nawabshah, Mirpurkhas, Sanghar, Khairpur, Pano Akil and Ghotki etc. Later on with the passage of time the network of roads (Farm to Market Roads) have been developed and linked with the remaining cities, towns and major villages of the study area (Ref Atlas Fig road map of the area). These roads have provided the major facilities for transporting agriculture commodities to the nearest markets as well as to the Agro-Industrial areas like Sugar Mill Industries etc.

Adequacy

Over all the network of roads is still in need of development for connecting further with the remote area villages and towns. Also the condition of the existing roads under present situation is poor and

requires the immediate attention of concerned authorities for minor/ major repairs for keeping light and heavy transport road worthy.

2.8.2 Markets

Role of Markets

Major role for establishment of markets depends upon the availability of raw material as well as the production of agriculture commodities and the approach facilities for transporting those goods to the markets. In addition to that the agriculture lands should be utilized in proper way for production of food and fiber, which can be transported from small markets to big markets and further extra available commodities for export to international markets (Mandies).

The marketing of the Study area mainly depends upon the trade with cities like Karachi, Hyderabad, Sukkur, Nawabshah, Sanghar, Mirpurkhas, Khairpur and other local markets of the interior Small Towns/ Villages of the left Bank of Lower Indus Region (Fig- Ref Atlas) showing the location of Markets (Mandies).

Markets and Markets Committees

Over all at Tehsil (Taluka) Level Government of Sindh has established the Market committees, the function of these committees is to establish and control the rates of agriculture commodities of the area and also facilitate them by providing the Market places or Market Mandies (Infrastructures) where a common man could be able to bring the agriculture produce for sale and also purchase the agriculture inputs like fertilizer insecticides/ Pesticides, Seed for growing cash crops and vegetables. Over all, market committees on Tehsil (Taluka) level are about 62 in the Study area and big cities are having the mega markets where all types of goods are sold and purchased.

Adequacy

It has been observed that Markets are not located in a proper way and at proper places where a poor farmer could be able to bring his agriculture commodities without facing any problem. Infrastructures (*Mandies*) have got no capacious space to keep the raw material safely so that it may not be damaged, for example fruits which are counted as perishable items are not preserved properly. However, it is need of time that on large scale for big towns/cities and at small scales on village basis Markets (Mandies) are required to be developed so that a common man can approach easily and able to bring his agriculture commodities without facing any problem.

2.8.3 Water Diversion

Irrigation Water in Study area is diverted from Indus River through Guddu barrage at Kashmore in the north. Ghotki Feeder Canal off takes from Guddu Barrage, Khairpur feeder East Canal, Khairpur feeder west Canal, Rohri Canal and Nara Canal off takes from Sukkur barrage and Akram Wah, Fuleli and Pinyari Canal off take from Kotri Barrage. Gross Command Area of 8 Canals is 9.75 MA and Cultivable Command Area 8.58 MA.

The annual Water entitlement of Ghotki Feeder Canal is 3.484 MAF Khairpur West is 1.148 MAF Khairpur East 0.369 MAF, Nara Canal 7.803 MAF, Rohri Canal 8.297 MAF, Fuleli Canal 3.280 MAF, Pinyari Canal 2.593 MAF, and Akram Wah 1.786 MAF with total annual entitlement of all 8 Canals is 29.562 MAF.

Adequacy

It has been observed that diversions system on Left Bank area is in need of O&M, so that they can carry the water according to their entitlements. The canals which have been silted up should be rehabilitated and most important factor is the adding of the drainage effluent of Town/Cities into irrigation system, which has not only polluted but also have, deposited its bad waste material into the System. Therefore, for running the system in proper way, the concerned authorities should take immediate action for rehabilitation of canals, branches, distributaries and also to stop the drainage effluent of cities and Industrial area into the irrigation system.

Agricultural Inputs

Common person, either belonging to agriculture sector or business community or any other discipline, are more or less dependent on utilities for their livelihood. Here specially with reference to agriculture / agro-Industrial people who are dependent on the important utilities like seed, fertilizer, insecticides, electricity, tillage equipments are the basic needs for agriculture production as well as for livelihood of people. The important basic utilities required from agriculture point of view are discussed as under.

2.8.4 Tillage Equipments

The first and foremost requirement for cultivating the land is the availability of equipments required for tilth & tillage.

Seed for Growing of Different Crops

After tillage the next requirement is to have a good variety of seed for obtaining best agriculture production of crops.

Fertilizer & Insecticides

Fertility level in soils of study area is very low, therefore, different type of fertilizers are required by crops and soils, which are necessary to apply for obtaining good yields. Moreover, during the crop growth period there is attack of insets & pests, hence proper chemicals with proper doses are required to save the crop from disease.

2.8.5 Electricity and Gas

Among all utilities the most important is the electric supply to the consumers, especially for agriculture sector to run the tube wells for irrigation purpose as well as to lower down the underground water to a certain depth, so that water logging and salinity may not affect the soil and crops of the area. Also for running the agro-industries both electricity and Gas energies are required, because many industries and some power plants are also running on gas. Hence, both are important from life line point of view.

Adequacy

Overall in study area it has been observed that there is deficiency in supplying all the above required utilities to a common man which plays the main role in livelihood of people of the area. This is because of the mismanagement of the concerned organizations responsible for supplying the above most important utilities, especially for running the agriculture sector.

2.9 Sector support organizations

2.9.1.1 Agriculture support services

Both public and private sectors support agriculture, livestock, and fisheries subsectors through a network of research, extension, and teaching institutions. The research institutes provide improved production packages and improved seeds for dissemination through extension service. Private sector companies that market agricultural inputs also provide extension services through their dealers and some print media. Research being a public good, and have long gestation period, private sector is still shy to invest in the research endeavors.

Agricultural Engineering Department is responsible to provide services to farmers for improving watercourses, land leveling, both heavy and precision land leveling, and development of tubewells.

2.9.1.2 Agriculture Research Extension

Both public and private sectors support agriculture, livestock, and fisheries subsectors through a network of research, extension, and teaching institutions. The research institutes provide improved production packages and improved seeds for dissemination through extension service. Private sector companies that market agricultural inputs also provide extension services through their dealers and some print media. Research being a public good, and have long gestation period, private sector is still shy to invest in the research endeavors.

2.9.1.3 Agricultural Marketing

The agriculture markets are reasonably liberalized, safe for wheat, paddy, and sugarcane. These are partially liberalized, as the federal government continues to announce the reference price to set the prices. Farmers are free to sell their produce to any of the preferred buyer. In case of wheat, the provincial food department procures wheat to meet their targets. To meet the procurement target, the food department uses administrative leverage to claim the first charge. Once the target is achieved met the farmers are free to sell their produce to any buyer. Farmers sell their rice and sugarcane to buyer of their choice and at a negotiated price.

The provincial agriculture department, however, regulates the markets through quality control and ensuring fair deal to the growers. The public sector grain, vegetable, and fruit markets are managed by the Market Committees elected by the commission agents, representatives of the growers and ex-officio officers from the department of agriculture. In the later report a description of marketing channels will be detailed for each crop.

2.9.1.4 Agriculture Credit

Agriculture credit is one of the main constraints to finance the short term inputs, along with medium term and long term inputs/investment. Various studies show that despite special allocation by the State Bank of Pakistan through commercial banks, agriculture development bank, microfinance bank, PPAF, rural support programs, and NGOs, the preference is still the informal sector, mainly, commission agents, money lenders, friends, and relatives. It is estimated that still the informal sources that charge exorbitant explicit and implicit interest rate/service charge account for 70 to 80 percent of the credit market.

2.9.2 Institutional Constraints

2.9.2.1 Uncertain Future for Operation, Maintenance and Management of the River Indus, Canals and Drainage Systems

This regional planning program is a continuation of over two decades of effort by the Government of Sindh and International Donors to reform and make self sustainable the delivery of irrigation water. Several serious problems and short comings in institutional arrangements currently are being addressed through financing and sponsorship of IBRD; it is urgent that Provincial Government now take vigorous action through this project. Otherwise known shortcomings and conflicts, if allowed to persist, will worsen and could become un-resolvable. Several problems have occurred because the objective of the Sindh Water Management Ordinance of 2002 is not clearly stated and this ambiguity results in conflicting provisions of the Ordinance. Additionally, a primary impediment to success is the perception that the Ordinance is designed to promote the dissolution of an organization of some 30,000 persons, the IPD, with the folding of its functions into an entirely new organization, SIDA. The new organization is mandated to be built afresh with no roadmap, vision, and clearly stated objectives, and most seriously, the lack of a comprehensive, focused plan for financing. A number of financing provisions are included in the Ordinance, yet potential sources of financing identified therein are totally inadequate for sustainable performance of each assigned responsibility.

A number of the issues that must be dealt with can be traced directly to specific provisions of the Ordinance. In this report problems, issues and some perceptions of potential solutions are laid out following, the below, brief reviews of the IBRD program and the functioning of SIDA, AWBs, FOs, and the IPD.

2.9.2.2 Review of the GOP/IBRD Continuing Program

A number of initiatives of several donors had contributed to on-farm water management improvements and programs over several decades. By the 1980s, it had become apparent to the Government of Pakistan and the World Bank that functioning of the irrigation, drainage and flood management through national and provincial organizations had declined to the point that the viability of irrigated agriculture was threatened. The Government of Pakistan (GOP) decided during 1996 to establish irrigation and drainage authorities in each province and introduce

institutional reform. It was through the National Drainage Program begun in 1997 and the SIDA Act of 1997, that reform was begun in Sindh Province; the process envisioned was for decentralization and management transfer of irrigation and drainage systems and functions to newly created entities, primarily for transfer to the Sindh Irrigation and Drainage Authority (SIDA) and its subsidiary AWBs and FOs. SIDA was envisioned to become an autonomous authority with responsibility for all aspects of the water delivery and drainage systems from barrages to canal head works and farm to main drains. Utility-like AWBs were to be established around canal commands. FOs were to be small self sustaining units controlled by farmers for management of distributaries and minor canals.

With the establishment of SIDA it was intended that new personnel would be recruited or transferred from IPD (SWMO, Article 16 2) and the functions of Sindh IPD would transition from an inefficient, entirely government run operation (bureaucracy) to one that would function more like self-sustaining business entities in series from farm to canal to river.

The Nara Canal AWB was established in name only in 1999 without proportional transfer of budget or system property. Two additional AWBs were named subsequently as the Ghotki Feeder Canal AWB and the Left Bank Canal AWB. Thus, to date, institutional reforms have been initiated in name only for four of 14 canal systems. There has been no transfer of system property from IPD to SIDA. Considering the dismal initial record, over the past five years there has been no will to initiate formation of additional AWBs for extending the area theoretically under the administration of SIDA.

After 10 years of effort it is widely recognized that the Ordinance is overly ambitious in that it posits that an existing organization with thousands of employees should be absorbed by an organization with a permanent staff numbering less than 100 and an inadequate revenue stream in prospect.

2.10 SIDA, Its Authority, Responsibilities and its Future

2.10.1 The Sindh Irrigation and Drainage Authority (SIDA)

The formation, legal status, functions; tasks of SIDA and responsibility to form Water Allocations Committees are detailed in Articles 3 through 27, Chapter 2, of the Ordinance. Three articles, 4, 10, and 11 are quoted in detail in the Box below.

SIDA, from its headquarters at Hyderabad, oversees three AWBs Ghotki, Nara and Left Bank Kotri. Its mandate is to transform the IPD into autonomous bodies, i.e. SIDA itself, the AWBS and the FOs The intention is to involve farmers at all levels, including tail area and small farmers, to achieve fair distribution of water.

In summary, responsibilities of SIDA, as the prime agent of change provided in the SWMO 2002, are mandated to maintain barrages, deliver water to the AWBS, and maintain Main and Outfall drains and bunds along the river. SIDA currently oversees the formation of AWBs and FOs, provides training, and manages donor funds to rehabilitate and upgrade channels and structures under the WSIP.

SIDA has acted for the Regulatory Authority for supervision and for conflict resolution. The Regulatory Authority is intended to be an independent government body that sets policy and arbitrates. Membership of the RA is to be headed by a Chairman, two member Advocates of the High Court and four academics as appointed by the Governor

Under SIDA jurisdiction are the AWBs and FOs. AWBs are responsible to maintain canals, deliver water to FOs, and pay SIDA for services. FOs are responsible to maintain distributaries and minors, deliver water to farmers at the intake to the watercourse, collect revenue, and pay AWBs for services.

FO’s are officially formed and ready for business when an Irrigation & Drainage Management Transfer (IDMT) is signed with SIDA. At September 2010, SIDA reported that 354 of a projected

383 FOs inside the three AWBs had registered with SIDA and of those 314 had signed their IDMT. Only some 215 of the FOs had become organized to collect Abiana.

2.10.2 Threat to SIDA and In-Turn to the Economy of Pakistan

As reported in 2009, by AHT Consultants[2], "SIDA is empowered, legislatively, under the Sindh Water Management Ordinance 2002 to take control of, "the water management system as a whole e.g. irrigation or drainage contribution rates, drought management and sea water intrusion; manage the transition process; promote the formation, growth and development of the AWBs and FOs into self-supporting and financially self- sustaining entities within a period of seven to ten years of their establishment; and perform any other function conferred on it.

"The SIDA has, so far, been mainly an implementing agency for the World Bank funded SOFWMP and a major stakeholder in the WSIP Phase-I project. The regulatory authority has been reconstituted with the provincial IPD minister as its chairman. Recruitments on merit basis were initiated under the WSIP by the FAO Consultants keeping in view the complaints of rampant corruption especially in its Operations and Finance wings. The process has, however, been interrupted due to political interference. So far, during the last ten years, 6 managing directors of the SIDA have been replaced, mainly on charges of inefficiency, corruption and/or misuse of powers." The report continues,

It is the view of this Regional Planning Project that, if SIDA is assimilated into IPD, all that the GOP, GOS, IBRD, and others have worked toward for more than a decade would be lost. There no longer would be effort to bring about self-management and self-financing of water and its distribution by Utility supplied farmers/users. There likely would be a halt of meaningful reform for realization of efficient, fair delivery of irrigation water countrywide.

2.10.3 Analysis of the Two Major Weaknesses of the SWMO Process

Provisions of the SWMO institutionalize a situation that: 1) makes it difficult for SIDA to achieve sustainable financing for water and drainage operations and 2) for cooperation between SIDA and IPD over the near term and throughout the Transition Period, perhaps an additional 10 years once firm, enforceable plans and regulations are in place and handover of budget begins

The poor record of SIDA, the AWBs and FOs for collection of revenue to date make operations of SIDA and it units financially unsustainable; and

There is serious conflict between SIDA and IPD because IPD does not want to have SIDA, AWBs and FOs succeed and displace the IPD top level management completely as is specified or implied in Articles 16 and 97 of the SWMO 2002.

Below is explored the current situation regarding collection of revenue (totally *Abiana*) and a review of the provisions of the SWMO of 2002. The Ordinance briefly addresses every aspect of the delivery of water from the Indus River to watercourses. The Ordinance does not, however, provide the depth of guidance required for an orderly transition of functions and responsibilities of a large bureaucracy (IPD) to business oriented utilities (SIDA, AWBs, and FOs).

SWMO - 2002
Select Legal Articles That Established the Responsibilities of SIDA

<u>Article 4</u> of the SWMO 2002 stipulates, the "Legal status of the SIDA –

- *"The SIDA-*

"shall be a body corporate, having perpetual succession and a common seal and shall by the same name, sue and be sued;

"shall have power to lease, acquire, hold and dispose of property save that it shall not hold or dispose of land belonging to Government all of which shall be held in trust for Government.

- *"The jurisdiction or the Authority shall follow hydrological boundaries and be clearly*

delineated by Government by notification."

Article 10 of the SWMO outlines the "Functions of the SIDA shall be to -

1) *"operate and maintain the parts of the irrigation system such as Barrages and outlets assigned to it;*
2) *"operate and maintain the parts of the drainage system. assigned to it including*
3) *spinal drains;*
4) *"carry out river flood protection and maintain the infrastructure of the Province of Sindh;*
5) *"advise Government of any matter strategic or tactical, related to its functions and tasks or to the water management system as a whole e.g. irrigation or drainage contribution rates, drought management and sea water intrusion;*
6) *"manage the transition process, to promote the formation, growth and development of the AWBs and FOs into self-supporting and financially self-sustaining entities within a period of seven to ten years of their establishment; and*
7) *"perform any other function conferred on it under this Ordinance".*

Article 11 of the SWMO notes that, "In order to perform its role and functions, the SIDA shall perform the following tasks:

Strategy

1) *to develop, on a periodic basis, a strategy statement for improvement of irrigation and drainage services, integrated water management, flood protection. Prevention of sea water intrusion, water distribution in times of drought and wetlands management within its command and catchment areas setting goals and objectives, formulating implementation policies and identifying priority and other actions;*

2) *to formulate annually a Business Plan setting out its proposals for its own activities for the following five financial years;*

3) *subject to provisions agreed with the Indus River System Authority, to receive Irrigation Water of the Barrages within the Province and/or from the inter-Provincial/link canals and deliver the same in agreed quantities to the various AWBs, FOs or, as the case may he to other agricultural users, local Councils, industries or wetlands, guaranteeing the minimum discharge below Kotri Barrage to prevent sea water intrusion, in the manner and on the terms and conditions as may be negotiated between the SIDA and the parties concerned and to receive drainage effluent at the designated points and convey the same to the sea;*

4) *to maintain the irrigation, drainage and flood protection infrastructure located within its territorial jurisdiction:*

5) *to levy and collect irrigation and drainage service fees, rates or cess and surcharge for late payment on such fees. rates or cess outside the areas of jurisdiction of AWBs and FOs, as prescribed by the SIDA*

6) *to coordinate/regulate measures being undertaken … in the total water management system, e.g. the recording/gauging of surface waters, monitoring of the ground water table and the quality of waters with compilation of data relevant thereto, and as provided in*

Article 13, SIDA shall establish at each Barrage a Water Allocation Committee (WAC).

2.10.4 Revenue Based on *Abiana*

Dire Situation of Revenue Collections Based on Abiana

As collected during the past 9 years, Abiana provides a small fraction of financial requirements of AWBs and FO s and nothing for SIDA operations. Specifically:

An FO with 10,000 acres and 40% retention of Abiana can currently collect a *maximum* Rupee equivalent of Rs. 190,000 (US $2,000) to Rs. 475,000 ($5,000)/year and remit 60percent of collections to the AWB.

During the past nine years, the three functional AWBs, Ghotki, Nara and Left Bank Kotri, have collected a combined total of Rs 400 Million/yr or money equivalent to $0.5 Million/yr for an area of 4.75 Million acres that are served by four networks of very large canals that extend for hundreds of miles across the Province.

The definition of Abiana in The Sindh Water Management Ordinance, 2002 is: "service charge levied on farmers by a FO or, where there is no FO, by an AWB or by SIDA for the supply of surface irrigations water and the provision of drainage".

Earlier studies, analyses of the status of SIDA and its AWBs and FOs, and field surveys of this project confirm that Abiana as it now is structured does not provide even a small fraction of the budget required to support SIDA. Current collections are inadequate to only partially sustain the FOs should they be allowed to retain all Abiana collections.

The lack of provision for and capacity to secure revenue adequate for both the period of transition and for long term operations likely is the most important defect in the Ordinance of 2002 that, in turn, makes achievement of Reform Goals of GOP, GOS and donor institutions unlikely to be achieved.

This point may be considerably ameliorated should powers authorized under Article 105 of the SWMO be fully implemented by SIDA. Article 105 states, "The powers conferred on the Canal Officers under the Sindh Irrigation Act 1879 and

The Financial Delegation of Powers Rules, 1962 relating to Infrastructure, Water Management, Flood Protection and Finances, shall be exercised by the SIDA and the AWBs in their respective areas of jurisdiction." The Delegation of Powers Act does not address revenues but provides guidance as to how and how much can be spent on construction and organizational housekeeping.

In the following sections of this report, the revenue deficiency that prevails after a decade of indecisive administration is successively stated as a Problem, Issues and Potentials for redress.

2.11 Partner Organizations, NGOs in the study area

During the first phase of the Consultancy agreement, NGOs were evaluated with respect to their capacities to perform components of the Regional Plan with a focus on livelihoods, poverty and health. Based on results of Social and Economic Surveys, abilities of villagers to contribute to availability of non-contaminated water, better health and sanitary conditions should be essential elements of the Regional Plan.

Use of the term NGOs herein includes both NGOs and GONGOs (government organized NGOs). They are well suited to partner for the conduct of economic, social and environmental elements of the Regional Master Plan at district, Taluka, village and household levels. Generally, a number of NGOs are promoting and executing programs that have an objective of sustainable community development for achieving equitable economic, social, political, and cultural development. As documented below, twelve listed NGOs have submitted information and have ongoing programs. They are staffed and equipped to carry out education, training and organization of local persons and communities.

The list of NGOs refers only about NGOs that currently are *actively engaged* in Sindh and who *were responsive* to invitations to prequalify. The list was drawn from among more than 100 NGOs who are registered. During the first phase, NGOs were invited through newspaper advertising to

submit prequalification documents both for future implementation of planned works and for conduct of current investigations. Additionally, available fact sheets for more than 30 NGOs were downloaded from web sites. Tables 2.6 to 2.10 present the area of engagement, names, location and contact information.

2.11.1 NGOs Active in Sindh

Table 2.8: NGOs Active in Health in Sindh

No.	Name of NGO	Contact Person	Email Address	Phone No	City
1	Health And Nutrition Development Society (HANDS)	Dr. Shaikh Tanveer Ahmed	Tanveer.ahmed@hands.org.pk	021-4532804	Hyderabad
2	Center for peace & civil Society (CPCS)	Jammi Chandio	info@cpcs.org.pk	0300-3013436	Hyderabad
3	Root Work Foundation (RWF)	Mr. Sartaj Abbasi	info@rootwork.org.pk		
4	Shah Abdul Latif Bhitai welfare Society (SALBWS)	Danish Channa	Salbws@yahoo.com	021 34978281	Karachi
5	Management & Development Center(MDC)	Dr. Yameen Memon	Info@mdcpk.org	022 2652290	Hyderabad

Table 2.9: NGO's Active in Rural Development in Sindh

No.	Name of NGO	Contact Person	Contact No.	Email	District
1.	Village Development Organization	Ali Hasan Mahar	0300-3192276	vdogtk@yahoo.com	Ghotki
2.	Allakh Welfare Association	Shabir Ahmad	0300-3263491	vdoaligtk@gmail.com	Ghotki
3.	Gazi Social Welfare Association	Lala Maqbool	0333-7563355		Larkana
4.	Sindh Rural Development Society	Abdul Samad	0300-3046328		Hyderabad
5.	Sharifabad Social Welfare Association	Raoof Mirani	0321-3108248		Sukkur
6.	Abdul Latif Bhitai Social Welfare Association	Assadullah Shaikh	0300-3136238 0333-7128004	philasad@yahoo.com	Sukkur
7.	Saami Foundation	Abaas Khoso	0345-3714181		Umerkot
8.	Village Community Development Organization	Maqbool Dal	0302-3348665		Mirpurkhas

No.	Name of NGO	Contact Person	Contact No.	Email	District
9.	Jaggarta Organization	Khaalid Babbar	0302-3319533 0334-3553908		Mirpurkhas
10.	Human Development Society	Karam Mangi	0333-7279190		Shikarpur
11.	Lateef Development Organization	Ghafoor Noonari	0300-3152411 0333-7342832		Kashmore
12.	Baiqar Development Organization	Akhtar Nizamani	0306-3455484		Saangharr
13.	SEHRA Thraparkar	Ayaz Bajeer	0333-2977248		Thraparkar
14.	Indus Community Development Organization	Murtza Arain	0300-3010135	icdo_moro@yahoo.com	Nosheroferoz
15.	Shah Sachal Sami, Sindh	Waahid Surhio	0333-7065601	wahidsurhio@yahoo.com	Dadu
16.	Gorakh Development Organization	Fida Pirzado	0300-3279389		Dadu
17.	Peoples Organization for Welfare and Awareness	Manzoor Laarrik	0300-3148070 0333-7580858		Khairpur
18.	Khairpur Rural Development Organization	Ikhtiar Khaskheli	0306-3693812	krdongo@yahoo.com	Khairpur
19.	Farhada Development Organization	Hasan Mashwari			Badin
20.	Rahbar Social Development Organization	Basheer Chandio	0333-7538628		Qambar-Shahdadkot
21.	Village Development Organization	Wali Jokhio	0300-3201323		Nawabshah
22.	Shah Sachal Sami, Sindh	Yaseen Khaskheli	0302-3221312	sachalsami@gmail.com	Nawabshah

Table 2.10: NGOs Active in Village Life and Social Welfare in Sindh -1

No.	Name Of NGO	Based	Contact person	Telephone Cell phone	Email	Recommended
1	Village Development Org	Ghotki	Mr. Ali Hassan Mahar	03003192276		Ghotki and Sukkur
2	Indus Resource Center	Khairpur Mir's	Sadiqa Salhuddin & Naveed Khayal	03323793716	Salahuddinsadiqa@yahoo.com	Khairpur and Sukkur
3	SEEDA Khairpur Mir's	Khairpur Mirs	Mukhtair Solangi	03003181901		Khairpur Mir's
4	Sath Development Society	Naushero Feroze	Mirza Khan Ghanghro	03003207382		Naushero Feroze
5	Badin Rural Development Socity	Badin	Dr. Akash Ansari	03008373293		Badin
6	Wahdat Thatta	Thatta	Mr. Qadir Lashari	03012403211/ 03212675877		Thatta
7	SAWFCO	Hyderabad & Sanghar	Mr. Suleman G Abro	03003012303	Suleman.abro@yahoo.com	Hyderabad,Sanghar,Mirpurkhas
8	Strengthening Participatory Organization	Hyderabad	Ghulam Mustafa	022 2654725	Mustafa@spopk.org	Hyderabad
9	Indus Development Organization	Hyderabad	Zain Daood poto	03313556353		Matyari and Hyderabad
10	Research and Development Foundation	Hyderabad	Masood Ahmed Mahesar	0222651728	mmahesar@rdfoundation.org.pk	Hyderabad
11	Sindh Net	Mirpurkhas	Mr. Zahoor Leghari	03312782473		Mirpurkhas
12	AWARE	Umer kot	A.Akbar	03337092067		Umar Kot
13	TRDP	Mithi	Zafar Junejo			Tharparkar

Table 2.11: NGO's for Village Life and Social Welfare in Sindh 2

No.	Organization	Contact Person	Contact No.	Email	District
1	Village Development Organization	Ali Hasan Mahar	0300-3192276	vdogtk@yahoo.com	Ghotki
2	Allakh Welfare Association	Shabir Ahmad	0300-3263491	vdoaligtk@gmail.com	Ghotki
3	Gazi Social Welfare Association	Lala Maqbool	0333-7563355		Larkano
4	Sindh Rural Development Society	Abdul Samad	0300-3046328		Hyderabad
5	Sharifabad Social Welfare Association	Raoof Mirani	0321-3108248		Sukkur
6	Abdul Latif Bhitai Social Welfare Association	Assadullah Shaikh	0300-3136238 0333-7128004	philasad@yahoo.com	Sukkur
7	Saami Foundation	Abaas Khoso	0345-3714181		Umerkot
8	Village Community Development Organization	Maqbool Dal	0302-3348665		Mirpurkhas
9	Jaggarta Organization	Khaalid Babbar	0302-3319533 0334-3553908		Mirpurkhas
10	Human Development Society	Karam Mangi	0333-7279190		Shikarpur
11	Lateef Development Organization	Ghafoor Noonari	0300-3152411 0333-7342832		Kashmore
10	Baiqar Development Organization	Akhtar Nizamani	0306-3455484		Saangharr
11	SEHRA Thraparkar	Ayaz Bajeer	0333-2977248		Thraparkar
12	Indus Community Development Organization	Murtza Arain	0300-3010135	icdo_moro@yahoo.com	Nosheroferoz
13	Shah Sachal Sami, Sindh	Waahid Surhio	0333-7065601	wahidsurhio@yahoo.com	Dadu
14	Gorakh Development Organization	Fida Pirzado	0300-3279389		Dadu
15	Peoples Organization for Welfare and Awareness	Manzoor Laarrik	0300-3148070 0333-7580858		Khairpur
16	Khairpur Rural Development Organization	Ikhtiar Khaskheli	0306-3693812	krdongo@yahoo.com	Khairpur

No.	Organization	Contact Person	Contact No.	Email	District
7.	Farhada Development Organization	Hasan Mashwari			Badin
18		Shafique Jokhio	03322053221		Thatto
19	Rahbar Social Development Organization	Basheer Chandio	0333-7538628		Qambar-Shahdadkot
20	Village Development Organization	Wali Jokhio	0300-3201323		Nawabshah
21	Shah Sachal Sami, Sindh	Yaseen Khaskheli	0302-3221312	sachalsami@gmail.com	Nawabshah

Table 2.12: NGOs for Village Life and Social Welfare in Sindh 3

No.	Name	Contact person	Telephone - Mobile	Email	Area served
1	Bhitai Social Welfare Association	Khadim Mirani President	0300 9314605		Kingri Khairpur
2	Rural Education& Socio-Economic Development Association (RESDA)	Lutuf Ali Sher, General Secretery	0301 3211226		Faiz Ganj
3	Goth Seengar Foundation	Nazir Ujun Chief Executive Officer	0300 8316137		Thari Mirwah
4	Shahbaz Young Welfare Association	Qurban Shah, President	0303 2141276		Sobhodero
5	Health Education literacy Program	Mahboob Ali,President	0321 3122720		Nara
6	Sindh Health Education & Development Society	Sikandar Soomro,President	0301 3420337		Khairpur
7	Saint Michel Educational Society	Banazir Bhitti, President	0300-3134649		Gambat Kot Diji
8	Sharfabad Social Welfare Association	Dilbar Meerani, President	0300 3135708		Roheri, Sukkur
9	Al-Mehran Social Welfare Association	Talib Hussain	0346 3666084		Salih Put
10	Marvi Welfare Association	Allah Wadhayo	0300 3145048		Pano Aquil
11	Allakh Welfare Association Jarwar	Illum Din, President	0300 3263491		Mirpur Mathelo, Ghotki
12	Roshini Educational Co-operative Society	Rasool Bux Mahar	0300 3197049		Daharki

No.	Name	Contact person	Telephone - Mobile	Email	Area served
13	Indus Community Development Organization	Yasin Kalari	0300 3729860		Khan Garh Shareef
14.	Organization For Development of Mariginalized People	Muhammad Siddique Kumbhar	0336 2099716	young_sameer @yahoo.com	Badin
15.	Badin development & Research Origanization (BDRO)	M. Khan Samo	0333-2524272	mail@bdro.org	Badin
16.	Thardeep Rural development Programme (TRDP)		0232-261462	info@thardeep. org	Badin
17.	Society For poverty Eradication and Education Development (SPEED)	Jameel Ahmed Qureshi	022-2650451	Speed_sindh1 @yahoo.com	Hyderabad
18.	Rural development Association (RDA) Tharparkar	Muhammad Siddique	0342-3609963	Drmsiddique88 @yahoo.com	Mithi (Thar)

International NGOs (INGOs)

There are two international NGOs actively working in the study area mainly IUCN and WWF. Both of them are headquarter at Karachi and work on development, advocacy, monitoring and evaluation, support to rural NGOs and their capacity building.

2.12 Employment and Livelihood Opportunities

Project area comprises of 15 districts of Sindh Province located on left bank of river Sindh. Being predominantly agricultural area, the available industries are argo-based. Presently there are 14 large scale units engaged in the production of fertilizer (2 units in Ghotki), Textile (1 unit in Sanghar) and sugar (11 units in Badin ,Mirpurkhas and Sanghar) and are providing employment to nearly 25,000 persons.

Besides there are 104 cotton ginning factories mainly located in Sanghar and Ghotki districts. A large number of skilled, semi-skilled, and unskilled labour force is gainfully employed in these factories. There are bright prospects of agro-based and agro allied industry as adequate raw material is available.

The pattern of occupational status varies significantly between rural and urban areas. In rural areas, most of employed persons are associated with “Skilled Agricultural and Fishery” workers followed by Element Occupations like making Sindhi *ajrak*. Making *khurzins* carpets, woolen *khatas* and *khes*.

In urban area, more than one third of the employed class is engaged in “Elementary Occupations” followed by Services Workers and Shop and Market Sales. The working population is also associated with “Community, Social, and Personal Services.

There are bright prospects of agro-based and agro allied industry as adequate raw material is available in the project area. With the implementation of the proposed project Employment opportunities will further accelerated due to increased trade and economic activities. A brief

description of pervailing trade and commerce activities is given below to have a good idea of potential of the project area districts to generate employment opportunists in future

Ghotki district has been progressing in trade and commerce. Cotton is grown in abundance in the district and supplied to other areas of the region. Mangoes and dates are produced in appreciable quantity in Ghotki taluka and also supplied to adjacent districts of Sindh and Punjab

The cotton, wheat, pulses, oil seeds and other agricultural products are main item of trade. Sanghar, Shahdadpur and Tando Adam cities of this district are good trading centers. Shahdadpur is famous for agriculture production and Tando Adam is famous for the trade of cotton. 58 cotton-ginning factories are running in this district.

Khairpur district has been progressing in trade and commerce. Dates are the main produce of this district and are grown in abundance. These are supplied to other places of the country. Pottery works of various designs are also produced in Gambat taluka. Sandles of good quality and costly as well as impressive khes are also prepared at Gambat

Umerkot is a trade center with eastern side of desert area. All type of goods are available, both on wholesale and retail, in the big markets of the district

The important items of trade in Thatta district are rice, leather and wool. The district has surplus in rice which is supplied to other parts of Pakistan. Bananas of very good quality are also cultivated in the district and are exported to Iran and other Middle East countries. The main commercial centers in the district are Sujawal, Jati, Chuhar, Jamali, Shah Bunder, Ghora Bari, Mirpur Sakro, Daro, and Mirpur Bathoro.

A brief glance of above mentioned trade and commerce activities indicates that with the improved irrigation water availability will bring boom in all walks of the regional economy resulting in great employment opportunities in the area ultimately help in poverty alleviation in the region.

2.13 Poverty incidence and Social Protection Programs

2.13.1 Introduction

According to the definition of the World Bank, “poverty incidence: is the share of the population whose income or consumption is below the poverty line, that is, the share of the population that cannot afford to buy a basic basket of goods. An analyst using several poverty lines, say one for poverty and one for extreme poverty, can estimate the incidence of both poverty and extreme poverty.

Poverty has remained one of the most serious problems of Pakistan- over one third of the population is living under the poverty line. About forty-four percent of population is below the poverty line on the human poverty index (UNDP, 2002). Although governmental bodies, local and international NGOs, and international organizations operating in Pakistan have made eradication of poverty a top priority and have operated many social development programs, poverty has been on a rise when compared to the level of 26 percent in 1988 (GoP, 2003).

As per ADB report 2006, the Badin and Thatta are the poorest districts. Among them the costal areas constituting at talukas have poverty line of 79% of which 54% are the poorest.

2.13.2 Social Protection Programs/ Projects

Pakistan and especially Government of Sindh have been working hard for launching series of development projects for socio-economic development of the people of Sindh. The Indus delta and coastal community have been given due consideration in the development process. In this regard, the launching of the Sindh coastal development authority by Sindh government has proved hallmark in the community development process of coastal community. Reviving Pakistan’s Mangroves program and the Sindh coastal community development program are one of the major social protection programs being initiated with the financial support of the Asian development program.

Keeping in view the rising level of poverty and adverse impacts of LBOD project, social protection and development programs are being initiated by the government of Sindh and Pakistan in the project area of left bank of Indus and coastal delta zone for the socio-economic development of the area. In this connection, Sindh coastal development authority and the Sindh Irrigation and Drainage Authority are some of the key role players in the development process for the people of Sindh. Few major programs from the series of development processes such as the Sindh coastal community development projects, Zakat program, Pakistan Bait-ul-Mal, Benezair Income support program, National rural support program, Sindh rural support program and Youth development program among others, have played key roles in producing skilled labour, removing disparity from masses and developing copying strategies for people facing poverty. They are described in the following paragraphs.

2.13.2.1 Benazir Income Support Program

According to the BISP website (www.bisp.gov.pk), the Benazir income support program is an initiative of current government of Pakistan and this was started in October 2008 with an initial allocation of Rs. 34 billion. The program is being implemented in all four provinces including Federally Administered Tribal Areas (FATA), Azad Jammu and Kashmir (AJK), Gilgit Baltistan (GB) and Islamabad Capital Territory (ICT). By considering the rising inflation, the program was basically launched to provide a big support to underprivileged sections of the society. This year, under this program, Rs. 70 billion are allocated to provide cash assistance to 5.5 million families covering around 18% of the entire population. The cash assistance of Rs. 1000 per month is provided on quarterly basis to poor families. In addition to this, interest free returnable financial assistance, vocational & technical training, health & life insurance coverage are also provided. The program objectives are to: enhance financial capacity of the poor people and their dependent family members; formulate and implement comprehensive policies and targeted programs for the uplift of underprivileged and vulnerable people; and reduce poverty and promote equitable distribution of wealth especially for the low income groups.

2.13.2.2 Pakistan Bait-ul-Mal

According to the PBM website (www.pbm.gov.pk), Pakistan Bait-ul-Mal (PBM) was established through 1991 Act as an autonomous body. The Bait-ul-Mal has provided large financial support to orphans, widow and poor needy persons. Therefore, it has played a great role in alleviation of poverty. The mission of Bait-ul-Mal is to provide social protection to the poor marginalized segments of the society. The main goals are focused on educational assistance to needy orphan and scholarship for the outstanding students, accommodation and necessary facilities for the deserving, free medical treatment for indigent sick people, free hospitals and rehabilitation centers for the poor, financial aid to charitable institutions including educational & vocational setups; self-employment schemes; and some other purposes approved by the Board.

The main projects running under Bait-ul-Mal are: Individual financial assistance (IFA); Child support programme (CSP); Institutional rehabilitation through NGOs / CSW; National centers for rehabilitation of child labour (NCRCL); Vocational training centers (VTC); Food support programme (FSP); Pakistan sweet home; Special friends; Lungar project; Free skill development at Zia Siddique Foundation; and Jinnah burn surgery center. In addition to these projects, other initiatives are being considered to be implemented and these are: Launching of special nutrition package; Bone marrow transplant unit (BMTU); Out-reach programme for poor patients; Jahez package for orphan girls; Activation of PBM special friends park for the amusement & welfare of the disabled; Complimentary lunch boxes; and distribution of stitching units.

2.13.2.3 Sindh Coastal Community Development Project

According to the SCCDP website (www.sccdp.gos.pk), the Sindh Coastal Community Development Program is initiated by Sindh Coastal Development Authority of Sindh government with the financial assistance of Asian Development Bank. The main objectives of the program are to address the issues and to reduce poverty in vulnerable coastal communities (where 54% people are the poorest), access to public services and improve environment of the coastal areas of district

Thatta and Badin. Along with achieving the program objectives, the project has to create community awareness, community participation and local ownership. The project also focuses on the re-structuring and capacity building of three Sindh government departments i.e., Coastal Development Authority, Sindh Fisheries Department and Agriculture Department were considered on priority basis.

The program has the following four components:

- Improved Coastal Management
- Community Development
- Institutional Capacity Development
- Project Management

In institutional component, the following major activities are envisaged:

- Organizational restructuring of coastal development authority
- Institutional strengthening of fisheries department
- Reform process in fisheries department
- Institutional strengthening of agriculture department by following two strategies
- Improved land management in pilot areas
- Dry land area strategy

In community development component, the following major activities are planned:

- Infrastructure development
- Mari culture and mangrove plantings
- Income generation and skills development

According to the reports in local newspapers, the project has raised the productivity and incomes and provided the indigenous people with access to basic amenities. The community organizations were established as part of the project and similarly village development plans were prepared and small-scale schemes were implemented by community organizations formed under the project. Hence, the role of Sindh Coastal Development Authority is being considered highly important in the fields of development, land management, alternate energy, hydrogeology, resource management, disaster management, environment, aquaculture, agriculture and natural coastal fisheries.

2.13.3 National Rural Support Programme

According to the NRSP website (www.nrsp.org.pk), the National Rural Support Programme is basically a non-profit organization that runs the largest rural support programme in Pakistan. The main focus is on outreach, capacity building and development activities in order to alleviate poverty. It operates in all four provinces of Pakistan through its field offices. The NRSP has established a large number of community organizations through which it has approached a big number of poor households. Therefore, through rural support programme, the NRSP has played a successful role in community and rural development. The overall purpose of the programme is alleviation of poverty. Through the process of social mobilization and by implementing conceptual tools, the programme polishes the skills of vulnerable male and female and enables them to meet their needs. The NRSP has provided the quality primary education, infrastructure schemes, and opportunities for income generation, improved agricultural productivity and so on.

2.13.4 Sindh Rural Support Programme

According to the Sindh RSP website (www.sindhrsp.org), the Sindh Rural Support Programme was formed in 1995 in order to reduce the poverty from rural areas of Sindh through sustainable development process of poverty alleviation, social, rural and community development. The vision of the programme is to promote sustainable development in Sindh through community participation in reducing poverty, hunger and unemployment. The programme mostly works in marginalized communities like haris (sharecroppers), small landowners and wage earners. In order to build local ownership, the SRSP has implemented so many programs with community

organization and working with them as development partner. Therefore, the SRSP is focusing on the organizational capacity of community organizations. The main objectives of the programme are to mobilize disadvantaged groups for socio-economic empowerment, to enhance capacity of mobilized groups, to provide micro credit, to facilitate in social infrastructure, to engage in research and advocacy, to enhance the institutional capacity of civil society organizations and to support the communities in environmental protection and conservational of natural resources.

2.13.5 Benazir Bhutto Shaheed Youth Development Program

According to the BBSYDP website (www.bbsydpsindh.gov.pk), The programme of Benazir Bhutto Youth Development is an initiative of the provincial government of Sindh (GoS) in order to address the issues of poverty and un-employment through Human Resource Development in the province. The aim of the programme is to register the semi-literate and educated unemployed youth in Sindh and to provide them with opportunities for skill development. The duration of the training programmes vary from three months to one year. The courses designed are certified and provides various training options to unemployed youth to attend the course according to local and international job markets. Through this practice, the program aims for the improvement of the socio-economic conditions of the common citizens and efficiency of the public and private sector through skilled workforce.

The main objectives of the programme are: to train human resources in Sindh to cater to the needs of public and private sector in local and international markets; to provide scholarships to various categories of unemployed educated youth, to provide quality trainings and certification to approximately 100, 000 unemployed educated youth in first phase through technical and professional institutes and “On-Job training” by the public and private sector to increase their employability; and to provide linkage to the trained manpower to the local and international job market and explore self-employment opportunities.

2.13.6 Sindh Skills Development Project

According to the STEVTA website (www.stevta.gos.pk), the project is launched in support of Sindh Government in strengthening and expanding its programme of skills development by improving the quality of vocational training to produce high quality skilled workforce from the Government funded training institutions and to provide better and decent employment opportunities to un-employed youth of the province. In order to build organizational capacity, the project would also seek to promote institutional reforms and innovations in the selected training institutions, improvement in the existing and development of new programmes and to strengthen the overall management capacity of the technical vocational education and training system in Sindh province.

According to the aims and objectives, the project has to establish responsive and market driven institutional training programmes in the institutions under the Administrative control of STEVTA to meet the growing demand of skilled workforce on one hand and to provide maximum opportunities for decent employment to trainees on the other hand.

2.13.7 Community Development Program

According to the CDP website (www.cdpsindh.gov.pk), the program of community development was initiated in 2008-09 with the allocation of Rs. 500 million by the Government of Sindh. The program aims to alleviate poverty and to bring about improvement in the lives of ordinary people. The program is being implemented through civil society organizations (CSOs) by using their expertise to bring change in the development sector. All the program activities are being monitored by the project coordination unit.

The working areas of the program include education, health, water & sanitation, women empowerment, skill development and legal aid. According to the one of their reports, about 36 projects with the funding of Rs. 609 million have been initiated through this program.

2.14 Challenges and Weaknesses

According to the review of some reports such as *(A Profile of Social Protection In Pakistan: An Appraisal of Empirical Literature By Haroon Jamal, May 2010),* there are few challenges and weakness of the described programs:

- Poor accountability and monitoring mechanism
- Bad implementation strategies
- Limited coverage of programs
- Non-preparation of coping strategies
- Bad governance
- Fail to access hard to reach areas
- Lack of coordination and cooperation
- Rising corruption
- Spending more on plans, design, policy and planning and less on implementation
- Inadequate cash or in-kind assistance
- Program overlap and duplication
- Less concentration on sustainability of programs
- Less ownership interest of locals for development programs
- High level corruption in recruitment process

2.15 Conclusion

The programs of social protection are designed to enable poor people to fulfill their basic necessities, to protect vulnerable people against livelihood risks. . The government of Pakistan has played a key role in implementing the programs. Besides government initiatives, there are various international and local organizations that work hard to provide social protection to the vulnerable and marginalized communities of Pakistan. Among all those organizations, there are few very active ones: s Food and agriculture organization, United Nations Development Fund, International union for conservation of nature and natural resources, National commission for human development, Pakistan fisher folk forum, Strengthening participatory organization, World wide fund for nature, Indus earth trust, Pakistan poverty alleviation fund and so on. In order to strengthen the protection process, government has taken serious step in reaching inaccessible population through public private partnerships (PPPs) with non government organizations.

2.16 Role of Gender as Partners in the Development Process

2.16.1 Introduction

"No nation cannot rise to the height of glory unless your women are side by side with you; we are victims of evil customs. It is a crime against humanity that our women are shut up within the four walls of the houses as prisoners. There is no sanction anywhere for the deplorable condition in which our women have to live." Mohammad Ali Jinnah 1944 (US Library of Congress report "Pakistan - A Country Study")

http://womenissuespk.blogspot.com/2010/10/situation-of-women-in-pakistan.html

Gender is the culturally specific set of characteristics that identifies the social behavior of women and men and the **relationship** between them. Gender, therefore, refers not simply to women or men, but to the relationship between them, and the way it is socially constructed. Because it is a relational term, gender must include women **and** men. Like the concepts of class, race and ethnicity, gender is an analytical tool for understanding social processes (Status of Women, Canada, 1996). Existing policies and laws related to water, women and land rights are given in table 2.13.

2.16.2 Existing policies and laws related to water, women and land rights

Table 2.13: Relevant policies and laws

	Water rights policies		Human Right/Women rights /policies	
	Year		Year	
1	1879	Sindh Irrigation Act	1948	Muslim Personal Law of Sharia
2	1879	Sindh Land Revenue Code	1955-56	The Commission on Marriages and Family Laws
3	1914	Amendment of the Sindh Irrigation (Amdt.) Act, Ordinance 2	1961	Muslim Family Laws Ordinance
4	1955	Amendment of the Sindh Land Revenue Code, Ordinance 5	1973	Sindh Civil Service Act
5	1997	Sindh Irrigation & Drainage Authority Act	1973	Sindh Civil Service E&D Rules
6	1998	Establishment of the Sindh Irrigation and Drainage Authority	1976	Women's Rights Committee
7	2001	National Drinking Water Policy	1985	Pakistan Commission on the Status of Women
8	2001	Water Vision 2025 (Water and Power Development Authority, 2001)	1991	Shariat Bill
9	2002	The Pakistan Water Resources Strategy (Ministry of Water and Power, 2002)	1997	Commission of Inquiry for Women
10	Oct 2002	The Sindh Water Management Ordinance No. XL, 2002	1997	Ministry Of Women Development

12		Tenants act	1998	National Plan of Action, Ministry of Women's Development
13			2000	National Commission on the Status of Women (NCSW)
14			2001	Sindh Local Government Ordinance
15			March 2002	National Policy for Development and Empowerment of Women, (MoWD)
16			2004	The National Gender Reform Action Plan (GRAP)
17			2005	CEDAW Debriefing session

Sources: SIDA 2004, Gender Equity Strategy, page# 10

These policies represent Government's effort to reduce gender gaps, empower women and create an environment that cultivates women's involvement in the public sphere. The Government has ensured the reservation of seats for women in local government and provincial and national assembly which has considerably increased women's political participation, made women's voice heard and concerns visible.

2.16.3 Gender role in water sector

Kamal (2005), in *'Women and Water Issues of Entitlement, Access and Equity', underlines* the prevailing view in the country which sees women's role in the water sector only in the sector of water for domestic use and sanitation. Consequently, with this view, there are no issues of ownership, control and access to water. Land ownership is usually a proxy for 'water rights' and access to water. Considering women's extremely limited ownership or control over the owned land, women have little or no control over water rights.

In addition, the author emphasized absence of gender-disaggregated data, which are rarely available, or if available, the data are very basic and fragmented. Some projects maintain reference to gender but these are usually relevant to the local area covered by the project.

Without aspiration to analyze every aspect of women's life and existing barriers to their full participation in the public sphere of life and ultimately in management of water, we will just briefly mention some relevant point of women's position under current circumstances. As already mentioned, women's role in water management is seen only in the domestic use of water. Fetching water is a 'women's job' and women are considered as users and beneficiaries of any domestic water projects. However, there is a chronic lack of involvement of women in planning, implementation and operation stages of such projects.

Rural women are mostly engaged in agriculture and domestic chores as unpaid workers. Paid work in agriculture is limited and women are usually paid much less than men for the same work. In fisheries, women used to play a much greater role in the past. Fishermen use to take the whole family for fishing and each member had its role in catching, cleaning, drying fish etc.

Expansion and commercialization of fisheries, as well as intrusion of non-indigenous fishermen in the coastal area, pushed out of business local fishermen and in particular, local women.

Pakistan: Country Gender Profile Study, (SDPI) reveals that there is no government policy framework or administrative action which deals with the socio-economic support of fisherwomen and sustainability of their livelihoods. Moreover, there is no any acknowledgement at the women's entire role in the fisheries sector and consequently, in the government policy documents, laws and rules etc. The situation in forestry is not much different either.

Employment of women in particular in water sector departments, is very low. The study on "*Feminizing Water Institutions in Sindh"*, stated that women constitute just 1% and 0.8% of total employment of WAPDA-WW (water wing) and WASA (Water and Sanitation Authority). There were only 5 women out of 1001 employees in WAPDA-Water Wing, and 20 out of 2294 in WASA. SIDA had seven females out of 141 employees in the main office and 5 out of 56 in the field teams in August 2009.

'…there is about 30-33% land holding possessed by women farmers in the command area of the three Area Water Boards (AWB) in Sindh province. So far, 1905 active women farmers have been identified by social cell SIDA out of which 914 are the registered members of Water Course Association and 15 Women groups have been formed to promote the women farmers in irrigation sector…Also, 1750 women khatedars are registered with SIDA '.

2.16.4 SIDA gender segregated data of Farmers Organizations

According to data on Farmers Organizations (FOs) maintained by SIDA, there is 383 FOs in the command area as of June 2011. Total No of FOs having women membership is 146, which makes 38% of all formed FOs. Table 2.14 illustrates a very symbolic role of women in water management organizations. Moreover, women's part decision-making position such as chairman's position is zero.

Table 2.14: Women in water management

Farmers organizations profile	Number	No of women
Number of Farmers Organizations	**383**	
Land shareholder registered in Farmers Organizations	119,786	146

Chair person in Farmers Organizations	383	0
Land shareholder members in Water Course Associations	119,786	924
Chairperson of Water Course Associations	9,582	3
Farmers Organizations Board of Management	383	4
General Body of Farmers Organizations	383	5

FOs profile and gender data by SIDA secretariat (2011)

2.16.5 Analytical View Point

The team of consultants during the field took primary data based on following guidelines. The responses received were analyzed and gender strategy was developed and the responses helped the team of consultants to assess the role of gender in development process.

The analysis of the responses loudly speaks about the status of women in water management sector and the stakeholders' perceptions of women's roles and position in the society as a whole. In addition, it shows the level of information and knowledge that highly qualified members and stakeholders such as AWB directors, FO chairpersons, NGO representatives and female employees have about existing policies, laws and women role in water management.

In order to get perceptions, opinions and learn about attitude prevalent, the team visited all three Area Water Board offices, SIDA field and the main office and some local NGOs offices.

There are no women working in LBC and GFC AWB office either. Consequently, there cannot be any discussion about working environment from the gender perspective.

AWB Nara office in Mirpurkhas has a much better working environment and there are four women employed on the WSIP. Women are satisfied with their working environment and professional relationship with male colleagues. The common complaints from male and female employees were lack of transport facilities for fieldwork for both, males and females.

There is 130 staff working in the SIDA's main Hyderabad office. Out of 130 employees, only five are females. In this almost exclusively male working environment is not rare to hear that women are not treated equally as their male colleagues.

From the gender perspective, men and women working in visited NGOs are active, more open to discussions and gender sensitized. They work in a relatively comfortable office setup and have basic services available.

2.16.6 Gender perceptions, actions and practices in visiting area

Gender perceptions, practices and information about existing policies in all three AWBs are almost at the same level. There is a prevalent opinion that the water sector activities are not related to women's role and are not considered important to women. Women are perceived (and treated) just as water users and beneficiaries. However, AWBs representatives and NGOs endorsed to some degree the importance of women role in water management stating that women need intensive involvement, stronger motivation and mobilization, trainings, awareness and separate well-defined budget.

In irrigation water management, people relate women's work with watering to land and as water users. Consequently, all water schemes and projects are designed in a way that cut off any female involvement in the whole sector. The stakeholders think that involvement of women as laborers in the field of irrigation is impossible as land is watered during the odd hours, which are not suitable and safe for women. However, women, regardless of how much land they own, are not allowed to manage land or water use, make important decisions and/or for example, manage conflicts between minors and water course associations. Therefore, overwhelming majority of men and some women and NGOs think that this field is not appropriate for women.

The consulted stakeholders think that women are just good in *"...misuse of water at home but not in management'*. In addition, constraints and barriers for any active women participation in the public sphere

are deeply embedded in the local communities' values. The following comments recorded during the focus group discussions, summarize one of the most dominated perceptions about women's role outside her home and therefore in the water management too:

"I don't know why you took this issue? This is completely men's field…We cannot trust even our relatives; we can't give permission to our women to go outside with our relatives, our brothers, then how can we trust rickshaw drivers as they are totally outsiders". (Male, FOC Mirpurkhas)

"My wife is a doctor, truly, I don't like her to go to work, but she is getting handsome salary, so for that, I let her to go "(Male, AWB Badin)

"I am an engineer. I sent my CV to many water related departments including SIDA but I didn't get job relevant to my degree because I am a woman engineer. Now I work in an NGO". (Female, Hyderabad)

"By law, we have to give share of land and property to our wives, daughters and sisters but we don't give them or they withdraw from their share because we feed them and fulfill all their requirements". (Male, FO Badin)

"My aunt is a shareholder of 80 acres of land. She is managing her land and income from crops but she still needs male to work on her land; my son helps her in watering land; however she is making decisions and managing her land". (Male, FO Badin)

"I worked In SIDA office and did lot of work in my duty, established communication strategy for SIDA still they are following , without any solid reason they kick me out because I am a woman" (Female, NGO Hyderabad)

"Now time is changed, people's mentality is going to change towards women and girls; this is very rigid community, women are working in various sectors and with time, women will also join water sector although it is a new topic or sector for us". (Male, AWB Ghotki)

2.16.7 Barriers for women to play role in water sector & development

Unclear entitlements in water and land share for women and poor increase barriers for them to participate in water related activities. According to the focus groups discussions, the barriers for women's full participation in any sphere of public life and therefore in water management too, are multifaceted: cultural, political and religious. Participants think that it is extremely difficult to overcome barriers in the male dominant society, where women depend financially on men and are often perceived and treated as male's property.

In conclusion, the main attitude towards women engagement in the water management is dominated by the following perceptions:

- Women are weak for labor work
- Women are not able to take decisions
- Women are generally less educated
- Women are too busy at home so they do not have time to participate in public affairs
- Environment is not safe for women due to men's behavior

- Women are unaware of water management due to lack of education and exposure
- Women do not contribute financially to family income
- Women are treated as a man's property in a typical family setup
- Cultural restrictions of women's mobility are strong

2.16.8 Overview of Consultation Process

The consultation process with project stakeholders has been carried on since Phase I of the master plan. In accordance with the analysis, the women participation has remained high in number. The overall status of consultation from Phase I to phase III is mentioned as under:

During Phase I, overall, **3,376** persons participated in community and stakeholders consultations. There were **669** at 15 stakeholders' workshops (Table 2.15) and **2,761** participants in 36 villages **(Table 2.16).** On average, there were 77 persons per village consultation and 45 per stakeholders' workshops. Ismail Bhud village in Benezirabad had the highest number of participants (259), while the stakeholders' workshop in Ghotki had the highest number of district stakeholders participating in consultations (73).

2.16.9 Women in the Local Context

The shortage of water, land salinity, ruined agriculture and livestock has changed women's lives. They used to work in the fields with their husbands and minded livestock. The loss of these major sources of women's work has had a substantial impact on local women. In many villages, they must walk long distances to fetch drinking water. In others, they sit all day at home without work, caring for children and waiting for their husbands to bring some food for the family. Some women go with husbands to cut wood while others, in villages where some land is cultivated, pick cotton or do some other agricultural work.

The consulted women underlined the following issues/needs:

- creation of opportunity for women's employment
- low literacy rate
- too many children per family
- lack of education and other basic facilities in villages
- lack of sanitation facilities for women
- increase in crime rate
- begging
- drugs and prostitution in urban settlements
- increased poverty
- child delivery problems and women's and children's health problems

The consulted women asked for schools for their children, particularly girls, help with the establishment of small home-based businesses such as *rali* making, embroidery, stitching or small industries where women can find some work and work opportunities for their men.

Table 2.15: Stakeholders' Workshops

District	No of participants
Umerkot	36
Sanghar	57
Thatta	46
Shaheed Benazirabad	54
Naushero Feroze	52
Khairpur	66
Ghotki	73
Hyderabad	17
Mirpurkhas	38
Matiary	29

Tando Muhammed Khan	28
Hyderabad	54
Badin	26
SIDA	22
SIDA	17
Stakeholders Region	54
Total	**669**

Table 2.16: Village Level Community Consultations

Number	Village	District	Participants		
			Male	Female	Total
1.	Sahib Khan Lund	Ghotki	29	16	45
2.	Pir Bux Lund	Ghotki	18	28	46
3.	Tig	Ghotki	36	20	56
4.	Hamzo Mahar	Ghotki	32	35	67
5.	Kazi Muhammad Murrad / Kazi Faqeer	Ghotki	34	38	72
6.	Khan Muahmmed / Mir Khan Gabool	Ghotki	30	21	51
7.	Khan Samejo	Ghotki	25	23	48
8.	Alam Khan Jatoi	Sukkur	68	23	91
9.	Mir Akhtar Talpur	Sukkur	22	15	37
10.	Mir Ashique Hussian	Sukkur	18	16	34
11.	Gaagri	Khairpur	41	37	78
12.	Tando Nazar Ali	Khairpur	67	43	110
13.	Dhakaie, (Dhakhani)	Naushero Feroz	64	80	144
14.	Rasool Bux solangi	Naushero Feroz	66	57	123
15.	Muhammed Usman Othoo	Benazirabad	75	36	111
16.	Ismail Bhund	Benazirabad	155	104	259
17.	Ahmed Din Laghari (Sanghar	Sanghar	43	27	70
18.	Razi Khan Rind (Kunri, Umerkot)	Umerkot	20	30	50
19.	Ghulam Mohammad Rind	Umerkot	29	21	50
20.	Abdul Aziz Maheri	Badin	35	37	72
21	Sirai Fazal	Badin	41	30	71
22	Jano Dale	Badin	10	12	22
23	Muhammad Khan Lund	Badin	33	17	50
24	Arab Mallah Racho	Thatta	21	33	54
25	Ladiyoon	Thatta	133	89	222
26	Qadir Dino Shah	Thatta	42	27	69
27	Ahmed Ajib Jat / Abdullah Jat	Thatta	25	36	61
28	Mureed Khoso	Thatta	32	15	47
29	Gul shah Colony	Hyderabad	22	13	35
30	Dani Miyar, Major Bakar and Usman Malandi	Hyderabad	13	45	58
31	Ramzan Lashari	Mirpurkhas	16	14	30
32	Saindad Aliani	Mirpurkhas	39	17	56
33	Muhammd Ali sungrasi	Matiary	53	51	104
34	Ali Navaz Khoso	Matiary	53	44	97
35	Katy Mehran, Nim Khoso and Mutko	Tando Muhammad Khan	44	47	91
36	Massan Waddi (Bari)	Tando Allah Yar	31	49	80
Total			**1515**	**1246**	**2761**

Table 2.17: Phase-I Consultations

PHASE-I CONSULTATIONS ON ISSUES								
Study	**No. of workshops**	**No. of key informants**	**No. of community consultations**	**No. of case studies**	**No. of villages**	**No. of participants**	**No of women in villages**	**No of women in w.shops**
LBOD/ drainage	19	36	72	0	36	3,689	1,246	98
Poverty assessment	0	8	16	16	40	296	110	0
Environmental study	0	0	12	0	12	846	0	0
Socio-economic study	0	0	0	0	60	633	0	0
Total Phase I	**18**	**44**	**100**	**16**	**148**	**5,464**	**1,356**	**98**

Table 2.18: Phase II Consultations

PHASE-II CONSULTATIONS ON SOLUTION /FIELD TRIPS SUMMARY										
Purpose	No of field trips	No of districts visits	No of villages visited	No. of workshops	No. of key informants	No. of consultations with women	No of consolations with men	No of women in village	No of women in w.shops	No. of participants
Solutions/LBOD/ drainage	15	15		16					121	1,442
Technical/ Flood assessment	91	15	83		83	83	83	870		2171
Total	**106**			**16**	**83**	**83**	**83**	**870**	**121**	**3,613**

Figure 2.2: No of Participants – Phase I and II

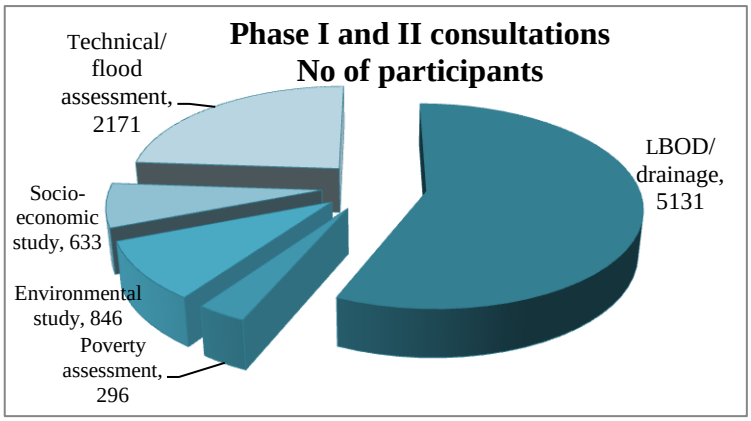


Table 2.19: Phase III Community Consultations participation status

No.	Village	District	Dhoro	Participants		
				Male	Female	Total
1	Ali Hassan Khoso	Badin	Dhoro Puran	2	2	4
2	Budho Uner	Badin	Dhoro Puran	12	21	33
3	Aulia Khan Shah	Badin	Bhai khan	13	14	27
4	Khalipho Faiz Mohd	Badin	Bhai khan	8	12	20
5	M. Qasim Ahmadani	Badin	Bhai khan	10	10	20
6	Dhano Kolhi	Badin	Bhai khan	17	25	42
7	Mohd Bux Khaskheli	Badin	Bhai khan	12	14	26
8	Bachal Araser	Badin	Bhai khan	16	21	37
9	Allah Dino Mallah	Tharparkar	Dhoro Puran	8	10	18
10	Kaloiabad	Tharparkar	Dhoro Puran	38	13	51
11	Ghulam Mohammad Khoso	Tharparkar	Dhoro Puran	13	22	35
12	Mir Mohammad Lund	Tharparkar	Dhoro Puran	7	12	19
13	Allah Dino Khokher	Tharparkar	Hakro Dhoro	11	10	21
14	Photo Bheel	Tharparkar	Hakro Dhoro	11	7	18
15	Janhan	Tharparkar	Hakro Dhoro	13	25	38
16	Haji Obhayo Chandio	Tharparkar	Naro Dhoro	9	16	25
17	Noor Shah	Tharparkar	Naro Dhoro	7	11	18
18	Arbab Zakaullah	Tharparkar	Naro Dhoro	9	12	21
19	Ramdan Gurgez	Tharparkar	Naro Dhoro	8	19	27
20	Long Khan Gurgez	Tharparkar	Naro Dhoro	19	20	39
21	Mohammad Ishaq Chandio	Tharparkar	Naro Dhoro	11	24	35
22	Mir Shezad Khan Talpur	Mirpurkhas	Dhoro Puran	8	19	27
23	Mir Ghulam Ali Talpur	Mirpurkhas	Dhoro Puran	10	15	25
24	Arbab Khaskheli	Mirpurkhas	Dhoro Puran	7	16	23
25	Rano Ramdan	Mirpurkhas	Dhoro Puran	11	17	28
26	Qaim Ramdan	Mirpurkhas	Dhoro Puran	14	7	21
27	Faqir Ghulam Ali Leghari	Mirpurkhas	Dhoro Puran	17	20	37
28	Bahram Khan Gorchani	Mirpurkhas	Dhoro Puran	19	17	36
29	Misri Khaskheli	Mirpurkhas	Dhoro Puran	21	27	48
30	Gulsher Gorchani	Mirpurkhas	Dhoro Puran	23	17	40
31	Hayat Tangri	Mirpurkhas	Hakro Dhoro	7	10	17
32	Karimabad Khawaja	Mirpurkhas	Hakro Dhoro	19	38	57
33	Haji Lund Khan Chandio	Mirpurkhas	Hakro Dhoro	19	21	40
34	Faqeer Faiz Mohammad Bilalani	Mirpurkhas	Naro Dhoro	16	18	34
35	Bacho Khan Tangri	Mirpurkhas	Naro Dhoro	38	21	59
36	Haji Sultan Tangri	Mirpurkhas	Naro Dhoro	19	16	35
37	Abdul Latif Gori	Mirpurkhas	Sohni Dhoro	13	16	29
38	Bhai Khan Kaloi (Hafiz Miro Khan Kaloi)	Mirpurkhas	Sohni Dhoro	24	21	45
39	Mir Allah Bachayo (Ghalpur)	Mirpurkhas	Sohni Dhoro	18	15	33
40	Seth Goband Ram (Sehri Farm)	Mirpurkhas	Sohni Dhoro	8	20	28
41	Shagan Bhagat	Mirpurkhas	Sohni Dhoro	19	18	37
42	Pinjal Khan Nondani	Mirpurkhas	Sohni Dhoro	11	14	25
43	M Moosa Jaeser	Umerkot	Pithoro	12	11	23
44	Haji Mohammad Ramzan Kalro	Umerkot	Pithoro	33	12	45
45	Haji Siddiq Halepoto	Umerkot	Pithoro	13	10	23
46	Ameer Bux Halepoto	Umerkot	Pithoro	18	8	26
47	Haji Ghulam Mohammad Mangrio	Umerkot	Pithoro	29	21	50
48	Haji Mohammad Daim	Umerkot	Pithoro	18	14	32
49	Haji Manjhi Mangrio	Umerkot	Pithoro	10	11	21
50	Haji Wali Mohammad Dars	Umerkot	Pithoro	11	6	17
51	Haji Mohammad Ismail Mahar	Umerkot	Pithoro	19	15	34
52	Haji Bacho Mangrio	Umerkot	Pithoro	19	15	34
53	Kamil Kalar	Umerkot	Hakro Dhoro	9	21	30
54	Haji Ahmed Ali Memon	Umerkot	Hakro Dhoro	19	19	38

No.	Village	District	Dhoro	Participants		
				Male	Female	Total
55	Saeed Khan Jamali	Umerkot	Hakro Dhoro	19	28	47
56	Khan Sahab Major Azhar Pali	Umerkot	Hakro Dhoro	19	19	38
57	Mureed Halepota	Umerkot	Hakro Dhoro	22	19	41
58	Khan Sahab Atta Mohammad Pali	Umerkot	Hakro Dhoro	8	38	46
59	Ahmed Ali Pali	Umerkot	Hakro Dhoro	5	20	25
60	Abdul Hakim Mahar	Umerkot	Hakro Dhoro	19	13	32
61	Nangodar Mangrio	Umerkot	Hakro Dhoro	18	9	27
62	Bashir Ahmed Chandio	Umerkot	Hakro Dhoro	23	19	42
63	Haji Irshad Ahmed Bajwa	Umerkot	Hakro Dhoro	5	26	31
64	Rais Gajyan Khan Chandio	Umerkot	Hakro Dhoro	8	19	27
65	Rahmore Pir Bachal Shah	Umerkot	Naro Dhoro	14	20	34
66	Choudhry Ghulam Ali (Shah Ali Wah)	Umerkot	Naro Dhoro	11	28	39
67	Bhoro Kolhi	Umerkot	Naro Dhoro	19	29	48
68	Sultanabad	Tando Allahyar	Drain D-4	11	23	34
69	Mir Jo Goth	Tando Allahyar	Drain D-4	9	17	26
70	Haji Jaffar Hakro	Tando Allahyar	Drain D-4	12	16	28
71	Mohsin Dhago	Tando Allahyar	Sohni Dhoro	12	12	24
72	Ghulam Qadir Dago	Tando Allahyar	Sohni Dhoro	6	13	19
73	Aliabad Farm	Tando Allahyar	Sohni Dhoro	16	12	28
74	Khuda Bux Dal	Matyari	Sohni Dhoro	10	6	16
75	Khan Mohammad Sand	Matyari	Sohni Dhoro	9	7	16
76	Essa Sand	Matyari	Sohni Dhoro	5	8	13
77	Khan Mir Mari	Sanghar	Sohni Dhoro	16	10	26
78	Major Nasir Ali	Sanghar	Sohni Dhoro	8	9	17
79	Jan Mohammad Panhwar	Sanghar	Sohni Dhoro	19	15	34
80	Piru Faqir Shoro	Sanghar	Sohni Dhoro	18	19	37
81	Sehra Mari	Sanghar	Sohni Dhoro	19	8	27
82	Shah Baig Mari	Sanghar	Sohni Dhoro	20	23	43
83	Duran Khan Brohi (Now in Tando Adam Taluka)	Sanghar	Sohni Dhoro	9	14	23
84	Haji Fateh Mohammad Brohi	Sanghar	Sohni Dhoro	7	10	17
85	Choudry Inayat Ali	Sanghar	Sohni Dhoro	16	19	35
86	Haji Sher Mohammad Khaskheli	Sanghar	Drain D-4	16	12	28
87	Bhobhar Wa (Daaith Malokani)	Sanghar	Drain D-5	16	13	29
88	Khan Mohammad Mari	Sanghar	Drain D-6	32	18	50
89	Haji Ghanwar Khan	Sanghar	Drain D-7	27	13	40
90	Manik Thaeem	Sanghar	Drain D-8	19	19	38
91	Allah Dito Thaeem	Sanghar	Drain D-4	6	13	19
Total				**1333**	**1482**	**2815**

2.17 Recommendations for Increasing Women Participation In Development Process

- Promote land and water rights entitlements to landholder and landless men and women in the Sindh region through possible legislation and gender awareness campaigns.
- Ensure gender sensitivity in SIDA institutional framework and culture in its programs by policies, implementation and actions
- Adopt Family Approach Interventions in structural and non structural activities (by mandatory requirement of family profile frame work in surveys, assessments, baselines and water related interventions)
- Securing women's access to and control on land and water resources by involving them throughout in project cycle at all level in command area of AWBs.
- Secure Multiple-use of water systems and entitlement for landless and poor
- Establishment of Gender support unit in SIDA secretariat

- Encourage participation of women and landless in water sectors activities
- Actively foster the participation of women, landless framer, fish farmer and poor water users in the decision-making process
- Help shape a "gender consciousness" among communities by providing information and education about gender mainstreaming in community development and water management for all uses.
- Use creative and flexible outreach and communication techniques to reach all parts of the community of irrigated, coastal and deltaic area.
- Ensure community access to publicly owned water projects, schemes and facilities for their sustainable livelihood,
- Encourage political responsiveness and accountability for gender mainstreaming at the provincial level and local.
- Seek and respect women, landless and poor's input on issues of water

2.18 Conclusion

In accordance with the field data and record assessed, this key component of development, gender's role, need full concentration in order to receive active participation of women along with men in every field of development. With time and space, the policies need to be reviewed and updated so that the gender sensitization can be justified at both platforms of public and private. In addition to this, professional minds should be encouraged to play their role in the implementation process which have been given low weight age.

In our society, women have remained highly sensitive part of our social structure. As per field data, in comparison to men; mostly women have less role playing in decision making into household activities, child rearing, farm/ crop activities, livestock rearing and social obligations. In sales and purchase activities, the participation of women has remained very poor and unjustified.

The government institutions have developed various policies, action plans and gender strategies to raise the process of development for the wellbeing of the society and socio-growth of the country. The civil society and academic organizations have been observed playing active role in promoting genders role in the development process. They have assessed the critical gender issues and they are in a position to implement the activities in accordance with the indigenous environment and conditions.

Therefore, the socio-economic indicators of the development of country can be improved with the equal participation of men and women in every path of development. And this can be ensured through public-private partnership process.

PRESENT SITUATION

3 Resource Base (Status and Issues)

3.1 Land Resources

Land resource is defined as a availability of land within the region and its utilization mainly for agriculture and other purposes depending on classification and categories of the soil. The development and utilization of land resources mainly depends upon the provision of water supplies, drainage, and the associated control of salinity. In areas under lain by fresh ground water the land has limited hazards because of sufficient availability of irrigation water for growing variety of crops, for reclamation of saline soils with provision of drainage facilities. There is therefore no doubt that fertile lands with fresh ground water provide the best investment opportunities.

Bulk of cultivated land in CCA has very high potential for agriculture and soils are generally stable and there exists little to moderate hazard of their salinisation by canal irrigation water or by high water table, although their progressive sodication by low quality tubewell waters is of great concern.

At present, most of farm lands are being utilized for below their potential and with a high level of inputs and modern management, the present production of most of crops could be increased to a high profitable level. Therefore, emphasis should be given on soil, water and crop management.

Comprehensive studies of the soils done by the soil survey of Pakistan have no such affliction. In fact the low crop yields are not only the consequences of any single deficiency or constraint, but many factors like low fertility, water shortage, over irrigation, inadequate farm power, improper soil management, insects, plant diseases, primitive method of cultivation, soil salinity and water logging, all retain the productivity of our land.

Canal irrigated land in the study area is the back bone of agriculture; The quality of the cultivated land is by and large good to very good and they have got no inherent soil problem, but due to inadequate drainage, due to high watertable due to collection of runoff and because of uneven surface the agriculture potential of these lands have been deterioted and classification of affected soils is changed (refer agriculture development potential). The soils free of any hazard are well suited for wide range of crops.

Hence, it is commonly believed that most of our prime agricultural land, though inherently problem free and fertile is still under impending danger of deterioration due to the hazards as stated above. Under such situation the land resources should carefully be utilized by eradicating salinity and water logging and adopting the technical measures to save the fertile lands from further deterioration. Moreover, the lands classified under land development potential categories of “land with moderate economic potential with irrigation”; could further be developed and fully reclaimed by adopting reclamation procedures in the affected saline patches within the cultivated fields.

3.1.1 Land Development Potential in the Study Area

The left bank study area comprises about 9,786,231 acres of land, which is irrigated mainly by three barrages canal system, however some additional supplies of irrigation water are being supplemented through fresh ground water (FGW) tube wells installed in the area. During the field investigations it is observed that the lands within the head & middle reaches of irrigation system are getting more water than the required supplies, where as the tail end area having high economical potential under irrigation is not fully cultivated due to shortage of water. This has created two way problem i.e. the lands which are getting more water than their crop water requirement, slowly have become water-logged & the lands which are left as such at tail ends of the irrigation system are becoming saline due to capillary action of salts coming up through the profile horizon to the surface of soil.

Therefore, over irrigations at the head, middle and under irrigation at the tail ends of system have created high watertable and salinity problems, are mainly responsible for the limited agricultural production in the areas of potential lands. According to development possibilities these lands have been classified into five different potential categories (Atlas Fig P3-MP-002) and are presented in tabular form in Table 3.1

3.1.2 Land with a very high economic potential under irrigation

The soils of this category have got very high economic potential and for agriculture. This type of land in study area covers about 1,947,475 acres (20%) of the total area, and is suitable for cultivating wide variety of cash crops. However, it has been observed during the field investigations that the yield/ production is remarkable below its potential, because of low standard farming and insufficient or over supplies of irrigation then the crop water requirements. Very high crop yields could be obtained by using the good quality and variety of seed, proper management and by selecting & cultivating the crops according to the agro-climatic zones of the area.

3.1.3 Land with a high economic potential under irrigation

The second category recognized comprises about 4,839,885 acres (50%) of the study area. The soils of this category have got textural limitations, for example some are heavy textured (clayey) soils with problem of low permeability and poses difficulties in seed bed preparation combined with lack of irrigation water in non-perennial or due to over supplies in the perennial areas of the left bank. Such type of areas requires the proper precession land leveling, improved crop varieties, special care in seed bed preparation, use of required fertilizers, high yields of most of the crops could be obtained. Somewhere saline-alkaline problems appear in a form of patches within the cultivated fields because of non percolation of salts in the unleveled land surface which could be solved by leveling and applying gypsum (CaSo4) to the affected areas.

3.1.4 Land with a moderate economic potential under irrigation

The area covered by this category is about 1,961,425 acres (20.2%) of the total area. This category mostly includes the saline or saline-alkali soils and mostly found in undulating (low lying) areas. The reclamation of these soils is economically feasible by extra applications of water and by providing drainage facilities to the affected areas. If necessary gypsum ($CaSo_4$) should be applied and followed by rice for couple of years. After reclamation of soil, most of crops could be grown and can produce good agriculture products. Somewhere, parts of this category are lying uncultivated in a shape of vast patches because of relatively higher topographical position; such type of land could be brought under cultivation by leveling the surface of soil. Also some where a small part of this unit have shallow horizon of silty soils over sand within the profile; such type of land requires frequent light irrigations and split application of fertilizers with emphasis on cultivation of shallow rooted crops.

3.1.5 Land with poor grazing potential

This type of category covers an area of about 721,069 acres (7.4%) of the total study area. The major parts of the area have sandy soils and are not suitable for cultivation, and are mostly covered with natural vegetation, which provides poor grazing for animals. Further small parts (not mappable) within this unit comprises saline-alkali, dense, clayey soils which are not economical to reclaim, however some patches are under cultivation producing poor crop yields. Over all entire unit is capable to provide (natural plants, herbs, shrubs) poor to moderate grazing for Livestock.

3.1.6 Agriculturally unproductive land

This category covers about 238,871 acres (2.4%) of the total area. It includes very fine sandy soils, gravelly land, and dune land, rock out crop, marsh land and urban areas. This type of land is un-suitable for agricultural development and no improvements are possible, and are declared as agriculturally unproductive lands.

Table 3.1: Summary of Land Development Potential

Land Class	Land Potential Category	Area in (000) acres	% of Total Area	Remarks
1	Land with very high economic potential	1,947,475	20	Capable to grow all type of high yielding crops
2	Land with high economic potential	4,839,885	50	Requires proper precession land leveling, capable to grow most of crops.
3	Land with moderate economic potential	1,961,425	20.2	Need reclamation of salinity patches within cultivated fields, capable to produce reasonable yields of some particular crops. Rice is recommended for reclamation of soil.
4	Land with poor grazing potential	721,069	7.4	Provide only poor grazing for animals.
5	Agriculturally unproductive land	238,871	2.4	Dune land, gravelly land, rock out crop, classified as unproductive land.
6	Total area of left bank	9,708,725	100	Land falling under canal command system of study area.

3.2 Land Capability Classification

The left over areas from drainage point of view have not been attended previously by WAPDA and irrigation departments. Following areas have been included in left bank regional plan and taken up for planning.

- Ghotki leftover area
- Khairpur South left over area
- Tando Adam, Tando Allah yar and Tando Mohammad Khan left over area
- Farash, Khipro, Umerkot left over areas
- Digri left over area

From Land capability classification point of view, maps of all above left over areas have been prepared separately, keeping under consideration the method and soil classification criteria suitable to the agricultural conditions of the particular area under study. It is similar in basic structure to the U.S. soil conservation classification. Generally for all the leftover areas the soils placed in highest class (I) have got the least limitations for agricultural use and relatively little efforts are required to produce high crop yields. Where as in other classes (II-IV) in some components there are limitations for agricultural use and special managements are required to produce high crop yields. Soils in the lowest (V) class are mostly unfit for economic arable use.

The major limitations to agriculture in all left over areas are the arid and semi arid climate, combined with some drainage and Irrigation problems. Hence outline for classification recognized for each leftover area, have been bifurcated into two levels i.e. main Land capability class & its associated subclass.

The first is broadest group identified by Roman numerical (I-V), where as second limitation factor such as “r” irregular relief is used as prefix with the class numerals. Kinds of limitation may vary within each class and are designated with small letters. On the basis of limitations the following sub classes are recognized.

e - Soils restricted in use due to erosion hazard.

r- Irregular local relief hindering irrigation or tillage.

w- Soils restricted in use due to excess water because of poor drainage, high water table or overflow.

s- Soils restricted due to shallow soils depth, stoniness or slowly permeable.

a – Soils restricted in use due to salinity or alkali problem

3.2.1 Class I: Very good agricultural Land

In general, this Land capability class occupies only the irrigated or irrigable Land of the left over areas. No subclass is recognized in this class, since there are no or only slight limitations for crop production. Overall status of this class in left over area is presented in (Atlas Fig P3-M-L-003-007). Further it is pertinent to note that this class according to land resource has more or less the similar characteristics as of the agricultural Land development potential class-1 soils. Hence these soils are capable to produce wide range of different crops. Topographically these are level to nearly level, usually deep, well drained and have good water holding capacity.

From tilth & tillage point of view, such types of soils are easily worked to good physical conditions, favorable for germination and growth of plants. The surface texture is usually loamy or silty, but may be somewhere clayey in nature. Under traditional management, these soils could be used for general cropping. Under modern management and with sufficient irrigation water supplies, cash crops are recommended for Rabi are wheat and oil seed, where as in kharif cotton can produce a very good product and sugarcane as a perennial crop gives the good response. However, rice in such type of soils should be restricted.

3.2.2 Class II: Good agricultural Land

In each left over project area, this class occupies only as irrigated or irrigable land of the area. Soils in this class have minor limitations, for example, maybe due to low water holding capacity or undulating topography or any other hazard. Therefore, during traditional management, this class may possess one of the limitations like IrIIr (relief problem), IrIIw (water logging), IrIIs (shallow depth or stoniness)

Hence, for such type of minor limitations, modern management techniques are required to eliminate the prevailing hazards so that land could be cultivated to general cropping, and capable to grow cash crops same as recommended for class-I soils for Rabi & Kharif season, further rice cultivation for such type land is also restricted.

3.2.3 Class III: Moderate agriculture Land

This class occurs mostly in all leftover areas (Atlas Fig P3 M-L-003-007) and has got severe limitations like IrIIIw, IrIIIa, dIIIw. It means that this type of soil contains one or more than one severe type of limitations; like soils somewhere are imperfectly drained, saline-alkaline and mostly loamy very fine sands with medium to fine textured surface. Traditionally most of these soils generally produce moderate yields, for such type of soils under modern management wheat & oil seed in Rabi & rice in Kharif are recommended and can produce moderate yields. However, rice can give good results from production point of view by applying fertilizer, insecticides & pesticides at proper time to save the crop from stem borer, subject to condition that rice is possible under sufficient irrigation water available during the cropping season. Further it is recommended that the low lying areas occupied by this class may be cultivated to paddy as it is high delta crop and resistant to water logging conditions.

3.2.4 Class IV: Poor (Marginal) Agricultural Land

Soils in this class have severe limitations for crop production and have very narrow range of agriculture use. Improvement to a reasonable level of productivity may or may not be technically feasible, but would go to high expenditure for development or maintenance.

The irrigated soils (Atlas Fig P3 M-L-003-007) in this class have either a severe hazard of water saturation below two or three feet due to the regional high water-table throughout the year associated with strong salinity at the surface or moderate salinity-alkalinity problem throughout the soil profile. Mostly soils in such type of class have poor structure, coarse textured, or of burial by shifting eroded sand dunes sand from the surroundings, therefore, the sub classes associated with this class are ir IVw, ir IVs and ir IVa. Traditionally these lands are used for poor grazing and capable to grow some type of saline resistant crops/ fodder.

Class V: Unproductive Land

The land in this class does not have a potential for economic agriculture, grazing or forestry. It is best to left in its natural state (Atlas Fig P3 M-L-003-007), some parts may need a forestation or other measures to protect adjoining agriculture lands from its effect like blown sand.

Because of sandy nature, this type of land does not support any vegetation, due to low rainfall, high temperatures, and very low water holding capacity. It has no potential for agriculture but its sandy material could be used for construction of buildings and other purposes. Other parts of the same class type of land are waterlogged and are mapped as perennially wet and partly saline marsh land with a poor stand of water reed grass and other grasses used for poor grazing. Therefore, on over all bases this class could be associated with Ve, Vw. Vs and Va sub classes. Keeping under consideration the maximum limitation factors, protection of such type of soils does not appear economic at present and irrigation water could better be used on better lands.

3.3 Land Use of the study area

3.3.1 Background

Land use surveys have been carried out in the past by a number of Govt/ semi Govt agencies. These surveys have been conducted at different periods, using different methodologies and classification criteria, depending upon the Land use situation of the area. The data produced by LIP (WAPDA) is of high value (Atlas Fig P3 M-P-010) and still serves as a base line for the forthcoming surveys, but it lacks both in uniformity and adequacy, hence in order to have a comprehensive soil survey of the Indus region a major program for fresh and updating the data was highlighted in Drainage Sector Environmental Assessment (DSEA) report for launching a National Drainage Program. In perspective of that a country wide survey was initiated for evaluating different aspects of physical resources by using the latest technology, and Land use studies were one of them.

Under present situation, the survey and investigations and their results are considered the latest one, as after that not a single survey of this type has taken place on a large scale within Lower Indus region. The responsibilities of these Studies were performed by the Soils and Reclamation Directorate SMO under NDP program from 2000 to 2005.

The above studies were conducted on canal command basis, and covered 14 canals of right and left bank of Guddu, Sukkur and Kotri barrages. For our studies only the data of left bank command of eight (8) Canals off-taking from three (3) barrages have been collected, processed and documented and their maps for each canal command are presented (Atlas Fig P3 M-C-011-019)

While using the data, consultants have further selected sample sites for verification of Land use throughout the study area and where ever necessary, changes have been made & updated the physical status of Land resource by ground truthing.

3.3.2 Methodology used for land use classification

The main objective of this survey was to map the different categories of Land use, mainly depending upon the availability of irrigation water, nature of relief/ topography, types of soils, climate and management. Besides the socio-economic factors have also great influences on the Land use. For conducting Survey/ investigation SPOT images of 1:50,000 scale and Ground Topo sheets at the same scale were used for appraisal and delineation of different categories and determination of overall status of the prevailing Land use. The main classes of Land use recognized and mapped in the eight canal command areas falling on the left bank of Indus for three barrages are presented in a tabular form (Table 3.2).

3.3.3 Cultivated Land

This type of land under each canal command has been found in normal conditions having no or a negligible hazard of salinity, high topography and shortage of irrigation water during low supplies from canal systems. Over all 6,767,289 acres (69.7%) of Canal commands of Indus Left bank study area is cultivated mostly by canal irrigation supplies, however within the fresh ground water zone cultivated Land is also supplemented by Tube well irrigation system. This class is further bifurcated into three major categories as shown in Table-3.2 and mentioned as under.

i. Perennially Canal irrigated
ii. Canal Irrigated supplemented by Tube wells.
iii. Non perennially Canal Irrigated

3.3.4 Perennially Canal Irrigated

The major part of Land served by eight canal commands of three barrages of Indus left bank fall under this category covering an area of about 3299362 acres (34%). Mostly within this category all type of Kharif & Rabi crops are sown, however ***major*** cash crops are cotton, wheat, rice and sugarcane. In some parts near the urban areas vegetables, fodder is sown for commercial purpose. The most of area is cultivated by mechanized farming

3.3.5 Non- Perennially canal Irrigated Lands

On Left bank area out of Eight Canals, the three major canals Ghotki feeder, Pinyari and Fuleli off-taking from Guddu and Kotri barrages respectively are non-perennial and are opened during the Kharif Supplies (summer season). However, the Ghotki feeder off-taking from Guddu barrage is mostly supplying the subsequent irrigations during rabi (winter) season. Overall acreage under these canal commands is almost 1593684 (16.4%) acres. In kharif the Land is mostly under use of rice, sugarcane and Cotton crops, where as wheat and pulses are shown on moisture conserved by the soil after the rice harvesting and further supplemented by one or two irrigations during the required period by the crops. Most of the area is under mechanized farming.

3.3.6 Canal Irrigated supplemented with Tube Wells

The area under this system is benefited by two way irrigation system. Mostly these Lands lie in fresh ground water zone and are supplemented by tubewell irrigation. The overall area under this category served by this system is about 1874243 acres (19.3%). As the area within this unit has no shortage of Irrigation water, therefore lands are capable to grow all suitable crops including orchard, vegetables under the required climatic conditions.

3.3.7 Forest

This category covers a very small area about 41531 acres (0.42%) of the study area this is because of the deforestation trend in the area & no further plantation up to the requirement is being planted either by public or private sector, only a little interest is taken by the forest department for the survival of remaining forest reserves in the area.

3.3.8 Presently unproductive Lands

This category is one of the most important, because most of the lands due to some hazards are lying as such and are classified un-productive Lands. This category includes the sand dunes, highly saline Lands, waterlogged (under water) and high topographic soils which are not within the reach of irrigation system. These Lands over all occupies about 2210780 acres (22.88%) of the left bank command area. such type of land only capable supported natural vegetation for grazing animals.

3.3.9 Miscellaneous Land type

A mapable area is covered by this class which includes the villages, Towns, Cities, grave yards, industries and the linear features like road, railways, canal, drains etc. The total area under this category is about 689125 acres (7%) of the Indus left bank Study area.

Table 3.2: Land Use Categories of Study area

S No	Name of Canal	Cultivated Canal Commanded Area					% of cultivated land	Forest	% of area	Un productive Land	% of area	Miscellaneous Land type	% of area	Total Area	% of area
		Perennially Canal Irrigated Land	% of cultivated land	Non Perennially Canal Irrigated Land	% of cultivated land	Canal irrigated+ Tubewell irrigation				Sand desert + under water + saline Land		Urban area + Grave yards+ Road+ Canal etc			
1	Ghotki Feeder	-	-	304286	31	392846	40	19666	2	177997	18	90000	9	984795	100
2	Khairpur feeder East	414920	82	-	-	15180	3	-	-	30360	6	45540	9	506000	100
3	Khairpur feeder West	260000	86.7	-	-	18000	6	-	-	1000	0.3	21000	7	300000	100
4	Nara	1286746	53	-	-	170000	7	18966	1	837682	32	118000	5	2431394	100
5	Rohri Canal	998588	34.3	-	-	1278217	44	1638	0.2	491180	16	158090	5.5	2927713	100
6	Lined channel (Akram Wah)	339108	64	-	-	-	-	-	-	120962	22.5	71895	13.5	531965	100
7	Pinyari	-	-	548672	56	-	-	1261	0.4	297674	30	133600	13.6	981207	100
8	Fuleli	-	-	740726	71	-	-	-	-	253925	24	51000	8.17	1045651	100
	Total	**3299362**	**34.0**	**1593684**	**16.4**	**1874243**	**19.3**	**41531**	**0.42**	**2210780**	**22.88**	**689125**	**7.0**	**9708725**	100

3.4 Agro-Climatic Zones

General Nature of Area

The study area is cultivated mainly by canal commands of three barrages of Lower Indus region with some additional supplies through fresh ground water tubewells. The canal commands of these barrages spread over 9,708,725 acres of land on left bank of Lower Indus basin. The quality of cultivated land is by and large moderate to good to very good and is capable to produce good quality to high quality of agricultural produce by adopting modern management techniques.

Due to the favorable temperatures for plant growth, the crop production is possible throughout year. Sugarcane, cotton and rice are the main Kharif, where as wheat and oil seed are the main Rabi cash crops. Mostly all these crops and some type of orchards are grown on good and very good lands as classified in the agricultural development potential. The lands in use vary considerably from place to place, in most of parts, the variations occur within such a short distance and patterns are so complex that it is not possible to draw boundaries between the different crops. Moreover, each type of land under different crops cannot be mapped separately on a broad scale of mapping used in this on reconnaissance investigations. Therefore, a combination of two or more crops is possible as shown in (Atlas Fig P3 M-P-008-009)

Overall, out of total command area about 6,767,289 acres (69.7%) of land is being cultivated to different type of crops as shown in Agro map. These are mostly cultivated through canal command system; however within the fresh ground water zone additional supplies are also being supplemented through tube wells installed by the public and private sector.

3.4.1 Agro-climatic zone under Guddu Barrage

Ghotki Feeder a nonperennial canal off taking from left bank of Guddu Barrage mainly irrigates the lands of Ghotki Area Water Board (AWB) with some additional supplies of fresh ground water tubewells.

The fresh ground water zone is naturally benefited to have additional supplies through public and private tubewells, hence all type of crops are grown throughout the year. The major cash crops are wheat, oil seed, vegetables, in Rabi and in Kharif cotton is a cash crop, where as sugarcane is perennial and is becoming dominant crop day by day due to flourishing of sugar industry within the study area.

However, cropping pattern is somewhat different in saline ground water zone as it is handicapped due to non availability of full canal supplies during the winter (Rabi) season. Therefore, major cash crop is cotton and rice in kharif and wheat, oil seed & pulses are grown on soil moisture conservation left in rice fields with some extra one to two irrigations supplies to Rabi crops allowed during their maturity period.

3.4.2 Agro climatic zone under Sukkur Barrage System

Overall, the left bank area under the command of Sukkur Barrage is perennially irrigated by four main canals viz Rohri, Nara, Khairpur East and Khairpur Feeder west. Nara Area Water Board (AWB) is one of the major part of this area.

Within the commands of above canals general cropping is practiced and mainly wheat, cotton, sugarcane, oil seed are the winter (Rabi) and summer (Kharif) crops. The fruits grown in this zone include dates, mangoes, banana, guava, etc; Under present conditions due to rapid increase in sugarcane industry on left & right bank of Indus, has created attraction to growers for growing the sugarcane throughout the study area. Especially the large areas of fresh ground water zones are thickly covered by sugarcane which is one of the major cash crop and next is the cotton. Whereas within the saline ground water zone of area the rice is mostly cultivated on slightly salt affected soils and cotton in grown on the lands which have got high potential and suitability for growing and producing high yields.

3.4.3 Agro Climatic Zone under Kotri Barrage

Kotri Barrage command on left bank have three canals, out of which Phuleli and Pinyari are nonperennial, whereas, Akram Wah (Lined channel) is a perennial canal. Within the command of non perennial canals mostly rice covers the major area and next to this is cotton grown in kharif season. Sugarcane as a perennial crop is a major cash crop grown within the perennial command of Akram wah. Due to favourable climatic condition sugarcane yield in this area (Lower Sindh) is higher as compared to the northern parts of Sindh. In Rabi wheat, oil seed, pulses are mostly grown on residual moisture left in the fields after harvesting of paddy crop. During the maturity period of these crops one to two extra irrigations are allowed through the canals. However, in command of the Akram wah, wheat, oil seed, pulses, banana and vegetables are the common crops of winter (Rabi) season.

3.5 Water Resources

The Lower Indus Left-bank region stretches along the River-Indus for 600 km like a curved v-shape, which expands from a 200 km wide desert range to 500 km wide coast along the Arabian sea. The natural river path use to meander over a wide range and split into many creaks and shallow channels as it reaches to the sea. Historically, the whole region was extended flood plains of the river Indus, which could be inundated during the flood season and simultaneously drained by the Indus and a supportive system of deeper drainage ravines dispersing into the coastal water bodies. All major tributaries of Indus join it before it enters into Sindh, however, contribution of hill torrents from the Kirther range could be occasionally substantial.

The river-Indus is the main source of water for the region complemented by highly skewed and erratic summer rainfalls. The groundwater aquifer is predominantly saline. About 20% of the area has fresh groundwater aquifer. In some areas, intensive canal irrigation provides a shallow layer of useable percolated water, which, is recharged during summer. The pumpage of this water through shallow tubewells has consistently increased supplementing surface irrigation, industrial and domestic water uses. About 80% of the river flows in the Indus basin have been allocated to the provinces and then to the main canals off-taking from the barrages. The accountable water resources of the left-bank include rainfall, allocated canal supplies, renewable groundwater in canal command areas and direct uses from the water bodies by the local livelihood and vegetation.

3.5.1 Rainfall

The rainfall in study-area is erratic and confined to the monsoon period of July to September. The dominant pattern of the monsoon is two to three medium downpours during July or August. Heavy rainstorms normally occur in August and September. The winter months or Rabi season receives less than 10% of the total rainfall. The rainfall-normal's for six meteorological stations are shown in Table 3.3. The maximum average annual rainfall (228 mm) occurs at Chhor, which is located in the lower-half of the region, closely followed by Badin, representing the coastal region. Towards the North, average rainfall decreases to 117 mm per annum (Rohri). The station- average rainfall is not the weighted average of the Left-bank. These normal-values better represent rainfall in gross canal-command areas of the left-bank.

The last column of the table 3.3 shows average rainfall measured from 1977 to 2011 at Badin, Chorr and Nawabshah stations. The average annual rainfall of the period 1977-2011 (35 years) is the same as long-term normal values for Badin. An increasing trend can be noticed for Chorr and Nawabshah, Figure 3.1. Thirty-five year rainfall shows two specific changes in average trends:

i. The annual average rains of 35 years at Chorr and Nawabshah are higher than the normal rains. The reason is increased frequency of high rainfalls and a decrease in incidences of nominal rainfall.

ii. Rainfall at the Chorr station has an increasing tendency because of more frequent above-average rains (Figure 3.1). The average rains of thirty-five years indicate 18.5 mm more rains at Chhor than the Badin.

Table 3.3: Climatic Normals of Rainfall at Left-bank Meteorological Stations in mm– updated 2010

Sindh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Avg. 1977-2011
Badin	1.8	6.4	0.7	1.9	6.2	9.9	67.6	92.5	27.1	5.5	2.9	1.0	223.5	223.67
Chhor	1	3.5	0.8	1.6	7.2	18.4	79.3	69.3	37.3	6.2	3.6	0.2	228.4	242.12
Hyderabad	2	4.3	2.4	5	4.6	6.2	45.5	63	12.6	2.9	2.3	1.3	152.1	
Nawabshah	2.4	3.3	2.4	2.6	1.5	2.8	50.9	46.3	16.2	4.9	1.5	1.8	136.6	148.64
Padidan	2.8	4.6	4.1	2.7	1.4	2.7	40.5	40.5	12.6	2.2	1.7	2.1	117.9	
Rohri	4.8	5.9	5.3	2.7	5.2	5.6	45.5	25.1	11.8	3.4	0.7	1.1	117.1	
Stations Average	2.47	4.67	2.62	2.75	4.35	7.60	54.88	56.12	19.60	4.18	2.12	1.25	162.6	

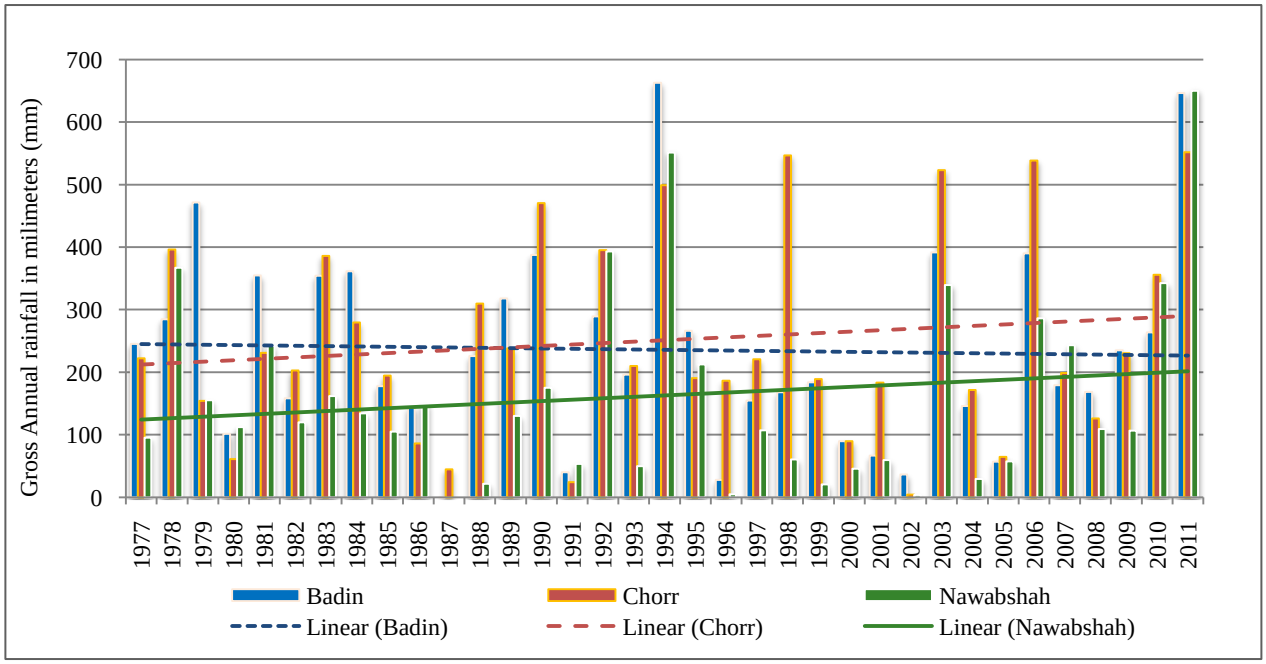


Figure 3.1: Total Annual Rainfall of 34 years at three MET Stations in LBOD catchment

The contribution of rainfall as a water-resource is limited in the region. The precipitation makes 25% of the reference evapotranspiration during July and August and only 13% in September. Because of unreliability of rains and maximum crop demands during summer, irrigation planning relies on high canal diversions. While, the rainstorm can generate more than fifteen billion cubic meters (15 bcm) during heavy monsoon years and more than ten cubic meters (10 bcm) during fifty percent of the years. The local topography and aquifer conditions could not safe rain-runoff from heavy showers and it needs to be evacuated through an effective drainage system. The rain-runoff and drainage issues are further analysed in the report on drainage assessment scenarios.

3.5.2 Surface Water

The diversion of river flows through long conveyance and distribution channels is the main source of water in the project area. The provincial-shares of river flows are accounted at the head of main canals off-taking from

river barrages. Under normal conditions, river structures, reservoirs and canal systems are regulated on 10-daily bases, to satisfy provincial shares and demands for water releases. The provincial water shares agreed in 1991, accounted as a sum of canal-diversions, provide seasonal and annual global targets for river water distribution. However, provincial requests could be different from the allocated shares for shorter periods. In the beginning of a season, the Indus River System Authority (IRSA) prepares a seasonal water distribution plan by keeping in view provincial allocations and expected availability of water in the network. The adjustments are made during operations, responding to the actual water availability, changes in demand and emergencies like floods.

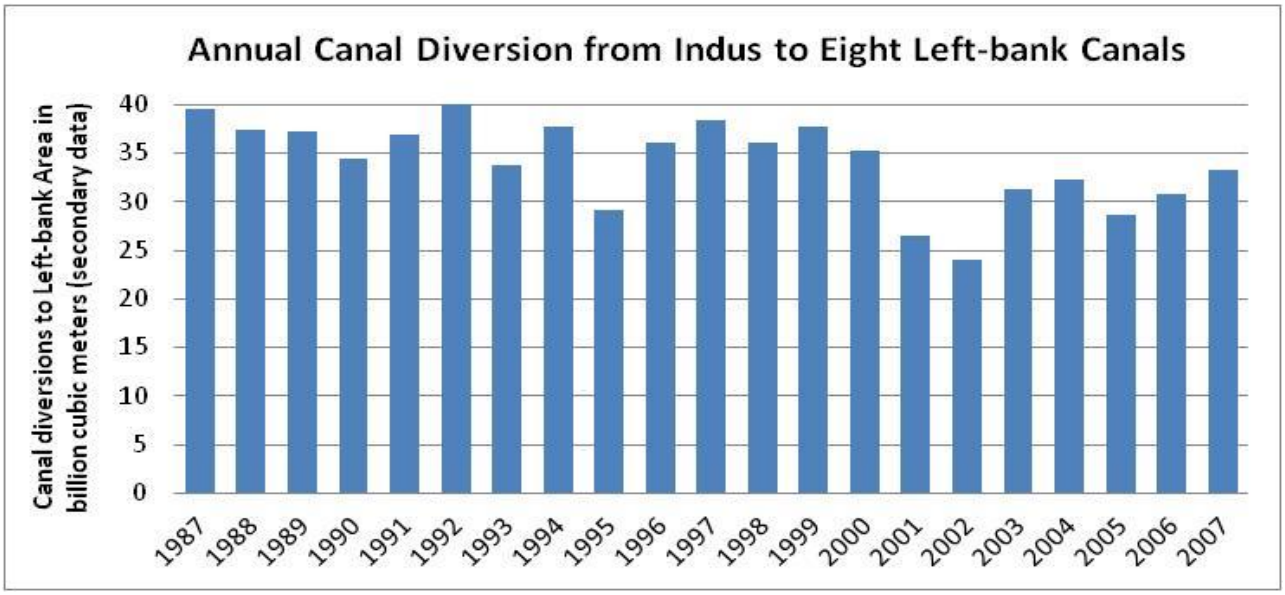


Figure 3.2: Annual Canal Diversion to Eight Left-Bank canals

The diversion-data of twenty years from 1987 to 2007 shows a decrease in maximum irrigation diversions to eight left-bank canals. Apparently, there is no reason for a systematic decrease in river supplies, however, it indicates that the formal irrigation diversions are currently constrained at the level of 1987. Some of the low-supply trends can be explained:

- From 2000 to 2002 were two years of severe drought in the basin. The river water availability was 30% less than the average annual flows.
- There were four years of heavy floods, 1992, 1995, 2003 and 2006. The canal closures and a decrease in water demands could be expected.

The irrigation diversions to individual canals against the seasonal allocations (WAA 1991) indicate higher water stress during Rabi than Kharif (Table 3.2). The natural Indus river flows in winter are only 25% of the summer flows. The snow-melt and monsoon rains are the major contributors of river flows during Kharif. Because of limited surface storages in the system, Rabi water availability is not sufficient to achieve the allocated flows in the system.

The water-balance analysis summarized in Chapter-10 shows the quantitative contribution of different water resources and predominant role of river flows in meeting different water demands.

Table 3. 4: Surface Water Allocations (1991) and Actual Supply (2007-08) to the Left-bank Canals

	Water Allocation 1991			Actual 2007-08			Diverted/Allocated	
	Kharif	**Rabi**	**Annual**	**Kharif**	**Rabi**	**Annual**	**Kharif**	**Rabi**
	Million Acre Feet			Million Acre Feet			Ratio	
Ghotki	2.30	0.95	3.25	2.237	0.913	3.150	0.97	0.96
North West	1.90	1.01	2.91	1.413	0.982	2.395	0.74	0.97
Khairpur West	0.65	0.53	1.18	0.526	0.333	0.859	0.81	0.63
Khairpur East	0.92	0.70	1.62	0.757	0.386	1.142	0.82	0.55
Rohri	4.84	3.95	8.79	4.172	2.365	6.537	0.86	0.60
Nara	4.16	3.25	7.41	4.913	2.662	7.575	1.18	0.82
Lined Channel	0.95	0.52	1.47	0.738	0.442	1.179	0.78	0.85
Fuleli	2.72	0.68	3.40	3.266	0.528	3.795	1.20	0.77
Pinyari	2.06	0.43	2.49	2.363	0.290	2.653	1.15	0.67

3.5.3 Groundwater

The use of groundwater remains limited in Sindh before the drought years of 2000-02. About 25% of the left-bank crop-zone has non-saline groundwater aquifer. The estimated number of tubewells in Sindh from 1970 onwards are shown in Figure- 3.3.3 (Water Statistics Project, reference Sindh Development Statistics 2006). The agriculture development, water shortages in winter and substantial increase in area with perennial cash crops, are the major factors behind the growth of shallow tubewells at a faster pace. Another factor behind this increase in well density is population pressure and increasing economic-value of the commercial agriculture.

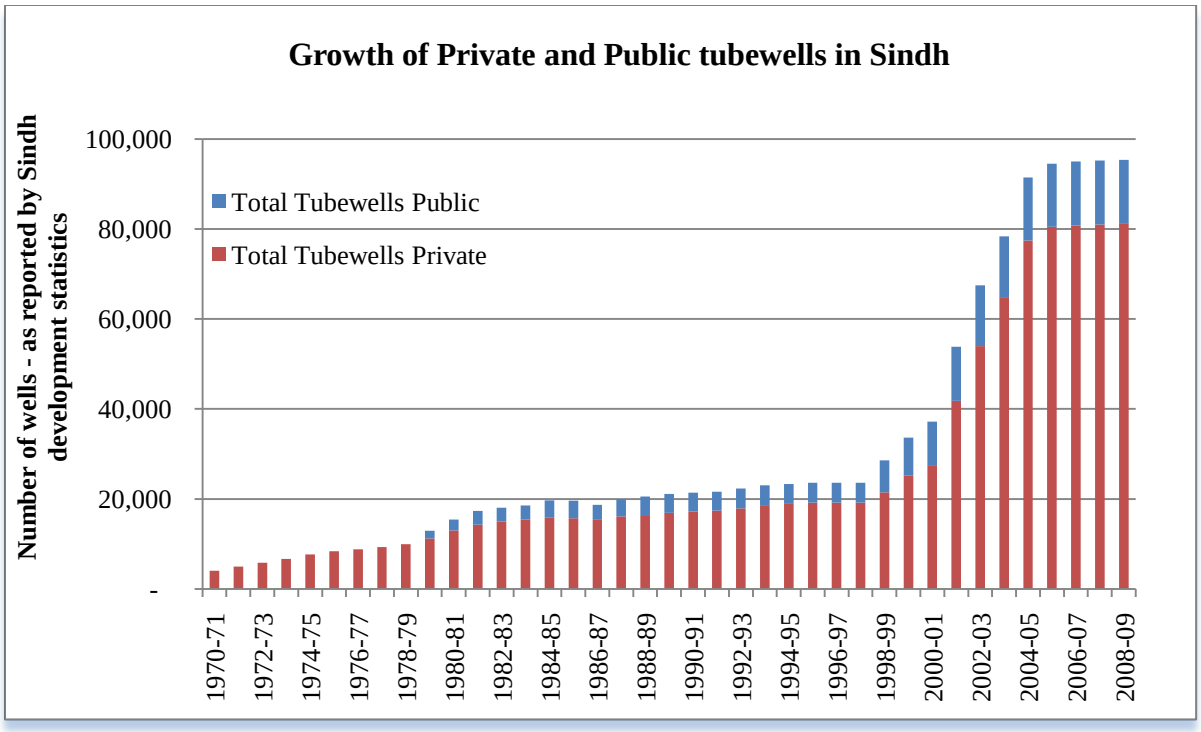


Figure 3.3: Growth of Tube-wells in Sindh from 1970 to 2010

The reported patterns of increase in private tube-wells could not be fully explained from the gross provincial data. As the monitoring surveys are not carried out on a regular interval, the reported data may contain a bias.

Table 3.5: Actual and estimated number of Public and Private Tubewells Installed in Sindh

Years	Electric Tubewells		Diesel Tubewells		Total Tubewells		Total Sindh
	Public	Private	Public	Private	Public	Private	
1970-71	0	2,082	0	1,989	0	4,071	4,071
1980-81	2,429	9,297	0	3,695	2,429	12,992	15,421
1990-91	4,164	12,431	42	4,739	4,206	17,170	21,376
2000-01	9,171	14,930	518	12,572	9,689	27,502	37,191
2008-09	13,099	18,637	1,116	62,541	14,215	81,178	95,393
Source: Agricultural Statistics of Pakistan							

The quantitative contribution of groundwater in different sectors is estimated and discussed in the sections on water-balance analysis.

3.6 Agriculture

Agriculture sector is an important engine of growth in the study area. It directly and indirectly provides livelihood to about three fourth of the Sindh population residing in the left bank. The left bank receives almost 60% to 65% of the canal withdrawals, while its share in the total cropped area is about three fourth. Apart from wheat, the main staple, most of the main cash crops and high value crops, such as cotton, sugarcane, vegetables, condiments, and fruits (mango and banana) are grown.

3.6.1 Farm Area, Ownership and Tenure

3.6.1.1 Farm structure and tenure

According to the last agricultural census of 2000[6], the farm structure in the left bank, despite dominance of small farms (in numbers), is in favor of large farms (in terms of total land area). Most farms are fragmented and are in joint ownership of extended family. This skewed structure is a constraint to access and distribution of factors of production, particularly to smaller farms. This also is a factor responsible for income disparity in the rural areas. Following is a description of farm structure vis-à-vis farm ownership, and tenurial pattern.

3.6.1.2 Farm ownership pattern

There are about 600 thousand farm owners in the Study area, managing about 3.4 million ha. The average farm size is about 5.7 ha. Three fourth of the total farm owners are subsistence farmers. They own about one fourth of the total farm area. The number of farmer owners, in very small farm size category[7], is about 21.4 percent (131 thousand), but they own only 2.4% of the farm area, with an average farm size of 0.6 ha. Similarly, 52.1% (312 thousand) small farmers own about 22.9% of the farm area, with an average farm size of 2.5 ha. The 77.4 thousand (12.9%) owners are medium size farmers, owning about 15.9% of the farm, with an average farm size of 7.0 ha. This farm size is optimal farm size for sustenance of an average family. About 69.2 thousand farmers (11.5%) are in the large farm size category and they own about 34% of the farm area, with an average farm size of 16.7 ha. The very large farmers are about 1.5% (9.1 thousand) and they own one fourth of the farm area, with an average farm size of 92.8 ha.

Based on the past trends in the ownership pattern, as evident from previous census, the number of farmers and the area owned in the higher farm size group is shrinking, consequently increasing share of smaller farms over the years. The main reasons are: i) land mutation; ii) land transfers; and iii) out migration by selling land and investment in urban areas.

3.6.1.3 Operational holdings and tenurial arrangement

There are 727.5 thousand operational farms cultivating about 2.8 million ha. About 441.4 thousand farms (60.7%) are operated by owners farmers (self/direct cultivation), managing 81.7% of the operated farms. The tenants or sharecroppers account for 35.2% and operate 21.2% of the area. The remaining farms are owner-cum-tenants accounting for about 4.1% of the total operators, cultivating 9.2% of the area. The average farm area operated is 3.9 ha. The average area operated by tenants is about 2.3 ha, while owner cultivators manage about 5.2 ha, and the owner-cum-tenants operate on an average about 8.6 ha.

3.6.2 Crop Area yields and Production

3.6.2.1 Cropping pattern

Sindh has two main cropping seasons, namely kharif – summer season (mid-April through mid-October), and Rabi – winter season (mid-October through mid-April). The main Rabi crops are wheat, rape and mustard, vegetables, and fodder. The main crops grown in kharif are cotton, sugarcane, paddy,[8] millets, and cluster-

[6] Agriculture Census 2000: Province of Sindh. Statistics Division, Government of Pakistan

[7] Very small farm size group = less than 1 ha; Small farm size =1ha to <5 ha; Medium size farm = 5 to 10 ha; Large size farm = 10 to 40 ha; and Very large size farm = above 40 ha.

[8] Mostly in non-perennial areas of Guddu and Kotri barrages

bean, kharif vegetables, pulses, nontraditional oilseeds,[9] etc. In addition to this, the left bank produces different fruits such as mango, banana, dates, papaya, guava, etc.

There is significant increase in wheat area and its share in the cropped area. The area under wheat reported as 764 thousand ha in 2007/08, accounting for 26% in the cropped area, has increased to about 821 thousand ha in 2009/10, sharing about 30% in the cropped area. It appears that wheat has replaced Rabi oilseeds whose area has reduced drastically. Similarly, area under cotton has increased from about 579 thousand ha in 2007/08 to about 600 thousand ha in 2009/10 accounting for about one fifth of the cropped area. The area under paddy has also increased from about 181 thousand ha in 2007/08 to about 261 thousand ha in 2008/09, and declined to about 238 thousand ha in 2009/10. The share of paddy in total cropped area oscillated between 6% and about 9% in the same period. The share of Sugarcane area in the total cropped area has declined from about 10.4% to 8.3% in the reported years. The area under sugarcane declined from about 304 thousand ha in 2007/08 to about 230 thousand ha in 2009/10. The area under fruit increased from about 142 thousand ha to about 145.5 thousand ha in the same period, while area under vegetables has also increased from 54.6 thousand ha to about 64.7 thousand ha in the same period indicating a shift to high value crops.

The existing cropping pattern and intensities of canal commands in the left bank was also estimated from the records of Sindh Irrigation Department, Sindh Irrigation Development Authority (SIDA), and Agricultural Department and published data by the Bureau of Statistics of Sindh and Pakistan. Where the availability of water is limited, the farmer prefers mixed cropping pattern with low delta crops such as pulses, oil seeds, orchard and fodder. In the upper reaches of the canal commands, the annual cropping intensity is higher than the lower reaches of the canal, because availability of water at tail ends is low. In Sukkur Barrage and Kotri Barrages, the upper reaches have higher cropping intensities compared to lower reaches.

The above cropping pattern is for the overall left bank and includes cropped area in the nonbarrage areas. In the following section cropping pattern and cropping intensities has been revisited using the command wise information on cropped area under various crops.

3.6.2.2 Cropping intensity

Based on computations from the land utilization data,[10] the overall cropping intensity in the Study area is estimated as 65%. It is highest in the Guddu sub-region (110%), followed by Kotri sub-region (63%), and 60% in the Sukkur region. One reason that explains high farming intensity in Guddu sub-region is rapid growth in private tubewells. Moreover, major portion of the culturable waste and area uncommandable lies in the Sukkur sub-region.

The cropping intensity mentioned above should not be seen same as command area specific cropping intensities. The estimated cropping intensity reflects cropping intensity of the Study area as a whole, which include barrage and non-barrage areas.

Based on further analysis of data[11] mentioned earlier, in 2009/10, the annual cropping intensity of Ghotki Feeder of Guddu sub-region is 35%. The annual cropping intensities of Khairpur West Canal, Khairpur East Canal Nara Canal, and Rohri Canal falling in the Sukkur sub-region is in the order of 89.7%, 82.7%, 40.4% and 63.7% respectively. Likewise annual cropping intensity of Akram Wah in Kotri sub-region is 30.1%, while cropping intensities of only Kharif season for Pinyari Canal and Fuleli Canal, both no perennial canals, is in the order of 19.3%, and 18.5% respectively. It is evident from the figure of cropping intensities that in Nara Canal command the annual cropping is very low which is the clear indicator that there is either acute shortage of water or the available water potential is not used intelligently. Similarly, there are alarming figures of cropping intensities in the command of canals falling in Kotri sub-region, which explicitly manifests that there is a huge shortage of water in this sub-region. This whole scenario needs a special attention to address the problem in a productive manner in order the alleviate the poverty prevailing in problematic sub-regions.

[9] Mainly sunflower and safflower,
[10] Volume-II Table 4.6.14
[11] Volume-II Table 4.6.27 through 4.6.34

A recent survey conducted by WAPDA in 2006/07 shows that the cropping intensities has decreased from 127.7% in 1982/83 to 114.9% in 2006/07 in the LBOD system.[12] The results are encouraging about increase in cropped area, reduction in current fallow, and production.

3.6.2.3 Production

In the left bank of Indus the production of wheat during 2007/08 through 2009/10 oscillated around three million mt. The Sukkur sub-region accounts for about two thirds of the total production, followed by about 20 % produced in Guddu sub-region, while Kotri sub-region contributes 6% to the total left bank production.

The total production of cotton (seed cotton) in the left bank during the same period was about 2.5 million mt in the first two years, which increased to about 4 mt in 2009/10. This phenomenal increase is due to wide adoption of Bt varieties. About two third of the cotton is produced in Sukkur sub-region, followed by Guddu sub-region which contributes about one fifth in total cotton production, while about 5% is produced in the Kotri sub-region. Recently it has been reported that the performance of Bt cotton in Kotri sub-region has demonstrated exceptionally high yields and cotton may be an important crop in the coming years.

In the left bank paddy is also an important crop, and its production increased from half a million mt in 2007/08 to about 700 thousand mt, of which about 70% to 80% is produced in the Kotri sub-region, while the balance is produced in the Guddu sub-region and Sukkur sub-regions.

The total production of sugarcane in the three sub-regions was about 18.5 million mt, in 2007/08, which significantly declined to about 13 mt in the last two years. The total production of vegetables, a high value enterprise, in the left bank was 686 thousand mt in 2007/08, which increased to about 800 thousand mt in 2008/09, while it shows a drastic decline in 2009/10 reducing to about 200 thousand mt. The Sukkur sub-region which contributed about two third of the total vegetable production in 2007/08, its share declined to about 45% by 2009/10. The share of Kotri sub-region in total vegetable production in 2007/08 was about 15%, which has increased to about 50% by the year 2009/10. Sukkur sub-region produces about 85% of the fruits, followed by about 10% in the Kotri sub-region.

3.6.2.4 Crop yields

The average yield of wheat during the last three years i.e. 2007/08 through 2009/10 is stagnant at about 3.6 mt/ha, which is higher than the wheat average for Sindh, and higher than national average. The yield of seed cotton has shown significant increase in the last three years. The yield of cotton in 2007/08 was 4.2 mt/ha, which increased to 4.6 mt/ha in 2008/09, and in 2009/10 it recorded a phenomenal increase of 6.8 mt/ha. The yield of sugarcane has been erratic. In 2007/08 the estimated average yield was observed as 61 mt/ha, which declined to about 50.5 mt/ha in 2008/09, and increased to about 58 mt/ha in 2009/10

3.6.3 Shift in Cropping Pattern

Within the study area, Badin and Thatta are the districts where significant shift in cropping pattern have been noticed. The parameters analyzed to assess the cropping pattern are the area and crop-wise index of area in Badin and Thatta districts. The data collected from secondary sources for last 20 years indicate that about 32,000 ha in Badin district and about 460,000 in Thatta district was lost to sea intrusion. Analysis of cropped area trends in the Thatta and Badin area based on crop acreage data for 1991/92 through 2009/10 for all the crops, save sunflower, shows that the total cropped area declined after the cyclone and sea intrusion. Nonetheless, the cropped area in two districts has increased significantly in the post cyclone period, if the area under sunflower is also taken into account in the total cropped area. As the two districts are served by the eastern drain system i.e. LBOD and the western drain system for the Kotri barrage command area, hence this aspect is also one of the factor significantly affecting the cropping pattern. The 2010 river floods and 2011 storm water are also the main factors making shift in the cropping pattern of the lower Sindh districts.

[12] Final progress Report: Continuation of Monitoring of LBOD System. August 2006 to July 2008. SCARP Monitoring Organization (SMO) WAPDA, Hyderabad. June 2009

Unfortunately, despite concerted efforts this data for 2010 and 2011 could not be obtained from the Agriculture Extension Department or the Sindh Bureau of Statistics, but it has been observed during the consultative meetings, field visits surveys and face to face interactions with the farming communities that there is significant shift in the cropping pattern in the area.

In Badin district the total cropped area (excluding sunflower) in 1991/92 was reported as about 230 thousands ha which declined to about 199 thousand ha by the year 1997/98, during which the LBOD was being constructed. After the collapse of the tidal link and associated structures, the cropped area continued to decline till 2004/05 (about 49 thousand ha), but increased thereafter to about 207 thousand ha, which is about 10% lower than the base year. Similarly in Thatta district, the total cropped area (excluding sunflower) in 1991/92 was reported as about 101 thousands ha which increased to about 120 thousand ha by the year 1997/98. After the collapse of the tidal link and associated structures, the cropped area initially declined, but recovered and has increased to about 145 thousand ha by the year 2009/10; an increase of 43% over the base year. Refer Table 3.6 and 3.7 and Figures 3.4 and 3.5.

The abovementioned tables also show that with the acreage under sunflower included, the total cropped area has increased significantly over the last 19 years. In the Badin district the area registered an increase of more than 40% over the base year, while in the Thatta district the area has almost doubled in the same period. It may be mentioned here that the decline in the cropped area in the two districts may have been offset by the western drainage system.

The data on crop shares (excluding sunflower) shows that in Badin district, the share of Cotton area has increased from 2% in 1991/92 to 9% by the year 2009/10. In the Thatta district the share of paddy has declined from 58% to 50%, while wheat has increased from 6% to 11% in the same period. With the area under sunflower included, the share of sunflower has increased from 1%, in both the districts, to about 37% and 27% in Badin and Thatta districts. The year wise detail is presented in Table 3.8. The phenomenal increase in area under sunflower is that the recently introduced hybrid varieties have lower delta and two crops can be grown in the Rabi season.

Table 3. 6: Crop Wise Details of Area Sown In Badin & Thatta Districts during Last 20 Years from The Year 1991 To 2010

Name of crop	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
BADIN																			
Rice	96,535	54,142	78,359	60,396	71,640	79,439	75,449	74,197	64,190	70,459	60,958	64,783	58,751	58,934	61,199	62,324	59,132	80,544	82,687
Cotton	4,141	2,369	3,470	942	2,321	2,824	2,732	3,015	2,956	1,788	3,237	6,210	2,438	4,706	5,671	9,376	14,857	13,628	18,890
Kharif Fruits	2,646	2,649	2,648	2,593	2,788	2,982	3,066	3,149	3,210	3,441	3,325	3,208	3,626	3,192	3,178	4,688	4,327	4,803	5,278
Rabi Fruits	90	92	90	89	91	92	93	94	103	117	117	117	123	125	393	433	462	476	458
Sugarcane	56,942	52,491	61,157	54,256	58,474	57,037	59,989	62,613	30,898	43,792	47,872	52,139	43,260	36,248	38,453	39,667	59,847	53,640	46,117
Kharif Veg.	1,052	1,150	1,220	1,257	931	932	937	960	973	960	1,992	1,498	1,326	1,176	1,210	1,850	1,210	1,852	2,302
Rabi Veg.	1,377	1,625	1,619	1,628	1,969	1,994	2,005	2,014	1,942	2,017	4,152	4,396	4,094	3,865	6,470	4,639	4,918	4,976	4,888
Wheat	41,638	42,651	42,893	32,189	33,385	33,762	32,431	34,892	35,079	21,326	21,763	18,047	22,178	28,146	30,947	28,346	29,730	33,350	36,142
Kharif Fodder	16,780	14,391	14,489	14,523	14,155	12,858	13,125	13,484	10,859	8,455	8,697	5,236	7,518	4,992	5,802	6,479	4,152	4,071	2,302
Rabi Fodder	8,819	8,895	8,944	1,978	9,551	9,365	9,486	9,529	8,787	8,127	7,536	8,028	8,359	7,735	7,804	7,952	7,952	8,333	8,022
Subtotal	**230,020**	**180,455**	**214,889**	**169,851**	**195,304**	**201,285**	**199,313**	**203,947**	**158,997**	**160,482**	**159,649**	**163,662**	**151,673**	**149,119**	**161,127**	**165,754**	**186,587**	**205,673**	**207,086**
Sunflower	2,146	1,734	2,375	4,047	7,919	7,875	7,924	16,187	19,424	13,597	14,019	34,510	91,369	118,936	138,000	123,773	127,136	132,221	121,049
Total Area	**232,166**	**182,189**	**217,264**	**173,898**	**203,223**	**209,160**	**207,237**	**220,134**	**178,421**	**174,079**	**173,668**	**198,172**	**243,042**	**268,055**	**299,127**	**289,527**	**313,723**	**337,894**	**328,135**
THATTA																			
Rice	58,291	42,961	60,118	51,448	61,418	68,394	65,321	66,249	58,140	61,496	45,792	56,422	54,778	54,169	54,178	68,192	77,646	78,486	72,100
Cotton	229	45	108	17	59	56	41	48	50	48	864	528	515	522	692	506	812	836	2,056
Kharif Fruits	1,810	1,817	1,810	3,013	3,216	3,419	3,479	3,538	4,573	4,963	5,381	5,798	7,925	8,765	16,219	15,866	12,488	11,047	9,606
Rabi Fruits	120	121	117	118	122	126	127	128	130	156	145	133	136	138	75	65	64	35	46
Sugarcane	22,438	21,727	25,308	23,470	24,361	23,676	25,851	28,319	25,009	23,697	26,742	28,226	30,695	22,648	20,851	27,356	40,969	33,179	31,229
Kharif Veg.	706	1,111	1,132	1,166	1,053	1,068	1,075	1,097	1,096	1,035	1,786	1,495	1,574	1,503	1,496	1,624	1,066	725	296
Rabi Veg.	2,724	2,405	2,396	2,383	2,711	2,717	2,810	2,820	2,734	2,846	1,892	1,980	2,122	2,092	2,555	2,824	4,097	5,060	4,764
Wheat	5,827	8,972	9,536	9,716	10,353	11,879	11,024	12,673	13,126	8,709	10,116	8,196	9,974	9,562	12,846	11,889	13,104	13,636	15,271
Kharif Fodder	1,330	2,268	2,363	2,382	2,372	2,000	2,051	2,111	1,838	1,532	1,561	1,806	3,921	2,510	2,156	4,101	3,607	3,516	3,145
Rabi Fodder	7,433	7,477	7,445	7,617	8,003	7,778	7,928	7,974	7,284	6,501	8,479	8,892	9,387	8,749	8,501	8,571	8,519	5,976	5,946
Subtotal	**100,908**	**88,904**	**110,333**	**101,330**	**113,668**	**121,113**	**119,707**	**124,957**	**113,980**	**110,983**	**102,757**	**113,476**	**121,027**	**110,658**	**119,569**	**140,994**	**162,372**	**152,496**	**144,459**
Sunflower	1,216	503	971	1,821	1,528	3,732	3,772	4,452	5,666	3,966	4,089	4,801	37,196	45,610	52,579	43,974	52,612	54,716	53,454
Total Area	**102,124**	**89,407**	**111,304**	**103,151**	**115,196**	**124,845**	**123,479**	**129,409**	**119,646**	**114,949**	**106,846**	**118,277**	**158,223**	**156,268**	**172,148**	**184,968**	**214,984**	**207,212**	**197,913**

Source: Unpublished Data from Department of Agriculture Extension 2011

Table 3. 7: Crop Wise Index of Area in Badin & Thatta Districts during Last 20 Years

District	Name of crop	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Badin	Rice	100	56	81	63	74	82	78	77	66	73	63	67	61	61	63	65	61	83	86
	Cotton	100	57	84	23	56	68	66	73	71	43	78	150	59	114	137	226	359	329	456
	Kharif Fruits	100	100	100	98	105	113	116	119	121	130	126	121	137	121	120	177	164	182	199
	Rabi Fruits	100	102	100	99	101	102	103	104	114	130	130	130	137	139	437	481	513	529	509
	Sugarcane	100	92	107	95	103	100	105	110	54	77	84	92	76	64	68	70	105	94	81
	Kharif Vegetable	100	109	116	119	88	89	89	91	92	91	189	142	126	112	115	176	115	176	219
	Rabi Vegetables	100	118	118	118	143	145	146	146	141	146	302	319	297	281	470	337	357	361	355
	Wheat	100	102	103	77	80	81	78	84	84	51	52	43	53	68	74	68	71	80	87
	Kharif Fodder	100	86	86	87	84	77	78	80	65	50	52	31	45	30	35	39	25	24	14
	Rabi Fodder	100	101	101	22	108	106	108	108	100	92	85	91	95	88	88	90	90	94	91
	Subtotal	**100**	**78**	**93**	**74**	**85**	**88**	**87**	**89**	**69**	**70**	**69**	**71**	**66**	**65**	**70**	**72**	**81**	**89**	**90**
	Sunflower	100	81	111	189	369	367	369	754	905	634	653	1,608	4,258	5,542	6,431	5,768	5,924	6,161	5,641
	Total Area	**100**	**78**	**94**	**75**	**88**	**90**	**89**	**95**	**77**	**75**	**75**	**85**	**105**	**115**	**129**	**125**	**135**	**146**	**141**
Thatta	Rice	100	74	103	88	105	117	112	114	100	105	79	97	94	93	93	117	133	135	124
	Cotton	100	20	47	7	26	24	18	21	22	21	377	231	225	228	302	221	355	365	898
	Kharif Fruits	100	100	100	166	178	189	192	195	253	274	297	320	438	484	896	877	690	610	531
	Rabi Fruits	100	101	98	98	102	105	106	107	108	130	120	111	113	115	63	54	53	29	38
	Sugarcane	100	97	113	105	109	106	115	126	111	106	119	126	137	101	93	122	183	148	139
	Kharif Vegetable	100	157	160	165	149	151	152	155	155	147	253	212	223	213	212	230	151	103	42
	Rabi Vegetables	100	88	88	87	100	100	103	104	100	104	69	73	78	77	94	104	150	186	175
	Wheat	100	154	164	167	178	204	189	217	225	149	174	141	171	164	220	204	225	234	262
	Kharif Fodder	100	171	178	179	178	150	154	159	138	115	117	136	295	189	162	308	271	264	236
	Rabi Fodder	100	101	100	102	108	105	107	107	98	87	114	120	126	118	114	115	115	80	80
	Subtotal	100	88	109	100	113	120	119	124	113	110	102	112	120	110	118	140	161	151	143
	Sunflower	100	41	80	150	126	307	310	366	466	326	336	395	3,059	3,751	4,324	3,616	4,327	4,500	4,396
	Total Area	**100**	**88**	**109**	**101**	**113**	**122**	**121**	**127**	**117**	**113**	**105**	**116**	**155**	**153**	**169**	**181**	**211**	**203**	**194**

Source: Unpublished Data from Department of Agriculture Extension 2011

Figure 3. 4: Trend of Crop Cultivation Badin Area

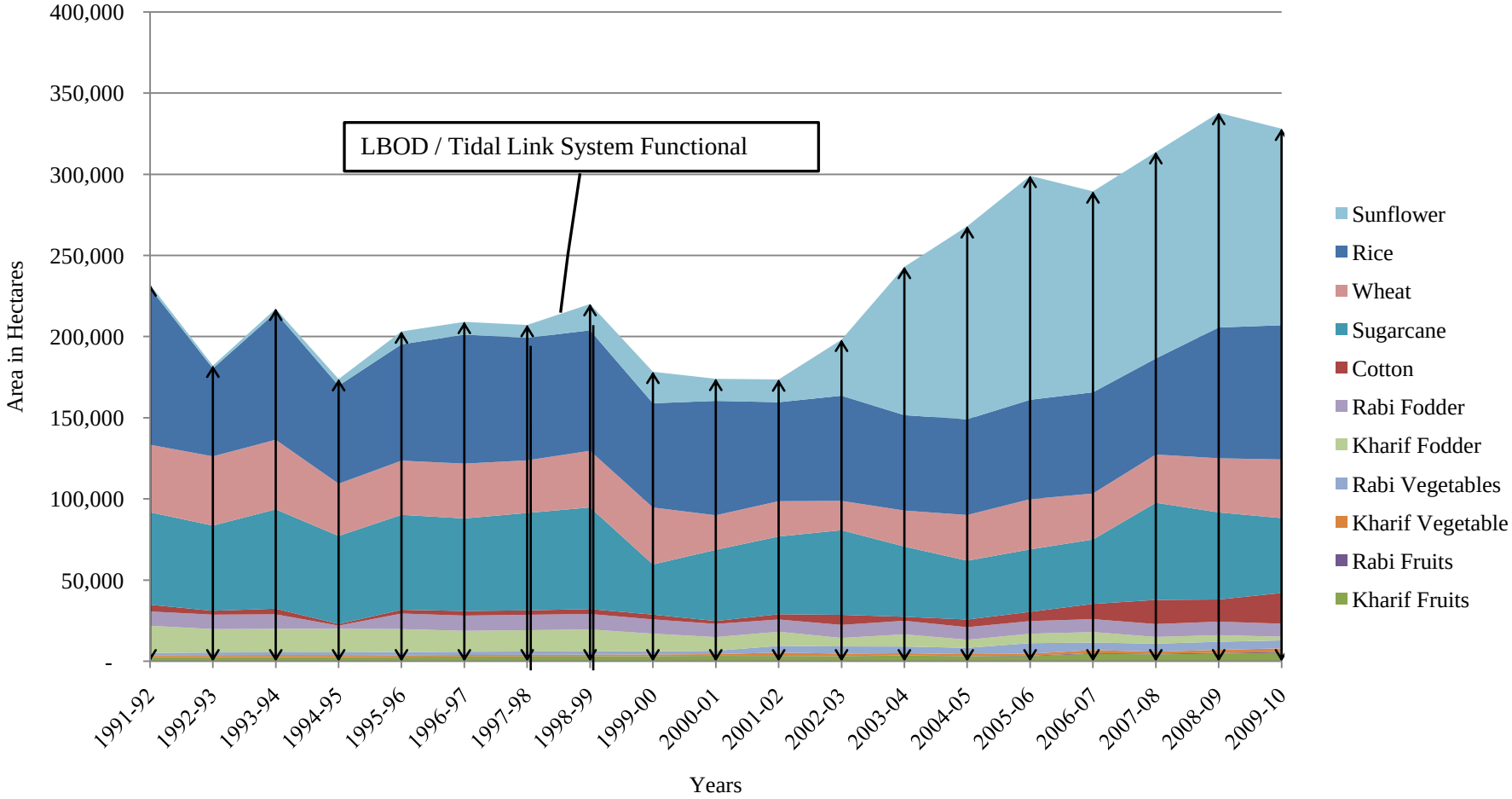


Figure 3. 5: Trend of Crop Cultivation Thatta Area

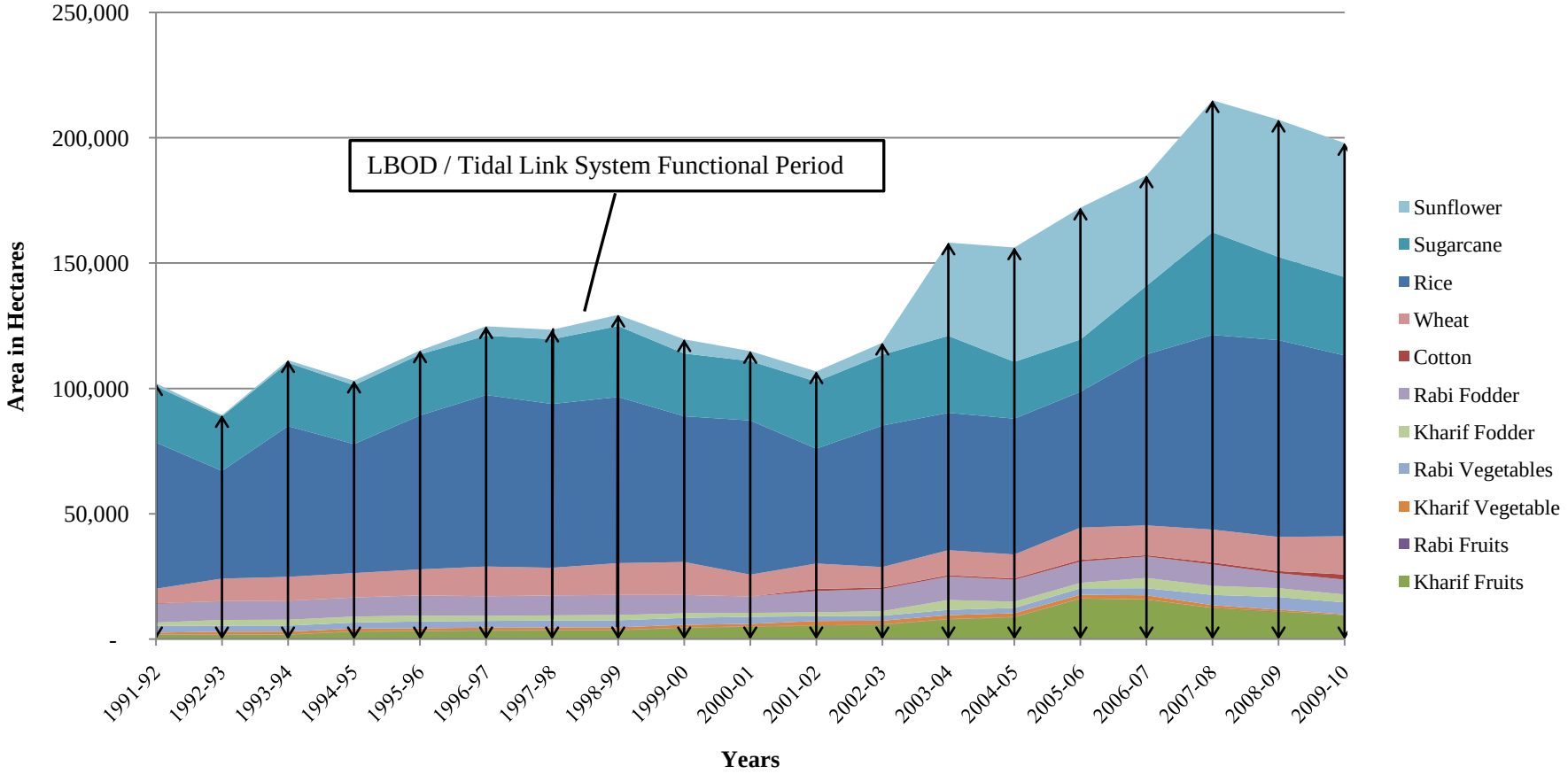


Table 3. 8: Share of Different crops in total cropped Area (Excluding Sunflower) In Badin & Thatta Districts during Last 20 Years

District	Name of crop	1991/92	1992/93	1993/94	1194/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Badin	Rice	42%	30%	36%	36%	37%	39%	38%	36%	40%	44%	38%	40%	39%	40%	38%	38%	32%	39%	40%
	Cotton	2%	1%	2%	1%	1%	1%	1%	1%	2%	1%	2%	4%	2%	3%	4%	6%	8%	7%	9%
	Kharif Fruits	1%	1%	1%	2%	1%	1%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	2%	2%	3%
	Rabi Fruits	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Sugarcane	25%	29%	28%	32%	30%	28%	30%	31%	19%	27%	30%	32%	29%	24%	24%	24%	32%	26%	22%
	Kharif Vegetables	0%	1%	1%	1%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
	Rabi Vegetables	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	3%	3%	3%	3%	4%	3%	3%	2%	2%
	Wheat	18%	24%	20%	19%	17%	17%	16%	17%	22%	13%	14%	11%	15%	19%	19%	17%	16%	16%	17%
	Kharif Fodder	7%	8%	7%	9%	7%	6%	7%	7%	7%	5%	5%	3%	5%	3%	4%	4%	2%	2%	1%
	Rabi Fodder	4%	5%	4%	1%	5%	5%	5%	5%	6%	5%	5%	5%	6%	5%	5%	5%	4%	4%	4%
	Subtotal	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
	Sunflower	1%	1%	1%	2%	4%	4%	4%	7%	11%	8%	8%	17%	38%	44%	46%	43%	41%	39%	37%
	Total Area	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Thatta	Rice	58%	48%	54%	51%	54%	56%	55%	53%	51%	55%	45%	50%	45%	49%	45%	48%	48%	51%	50%
	Cotton	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%	0%	1%	1%	1%
	Kharif Fruits	2%	2%	2%	3%	3%	3%	3%	3%	4%	4%	5%	5%	7%	8%	14%	11%	8%	7%	7%
	Rabi Fruits	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Sugarcane	22%	24%	23%	23%	21%	20%	22%	23%	22%	21%	26%	25%	25%	20%	17%	19%	25%	22%	22%
	Kharif Vegetable	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	1%	1%	1%	1%	1%	1%	0%	0%
	Rabi Vegetables	3%	3%	2%	2%	2%	2%	2%	2%	2%	3%	2%	2%	2%	2%	2%	2%	3%	3%	3%
	Wheat	6%	10%	9%	10%	9%	10%	9%	10%	12%	8%	10%	7%	8%	9%	11%	8%	8%	9%	11%
	Kharif Fodder	1%	3%	2%	2%	2%	2%	2%	2%	2%	1%	2%	2%	3%	2%	2%	3%	2%	2%	2%
	Rabi Fodder	7%	8%	7%	8%	7%	6%	7%	6%	6%	6%	8%	8%	8%	8%	7%	6%	5%	4%	4%
	Subtotal	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
	Sunflower	1%	1%	1%	2%	1%	3%	3%	3%	5%	3%	4%	4%	24%	29%	31%	24%	24%	26%	27%
	Total Area	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Unpublished Data from Department of Agriculture Extension 2011

3.7 Livestock

Brief overview of livestock subsector in the left bank: Nationally, it is estimated that the livestock sector accounts for about 50% in the total agriculture Gross Domestic Product (GDP)[13]. As the demand for the dairy products is significantly higher in the province of Sindh, it is estimated that the share of livestock in total provincial GDP is higher than national estimate. In the left bank there are about 8.5 million large ruminants, followed by 11.5 million small ruminants. Amongst the 936 thousand pack animals in the left bank, 73% are horses, mules, and assess. Camel population is about 218 thousand, and is concentrated in the Tharparkar district of the Sukkur sub-region.

Status: Livestock plays an important role in the economy of the Sindh province. Livestock represents an important component of agricultural sector in Sindh. Indeed, crop and livestock activities are to a great extent, interdependent upon each other for their functioning in the farm sector.

Broadly there three systems classified as mixed farming system, extensive system and intensive system. In the mixed farming system, crop farming and livestock raising are supplementary and complementary to each other. In extensive system livestock is raised mainly depending upon the grazing of pastures and crop residues. In intensive system, livestock especially buffaloes are produced in urban and peri-urban areas for milk purposes. In this system all the inputs including feed, water and medicines are made available at farm shed and there is no grazing of animals.

Table 3. 9: Number of Livestock in Sindh, 1986, 1990, 1996, 2000 and 2006 Census (in '000')

Type	1986	1990	1996	2000	2006
Cattle	3,874	2,792	5,464	3,946	5,968
Buffaloes	3,220	2,566	5,615	4,222	1,928
Sheep	2,616	1,194	3,710	2,220	3,363
Goats	6,755	4,618	9,734	8,913	9,599
Camels	218	140	225	261	64
Horses	76	30	63	49	76
Mules	5	4	12	10	67
Asses	500	302	694	533	560

Source: i) Agriculture Census, 1986, 1990, 1996, 2000, & 2006

ii) Agriculture Statistics of Pakistan, 2006-07

iii) Development Statistics of Sindh, 2008

Table 3. 10: Number of Livestock by district in Left Bank of Indus (1996 Census) (in '000')

District	Cattle	Buffaloes	Sheep	Goats	Camels	Horses	Asses	Mules
Hyderabad	436	772	173	854	8	3	30	0.4
Badin	289	368	164	302	7	1	9	0.3
Thatta	339	314	170	241	11	1	24	0.2
M. Khas	364	300	201	1,000	6	4	24	0.4
Tharparkar	485	40	899	1,971	103	8	151	0.5
Sanghar	353	253	197	702	8	4	31	0.6
Shaheed Benazirabad	328	355	136	500	4	2	19	0.7

[13] Economic Survey of Pakistan 2009/10, Economic Advisers Wing, Ministry of Finance, Government of Pakistan

Naushahro Feroze	309	395	111	527	7	1	28	0.5
Khairpur	436	493	124	694	10	3	32	0.6
Sukkur	209	171	56	272	7	4	15	0.7
Ghotki	173	193	63	372	2	2	17	--
Total	3721	3654	2294	7,435	173	33	380	4.9

Source: Pakistan Census of Livestock, 1996

Cattle population during the decade (1996-2006) increased 26.74%, buffaloes by 30.71%, sheep by 60.69% and goats by 29.15%. In draught animals camels increased by 23.93%, mules by 69.32%, asses by 44.87% and horses decreased by 28.19%. The animal population (2006 census) in Badin and Thatta districts is tabulated hereunder:

Table 3. 11: Number of Livestock in Badin and Thatta District

Name of Animal	Badin District (number)	Thatta District (number)
Cattle	315,369	410,614
Buffaloes	498,253	367,117
Sheep	223,072	162,131
Goats	878,299	351,366
Camel	8,672	10,702
Horses	1,714	3,036
Mules	184	566
Asses	18,947	19,137
Poultry	611,560	973,268

Source: Livestock Census Report, 2006

Livestock plays a vital role in agriculture-based economy by providing motive power for agriculture operations and supply of beef, meat, milk, hair, skin, manure and number of other products. Livestock is treated as part of agriculture. This is natural and logical. Agriculture provides food in form of grains, fruits, vegetables, oilseeds, sugarcane etc. Livestock give milk and meat directly as food. Livestock directly helps in production of food grain and supplying dung as organic manure. Similarly, muscle power of draught animals for land preparation and other agricultural operations is a great contribution towards agriculture. Therefore, there is an organic relationship between agriculture and livestock.

Livestock live on pasture, straw and crop residues, not edible for man. This way, livestock convert waste into useful products.

3.8 Fisheries

Brief overview of fisheries subsector in the left bank: During the past years the fish catch increased from 57 thousand mt in 2003/04 to 62.8 thousand mt and declined to 60.3 thousand mt in the year 2006/07. During the past few years the share of fish catch in Kotri subregion declined from 62.4 percent to 55 percent, while the share of the Sukkur subregion increased from 12.7 percent to 24.4 percent in the same period. Similarly the catch increased from 29.7 percent to 31.5 percent in the Sukkur subregion, while in the Ghotki subregion it increased from about 13 to 24 percent. This is mainly due to the salinization of freshwater bodies in the Kotri subregion, particularly in the delta and coastal zone.

In the Study area, the fisheries subsector provides livelihoods to about 32,000 household. It is reported that in 2006/07 fisher folk population distribution, there were 23 thousand full time fisher folks, while there were about 8.8 thousand part time fisher folks. The table also shows that there are 3,560 boats, out of which 1,810 are sailboats and 1,750 are rowboats.

Status: Sindh province holds the premier position in the fisheries sector of the country. It commands almost 100 percent of the brackish, 65 percent of the fresh water and 71 percent of the marine water resources of the total fisheries area of the Pakistan. These resources comprise 400 commercially important species of the marine fish, 200 species of fresh water fish and 13 species of shrimp. The coastal areas of Thatta and Badin districts are considered major fishing areas.

Fisheries are an important activity in Badin. About 10 percent of the overall marine fish exports originate from Badin. The district is also considered to be among the most productive in Sindh for fresh water fisheries. Badin is considered to have some of the most productive fresh water fisheries in Sindh. Inland fisheries statistics for Sindh in 2002 revealed that out of the total fish production of 80,659 tons, some 14,152 tons or 17.5 percent were produced in Badin which was second only to Thatta district in inland fish production.

As a coastal district, Badin relies on fisheries as an important component of economy. The current situation suggests that habitat protection has not been addressed, enrichment is not a priority and general indifference to the fisheries sector is pervasive. As such, it is no surprised that little has been done to check the discharge of dangerous effluents and untreated waste into water sources, which not only seriously undermines water quality but also threatens the existence of fish species. Similarly, the absence of land use planning, accelerated urbanization and population growth have transformed some streams into virtual municipal drains.

About 10 percent of the overall marine fish exports originate from Badin. Promoting fish production will not only raise the income of fish farmers, but will also benefit other businesses including processors and exporters.

During 2000-2001, total fish production in Pakistan was recorded at 665,000 tons; the contribution from marine fisheries along Sindh and Balochistan coast lines was 480,000 tons, while the contribution of inland fisheries was 185,000 tons. Of all the coastal fisheries the contribution from the Sindh coast and Indus delta is higher than Balochistan despite Sindh's coast line being smaller (only 350 km). During 1999, out of a total of 474,665 tons of marine fish catches in Pakistan, the Sindh coast contributed 333,047 tons; the exclusive economic zone (EEZ) under the control of the federal government produced an additional 184,545 tons. Badin, being part of the Sindh coastal area, contributes significantly to marine fish production, especially shrimp. It is estimated that out of the marine fish exports worth US $100 million, about 10 percent comes from the Badin coast.

In Badin taluka, there are 100 fish farms covering 1,619 hectares. In Tando Bago taluka, there are 150 fish farms encompassing 3,540 hectares. Fish farms are also found in Golarchi, Matli and Talhar.

The vast majority of these fish ponds have been established in former lakes and natural depressions. Only a dozen or so fish farms are reported to be managed on scientific lines and profitable in financial terms. Most of the farms are facing problems related to technology, maintenance of proper soil and water balance and feeding practices. There is a need for appropriate training as well as the establishment of hatcheries to supply fry from successful species.

Badin has many other fresh water fisheries including natural depressions and water bodies such as the Dhoro Puran, surface drains, inland lakes, tidal lakes and canals and distributaries. The development of fresh water fisheries at selected locations in these vast areas could yield significant gains in terms of fish production as well as income generation for the local communities.

3.9 Forestry

After agriculture, forestry is the second largest land use in Sindh. Forests are a natural endowment and valuable resource for the province with a distinctive feature of being renewable. Sindh is blessed with variety of forest types such as Riverine forests located along both sides of Indus, irrigated plantations located in the command area of irrigation systems of Sukkur, Guddu and Kotri barrages and Coastal forests located in deltaic region of Indus.

Forests have vital social, economic and environmental importance for the people of Sindh province. They provide productive and protective functions, diversified types of functions such as production of timber for constructions and raw material for industries, fuel wood for energy, non-wood products for domestic and industrial uses, protection and preservation of environment including erosion and water logging and salinity control and, employment generation for rural people. Role of forests and

farmland trees in the maintenance of environment, absorption of solar energy and sequestration of Carbon dioxide, protection of river banks from erosion, conservation of biodiversity and wildlife and prevention of desertification is also equally important. Due to these functions, forestry is considered as an important resource for social and environmental development.

3.9.1 Forest Resource in Sindh

Out of Sindh's total land area of 14.091 million ha, an area of 1.126 million ha, is under the control of Sindh Forest Department (SFD) for different types of forests. Although total area controlled by SFD is 8% of the province, but only an area of 2.3% is covered by productive forests. Functionally, forests in Sindh are categorized as productive and protective forests. Table -8 provides the forest types and details of area under each category.

Table 3. 12: Categories and types of Forests and area in Sindh

Category	Type	Area (M.ha)	% of total land area of Sindh	% of area under forests
Productive Forests	Riverine	0.241	1.72	21.5
	Irrigated Plantations	0.082	0.58	7.3
	Sub-Total	0.323	2.30	28.8
Protective Forests	Mangroves	0.344	2.45	30.6
	Rangelands	0.457	3.25	40.6
	Sub-Total	0.801	5.70	71.2
Total		1.124	8.00	100

Source: Sindh Forest Department's Records

3.9.2 Forest resource base in study area

There are three major types of forests in the study areas viz irrigated plantations in the command area of Sukkur, Guddu and Kotri barrages and coastal forests along the coast. Rangelands located in Kohistan and Registan areas are also declared as protected forests. All these forests are managed by the Forest Department Government of Sindh.

3.9.2.1 Irrigated Plantations

Irrigated plantations of Sindh, also known as inland forests, were once riverine forests but isolated from Indus waters by earthen embankments constructed in the 1930s. Presently, these plantations are irrigated from Sukkur, Kotri, and Guddu barrage irrigation systems. The concept of irrigated forestry was introduced by British with the objective to provide fuel wood to railways and cantonments in the country. Due to these reasons almost all the irrigated plantations are located along or close to railway line in Sindh and Punjab provinces. The principal species used to be *Dalbergia sisoo* (Shisham) in Upper Sindh plantations, while *Acacia nilotica* (Babul) in the lower Sindh. Due to the fact that *Shisham* is water demanding species it was replaced by Babul and *Eucalyptus camaldulensis. Eucalyptus* was increasingly planted in all the plantations as it was a fast growing tree used for industrial purposes.

3.9.2.2 Area located in left bank of Indus/study area

Of the total area of 82,000 ha under irrigated plantations in Sindh, an area of 65,175 ha is located left bank of Indus in Thatta and Badin districts. District-wise area of irrigated plantations is shown in Table 3.13.

Table 3. 13: District-wise Area of Irrigated Plantations on Left Bank of Indus in Sindh

District	Area (Ha)
Ghotki	11,431
Khairpur	5,013
Naushahro Feroze	634
Nawabshah	1,933
Sanghar	9,121
Umerkot	500
Hyderabad	3,282
Tando Muhammad Khan	7,918
Thatta	15,833
Badin	9,510
Total	**65,175**

3.9.3 Management Objectives of forests

The following are the main management objectives of Forestry.

1. To increase vegetative cover over state forest lands in the province through conversation and improvement in the existing Riverine and irrigated for maximizing sustained production and preservation of ecosystem.
2. To meet the fuel wood and timber requirements of the province on sustained basis.
3. To promote environmental stability and preserve bio-diversity and natural heritage.
4. To intensify management and adopt post care and strict measures against deforestation as so to enhance productivity in line with potential of the site.

3.9.4 Sources of irrigation of Forests

The only source of irrigation to these plantation areas is through network of canal irrigation system of three barrages. Like agriculture, water has been allocated at the rate of 1.0 cusec for 40.0 ha plantation from different distributaries throughout the province. Internally, the Forest Department has constructed water courses for proper distribution to all irrigated plantations.

3.9.5 Coastal/Mangrove Forests

The area of the deltaic plain from the shoreline to the alluvial valley covers about 29,500 sq. km in the shape of fan. It represents a typical dry (arid) subtropical delta with high evaporation rate and negligible precipitation.

The Indus delta, built up by the discharge of large quantities of silt washes down in Indus River from Karakoram and Himalayan mountain ranges. The delta is spread over in about 600,000 hectares and is characterized by 17 major creeks, mud flats – satellite imagery in the year 1999 indicates about 260,000 hectares of delta are covered with mangroves.

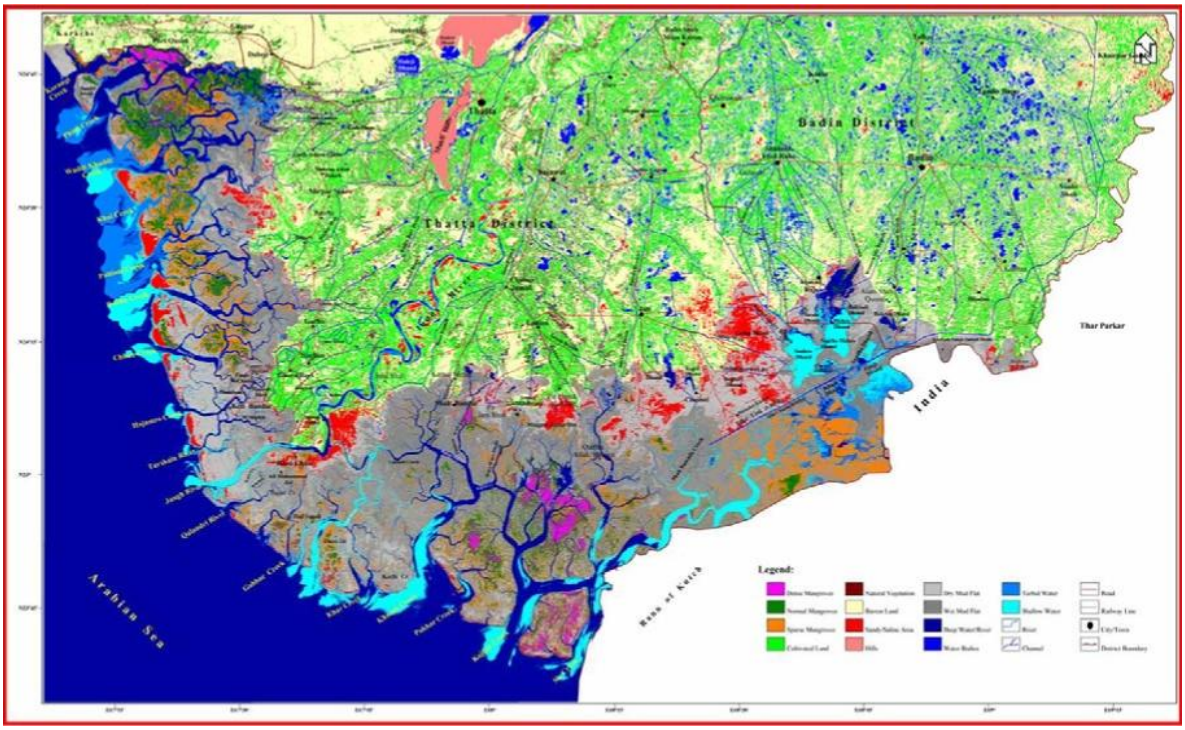


Figure 3.6: The Indus Delta

The mangroves are biologically a highly productive environment, as today, the only species growing and forming forests is *Avicennia marina* locally known as *"Timer"*. The mangroves are very important ecosystem both economically and ecologically. Although the mangroves play productive roles but their protective role is more effective than productive. Some of the roles/functions of mangroves are as under:

- As a pool of biodiversity they support diverse forms of plant and animal life.
- Provide food, shelter and breeding ground to prawns, several fin-fish, crabs and other marine life.
- Reduce wave action and help stabilize coastlines.
- Assimilate sewage water wastes and heavy metals from industrial plants.
- Protect seaports from siltation.
- Reduce the intensity of Cyclones
- Provide livelihood to a population of more than 100,000 people living along the coastline.
- Source of wood for heating and cooking and fodder for livestock.
- Provide shelter to migratory birds during winter.

Nutrient flows: The major sources of nutrient supply to the Indus Delta are:

- Freshwater and the riverine sediments as suspended load through Indus River discharge.
- Regeneration of nutrients within the deltaic areas through microbial activities.
- Supply through the physic-chemical processes operative on the coast and in the offshore delta**.**

Mangroves are dependent upon fresh water discharges from River Indus. The mangroves are dominated by a single species, *Avicennia marina* which is over 95% of the trees, though a few stands of *Ceriopsis tagal*, *Brugiuiriera conjugate*, *Aegiceras corniculatum* and *Rhizophora mucronata* also occur.

Mangroves are uniquely adapted to water-logged and oxygen-deficient tidal mud flats, where no other plant survives. These forests, besides having environmental value, also protect the sea ports from siltation and erosion, act as perfect breeding ground for shrimps, besides providing low grade timber for house construction, poles for boats, fuel wood for curing shrimp, and fodder for livestock. Mangroves are used as firewood and fodder for domestic animals. *Avicennia* wood does not make good fuel wood as other mangrove species e.g. *Rhizophora*, it is still used extensively by local people for their own uses. On the other hand *Avicenia* are excellent fodder for domestic animals. It is estimated that in past about 16,000 camels were fed upon mangroves. This practice has reduced the quality of growth and quantity of resource. Besides mangroves protect coast from wind and ocean currents

Commercial exploitation of mangrove forests for extraction of wood was not permissible except dead, dying and uprooted trees were allowed to be removed to meet the fuel wood requirements of local population and their removal was carried out legally under permits. Grazing, browsing and lopping however, is regular feature for livestock especially camel grazing and local use.

3.10 Wetlands

In Sindh there are more than 100 wetlands of which about 90% fall on the left bank of Indus. All wetlands are storehouses of biodiversity including wetland vegetation, plants, fish, birds, wildlife and other aquatic life especially for local communities and sources of livelihood of majority of population. There is great reliance on the wetlands as they are the main source of livelihood to the poor communities. Wetlands are ecosystems that provide numerous goods and services that have an economic value, not only to the local population living in its periphery but also to communities living outside the wetland area. Furthermore, wetlands also provide recreational opportunities and amenities, and flood control and storm buffering. Wetlands also provide a range of ecosystem services, including ground water recharge, flood control and water purification and also eco-tourism.

There are nineteen (19) wetlands declared as Ramsar Sites in Pakistan, nine are located in Sindh province of which six are situated on the left bank of Indus namely, Deh Akro, Nurruri lagoon, Jubbo lagoon, Runn of Kutch, Indus delta, and The Indus Dolphin Reserve. They have gained importance due to their unique biodiversity and habitat which shelters large number of species.

There are three important wetland complexes located on the left bank Indus in Sindh, the study area, namely Deh Akro II, Coastal wetlands and Chotiari reservoir and wetlands located in Shaheed Benazirabad, Badin and Sanghar districts, respectively. Deh Akro II and some wetlands of coastal wetlands are declared as Ramsar Sites under UN Wetland Convention at Ramsar, Iran.

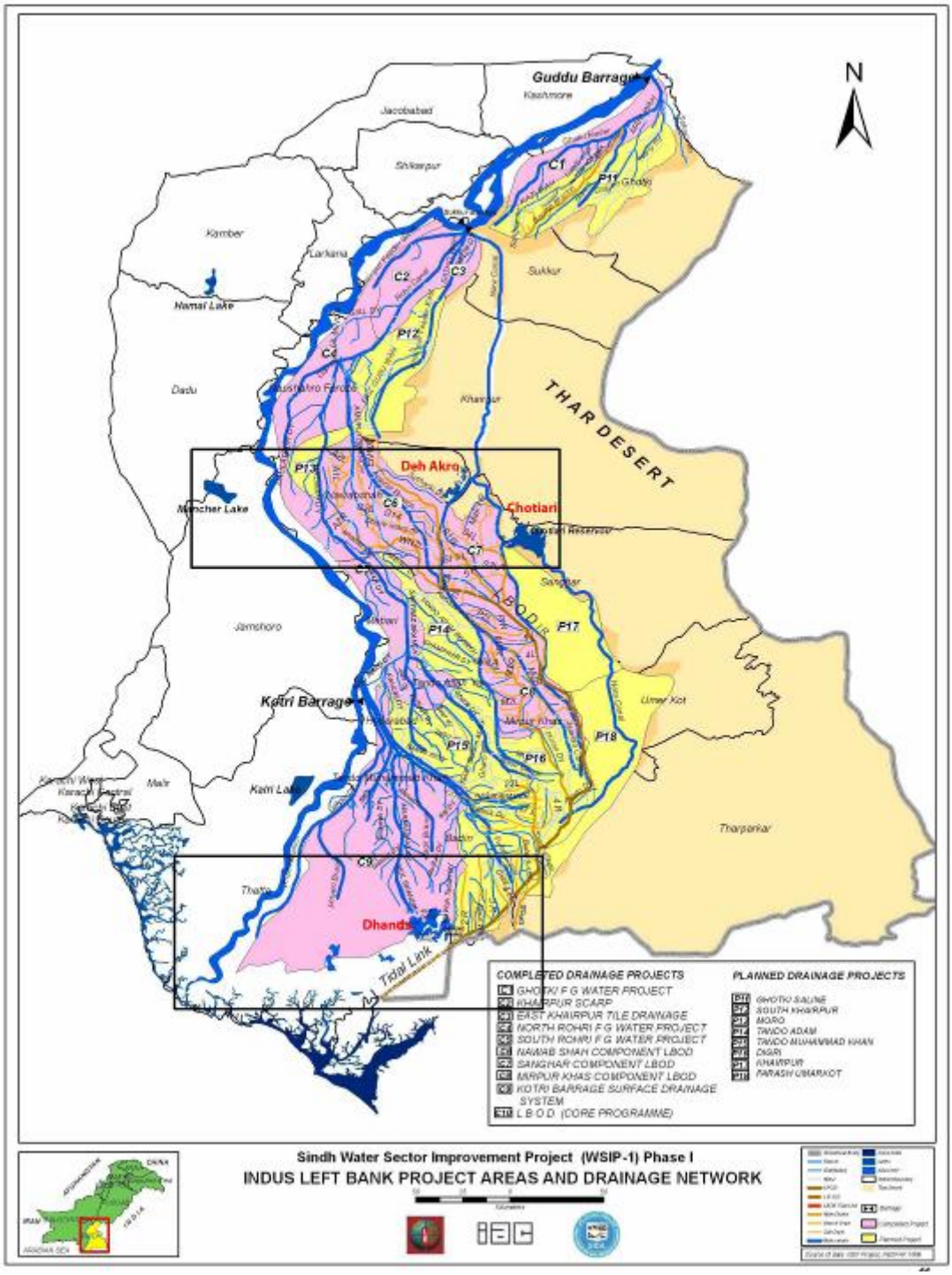


Figure 3. 7: Sindh Province and location of Wetland Complex sites

Chotiari wetland complex extends over 20,243 ha and includes about 36 lakes, of which five are freshwater and 31 brackish water, fed by seepage from the Nara Canal and its Jamrao offshoot. Located in a typical stable sand desert habitat, the lakes occupy flat bottomed valleys surrounded by 5 to 10 m high sand dunes.

Deh Akro II is wildlife protected area and declared as Ramsar site under UN Convention on Wetlands. It consists of four major habitats; desert, wetland, marsh and agricultural. It is a natural inland wetland ecosystem, which supports a variety of rare and endangered wildlife species. This area hosts a considerable number of rare fauna. Many indigenous fish species are also found. Water scarcity during a persistent dry spell is adversely affecting the area. There are 36 wetlands forming a

complex and having pre-dominant wildlife species of Chrocodiles. This area is managed by Wildlife Department, Government of Sindh.

Since the 1960s, when the Kotri Basin drains were built to discharge into the dhands they have become an important local fishery, and a waterfowl habitat of international importance. Portions of two of the Sindh dhands (Sanhro and Mehro) have been declared Ramsar sites, and the Rann of Kutch is included on the WWF list of the 200 globally most important biodiversity hot-spots. The natural pattern of surface drainage and overland flow, especially of storm runoff, from this coastal and near-coastal zone in Badin District is south and southeastward towards the Rann of Kutch. To avoid discharging LBOD through KPOD directly into this environmentally sensitive international wetland, a Tidal Link Canal was built 42 km southwestward across the dhands and the Rann of Kutch from KPOD to the nearest active tidal creek, Shah Samando Creek. The Tidal Link drain was isolated from the Rann of Kutch and the dhands by high embankments. An 1800 ft weir, called the Cholri Weir, was built where the Tidal Link Canal passes through Cholri Dhand in order to attenuate high water levels in the Tidal Link Canal during high tide by allowing water to flow into the dhands during this period, and to protect the dhands from excessive drainage during low tide when the water would flow back into the Tidal Link Canal.

4 Sector Context

4.1 Chronology of Irrigation and Drainage development in Sindh

Sindh Province has a vast irrigation and drainage network and it is one of the primary beneficiaries of the Indus Basin Irrigation System of Pakistan (IBIS). The IBIS is considered as one of the largest contiguous irrigation systems in the world. Of the total 14 barrages of the IBIS, Sindh has three major barrages on the Indus River that divert approximately 48 million acre feet MAF (59.0 billion cubic meters- BCM) of water annually to the 14 main canal commands in Sindh Province. These canal systems have an aggregate length of 13,325 miles (21,445 Km), which serve a gross command area (GCA) of 14.391 million acres (5.8 million ha). There are also about 42,000 watercourses (tertiary channels), which have an aggregate length of about 75,000 miles (120,000 Km). The water diversion in the study area Table 4.1 is approximately 11.6 MAF for eight canal commands.

Table 4.1: Major Barrages on the Indus River in Sind Province

Barrage Name	Nearest city	Year constructed	Diversion Quantity Left Bank (MAF)
Guddu	Ghotki	1962	3.484
Sukkur	Sukkur	1932	5.532
Kotri	Hyderabad	1955	2.577

A map showing this extensive drainage system is shown in Figure 4.1.

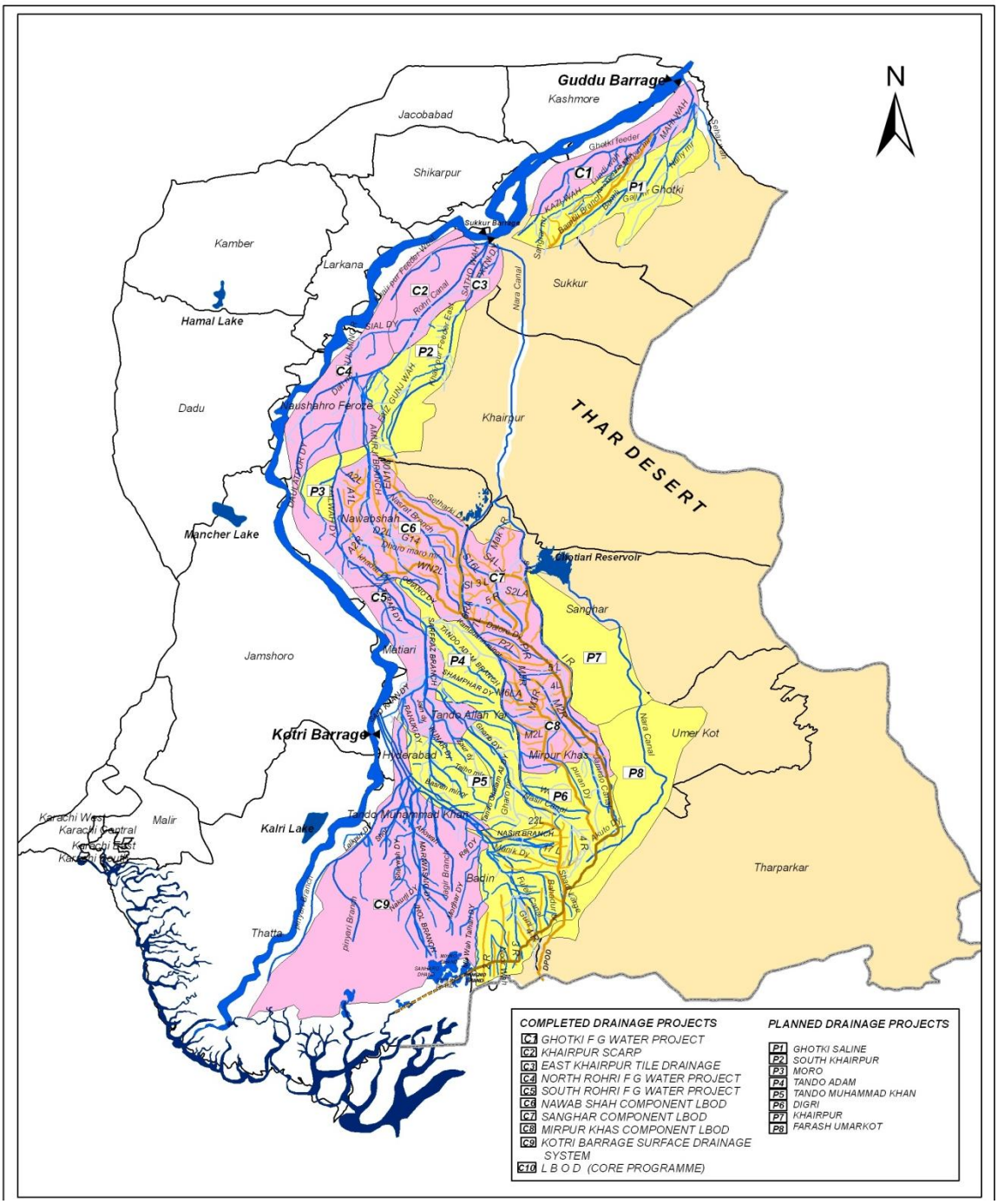


Figure 4.1: Map showing the drainage system of Lower Indus Region

4.1.1 Irrigation Infrastructure

The Southern/lower part of the Indus Basin Irrigation System is the main source of water resources for the Sindh province. In addition to this, underground fresh water, torrential flows, and water bodies supplement water availability. The water resources support irrigated agriculture, livestock, inland fisheries, forest plantation, municipal use, and industrial subsectors.

The Indus River in Sindh is managed with an elaborate system of irrigation, and drainage network to dispose off underground effluent, flood, and storm water. The irrigation system consists of three barrages, Guddu, Sukkur, and Kotri, diverting water into 14 main canal systems, of which eight are on the left bank and six are on the right bank. The canal systems deliver water to millions of farms through distributaries, minors, and watercourses. In addition to this, the system provides drinking

water supplies to the various urban settlements and industrial establishments. The river supplies, downstream of Kotri, fall into the Arabian Sea, supporting riverine forests, mangroves, and estuaries.

The development of Sindh province has always been governed entirely by the water of the Indus, even name Sindh, has been derived from one of the original name of the Indus. Therefore, the main source of virtually all water used in the region is of the river Indus.

The history of Irrigation development goes back to 500 years ago, where the people use to cultivate their lands on the flooding of the river Indus. Later on Inundation canals were excavated for irrigation purpose. These canals mostly were active during the summer (flooding) season. Then by the middle of 19th century the inundation canal system) was steadily improved and extended until by 1921 and about over two million acres were commanded by it. As the inundation system neared its zenith, plans were made to build barrages across the river to control river levels and direct the waters into a vastly canal system. In this way supplies could be ensured through out the year, so that summer and winter cropping could be possible.

4.1.2 Development of irrigation System

The first Sukkur barrage in the region was completed in 1932, some 80 years back, and then second one Kotri barrage in 1955 and the last one Guddu barrage in 1962 were commissioned. These three barrages irrigated the all parts of Lower Indus region.

The introduction of barrage controlled irrigation resulted in assured and more timely supplies for the existing cultivated areas. Two systems have been developed: Non perennial, with irrigation water in Kharif season only, and the Perennial, with water normally available through out the year for the summer (Kharif) and winter (Rabi) crops.

Outside the command areas, cultivation falls into two groups: rain-fed and flood irrigated. In general there is insufficient rainfall for normal cropping, hence during the rainy season especially in Thar desert the depressions are ponded by the run-off and retain the moisture for growing the crops and the second one sailaba, confined to river flood (Katcha or active flood plain) plain, during the high floods it is inundated and when water recedes, moisture is contained by land and crops are cultivated.

4.1.3 Water Diversion in Study Area

Irrigation water in study area is diverted from Indus river through Guddu barrage at Kashmore in the north. Ghotki Feeder canal off-takes from Guddu Barrage, whereas Khairpur Feeder east, Khairpur Feeder west, Rohri canal and Nara canal off-takes from Sukkur barrage and Akram wah, Fuleli canal and Pinyari canal off-takes from the Kotri Barrage. Gross command area of 8 canals is 9.75 MA and cultivable command area 8.58 MA.

The annual water entitlement of Ghotki feeder is 3.484 MAF, Khairpur feeder West is 1.148 MAF, Khairpur East 0.369 MAF, Nara Canal 7.803 MAF, Rohri Canal 8.297 MAF, Fuleli Canal 3.280 MAF, Pinyari Canal 2.593 MAF and Akram Wah 1.786 MAF with total annual entitlement of all 8 Canals is 29.562 MAF. The available data shows that the total annual diversions in 8 canals for years 2004-05, 2005-06, 2006-07, 2007-08, 2008-09 and 2009-10 were 26.7, 29.0, 24.8, 25.199, 22.02 and 23.696 MAF.

4.2 Drainage Infrastructure

More than three fourth of Sindh is underlain with saline groundwater, and is generally not fit for irrigation. The fresh groundwater, generally confined to the corridor along the Indus River, is of better quality, and is suitable for irrigation and domestic use. To supplement the canal water supplies, the private tubewells pump out the fresh groundwater.

To combat the increasing water table, causing water logging and salinity, declining farm productivity, and damage to physical infrastructure, the deep turbines and tile drains/interceptors are employed to pump and drain out the saline groundwater effluent. This effluent is disposed off into canals and or drainage network. The same is transported to natural depressions in the delta and Arabian Sea. The drainage network provides relief to the storm water. In the left bank, about one fifth of the canal command area suffers from water logging and salinity, and hampered farm productivity. The system, therefore, needs to drain out the surplus saline water effluent out of the basin. The Left Bank Outfall Drain (LBOD) collects drainage effluent from the major part of left bank command areas of Sukkur,

and Kotri barrages, and drains into the sea. The tidal link and Cholri weir at the tail end of the LBOD botched due to various acts of nature and technical reasons. The failure led to seawater intrusion and devastated the farmland, freshwater bodies, inland fisheries in the delta, and mangroves in the coastal zone. This had an adverse impact on the livelihood of people residing in the lower reaches of Kotri command, delta, and coastal zones, compromising their food security in the deltaic region and coastal areas. This also severely blighted the local ecology and environment. The communities in the affected area strongly feel they were not consulted during the planning, designing, and implementation stages.

The main reasons of water logging and salinity are high losses from canal seepage, losses from high doses of irrigation applications to the crops more than its requirement and also not adopting proper cropping patterns according to their agro climatic zones and soil conditions and over all mis-management of water which have created the twin menace of water logging and salinity within the irrigated areas of lower Indus region.

As explained above the continuous recharge to ground water from irrigation canals, water courses, field application to different crops and practice of growing high delta crops resulted in high water table which created the water logging and salinity problems within the study area. Hence, a considerable area of good agriculture land with high productivity potential started deteriorating every year.

Lower Indus Project investigations were started in 1959 to provide a plan for the optimal development of the water resources in Lower Indus Region. As a result of these investigations extending over a period of six years, the Lower Indus Report was prepared in 1966 by Hunting Technical Services Ltd and Sir M. MacDonald & Partners for WAPDA which provided benchmark data as well as comprehensive plan of intensive development of the land and water resources of the province to ensure that agricultural production meet the growing internal demands and export targets. The plan envisaged interrelated projects for both additional water supplies and drainage to be carried out in a program, phased over a period of 25 years. The Lower Indus Report covers the irrigated area of three barrages of Sindh viz. Guddu, Sukkur and Kotri. The whole area is divided into four parts in following categories:

- Perennial fresh ground water.
- Non-perennial fresh ground water.
- Perennial saline ground water.
- Non-perennial saline ground water.

Priority was recommended for the projects in fresh ground water areas, where tube wells could be easily installed to provide both increased irrigation water and providing drainage and can bring about large and early increase in agriculture production.

4.3 Vertical drainage

Drainage facilities in Sindh have been provided over a gross command Area of 5.3 Mha. These facilities include installation of 5,835 tube wells (3,697 FGW and 1,777 SGW) 365 Scavenger wells. Construction of 8,200 km surface drains. 565 km interceptor drain 0.1 MA covered with tile drain.

Under Salinity Control and Reclamation Projects (SCARPS) the sub-surface drainage systems of tube wells on the Left Bank of river Indus has been completed on Gross Command area 3.685 MA where various drainage technologies have been adopted for water table and salinity control. The drainage facility comprises of 3170 fresh Ground Water tube wells, 2168 saline ground water tube wells, 365 scavenger wells, tile drains over an area of 0.1 MA and 4,458 KM surface drains under other surface drainage projects. The operational status of the tube wells in each SCARP Project is as under.

4.3.1 Ghotki Fresh Ground Water Project

The project is located in Ghotki district, the GCA of project is 0.178 million hectares (0.44 MA) and CCA is 0.162 Mha (0.400 MA). A total of 1015 fresh ground water tube wells of total capacity of 2070 cusecs were installed. The capacity of individual tube wells vary from 1.5 cusecs to 2.5 cusecs depending upon the aquifer conditions. This project has been framed to increase its cropping intensities (Base year) from 95% to 150% at ultimate development. Additional tube wells were installed as such total number of tube wells in the project area is 1,092 out of which 875 are

operational and 217 are non-operational due to various reasons. As such the pumping capacity has been reduced by 19.87 percent.

4.3.2 Khairpur SCARP Project

A drainage project is located in District Khairpur the GCA of the project is 0.178 Mha (0.44 million acres) of which 0.15 Mha (0.380 million acres) is cultivable under command of Khairpur Feeder East and Khairpur Feeder West both canals are perennial. A total of 540 tube wells of various capacities were installed to control the ground water table at 7ft below the natural surface level. Out of total number 540 tube wells, 175 pump ground water of acceptable (fresh water) quality which is directly utilized in the field channels for augmenting the existing irrigation supplies on full development. For disposal of saline effluent 550 km of surface drains were constructed and five pumping stations with an installed capacity of 855 cusecs to dispose off the saline effluent into the Rohri Canal. Additional 105 tube wells were installed under Khairpur SCARP extension program, accordingly the total number of tube wells in Khairpur SCARP has increased to 645.

The operational status of tube wells indicates that 289 tube wells are operational and 356 tube wells are non operational due to various reasons.

4.3.3 SCARP North Rohri Fresh Ground Water Project.

The project is located in Districts of Khairpur and Naushero Feroze. The GCA is 0.32 Mha (0.793 MAa) and CCA is 0.278 Mha (0.69 MAa). A total of 581 tube wells of various capacities between 1.5 cfs and 5.0 cfs have been installed. Annual pumpage of fresh ground water is about 1.08 MAF to supplement the irrigation supplies. The cropping intensity during base year was 98% and with target of 150 percent.

Out of 581 tube wells 259 are non-operational.

4.3.4 SCARP South Rohri Fresh Ground Water Project.

The project is located in districts of Nawabshah and Hyderabad. GCA is 0.22 Mha (0.541 Ma) and CCA is 0.152 Mha (0.375 Ma). The project receives perennial irrigation supplies from Rohri Canal system supplemented by the additional of 1,214 fresh ground water tube wells with designed capacity of 1 to 2 cusecs. The cropping intensities during base year were 88 percent which is planned to increase upto 110 percent.

1,214 tube wells were constructed in the priority area providing a discharge capacity of 1 to 2 cusecs of individual tube wells. Additional 8 tube wells were installed as such total number of tube wells is 1,222.

The operational status of the Tube wells indicate that 860 tube wells are operational and remaining 362 tube wells are non-operational as such the pumping capacity of Tube wells has been reduced from 2,660 to 1,873 cusecs which have direct impact on the agricultural production due to reduction in pumpage from tube wells. Non-operational Tube wells are 205.

4.4 Surface and sub-surface drainage

4.4.1 LBOD Stage – 1

Surface Drainage network in the LBOD-Stage -1 project was designed to cater need of evacuation of surface runoff generated from the drains and rainfall in the project area for ultimate disposal through network of Sub-drain, Branch drain, Main dain, LBOD spinal drain out fall drains, and Tidal Link to the Sea Figure 4.2. The drainage effluent generated from saline tubewells and scavenger wells installed along the main Branch canals is 1240 cusecs. The drainage effluent generated from the interceptor drain installed along the main/ branch canal for interception of seepage is disposed off into the canals. The fresh water component generated from scavenger wells is directly used for augmenting surface irrigation supply for cultivation of crops

The construction of LBOD Stage-1 project was completed in 1997 except Chotiari Reservoir, which was completed in 2002 and handed over to SIDA. Total area served by the three component projects Nawabshah, Sanghar and Mirpurkhas is over Gross Command Area (GCA) 1.426 MA and Cultural Command Area (CCA) 1.276 MA.

The System comprising three components Nawabshah, Sanghar and Mirpurkhas LBOD Branch Drain and outfall System were handed over to Irrigation Department/ Sindh Irrigation & Drainage Authority upto 2002. The management transfer process was initiated in 1998 and completed on January 2002. WAPDA Operated System for one year before management transfer to IPD/ SIDA.

4.4.2 Nawabshah Component

Nawabshah component provides drainage facility on gross area of 0.626 MA with a network of main branch and sub-drains totaling 323 km. subsurface drainage comprises 274 Tube wells and scavenger wells 191and 225 km of interceptor drains. The tube wells have been designed to operate at 60% efficiency and maintain Water table at 7ft below ground Surface. Storm Drainage disposal has been provided through network of Surface drains and inlets.

4.4.3 Sanghar component

Sanghar project provide drainage facility over a gross area of 0.424 MA with network of main, branch and Sub – drains. 93.8%of this area has been provided with Sub-Surface drainage by 642 tube wells and 175 scavenger wells, 122 km of interceptor drains are provided for seepage control along main canals. The Tube wells have been designed to operate at 60% efficiency and maintain Water table at 7 ft below ground surface. The project has been designed to reduce flood damage by lowering high water table to provide more capacity for infiltration of excess irrigation applications and part of storm water. Surface drainage network will provide evacuation of surface runoff within 2 and 3 days. 572 tube wells are operational and 224 tube wells are non-operational due to various reasons.

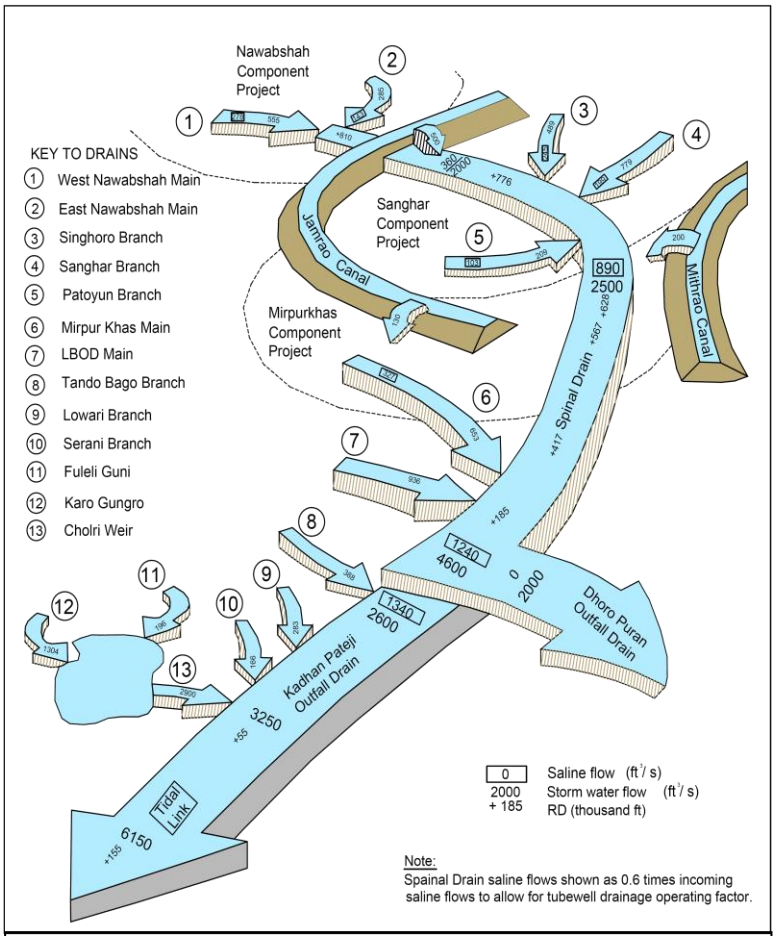


Figure 4. 2: LBOD Schematic Diagram

4.4.4 Mirpurkhas Component

Mirpurkhas project provide drainage facility over a gross area 0.376 MA, with network of main branch and Sub-drains Main drain following the approximate course of existing Doro Purim. Most of the project area (77.1%) has been provided with Sub-surface drainage by 752 tube wells, tile drains on 0.55 MA. The project has been designed to reduce flood damage by lowering water table to 7 feet´ depths for enhancing infiltration of excess irrigation application and Storm Water. Surface drainage network will provide evacuation of Storm runoff within 14 ½ days to 3 days through network of inlets. There are 188 operational and 172 non-operational tube wells.

Table 4.2: Drainage facilities of the LBOD Stage-1 Project.

Component	Gross area 000 acres.	Culturable command area (CCA) 000 acres.	Length of surface drains km	Length of disposal channel (saline) km.	No. of drainage tube wells	No. of Scavenger wells	Interceptor Drains		Tile Drains		No. of storm water inlets.
							Length km	No. of pumping stations	Area served in 000 acres	No. of pumping stations.	
Nawabshah	626	555	323	602	274	191	225	53	-	-	435
Sanghar	424	632	554	913	642	175	122	122	-	-	566
Mirpurkhas	376	359	326	876	752	-	235	75	55	68	590
Total Project	1426	1276	1203	2391	1668	365	582	250	55	68	1581

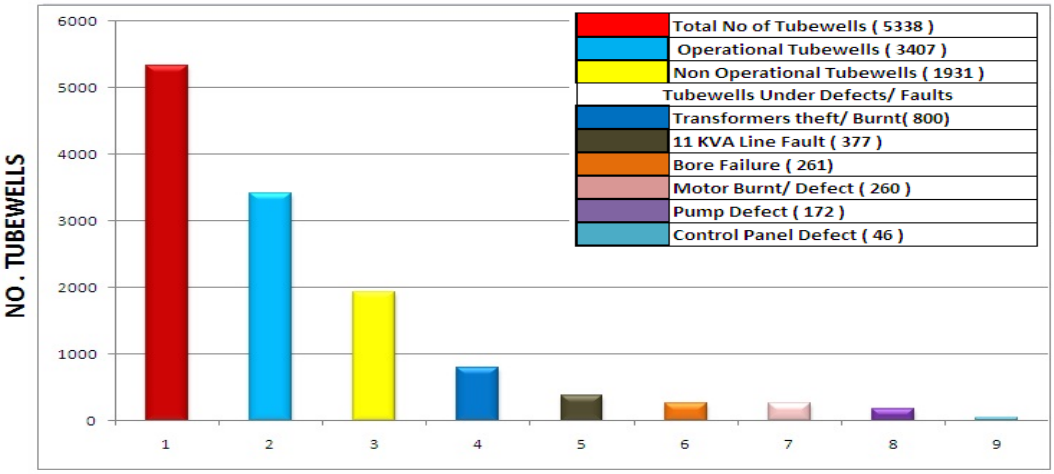
4.4.5 Overall Operational Status of Tube wells in Study area

There are 5,338 tube wells in Study area out of which 1931 tube wells are non-operational and 3407 are operational tube wells.

Over all operational status of tube wells in study is presented in Figure 4.3. The Status indicate that 800 tube wells are closed due to theft/ burning of transformers, 377 due to fault in 11 KVA line, 261 due to bore failure, 260 due to motor defect, 172 due to pump defect and 46 due to control panel defect

Drainage and flood subsector infrastructure is in dispair due to deferred maintenance, poor governance and operational management, and equity issues..

Figure 4. 3: Overall Tubewells Operational Status in Study Area



4.5 Flood Protection Infrastructure

4.5.1 Flood Embankments

The River Indus, in its course through the plains of Sindh, has been depositing silt and sand since time immemorial; due to this phenomenon the riverbed is up raised much higher than the natural ground. Therefore, the river is flowing on ridge; with the ground surface sloping away from River's both banks. Generally the river flows at the level 6 ft: to 10ft: above the adjacent ground level. During the monsoons when the river discharge increases above the full bank stage, floodwater spills over the lands devastating everything there. In early 18th century land owners constructed some flood embankments (bunds) to hold up river spill for protecting their lands and dwellings. Thus prior to 1869 the flood protective bunds were local bunds; those were maintained by the farming community

by themselves. Subsequently in the year 1869, Sindh Government constructed one such flood protective bund near Sukkur Barrage. This was first bund constructed and maintained by the Government since then more and more attention was paid for construction of flood protective embankments to make the countryside safe against the vagaries of the almighty River Indus. At present, both banks of river are fully protected by means of series of flood bunds, from Guddu Barrage to the Arabian Sea except in hilly portions where the adjoining hill levels are higher than High Flood Level (HFL) of the river.

As in the province of Sindh, Indus River mostly runs on the ridge therefore in case of breach into embankments, the floodwater, which flows out, cannot be diverted back into the River Indus and it inundates the vast developed areas. Thus, in order to protect the areas and the local population from devastation, the flood is required to be contained in between flood protective embankments. SIDA is responsible for flood bunds between Sukkur Barrage and Kotri Barrage; all along left bank of River Indus.

Table 4.3: Left Bank Area Bund System of Districts

Type of Bund	Khairpur	Naushahro Feroz	Shaheed Benazeer Abad	Matiari	Total Length (Miles)
Front Line Bunds	71.3	68.5	54.1	50.6	244.7
Second Line Bunds	54.3	25.0	8.3	11.5	99.3
Total Length (Miles)	125.6	93.5	62.4	62.3	344.2

Source: Sindh Irrigation Department (2010)

4.5.2 Barrages of Left Bank Area

Irrigation in Sindh has a history of several thousand years. Indus River is flowing since millions of years. It is mentioned in Vedas (Rigveda) - Oldest Book of Hindu Civilization. Indus civilization is the richest and one of the oldest in the world. Irrigation canal system was extended and improved during the late 1800s. A major program for improvement and construction of new inundations canals was undertaken in the latter half of the nineteenth century when construction of barrages was started in 1924. Barrage commanded irrigation was introduced with the construction of Sukkur Barrage system in 1932 irrigating a gross area of some 8 million acres on the left bank of the River Indus. Kotri Barrage and Guddu Barrage were completed in 1955 and 1962 respectively with very extensive distribution network.

Table 4.4 : Infrastructure of Barrages

Barrage	Year of completion`	Design Discharge (cfs)	Clear Waterway (ft)	Maximum Flood Level Height (ft)	Withdrawal Capacity for Irrigation Canals (cfs)
Guddu	1962	1,200,000	3840	26	46120
Sukkur	1932	1,500,000	3240	30	65933
Kotri	1955	875,000	2640	43	38878

Source: Sindh Irrigation Department (2010)

The data of historical peak discharges with return period is given below in table 4.5.

Table 4.5: Historical and 2010 Flood Peaks and Return Period for Barrages on Indus

Locations	Design Discharge (cfs)	100 -yr Flood (cfs)	2010 Flood		Historic Peak	
			Peak	Return Period		
			cfs	Years	Year	Cfs
Guddu	1,200,000	1,332,000	1,148,738	34	1976	1,176,150
Sukkur	(1.5 million as originally designed; reduced to 900000	1,290,000	1,130,995	39	1976	1,161,472
Kotri	875,000	962,000	964,897	102	1956	981,000

Source: Sindh Irrigation Department (2010)

4.5.3 Drainage Infrastructure of Left Bank Area

In May 1961 WAPDA published a report entitled "Program for water logging and salinity control in irrigated areas of the then West Pakistan" comprising of 10 year Program for water logging and salinity control measures through development of groundwater resources. 16 salinity control and Reclamation projects (SCARPs) were identified for Lower Indus Region. SCARP Projects completed on Left Bank of River Indus in study area were.

- Ghotki (Fresh Ground water) completed during 1976-90
- SCARP Khairpur completed in 1963-70
- SCARP North Rohri (Fresh ground water) completed in 1969-1979
- East Khairpur Tile drainage Project completed in 1985
- SCARP south Rohri (Fresh ground water) completed in 1976-1090
- Left Bank outfall drain stage-1 Project started in 1985 and completed in 2003

Seven main surface drainage systems in Left Bank Kotri Barrage command have been rehabilitated under National Drainage Program during the period of 1995 of 2002.

4.5.4 Drainage Infrastructure for Storm Water Control – LBOD Project

- A network of surface drains discharging to the sea via a spinal drain and tidal link.
- Deep tube-wells to intercept seepage water and control the groundwater table by pumping groundwater into the surface drainage network.
- Interceptor drains beside canals to recover fresh water seepage for use in irrigation.
- Buried tile drains to control groundwater tables where drainage tube-wells are not feasible.
- Additional power capacity at seven (2x Nawabshah, 2x Sanghar & 3x Mirpurkhas) existing grid stations (required for the operation of 1700 x tube-wells with 1.0 to 1.5 cusecs discharge).
- A network of power supplies to tube wells and drainage pumping stations.
- Remodeling canals (Nara Canal) to increase capacity (in order to provide irrigation water for the reclaimed land from water logging and salinity).
- Construction of Chotiari Reservoir to provide system storage allowing secure supplies to the Lower Nara Canal System. The purpose of linking LBOD project with Chotiari Reservoir was to utilize the stored water for Rabi season crops (November to May) in LBOD benefited area.
- On Farm Water Management to improve watercourses and water use practices.

Hierarchy of the surface drainage system of LBOD Stage-1 Project comprise; Sub-drains, Branch drains, Main drains, Spinal drain, Outfall drains and Tidal link out falling into the Arabian sea. Geographical units, where this surface drainage system is located, are:

- Nawabshah (Shaheed Benazirabad) Component;
- Sanghar Component: and
- Mirpurkhas Component.

In addition to the above three components, there are several drainage systems of Badin area out falling into Spinal Drain and KPOD. Surface drainage systems of LBOD Stage-1 Project and Kotri Surface Drainage comprise of:

- Surface Drainage Network of Nawabshah Component Project.
- Surface Drainage Network of Sanghar Component Project.
- Surface Drainage Network of Mirpurkhas Component Project.
- Surface Drainage Network of Badin Area.
- Spinal Drain.
- Dhoro Puran Link Drain.
- Dhoro Puran Outfall Drain (DPOD).
- Kadhan Pateji Outfall Drain (KPOD).
- Tidal Link.

The surface drains are intended to carry two different types of effluents. The first type is designated as "Base Flow", which is the drainage effluent discharge by sub-surface facilities like drainage tube wells and tile drains. Base flow is generally highly saline. The second type is the "Storm water flow", which is generated by rainfall over the catchment area. The chemical quality of the storm water is non-saline. Apart from the surface drains, several canal escape channels carrying surplus water from the irrigation system also contribute to the main drain flows.

Table 4.6: Salient Features of 3 Units of LBOD

Sr. No.	Drainage System	Length	
		RDs	Canal Miles
1.	Nawabshah Drainage System	1967.882	394
2.	Sanghar Drainage System	1398.371	280
3.	Mirpurkhas Drainage System	1474.635	295
	Total	4840.888	968

The LBOD project has been selected for detailed feasibility study under Phase-III of the consultancy work.

4.6 Performance of the Infrastructure

Pakistan is one of the five South Asian countries with the highest annual average number of people physically exposed to floods, which occur normally due to storm systems that originate from Bay of Bengal during the monsoon from July to September each year. Storms originating in Bay of Bengal, passing over lower Central India and Rajasthan, enter Pakistan and continue towards the North into Kashmir Valley. The mountain ranges in the extreme north of Pakistan provide a perennial source of inflow into the Indus River.

Fifty six (56%) percent of the Indus river basin lies in Pakistan and covers approximately 70 % of the country's area. Generally major floods in the Indus basin occur in late summer (July-September) when the South Asian region is subjected to heavy monsoon rains. In upper to mid reaches of the Basin, tributaries including the Jhelum and Chenab are mostly the cause of flooding. Major flooding is mainly associated with the monsoon low depression that develops in the Bay of Bengal and moves across India in a west/north-westerly direction to enter into Pakistan.

4.6.1 Performance of Flood Bunds

Whenever an area is flooded by the sudden breaching of bunds of Indus River, there occur extensive damage to public property, agriculture, commerce and life in general. The flood of 2010 caused great damage to bunds of the Indus River with serious breaches occurring at vulnerable places. One such breach occurred in the main River Bund known as the M.S. Bund at Kot Almu on the left side of the river near Daro Town. Flooding caused great damages in large areas of Bathoro, Sujawal, Jati and Shah Bunder Talukas as it extended some 75 miles from the breach site to the vicinity of the Tidal Link. Flood maps were prepared following visits of GIS and engineering personnel of LBG and IAC

consultants to document the extent of flooding during July and August of 2010. LBG/IAC teams had visited the area to assess damages and to seek a potential solution to alleviate the widespread misery and suffering as well as to avoid such large economic losses to the provincial and national economies.

Area roads were overtopped resulting in disruption of communications. Cities, towns and villages came under flood due to which people were compelled to vacate their homes and seek shelter at places far away. Damage to public property and loss of standing crops and cattle was very extensive and was accompanied by human sufferings due to migration from homes and relocation to camps where facilities for shelter, food and medicine were scarce. Often there was total absence of amenities of life in these camps. The role of district administration was poor and objectionable.

4.6.2 Performance of LBOD Drainage Network

The lower part of Sindh received ever maximum monthly rainfall during August and September 2011.The average rainfall was about 300 mm with duration of 24 - 48 hours and was 2-3 times higher than the land drainage capacity of existing drainage system. The heavy rainfall in Districts of Badin, Mirpur Khas, Tando Muhammad Khan, Nawabshah and Sanghar generated runoff of 15000 cfs, while LBOD system is designed for a discharge of 4600 cfs. The above districts were inundated with a depth of storm water ranging from 3 to 4 feet. The system performed satisfactory though there was limited capacity, obstructions and encroachments to natural drainage and overtopping/breaching at number of places was reported. The high level of water in Spinal drain caused submergence of Mirpurkhas Main Drain in city area of Mirpurkhas and LBOD branch drain resulting inundation of adjoining villages and towns of Badin and created havoc with the life and property in above areas. The outfall drains of KPOD and DPOD were running with a discharge of 7000 cfs and 4000 cfs respectively much above their design capacity. Many a farmers cut the banks of spinal and branch drains to quickly evacuate the storm water from their cropped lands and more from cotton fields. The damage to drainage infrastructure was enormous and quite a few Watercourse Crossing Aqueducts collapsed and quite a few Bridges damaged.

4.6.3 Performance of Flood Protection Embankments

As a result of these low values of discharge, the river bed silted-up and water levels standing against bunds were high. Thus there was water pressure and flood risk to the bunds. Also, during the past 14 years, many experts and competent flood fighting staff retired and new staff has not had any experience and training in flood fighting. In fact it has been suggested that there was no flood fighting spirit in the flood management staff and they did not take the flood situation seriously.

During 2010 a breach occurred in the left bank M.S. Bund near Kot Aalmoo above Sujawal on 24 and 25 August which inundated areas in Sujawal and Jati Talakas of Thatta district. Immediately on the next day a breach occurred on the right bank of the Indus in the Pana- Baghar bund opposite Thatta town. This breach was poised to inundate old Thatta town as breaches also occurred in the K.B. Feeder lower canal. But timely and successful efforts were made to plug this breach with big stones, and the town was saved.

These three breaches in river protection bunds, and the flooding effects on flood protection infrastructure, caused extensive damage to canal and drainage systems, bunds and barrages in the inundated areas. The magnitude of much of this damage is still not known; and most of the damage is still not repaired (as of mid-December 2010).

4.6.4 Future Trend of Flood Threats in Sindh

Recent trends in climate change for Pakistan, based on last 70 years of data, shows the following fundamental changes in the Sindh and county's climate:

- A rise in mean daily temperature of 0.6 to 1.0 degree centigrade in arid coastal areas and in arid western/north-western mountains
- A 10-15% decrease in both winter & summer rainfall in the coastal belt
- A 18-32% increase in rainfall in the monsoon zone (sub-humid and humid areas)
- A further decrease of 5% in relative humidity over the arid plains of Balochistan
- A 3-5% decrease in cloud cover over central and southern part of Pakistan resulting an increase in sunshine

This change in climatic conditions over Pakistan and Sindh in particular is considered to have given rise to an increase in the frequency of extreme events such as heavy rains, flash floods, dust/thunderstorms, hailstorms, heat waves, density and persistence of fog.

The current super-flooding in Sindh is considered to be mainly due to climate change. An unusual climate-change led seasonal cycle of land temperature in Pakistan has aggravated the monsoon rainfall and produced the largest volume of water run-off in the northern mountainous region of the country ever recorded in history, causing massive floods in the Indus River Basin (Marri, 2010)

4.6.5 Impact of Flooding on Sindh Agriculture

Agriculture is the primary or sole means to meet household food requirements and secure income in Sindh. At least 80% of the population is dependent on agriculture for their livelihood and survival. Over 1.7 million acres of standing crops were damaged during rain storm of 2011 in lower Sindh. The summary of damages is given below.

Table 4. 7: Summary of Year 2010 Super-flood Damage in Sindh

Districts affected	Total 19 districts
Population affected	Over 7 million
Total area affected	2.9 million acres
Villages affected	7,500
Towns affected	Over 40
Deaths	179
Injured	700
Houses damaged	402,350
Infrastructural damage	PKR 447 billion
Cropland loss	1.7 million acres
Agricultural loss	PKR 122 billion

Source: DRIP, Tando Jam (2010).

4.6.6 Integrated Flood Management Concept

Integrated flood management calls for a paradigm shift from the traditional, fragmented and localized approach, and encourages the use of the resources of a river basin as a whole, employing strategies to maintain or augment the productivity of floodplains, while at the same time providing protective measures against losses due to flooding.

Key challenges of flood management that need to be addressed in an integrated approach include:

- Population growth and economic growth exert considerable pressure on the natural resources system
- Increased population and enhanced economic activities in floodplains further increase the risk of flooding
- Designing for large floods must account of the likelihood of failure in cases of floods of magnitude below the notional design standard
- Riverine aquatic ecosystems provide such benefits as clean drinking water, food, materials, water purification, flood mitigation and recreational opportunities
- Magnitude and variability of the flow regime needed within a basin to maximize the benefits to society and to maintain a healthy riverine ecosystem must strike a balance between competing interests in the river basin

- Intensity and duration of precipitation events are likely to increase due to climate change, resulting in an increase of the frequency of major floods in many regions, particularly in Lower Sindh
- Impacts of global and regional climate change; and their impact on the magnitude, duration and return period of water disasters and flooding

There is a need for an approach to flood management in the Lower Indus Basin that improves the functioning of the river basin as a whole, recognizing that floods have beneficial impacts and can never be fully controlled. Such an approach seeks to maximize the net benefits from the use of floodplains and to minimize loss of life, subordinating flood loss reduction to the overall goal of maximizing the efficient use of the floodplain.

Integrated Flood Management (IFM) is a process that promotes an integrated, rather than fragmented, approach to flood management. It integrates land and water resources development in a river basin, within the context of Integrated Water Resources Management (IWRM), with a view to maximizing the efficient use of floodplains and to minimizing loss of life.

Elements of Integrated Flood Management are given below:

- Water Resource Management
- Land Use Management
- Coastal Zone Management
- Hazard Management

4.6.7 Perception of Stockholders about Drainage Network and Flood Protection Infrastructure

a. The opinions of the stakeholders and communities about the LBOD were divided. Those who expressed positive opinion said that it has reduced the drain out time for flood and storm water, and has improved the productivity. Those who strongly feel that it had affected them negatively feel that it has degraded their lands, decreased farm and fish productivity, and degraded underground aquifers. The degradation is mainly due to drainage, industrial waste discharges and sea encroachment.
b. Communities in Badin and Thatta districts, and delta and coastal area expressed serious reservation against any future drainage projects saying that new projects will bring more devastation, including additional contaminated and poisonous urban and industrial effluent. In the absence of mitigation measures to arrest seawater intrusion through eroded tidal link and KPOD is destroying agriculture lands, salinizing aquifer and destroying the ecosystem of lakes and wetlands.
c. Stakeholders of the Ghotki district in two consultative workshops held at Ghotki and Sukkur complained of the Government of Sindh not taking any initiative in stopping the Drainage effluent of SCARP-VI mixed with industrial effluent and is a crime against civil society. The effluent is disposed unattended in district Ghotki severely degrading the agricultural lands. Water logging and salinity is on the rise resulting in crop failure and depletion of the resource base with an adverse impact on livelihoods of people.

Disposal of Flood and Storm Water

a. Farmers feel that there is no widely known mechanism to deal with disposal of storm water and have to resort to *ad hoc* and unplanned measures thereby damaging drainage and other infrastructure. They desire development of options for safe and timely disposal of storm water
b. People complained that the government flood response was too late, particularly, rescue and relief was unplanned, and support for rehabilitation was inadequate. They were apprehensive of unexpected breaches during floods and felt concerned by the threat to the human lives, livestock, assets and livelihoods.
c. They suggested development of possible flood retardation basins, and escapes routes, etc. to protect barrages and irrigation and drainage network, physical infrastructure, vital installations, and properties. They complained of inadequate early warning mechanism or crisis management in case of super floods.

d. The perception is that national and provincial disaster management institutions are ineffective in combating flood and storm water disaster.
e. They desired development of options for safe and timely disposal of storm water. Stakeholders suggested options to harvest rainwater through conservation in the desert area for storage and recharge of the groundwater.

4.6.8 Operation & Maintenance of Irrigation and Drainage Infrastructure

a. The drainage network is clogged with silt and weeds. This restricts free flow of the drainage effluent and causes breaching.
b. Farmers reported that organized gangs are involved in the stealing of high tension wires, motors and pumps, electrical fittings, and in some places even the doors. Where tubewells were functioning, they were a source of power theft for non-agricultural uses. This has reduced the effectiveness of the SCARP tubewells, and reduction of water table is constrained.

4.7 LBOD Project and Outfall Debacle

4.7.1 Failure of Tidal Link

During the designing/planning stage it was expected that Seawater would penetrate only up to 19 km from its outlet upstream into the Tidal Link, to an area about 11 km downstream of the Cholri Weir. Whereas it is evident from the NIO observations (2008), that erosion and intrusion of seawater in the Tidal Link commenced just after its completion. Later on rain storms in 1998 and 'Cyclone 2A' in 1999 further worsen the situation. The rain storm, in July 2003, was the final blow and destroyed the already deteriorating Tidal Link now it is turned to be tidal creek rather a regulated outflow of drain. During the post storm inspection (GOS - Technical Review Committee) 56 breaches were recorded, it was a almost complete disaster of the outfall system of the LBOD.

4.7.2 Probable Causes of Failure of Tidal Link and Cholri Weir

The consultants presented the following possible causes for the failure:

- The design capacity of the Tidal Link was 2400 cfs and a maximum carrying capacity of 4440 cfs corresponding to a 125 mm rainfall of 5 days duration, which would result in flooding duration of 5 days, leaving a freeboard of 2 feet only. As a result of the Cyclone July 2003, Badin District experienced ever recorded highest rainfall, 218 mm in 24 hours that led to pass about 8000-10000 cfs floodwater through KPOD and the Tidal Link and quantity of outflow was more than the twice the maximum designed capacity of Tidal Link.
- July 2003 resulted in the largest monthly rainfall recorded at Badin station in history of 67 years. It was assumed in the design of LBOD canals that the channel system would not be allowed to carry base flow during heavy rainfall, but it was not the case during the 2003 storms. Not only base flow was present in the drainage system but irrigation water refusals were also diverted directly to the drain system and additional inlets were provided by influential landlords by cutting drainage embankments with show of force.
- Soon after completion some of the banks and weir structures in the Tidal Link failed mainly because of the silty loam material of the soil in the area used in the construction which is highly sensitive to flow velocity which scoured the bed and breached the embankments at number of places.
- Probably during designing stage the effect of the flow velocity of Ebb tide on the material of bed and the embankments was not seriously considered. Both measured data and computer simulations suggest that maximum observed velocities in the Tidal Link were around 1.5 m/s. This velocity is greater than the permissible velocity of the loam material forming the channel, which should be less than 0.9 m/s for silt loam. Velocities caused by ebb flows were even greater than when the Tidal Link was recently built. Therefore, the channel cross sections and longitudinal profile were continuously changing, due both to erosion produced by the above mentioned high velocities and the relatively high load of sediments brought from upstream sections. Erosion was especially intense at the outfall of the Link to the Shah Samando Creek

(part of open sea). It is likely that these high velocity flows and insufficient cutoff against erosion were the primary cause of the Cholri Weir failure in 1998. The sheet pile cutoff of 22 feet was highly insufficient for protection against sea currents and particularly when substrata were very weak in strength.

- Probably no hydrographic survey such as bathymetric survey at Shah Samando Creek, such as castling (HW Line), long term tidal observations, (at least once a month), flow current observations, were not conducted before designing/planning of the Tidal Link, as it is not mentioned in the reports/studies, which have been reviewed. All the estimation regarding level, particularly sea water intrusion would be made with reference to the HW (spring) level. Though it was expected that high water would reach up to 19 Km from the terminus of Tidal Link, that was done without taking observed HW (spring) level into account. Moreover, demarcation of HW line might provide valuable data to indicate exact extent of seawater intrusion and would lead to design an appropriate and a stable Tidal Link.
- The design of the embankment was based upon insufficient geotechnical data.
- The level of Outflow of the drain water could not be maintained as per the designed to obstruct seawater intrusion at RD -93, it should be 19 feet from the bed and 7.5 feet from the amsl, as it is evident from its design and various observations such as Tidal current and salinity observations. As a result high ebb velocity eroded bed and the banks of the Tidal Link.
- Even if the level of outflow of drain water would have been maintained at 7.5 feet amsl at RD-93, it would achieve high velocity with descending tides particularly during Spring Tides. Some mechanism should have been in place at the mouth of the Tidal link to control seawater intrusion and control the flow velocity.

From the above discussion it can be concluded that Cholri Weir failure was a design fault.

Figure 4. 4: Pictorial View of Tidal Link -

Damaged Cholri Weir at RD-54 of Tidal Link

Active Erosion of Northern Embankment RD-40 of Tidal Link

Breached Section of Tidal Link opposite Dhand Complex

Distant View of Southern Embankment opposite Dhand System

4.7.3 Implication of Tidal Link Failure

The basic purpose of the tidal link was to carry LBOD effluent to the sea without affecting the environment , however, the Tidal Link collapsed due to obvious reasons and required results could not be attained rather complicated the situation and inflicted severe damage to the environment and ecosystem of the Dhands and their surroundings with strong protest from local population.

The Tidal link passed through Dhand complex, to preserve the ecosystem of the Dhands and reduce tidal impact in LBOD and Tidal Link, a 1800 long Cholri Weir was constructed on Northern bank. However, Cholri Weir and Tidal Lind collapsed and Dhands got directly connected with the sea, now they became part of sea and saline area of Dhands expanded from 17,004 hectares in 1991 to about 24,291 hectares in 2003.

Previously the Dhands used to capture storm freshwater and slightly saline water of the Kotri Basin Daring and occasionally exchange water with Runn of Kutch, as a result the salinity of water used to stay within tolerable limits of the ecosystem. Now the Dhands have been transformed in hyper saline water body.

Tidal Link failure has brought drastic changes in the area and affected the flora and fauna in the Dhand system. This site consistently used to host a large population of migratory birds is no longer a sanctuary of waterfowls. The area used to be famous for freshwater fish that has been almost eliminated.

After direct connection with sea, the water level rises in the Dhands and KPOD, as result the seawater intrusion has increased and affected the prime agriculture land situated far from sea. It has also contaminated ground water aquifer and raised water table and water logging in the area.

The lack of fishing activities and agriculture activities seriously disrupted the livelihoods of area. The local population believes that the situation of their livelihood before the LBOD project was much better before LBOD project, as they had better agricultural crops and better yields. They had more fish catch and more species. The financial position of communities was generally better with better employment opportunities.

Tidal link may give way to storm surges which pose serious threat to the local settlements as it was experienced in 2003; a storm surge claimed 30 lives.

Tidal Link failure and both structural and non structural measures to rehabilitate tidal link have been discussed in detail in the Feasibility Report of LBOD project.

4.7.4 International Policy Guide Lines and Practices for Coastal Erosion Management

The developed nations have formulated their own policy guide lines to protect their valuable assets from the unwanted impacts of ocean forces resulting sea intrusion.

The specific principles that guide this coastal Protection Policy are to:

- Minimize the need to interfere with natural coastal processes;
- Undertake coastal protection works only if the benefits outweigh the costs;
- Ensure that the direct beneficiaries of coastal development carry all consequential costs;
- Ensure that the coast continues to be available for the benefit of the whole community;
- Ensure that local coastal managers receive proper guidance and assistance to solve their coastal protection problems;
- Establish that coastal protection is a partnership between the state and local coastal managers, with the lead taken by the local coastal managers; and
- Ensure that the most appropriate coastal protection technologies are considered.

The review of international practices was done to check sea erosion for preparing the plans for shore management and protection of coastal structures. The major concepts are the followings:

- Work with the dynamic nature of the coastal environment rather than fighting the forces of the sea
- Use "soft" engineering measures like beach nourishment where applicable
- Make more environmentally friendly designs of "hard" engineering works like breakwaters (e.g. minimize the length, lower the crest elevation, make it submerged where appropriate)
- **Apply the concept of "retreat" management**
- Apply the concept of "do-nothing" option
- Introduce a detailed monitoring program to observe the coastal changes near the sea structures

There are three famous types of managerial options in response to coastal erosion (Van der Weide, de Veroeg & Sanyang (2001). These are:

- Retreat
- Accommodate for the present
- Defend

The "retreat" option indicates the acceptance on the shoreline erosion as a long-term phenomenon, and movement of development to inland locations that are sufficiently far away for not being affected from the ongoing erosion within a reasonable timeframe. This option is especially meaningful for undeveloped (rural) coasts where not many people suffer critically from the ongoing erosion process.

Accommodate for present option could be the rational choice when an important infrastructure (such as a highway) can be modified with a reasonable budget so that it can be used for an additional period after the eroding shoreline more or less hits a length of the structure. This option merges with the "retreat" option in the long run.

The "defend" option is the undisputed choice for an eroding urban coast. It indicates the use of one or more types of structural or non-structural measures to stabilize the length of the eroding coast facing the urban areas. The "defend" option may also benefit from improved watershed management practices.

The shoreline management options should pay due attention to the climate change and the anticipated sea level rise.

4.7.5 Recommended Action Plan for Outfall of LBOD

Outfall conditions of LBOD are affected by cyclones and tidal waves and their compounding affects. The area has suffered from sea based storms in varying degrees. The devastating cyclone types of 1999 and the periodic storm surges are the most destructive natural forces of the area and causing large scale erosion of coast line and the KPOD outfall drainage system. A field team of Consultant visited the Tidal Link and concluded very clearly and loudly that now Tidal Link is a past history and this costly mistake shall not be repeated. By accepting the principal of retreat it is recommended to construct a Tidal Control Gated Structure at RD 26 of KPOD as the subsoil strata is very stable in this reach and would not need major flood protection works and the type of structure would be simple and easy to maintain.

4.8 Status and Inventory of waterways and depressions

4.8.1 Inventory

In Sindh there are many short and long reaches of the abandoned river courses on both sides of Indus. These abandoned river courses used to serve as natural waterways aka dhoras, for river and storm floods. Historically these dhoras braided with several small tributaries served as a network of natural drainage.

The most prominent and major dhoras identified in the study area on left bank of Indus river through satellite imagery and field visits are Karo Naro, Changlani, Gurhelo and Rainee in Ghotki area, Hussainabad-Mehrabpur (H.M)dhoro and Nangreja-Talpur Wada (N.T.W)dhoro in Khairpur area, Kandiaro- Moro (K.M) dhoro in Naushehro Feroze area, Miranpur-Bachal Rahu (M.B.R) dhoro in Shaheed Benazirabad/ Matiari area, Sohni dhoro in Tando Adam/ T.Allahyar

area, Bhai Khan dhoro in T. M. Khan/ T. Ghulam Ali area, Puran dhoro in Mirpur Khas/ Badin area, Hakro dhoro in Umar Kot area, Sarfraz(Dighri) dhoro in Dighri area and Naro/ Fakir M. dhoro in Kunri/ Naukot area. Total length of these dhoras is approximately 1462 kilometers. (Map-1) Detail breakup of length, coordinates etc are given in main Feasibility Report for this intervention.

In addition to the aforesaid major dhoras there are several small isolated reaches of dhoras on the left bank of Indus which do not have any drainage outlet. More than forty of them are found in Ghotki area and their combined length is 615 kms. It indicates that historically the Indus has extensively meandered in Ghotki area particularly in its north.

4.8.2 Status

Flow of water in all the major and minor dhoras on left bank of Indus has been blocked by construction of infrastructure like roads, drains, settlements, and irrigation channels. The crossing structures like culverts, pipes and bridges provided at few places on the dhoras are of inadequate size and are not capable to pass storm water. The major cause of obstruction in timely disposal of the storm water is these obstructions in the natural waterways aka *dhora*s. The *dhora*s particularly Puran Dhoro in southern part of Sindh on left bank of Indus used to be operational before the construction of the LBOD system. Later on, in four reaches of Puran Dhoro, LBOD Spinal Drain has been constructed exactly on the alignment of Puran Dhoro. Whereas few meandering reaches of Puran Dhoro have been cut off and isolated by construction of Mirpur Khas Main Drain (MMD) and Spinal drain on their left as well as right side. Storm water from adjoining high elevation lands accumulated in these isolated portions of Puran Dhoro having no drainage outlet, spills over and moves in the direction of ground slope in the shape of sheet flow. Consequently, it inundates settlements, crops, road infrastructure, factories, and other types of private properties enroute. It is understood that 70% damages during 2011 storm water flooding were caused by these blocked sections of dhoras not LBOD. It warrants provision of adequate drainage outlets, culverts, bridges, Aqueducts, and waterways to facilitate the prompt disposal of flood water.

4.9 Scope for Water Harvesting and Storm Water Retention

Rainwater harvesting is process of collecting and storing of rainwater before it is lost as surface run-off. There are two main categories of rainwater harvesting projects: i) small scale for household use and, ii) large/minor scale for irrigation.

4.9.1 Small scale rainwater harvesting for household use

Different projects around the world have been designed and implemented. USAID in El Salvador[14]built a number of small rain harvest schemes to benefit poor farmers living in hilly areas. The project consisted of an open interceptor drain to capture the run-off; a gravel filter gallery; a rubber lined pond; a reservoir of about 35,000 ft3 and; a drip irrigation system to irrigate an average of 0.25 acres. Similar type of schemes were proposed in Afghanistan to help the very poor that live in the hilly areas and away from the irrigation canals and also to help the nomads for the period that they live in the mountainous part of the country, as the limited water would last for only few months. Similar projects could be implemented in Sindh.

Another common type of scale rainwater harvesting projects for household use are rainfall water catchment on roofs and storage on lined pits dug in the ground. A number of experiences around the world indicate that this is feasible and it could also be implemented in isolated parts of Sindh where the water resources as severely limited.

4.9.2 Large scale rainwater harvesting in sindh

The quantum of storm water in the study area generated from rainfall is 6.73 MAF Out of which 5.46MA is generated in the eight canal command areas and 1.27 MAF in Thar area which is outside

[14]USAID El Salvador Surface Water Diversion, Storage and Use Project. San Salvador. April 2005

canal command area. Storm water is presently disposed of through drainage systems and accumulates in the depressions or create ponding situation in the fields.

4.9.3 Depressions (Dhoras) in left Bank study area

Lower Indus Valley has remained the playground for mighty Indus River and has often shifted its course from East to West touching the Khirthar ranges and again West to East hitting and dissecting the Thar Desert. In this way it has shifted its course for many times and now has been confined by weir control.

During its shifting (meandering) period, the River has left its prominent features like depressions (Dhoras) on the surface of soil in the shape of oxbows, scars and channel remnants. These prominent features are still intact and are quite visible on ground.

Table 4. 8: Annual Rainfall Potential and Available Water for Storage

District	Area in (000 acres)	Annual Average Rainfall (m)	Annual Average Runoff Potential (mm)	Available Water for Storage in Million Acre feet (MAF)
Ghotki	1,554	35.3	16.6	.085
Khairpur	3,889	35.3	16.7	0.213
Sukkur	1,186	91	43.0	0.167
NausheroFeroze	746	91	43.0	0.105
Nawabshah	1,107	124	58.5	0.212
Chhor	1,554	268	126.5	0.645
Sanghar	2,651	268	126.5	1.100
Mirpurkhas	1,977	268	126.5	0.820
Hyderabad	1,364	183	86.4	0.387
Thatta	4,287	192	90.6	1.274
Badin	1,661	174	82.1	0.447
Sub Total	**21,977**			**5.45**
Tharparkar	4,984	165	77.9	1.274
Total				**6.724**

4.9.4 Past and Present Physical Status of Depressions (Dhoras)

During Lower Indus Project (LIP) studies (1964), the aerial mosaics of 1954 at the scale of 1:40,000 were used to map the different physical features of the ground among others. These photographs were used to map the exact locations of different physical features of the terrain, where it was observed that during the period of investigations most of the depression areas were under cultivation, having no problem of salinity and waterlogging.

With the passage of time, overall cropping intensities increased within the left Bank Canal commands of three Barrages. Later on this situation was changed by cultivating high delta crops, mismanagement of irrigation system and seepage losses from the network of canals, branches, distributaries and minors. Such conditions in the study area created waterlogging problem. This menace was confirmed during the soil salinity and waterlogging survey conducted in 1976-79 for irrigated areas of Indus basin by survey and Research organization Planning Division Lahore and report published in 1981. From the result it was obvious that major parts of the existing depressions (Dhoras) areas were waterlogged and mapped under the category of “Water Bodies”.

In converting the depressions areas into water bodies, two major factors played the main role;

1- Increase in ground water table depth in adjacent cultivated Land

When the water table rises above the surface level of depressions, the horizontal underground flow from cultivated fields started flowing towards the depressions (Dhoras) areas and these served as

natural drainage to the nearest cropped lands. The seepage from all around the agriculture lands, slowly nearly filled up the depressions (Dhoras) with water

2- Irrigation and Storm water

The next factor is the irrigation and storm runoff. These have played a main role in inundating the depressions areas. The waste water of irrigation system when it is not required by crops is allowed to go into the nearest depressions. During monsoon season the storm water standing in the agriculture lands is also being drained out into these Dhoras. However, some of the wise land owners have converted them into fish ponds and are making sustainable profit.

In recent past (2000-2005), the irrigated areas of Indus basin were resurveyed under S&R, project by SCARP Monitoring organization WAPDA, using the SPOT Satellite imagery for mapping the Physical features of the ground. It was observed that condition of depressions (Dhoras) was more or less the same as compared to the previous survey conducted by WAPDA during 1981. There was little difference due to drought conditions prevailed during the survey period of (2000-2005). Overall water table was lowered down that also resulted in lowering the levels of standing water into depressions. Again during the last couple of years (2010& 2011) due to heavy rain fall, the water levels have been raised in depression areas. The names of main depressions (Dhoras) located at various locations of study area are mentioned in Table 4.9. The dhoras are covered in detail in separate chapters of this report.

Table 4. 9: Location of Naturally Occurring Dhoras and Dhands

Guddu and Sukkur Commands in Study Area

Figure	Location of Dhoras	Latitude	Longitude	Area in acres
1.	Reti	N 28°05'39	E 69°48'18"	1210
2.	Ghotki area	N 27°57'54"	E 69°21'54"	717
3.	Ghambat, Jiskani, TalpurVada	N 27°18'36"	E 68°37'	1798
4.	Behlani	N 27°06'54"	E 68°20'42"	582
5.	Phul Town Area	N 26°42'36"	E 68°10'12"	2176
6.	Bandhi Area	N 26°37'48"	E 68°18'	1664
7.	Dour area	N 26°29'24"	E 68°16'12"	3162
8.	Bucheri area	N 26°21'	E 68°16'12"	2362
9.	BachalRaho and Din Muhammad Zardari	N 26°15'	E 68°15'18"	1856
10.	Sakrand	N 26°10'30"	E 68°18'18"	608
11.	Tando Adam Shahdadpur, and Mansoora	N 25°51'	E 68°43'	1754
12.	DhoroNaro			
13.	DhoroPuran			

4.9.5 Depth & Quality of Water in Depressions (Dhoras):

It has been observed during the different surveys conducted that an average depth of water in depressions (Dhoras) ranges in between 3' - 6' ft. In those used as fish ponds, the average depth ranges from 4-7 ft.

As per the quality of water is concerned, mostly are classified as marginal water (EC ranges in between 2500 – 3000μs/cm). During shortages of irrigation water in the canal system, some of this water is pumped out for irrigating the adjacent cropped area. However, the water quality of Dhoras trapped in between highly saline lands, are considered hazardous, with EC readings of more than 3000 μs/cm, which are harmful for all types of water use.

A feasibility study is required to quantify the extent and storage capacity of each depression and availability of runoff water for storage. It is essential to conduct surveys of all potential sites. A list of natural Dhoras/depressions is presented in Table 4.9 and Dhands in Badin area in Table 4.10.

Table 4. 10: List of Dhands in Badin Area

Sr. No	Dhand	Average Depth	Average water Level	Average Bed level (AMSL)	Average Salinity (PPM)
1.	Sanhro	2.93	2.02	-0.90	7654
2.	Sanhro-Mehro	3.08	1.79	-1.29	6638
3.	Mehro	2.69	1.93	-0.76	3681
4.	Cholri	1.82	3.20	1.38	13640
5.	Pataji	1.62	3.08	1.46	49,610

4.9.6 Limitations Rainwater Harvesting

Very high water evaporation rates are observed in the area, which substantially limits the use of the small dhands as the water evaporates within few months. Few depressions (Dhoras) are deep and large enough in length and could be used for rain harvesting.

5 Environmental Issues of the Study Area

5.1 Seawater Intrusion - Causes and Impacts

5.1.1 Introduction

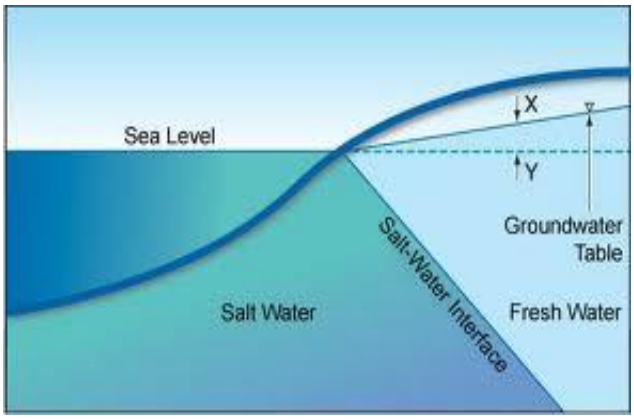
Saltwater intrusion is the movement of saline water into a freshwater aquifer. Where the source of this saline water is marine water, this process is known as seawater intrusion. Thus if intrusion problems become extreme, they can render an aquifer unusable for most purposes. If the freshwater gradient near the coastline (i.e., freshwater height above sea level) is high and the aquifer water balance is adequate to maintain flow to the seawater, the interface layers can be close to vertical and located off the shoreline. As the freshwater head decreases, the interface layer becomes less vertical and moves inland. In this condition, seawater, being heavier, can flow under the freshwater and pushes it up slightly forming a Ghyben-Herzberg lens (i.e., the lens is the underground freshwater that floats on top of the seawater). If the freshwater head is maintained, the interface layer will remain relatively static. Under Ghyben-Herzberg conditions, a one-foot drop in freshwater head may result in a 40-foot movement in the freshwater/seawater interface layer. Consequently, relatively small decreases in a fresh water aquifer may have relatively large impacts on the intrusion of salt water into that aquifer. Aquifers are replenished through recharge. Any surface activity which serves to reduce aquifer recharge has the potential to effect seawater intrusion.

5.1.2 Sea Intrusion Phenomenon

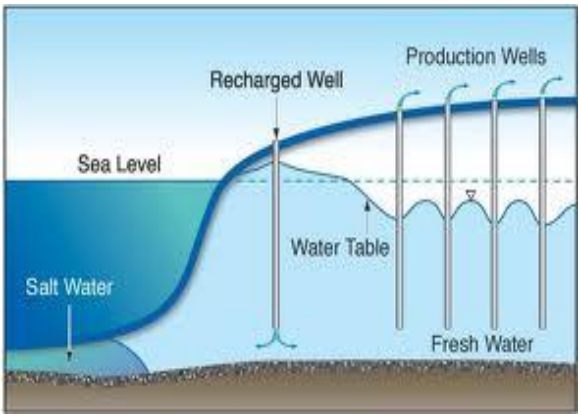
Ghyben, a Dutchman, and Herzberg, a Swede, observed independently at the beginning of the 20th century that coastal wells often intercepted seawater at depth. Moreover, they observed that depth to seawater correlates very well with head. In fact, this is easy to verify if one assumes a static saltwater wedge and a sharp fresh-seawater interface. Seawater (density around 1.025 kg/L) is 2.5% heavier than freshwater. As a result, freshwater will tend to float on top of seawater. The thickness of freshwater can be obtained equalizing the weights of freshwater on top of the interface and seawater on top of a point at the same elevation. The resulting depth of freshwater below sea level is forty times its head (depth above sea level). This is known as the Ghyben-Herzberg equation, which is the basis for seawater penetration.

Figure 5.1: Seawater Intrusion Phenomenon

a) Saltwater freshwater interface



b) Effect of recharge on seawater retreat



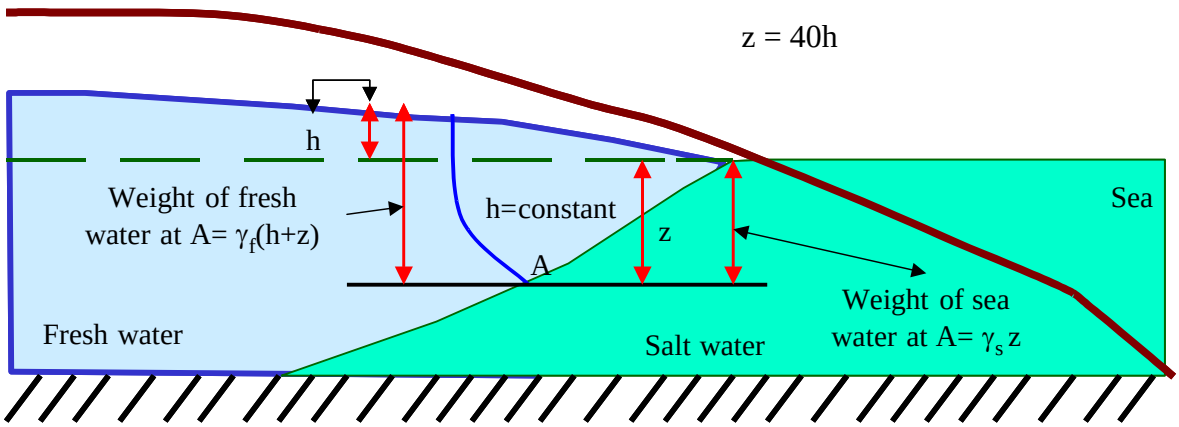


Figure 5.2: Ghyben-Herzberg equation and its description

5.1.3 Causes of Indus Delta Degradation

Degradation of the Indus Delta, its biodiversity, and natural resources, is increasing with the passage of time. This situation is not only affecting the Deltaic ecosystem but also the natural livelihood resource of the region. Although, there are a number of causes of the degradation, however, the major causes include the water shortage caused by upstream damming and diversions of Indus and the government policies in regard to resource management. (Altaf A. Memon 2005)

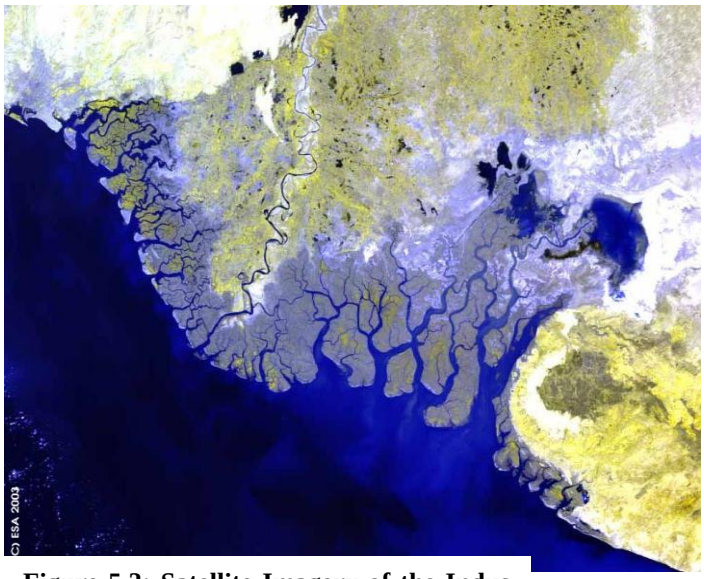


Figure 5.3: Satellite Imagery of the Indus

Reduction of Indus Flows: Fresh water flow down the Indus was about 150 MAF per year in the past and Indus carried over 400 million tons of silt to the Delta. Only about 20 MAF outflow reached the Delta from barrage releases before 1991 depositing only 36 million tons of silt per year. However, the 1991 Water Accord put an interim limit of 10 MAF outflow and even that limit has not been met (Figure 5.3). The silt deposits are estimated to drop way below 30 million tons per year if the outflow remained 10 MAF or lower.

The Indus River Delta plays a central role in the lives of the people, economy, environment, and ecological well being of the region. Waters of the River Indus have been dammed or diverted upstream. Only a fraction of water and most of the times no water is released to the Delta region.

5.1.4 Seawater Intrusion in Badin and Thatta

The Indus water discharge to the sea keeps the sea water at bay and does not let it intrude too much into the surface and subsurface water resources inland. The salt water intrusion is directly related to the decrease of flow in River Indus. The rising level of the sea is encroaching the fertile lands of the region and converting them into the seabed. Vast areas of district Thatta and Badin, where previously fertile crops existed, are now under seawater or eroded due to sea currents. Desertification is visibly seen in vast areas of Badin district after 1999 cyclone due to increased salinity and deprivation of fresh water. Results of a survey conducted by the government of Sindh indicated that over 486,000 hectares land were eroded or lost to the sea within Thatta and Badin districts, dislocating a quarter million people, and inflicting financial losses over 2 billion dollars. The seawater has destroyed at least one-third of the land. Recent estimates put the figure at 567,000 hectares of the land lost to the sea. Thus, more loss of land due to erosion and seawater is possible.

Availability of Water for Drinking: The reduction in Indus River flows downstream Kotri Barrage has created a crisis-like situation with the shortage of drinking water. Due to the water shortage and resulting salinity and depressed quality of the surface water bodies and loss of groundwater due to salt-water intrusion and water table depression, the drinking water supplies have dwindled and degraded in quality. The only way left is to bring water by tankers from outside and that is not very cheap. People are not able to afford it and are thus forced to use brackish and/or otherwise degraded water.

5.2 Flow Downstream Kotri

Extensive use of fresh water for irrigation in recent years has caused a decline in the downstream discharge of the Indus River; consequently, the seawater intrusion has resulted in tidal intrusion in the prime agricultural land in the Indus Deltaic region. Construction of barrages, dams, and link canals has further reduced the freshwater flow downstream Kotri Barrage from 146 MAF/year to less than 10 MAF/year. Indus River downstream Kotri Barrage has practically zero discharge, as a consequence, the river below Kotri shows increased braiding and sand bar development.

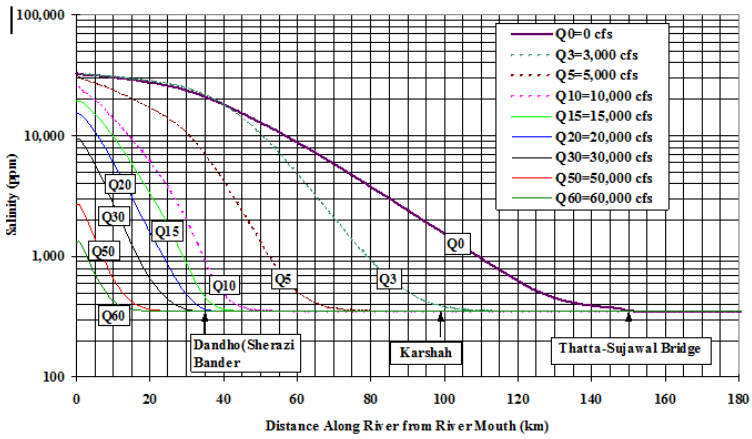


Figure 5. 5: Seawater River water interface with respect to flow quantity +dhands

Sediment passing down the system tends to be deposited in the section south of Kotri, rather than maintaining the growth of the delta. As a result the Indus Delta that used to occupy an area of about 6,180 km^2 consisting of creeks, mudflats and mangrove forest is now reduced to 1,192 km^2 since the construction of dams and barrages on the Indus River Inam (NIO).

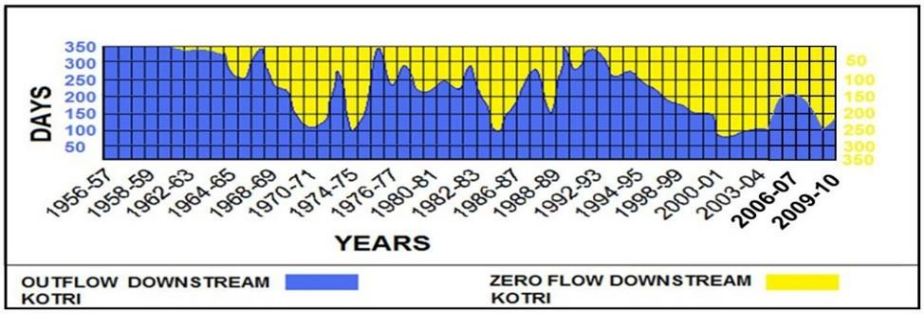


Figure 5. 4: No of Days Flow Downstream Kotri Barrage is

Drainage canals were constructed down in the Indus Basin to drain saline ground water to mitigate the impacts of rising ground water and associated problem of water logging and salinity, but the system has been less effective due to low gradient/flat topography and it has in fact resulted in the seawater intrusion into the link canals up to about 80 km upstream (Panhwar 1999).

The man made changes coupled with natural physical forcing in the Indus delta and adjoining area will conspicuously change the geomorphic and hydrodynamic setting of the delta, that may result in the associated changes in the prevailing physical processes, which in turn will have a negative influence on coastal resources, communities, infrastructures, ecosystems and habitats and socio-economy of the area.

5.2.1 Effect of reduced river flow downstream Kotri

Seawater intrusion in the river is variable and depends upon quantum of outflow in the river. MHW, ACE(Pvt.) Ltd, NESPAK jointly carried out a model study to see likely extent of seawater intrusion

in the Indus River under various outflow conditions as shown in the (Figure 5.4). According to this study, in case of no flow in the river seawater intrusion may be experienced in the river up to Thatta-Sujawal Bridge up to about 150 km from the river mouth. With the improvement in river outflow the seawater intrusion retreats. An outflow at the rate of 30,000 cusecs limits the seawater at just 10 km away from Sherazi Bandar. Presence of seawater in river for hours pushes the saltwater freshwater interface farther rendering freshwater packets brackish and unfit for drinking.

5.2.2 Tidal influence

Periodic rise and fall in the level of the sea associated with the gravitational pull of the moon refers to sea tides. In most coastal areas, the tidal forces result in two high tides and two low tides each day with high tides occurring when the moon passes directly over an area and when directly opposite that location. Higher than average high tides (i.e. spring tides) and lower than average lows (i.e. neap tides) occur twice in a lunar cycle (during the new moon and full moon phases) when the Earth, sun, and moon are all in alignment.

The Indus River has the world's largest contiguous irrigation system with three major reservoirs, several smaller ones, 19 barrages, and a canal system over 58,000 km in length. With the completion of all of the major water diversions in the early 1955 and onwards up to 1967, the river downstream of the Kotri Barrage has run dry for more than 200 days during several years, particularly in the last decade. With little flow moving to the lower delta, an important source of freshwater is cut off to the sensitive brackish water dhands. The loss of freshwater inputs from the Indus has resulted in increasingly salty conditions in the dhands and allows saltwater to invade further upstream with consequent negative impacts to mangrove forests and agricultural fields (Memon, 2005). The mangrove forests are one of the largest mangrove systems in the world and are being further degraded by direct human destruction and over use (Inam et al, 2007).

5.3 Impact of Tidal Link Outfall Structure on Seawater Intrusion

Tidal link terminating in Shah Samando creek was not provided any gated structure at the terminus point; therefore uncontrolled tidal influence resulted in erosion of the Tidal Link channel as it was opened to the sea in 1995. The Cholri Weir experienced almost immediate settling and later complete destruction in 1999 cyclone. Even at present the breaches continue to widen as tidal creeks develop through them, resulting in daily inundation of the dhands by high tides.

Figure 5. 6: Google image of Creek towards

The influence of tides and intrusion of saltwater is also extending beyond the Tidal Link and affecting the downstream end of KPOD and smaller branch drains that discharge directly into the KPOD.

5.3.1 Seawater intrusion, its impacts on Dhand Complex

Seawater intruded further upstream than was anticipated during the design of the tidal link. Tidal fluctuations were supposed to move through the Tidal Link reaching KPOD, but seawater was expected to extend only 12 miles upstream from the tidal creek to RD -93, still downstream of the dhands and Cholri Weir. But now the tidal influence in KPOD extends upstream of RD 84 where a 2.3 ft difference in water elevation is observed between low and high tide. However, the influence of tides is negligible at RD 159. Seawater now moves into KPOD twice daily with the tides as far upstream as RD -13, more than 15 miles further upstream than model predictions at the time of the design. As a result, high tides can slow runoff down the drainage canals during the monsoon season and agricultural lands can be destroyed by-salt accumulations where seawater intrudes.

As the Tidal Link continues to enlarge and the delta front continues to recede due to no flow of freshwater and sediment into the Arabian Sea, tides and seawater are expected to move further upstream over time. The destruction of the embankments along the Tidal Link also means cyclones, even smaller than cyclone 1999 with a storm surge of up to 10 ft, can move further inland than before. A storm surge without embankments can now move inland for several miles without encountering any obstructions over the very flat terrain.

5.4 The Dhand Complex and its Degradation

The collapse of Cholri Weir, the widening of the breaches through the embankments, and the growth of tidal channels into the dhands has led to a twice-daily tidal fluctuation into Pateji Dhand. The resulting changes due to tidal influx into dhands have direct impact on fish production and the livelihoods of local fishermen. As the tidal water grow further into the dhands, the brackish water lakes are increasingly exposed to sea water intrusion, sedimentation, and excessive drainage during low tide. The dhand degradation had already begun before 1995 when freshwater inputs from the Indus River had been severely curtailed when the Kotri Barrage was commissioned. Some freshwater continues to reach the northern dhands through the drainage infrastructure, but sugar factories and other sources often pollute this water, further degrading water quality.

5.4.1 Recent visit of the Tidal link and Dhands complex by the consultants

A Group of LBG / Indus Associated, Master Plan Consultants, made a visit of tidal link on 10/7/2012 to observe its morphological behavior and to suggest the possible structural/non-structural measures to improve outfall conditions for LBOD. The following team members participated:

i. Dr. Muhammad Saleh Soomro
ii. Dr. Bagh Ali Shahid
iii. Dr. Zaigham Habib
iv. Dr. Ghulam Rasool Keerio
v. Engr. Khadim Hussain Soofi
vi. Mr. Anwar Ali Baloch

Forest Department Government of Sindh facilitated the visit and provided a boat. The main objective of the visit was to identify and analyze the existing conditions of the tidal link, the process of creek development and the flow of tidal water from sea through tidal link to Dhand complex and back to sea. The team started travelling from old Rangers Check post at about RD (-120) moving upstream of the Tidal link towards dhand Complex. Following observations were made during the visit of the tidal link and suggestions are also offered about proposed structural / non-structural measures:

1. It was observed that the tidal link at old rangers check post was very wide to the extent that it was approximately 3500 feet against the original width of 332 feet. Average width of the tidal link was about 3000 ft. There was no sign of bank on the right side of tidal link and on the left side the banks were washed away at some intervals.
2. The depth of water was measured at four locations at the following coordinates:

Location	Coordinates	Depth of water (ft)	Altitude (ft)	TDS (ppm)	pH	Salinity EC(mS/cm)
At Cholri Weir	24 15.5478 N 68 40.4230 E	37	3.25	41216	8.3	64.4
Creek in dhand	24 16.0502 N 68 37.1513 E	26	4.93	44352	8.4	69.3
Creek at Zero Point	24 15.3603 N 68 40.7705 E	18	10.22	44800	8.3	70.0
Tidal link RD (-53)	24 15.3640 N 68 40.7542 E	20.5	9.02	41336	8.3	65.0

3. The design top width of the tidal link at the beginning was 152 ft and that at the outfall 233 ft. This width has increased manifold and has reached 3600 ft or more at some places in the vicinity of the outfall and near dhand complex
4. Pronounced scouring of the tidal link banks was noticed with mixing of the eroded soil in the tidal link waters making it muddy and highly turbid. The creek developed at the location of damaged Cholri weir kept deepening and widening with the passage of time due to erosion by high velocity tidal waters at the time of tide recession.
5. It was noticed on 10th July 2012 that the depth of the creek has reduced most probably due to inflow of silt laden water of the Indus river breach at Kot Aalmoo through dhand complex and adjacent areas due to which the creek in the dhands has been silted up. Moreover, the wave wash of the land on the banks of the creek also caused accretion of silt in the creek bottom.
6. Flow of tidal water to and from the dhand complex together with wave wash has tremendously eroded the tidal link banks and the process appears to continue that may result in width wise expansion of tidal link for quite some time.
7. Presently the tidal link has been converted to a sea creek due to non existence of protected bunds.
8. Due to erosion the coastal lands of Badin and Thatta districts are progressively under severe threat of washing away into the sea by tidal waves.
9. Stopping seawater intrusion is therefore, the need of the day because the tidal influence is adding to the environmental degradation causing severe scouring of soil and adding to the salinity of soils in dhands area. Moreover, tidal progress upstream of the KPOD up to RD-100 creates doubt among the minds of the people that the salt laden tidal waters may flow back in the sub-drains in case of submergence badly affecting the fertile lands in the vicinity.
10. The coastal wetlands are an important ecosystem and a predominant source of livelihood for coastal communities. The revival of the coastal wetlands has therefore become a dream unless some viable solution to check sea water intrusion is made effective and is sustainable
11. Apparently the structural solutions does not seem workable in this area, we may then think of some non structural options or indirect approach for revival of the productivity of dhandhs i.e. ecosystem approach. Ecosystem is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. The ecosystem approach as defined by Convention on Biological Diversity “a strategy for integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way”. We may think of this solution especially for revival of dhandhs under given scenario.
12. The team has already proposed a biological solution i.e. plantation of mangroves in the area. This solution is to be extended and implemented on the potential sites so as to ensure their protective role.
13. The interventions of Zulfikarabad Project which is being actively executed in the coastal areas of Jati, Shahbander, Kharo Chan and Keti Bunder are also of worth consideration.
14. Master Plan Consultants suggest inviting an expert from Delft, Holland to guide for checking sea intrusion and protective measures for outfall of LBOD.
15. The proposed plugging of tidal link, construction of new embankments along tidal link and protective bunds along dhand complex is completely risky under frequent cyclones and tsumnamies.
16. If the option of any structural solution is considered, the cost of the intervention would surpass the benefits to accrue. Secondly, the prevailing conditions at tidal link do not warrant taking risk of possible failure of structure either at the tail end of the tidal link or the place where the cholri weir failed.

5.5 Proposal to revive the dhand ecosystem through "Ecosystem Approach"

It is proposed to make efforts to close the major creek at some distance away from the mouth of the creek with gabions filled with boulders / or with concrete blocks across the creek to stop the flow of tide water into the dhands. The Dhands will receive water from Karo Ghungro and Guni Phuleli drains by completely stopping the sugar mill effluents into these drains. The water of these drains is slightly brackish with 1000 to 1500 ppm all the year round and is suitable for local fish, reed grass and migratory birds. The area of dhands is around 60,000 acres. This area will be divided into suitable parcels after a detailed survey of the area using appropriate dykes and the following interventions shall be practiced depending upon the location, status of soil salinity and surface elevation:

1. Fish ponds
2. Reed grass areas
3. Salt tolerant trees and bushes
4. Mangroves
5. Salt tolerant crops and grasses for livestock fodder
6. High value Oil seed crops like castor and linseed etc.

5.5.1 Recommendations of the International Panel of Experts (IPOE)

1. At present both tidal fluctuations and sea water intrude into the dhands and KPOD, and the drainage and environmental functions of the Tidal Link portion of the LBOD outlet are impaired. The result is that there is now an open connection between the dhands and the Tidal Link, exposing the dhands to tidal fluctuations, sea water intrusion, sedimentation, and excessive drainage during low tide.

2. The LBOD can now be described as a "new river" that is forming an estuary and is an integral part of creek formation into the coastal area. The Tidal Link has invited the sea to approach the land and now the tidal fluctuations are visible. This process will continue, and its progress is difficult to predict. Adapting to this new process requires continuous hydraulic and environmental monitoring in learning by doing approach.

3. The proposal to extend the drainage system by studying LBOD Stage II & III in light of the present outfall conditions of LBOD Stage I should be postponed until the existing problems at the outfall are adequately address and solved.

4. The present conditions of the outfall system do not provide the hydrological, environmental and social functions that were originally considered at the design phase. The LBOD- KPOD can now be described as a "new river" that is forming an estuary and is an integral part of creek formation into the coastal area. The Tidal Link has invited the sea to approach the land and now the tidal fluctuations are visible in the KPOD. This process will continue, and its progress is difficult to predict. Adapting to this new process requires continuous hydraulic and environmental monitoring in learning by doing approach.

5. In March 2001, the World Bank organized a Fact Finding Mission to understand the technical details, system performance and the damages to the Tidal Link; also to understand the possible technical, environmental and social consequences, and to suggest to the Government of Sindh further steps to be taken. The mission concurred with the view of the GOS Technical Committee that the "no-action" recommendation of the committee is justified not only because the damage is beyond repair by conventional methods, but also because the scour of the channel bed and erosion of the embankments are still active under the influence of the uncontrolled tidal flow through the tidal link and flow to and from Rann of Kutch and the Dhands. The mission believed these conditions would render any attempt to repair the damages useless using conventional methods until such time as there is more knowledge of the processes underway in the Tidal Link area. The mission stressed that intensive monitoring

of the physical and environmental conditions in the Tidal Link area should be continued to provide a basis for formulating further action. This included continuation of the hydrologic and hydraulic monitoring being carried out by the National Institute of Oceanography (NIO), water quality and LBOD Stage I Project.

5.6 Conclusions

The scour of the banks of the tidal link is going on at high tide together with wave wash and the scouring of the bed of the creeks and the tidal link continues at low tide with increased velocity of receding tide with the result the width of the tidal link canal has increased manifold. The depth of the canal has also increased at various locations as reported in NESPAK 2009 report.

John Field Farmington (2011) in the Geomorphology Review of Redesign of LBQD Stage-1 Badin Area Drainage System reported after analyzing the existing conditions of the LBOD outfall has concluded that severe erosion of the Tidal Link, breaches in the flanking embankments, and the collapse of Cholri Weir are ongoing problems with the LBOD drainage system caused by several natural and anthropogenic processes. The primary structures for restoring lost function of the Tidal Link include tidal plugs at the downstream end, a gated structure in KPOD, and reconstruction of the embankments. The structures will need to be built with far more reinforcement than the initial Tidal Link in order to survive in an environment facing earthquakes and the specter of global climate change where the effects of tides, cyclones, and sea level rise are likely to worsen over time. If the requirements for bank protection cannot be provided, such as driving sheet piles 100 ft below the bed of the Tidal Link for the tidal plugs, then the projects should not be completed as the risk of failure will be too high and the potential for rapid repairs to damaged structures low given the remoteness of most areas.

Ultimately, the solution of the revival of the dhand complex lies in considering the “Ecosystem approach”. Entire dhand complex comprising of 60,000 acres is to be thoroughly surveyed and parcels of land will be marked for different eco- friendly interventions considering their suitability in consultation with stakeholders in a coordinated approach.

5.7 Desertification

Due to increasing population and poverty, massive forest cutting is on the rise that has changed the rain pattern, which is causing an increase in desertification and Sindh is the worst affected. Environmentalists, nature conservationists and experts say that due to the change in the weather pattern and decreasing rains, the coastal belt of the province would be hit worst by desertification where seawater would intrude the productive coastal land. Experts warned taking immediate precautionary measures; otherwise the situation could be fatal. Quoting an example of some of trees of the Thar Desert.

Kella, a forest expert of Sindh said that guggal (*Commiphora wightii*), gum acacia, kandi, booh and other trees are on the verge of extinction due to reduced rainfall and massive tree-cutting, followed by increasing poverty (Kella, 2010).

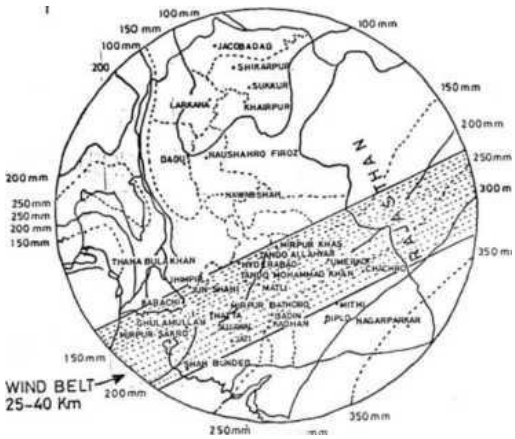
5.7.1 Desertification Process

Land desertification has been continuing since centuries due to over and improper exploitation of natural resources by human being through over cultivation, poor soil and water management, deforestation and climatic factors. Dry sandy areas of the world have been susceptible to desertification due to exacerbation of the process by droughts and wind storms turning the areas into sand dunes. It has been established that desertification problems is not only due to sand dune encroachment but the process of fertile land's degradation is also taking place in areas away from true deserts due to improper exploitation of natural resources.

Sandy arid areas of Sindh in Tharparkar, Umerkot, Sanghar, Khairpur and Ghotki districts spread over 44000 sq kilometers called Thar. These sandy areas although dominated by sand have very good plant sustaining capacity and therefore turn into greenery during rainy season. With the increase in human and live stock population, the vegetative cover in the area has been reduced due to lack of

proper planning, desertification process has continued unabated. However, it has never been ascertained through any study how much valuable organic matter and nutrients of our soil are blown with winds and taken to a distance of hundreds of Kilometers into the Rajasthan desert causing colossal loss to the fertility of our soils.

Figure 5. 7: Average Rainfall and High Velocity Wind Belt in Sindh



(Source: Engr. Shoukat Rahmoon)

5.7.2 Effects of desertification

Desertification is essentially a result of soil degradation. The direct effect of land degradation is either a decrease of land productivity or the complete abandonment of agricultural land, which leads to the food crisis confronted by arid regions. Severe soil degradation may ultimately result in complete desertification. Deserts all over the world are known to be increasing at the expense of agricultural land and this is most severe in arid and semi-arid regions. The desertification leads to agricultural productivity losses and increases poverty. It also contributes to global warming, and loss of biodiversity. It triggers soil erosion because of the loss of vegetative ground cover exacerbating water erosion and flash floods, accelerating siltation of rivers and reservoirs. In developing world, the key driving force behind this degradation is a nexus of poverty, rapid population growth, and inadequate progress in increasing agricultural productivity. The people in their quest for food and other livelihood needs, pursue land management and cultivation practices that deplete soils of their nutrient and organic matter content and promote erosion; overgrazing of rangelands, and cut trees and bushes for fuel wood and other purposes. Population growth rates remain high in many dry land areas. With slow agricultural and economic growth, the pressure on natural resources in dry land areas seems destined to worsen. Social and environmental crises are already common and are proving costly to governments and donors. These problems are likely to become much more complicated unless major new efforts characterized by profound changes in local and international behavior are made to address the livelihood needs of dry land population and reversal of desertification process on war footings through short and long term initiatives with a political will and commitment.

While people are without doubt a most valuable resource in Pakistan, uncontrolled population growth puts ever-increasing pressures on the country's natural resource base. Misguided economic policies have widened inequalities and forced rural people and others to exploit biodiversity at rates that are no longer sustainable. As a result, processes such as deforestation, overgrazing, soil erosion, salinity and water logging have become major threats to the remaining biodiversity in Pakistan. It is now feared that Pakistan has the world's second highest rate of deforestation. The continuing loss of this forest habitat with its associated fauna and flora will have serious implications for the nation's other natural and agro-ecosystems.

Humans now have the capacity to alter the earth system in ways that, threaten the very processes and components, both biotic and abiotic (upon which the human species depend) ultimately leading to loss of productivity and desertification. Pakistan's population during the last three decades has increased to 190 million at present, and is expected to increase to 234 million by 2025 reaching 357 million by 2050. The situation of per capita availability of land and water in the country is extremely alarming and has further accentuated the problem of agriculture productivity. The per capita land availability has progressively declined to 0.15 ha at present, shrinking further to 0.06 ha by 2050. Similarly, the per capita water availability has dropped from 5600 cu meters in early 50's to approaching below 1000 cu meters per year at present. Such figures demonstrate that our resources are limited and that the damage represents a threat to our survival. The availability of arable land within the next several decades will diminish in extensive regions. The major causes of land degradation are deforestation, shifting cultivation practices in agriculture, and over- grazing. Land degradation now affects the lives of hundreds of millions of people and is hampering the development of countries. Stopping land degradation is a high priority in many areas of the world. Human-induced degradation is around 30% in Africa, 27% in Asia and 18% in Latin America. Most of the degradation is taking place on agricultural and pasture lands, which are major sources of food, incomes, and employment for rural people in many developing countries.

Desertification is described an aspect of the widespread deterioration of ecosystems, with diminished or destroyed biological potential, i.e. plant and animal production, for multiple purposes at a time when increased productivity is needed to support growing populations in quest of development. Desertification contributes to other environmental crises, such as the loss of biodiversity and global warming". The deterioration of productive ecosystems is an obvious and serious threat to human progress. Over exploitation gives rise to degradation of vegetation, soil and water. These three elements serve as the natural foundation for human existence. In exceptionally fragile ecosystems, such as those on the desert margins, the loss of biological productivity through the degradation of plant, animal, soil and water resources can easily become irreversible, and permanently reduce their capacity to support human life. Land degradation is both a cause and a consequence of rural poverty.

About 90% land area of Pakistan falls into arid and semi-arid, and is vulnerable to desertification. High evapotranspiration and low rainfall are salient features of arid and semi-arid areas. Pakistan's economy basically dependents on agriculture. "In Pakistan, out of a total of 88 million hectors, around 63 million hectors is dry land, including the glorious mountains, deserts and other areas, so we need to restore forests in these areas to save them from desertification."Population pressure is the leading cause of desertication. Sustainability of agricultural and environmental systems is the major concerns in the country. There is an urgent need to accelerate efforts for increasing agricultural production in view of the existing 190 million people (Est. July 2012) and also growing population which is expected to become 345.5 million in the next 50 years.

5.7.3 The process of desertification falls into three categories

i. The expansion of the desert
ii. The expansion of desertification due to deforestation;
iii. Land lost of land because of waterlogging and salinity, overgrazing, urbanization and unsustainable management.

Key problems threatening natural resources and the sustainability are: soil degradation, the availability of water and the loss of biodiversity. Desertification contributes to other environmental crises, such as the loss of biodiversity and global warming. Land degradation is both a cause and a consequence of rural poverty. Combating desertification can be done successfully using modern techniques if financial resources are available and political will to act is there. This will include providing alternative livelihood opportunities, tenure security, appropriate and improved grazing and irrigation practices.
The impacts of desertification and their inventory are as follows:

- Arid area of Pakistan is 41 mha
- Desert 11 mha

- Arid areas are being turned into useless lands due to desertification
- Desertification threatens future of the people
- Land productivity decreases
- Direct cost of desertification in terms of loss in agriculture production stands billions of rupees

5.7.4 Main causes of desertification

5.7.4.1 Drought

Drought is considered as one of the main causes of desertification. Drought can be attributed to inadequate seasonal precipitation, a prolonged dry season or a series of sub-average rainy seasons. The drought also severely affected local livelihoods and forced local people to migrate in search of work and food. This disrupted traditional land use patterns, resulted in the permanent loss of traditional management practices and exacerbated the trends toward land degradation and desertification.

5.7.4.2 Excessive Cultivation

A rapid increase in human and animal populations necessitates a corresponding expansion of cultivated areas; leading to land over-utilization and thus causing land degradation.

5.7.4.3 Soil erosion

Soil erosion implies loss or removal of surface soil material through the action of moving water or wind. Soil wind erosion is an important process that affects both the surface features and the biological potential of soils. Soil erosion is taking place at an alarming rate and is mainly due to deforestation.

Table 5.1: Area affected by wind erosion (000 ha)

Degree of erosion	Puniab	Sindh	NWFPFATA	Balochistan	Pakistan
Slight	2251.4	295.0	13.1	36.3	2595.5
Moderate	279.1	70.2	3.8	143.6	469.7
Severe	1274.2	168.8	19.6	100.9	3081.3
Total	3804.5	2052.1	36.5	280.5	6173.5

Source: Land Degradation in Pakistan. Shah and Arshad (2006).

Table 5.2: Area affected by water erosion (000 ha)

Degree of erosion	Punjab	Sindh	NWFP/FATA	Balochistan	Northern Areas	Pakistan
Slight (sheet & rill erosion)	61.2	-	156.3	-	110.5	328.0
Moderate (sheet & rill erosion)	896.8	-	853.8	1858.6	25.8	3635.0
Severe (rill, gull and/or stream bank)	588.1	58.9	176.1	2724.4	504.2	5640.7
Very severe (gully, pipe & pinnacle erosion)	357.9	-	1517.0	-	1571.6	3446.5
Total	1904.0	58.9	4292.2	4583.0	2212.1	13050.2

Source: Land Degradation in Pakistan. Shah and Arshad (2006).

5.7.4.4 Waterlogging and salinity

Water table depth of the areas irrigated by three barrages for the last 30 years show that major part within different canal commands remained under 0-150cm depth during post monsoon season. This is because of the rainfall, flooding condition & simultaneously canals are running in full supply level in the kharif season, and water table rises at the peak before the start of the Rabi season. As the water table starts increasing soon after Rabi, the area covered by water logging is higher at the end of monsoon period.

5.7.4.5 Deforestation

Deforestation is the root cause of land degradation. The forest area in Pakistan is 3.77% (Table 3). Due to deforestation, forest cover is shrinking by 3.1% and woody biomass by 5% annually. The mangrove forests of the Indus Delta have halved from 2600 square kilometers in late 1970s to 1300 in 1990s, due to the grazing by camels. Almost 50 % of the original riverain forests have been degenerated beyond economic viability.

Table 5.3. Rangeland and Forest Area of Pakistan

Province	Land Area (mha)	Rangeland Area		Forest Area	
		Area (mha)	% of total	Area (mha)	% of total
NWFP	10.17	4.73	46.51	1.49	14.65
Punjab	20.63	5.19	25.16	0.44	2.13
Sindh	14.09	2.66	18.88	0.28	1.99
Blochistan	34.72	8.95	25.78	0.45	1.30
Northern Areas	7.04	1.15	16.34	0.32	4.55
AJK	1.33	0.87	65.40	0.34	25.56
Pakistan	87.98	23.55	26.77	3.32	3.77

Source: National Forests and Range Resources Assessment Survey (2003-04).

5.7.4.6 Overgrazing

Overgrazing is the major cause of desertification. Among the human activities that degrade rangelands, overgrazing practices by different types of livestock are perhaps the most significant. Overgrazing has brought down the productivity of rangelands to as little as 15-40% of their potential. More than one-third of the country area has been classified as under risk of desertification. To halt desertification the number of animals must be restricted, allowing plants to regrow. Fencing is valuable tool for preventing the domestic and wild animals from moving around the fields.

5.7.5 Proposal to Reduce the Impacts of Desertification

5.7.5.1 Shelterbelt plantations to reduce wind velocity

Shelterbelts and tree-screens consisting of a row of trees are found to be very effective for Thar Desert. Shelterbelts reduce the wind velocity by 20-46% on the landward side during the monsoon period. There are shelter belts in the area hence desertification process in not checked.

5.7.5.2 Inadequate Rainwater harvesting in drylands

Rainfall is the only source of freshwater source during monsoon (July to September) in non-irrigated areas. The Pakistan Council of Research in WaterResources (PCRWR) has been developing various techniques to harvest rainwater by constructing ponds with different storage capacities. These ponds have been designed to collect maximum rainwater to minimize seepage and evaporation losses. Large scales adoption of all these interventions would ultimately help improve the socio-economic conditions of the residents of hyper arid area of the country. To combat the impact of desertification the rain water harvesting in dry lands is inadequate.

5.7.5.3 Industrialization / urbanisation

Industries also entail a large chunk of agriculture land be it in coastal, urban or rural area. The problem is more severe when the area around industries is denuded of total vegetation in miles making land totally degraded to desertification (case study of Nooriabad). Urbanization is also encroaching upon agricultural lands causing immense damage to our natural resources.

5.7.5.4 Space technology to combat desertification

Delineation and mapping of affected areas has been performed to establish a reliable base-line data for monitoring desertification processes and evolving suitable strategies for combating them.

5.7.5.5 Remote Sensing and GIS Techniques

The integration of remote sensing with GIS techniques is becoming increasingly important for the assessment of environmental changes .Land desertification monitoring using remote sensing and GIS

needs to be continued and also refined for the purpose of long-term monitoring and the management of fragile ecosystems in semi-arid regions of Pakistan.

5.7.5.6 Sustainable Land Management (SLM)

Land degradation is a central challenge to sustainable development. The latter has been defined as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable Land Management combines technologies, policies and activities aimed at integrating socio- economic principles with environmental concerns simultaneously to maintain or enhance production and services; reduce the level of production risk; protect the potential of natural resources and prevent degradation of soil and water quality; be economically viable and socially acceptable.

Taking note of the serious challenges that we face, the Ministry of Environment of Pakistan has launched a 2 years project for 2008-2009"Sustainable Land Management to Combat Desertification in Pakistan" with the cooperation of Global Environment Facility (GEF), United Nation Development Program (UNDP) and Government of Pakistan. The overall goal of the project is to combat land degradation and desertification in Pakistan in order to protect and restore ecosystems and essential ecosystem services that are key to reducing poverty.

5.7.5.7 Soil and Water Factors

Life on earth depends on the layer of soil that is the source of nutrients for plants, crops, and forests. Without it, ultimately none can survive. Although topsoil takes a long time to build up, it is more prone to erosion leading to desertification.

- Soil moisture content: only dry soils undergo erosion due to a total loss of moisture.
- Soil texture: fine particles are more vulnerable to erosion than coarse ones.
- Cementing materials: an absence of cementing materials (such as organic matter) makes soil more prone to erosion.
- Poorly drained irrigation practices turn cropland salty and desertify 500,000 hectares annually.

5.7.5.8 Climatic considerations

Climate relates to climate variability, climate change, or drought. The frequently occurring *drought episodes* have been cited a major cause of desertification, as during extended dry spells desertification becomes relatively more severe, widespread, and visible, and its rate of occurrence increases manifold.

5.7.6 Impacts of desertification

In addition to agricultural productivity losses and increasing poverty, desertification results in significant reductions in carbon storage in soils, contributing to global warming, and loss of biodiversity. It also triggers soil erosion because of the loss of vegetative ground cover exacerbating water erosion and flash floods. These accelerate siltation of rivers and lakes and pollute water reserves.

The key driving force behind this degradation is a nexus of poverty, rapid population growth, and inadequate progress in increasing agricultural productivity, poor rural people in their quest for food and other livelihood needs, pursue land management and cultivation practices that deplete soils of their nutrient and organic matter content and promote erosion; overgraze rangelands, and cut but not replant sufficient trees and bushes for fuel wood and other purposes.

5.7.7 Consequences of desertification

- Desertification is a self accelerating process feeding on itself and as it advances, rehabilitation costs rise exponentially

- Desertification is not draught, which seizes when rains return, but it is steady process that robs the productive lands
- Desertification results not only in the loss of nation's productive resources but also in the loss of valuable genetic resources.
- Desertification is a threat to our planet's life support systems, causing social, economical instability and depletion of the resource base.

5.7.8 Organizations involved in desertification control

The main organizations involved in desertification control in Pakistan are: PARC, PCRWR, WAPDA, Forest Departments, Irrigation Departments, Agriculture Departments, Sindh Arid Zone development Authority, Cholistan Development Authority, Arid Zone Research Institute, DRIP, Pakistan Desertification Monitoring Unit, Soil Conservation Departments, Agriculture Universities, Pakistan Atomic Energy commission, Irrigation Research Institute, and NIAB etc. The main focus of these organizations is:

i. Afforestation
ii. Soil and Water Conservation
iii. Reclamation of salt affected and water logged soils
iv. Range Development and Sand Dune stabilization

5.7.9 Causes, consequences and global responsibility

Developing countries face the obvious life- threatening challenges of

i. Desertification
ii. Deforestation
iii. Pollution
iv. Poverty
v. Environmental degradation
vi. Disappearance of rain forests in the tropics and thorny scrub forests in the semi arid regions
vii. The loss of plant and animal species
viii. Changes in precipitation patterns
ix. The challenges of toxic chemicals
x. Toxic wastes, dumps
xi. Acidification
xii. Carbon dioxide emissions, and
xiii. Gases that react with the ozone layer depletion

Since the world has been intertwined economically, ecologically, environmentally the causes and consequences have also been the global responsibility. All nations therefore will have a role to play in changing trends, and evolution of an international economic system that increases rather than decreases quality of life and that decreases rather than increases numbers of poor and hungry people all over the world.

The next few decades are crucial. The time has come to break out of past patterns. Attempts to maintain social and ecological stability through old approaches to development and environmental

protection will increase instability. So the security to this must be sought through determination and commitment for change.

5.7.10 Pakistan Scenario

The country has highly complex and diversified agro-ecological and socio- economic set-up. One fourth of the country's land area, which is suitable for intensive agriculture, is seriously subjected to threats of wind and water erosion, salinity / sodicity, waterlogging, flooding and loss of organic matter. Watersheds in upper Indus and its tributaries suffer from unfavourable soil and moisture regimes. Accelerated surface erosion is reducing the life of Tarbela and Mangla reservoirs which provide water for 90 percent of the food and fibre production in the country.

5.7.11 Sindh Scenario (arid zones)

The arid zones of Sindh represent 17 percent of the arid land of Pakistan and are classified as sub-tropical semiarid deserts. They cover an area of over 68,000 sq. km of the province and can be roughly divided into three even-sized distinct regions of Thar, Nara and Kohistan. Out of a total area of 14.09mha, 9.28mha form rangeland in these areas.

5.7.12 Sea Intrusion

The key potential impacts of sea-water intrusion on coastal systems and lands are:

i. increased coastal erosion,
ii. inhibition of primary production processes
iii. more extensive coastal inundation
iv. higher storm-surge flooding
v. landward intrusion of seawater in estuaries and aquifers, and
vi. changes in surface water quality and groundwater characteristics

5.7.13 ICARDA'S Approach Module

- foster integration among the stakeholders;
- stimulate stakeholder participation;
- facilitate technology transfer;
- promote collective action; and
- improve livelihoods and human welfare

Multi-disciplinary teams of stakeholders work alongside the communities targeted. The strategy involves agro-ecological characterization and the development and transfer of appropriate technologies; first to the community and then, via modeling and scenario-building, to other communities and stakeholders, thus beginning the process of benefits scaling.

Reversal of trends in land degradation requires a holistic approach focusing on three key components. Firstly, technological interventions must address land, water and food security problems. Secondly, the active involvement of local communities within a strategy that increases their knowledge and organizational capacity is called for. With increased capacity to manage risk and to solve problems, communities can reverse land degradation, improve their livelihoods and become responsible stewards of natural resources. Thirdly, appropriate incentives at the policy and institutional level are required to induce land users to adopt more conservation technologies.

5.7.14 Combating Measures

To meet the food and fiber needs of ever increasing population of the country and to help non potential areas of the world, it is necessary to formulate long term strategies for conserving the arid

lands and to develop the neglected potential areas on scientific grounds. The pace of development is required to be accelerated to save the human being from hunger. Various reports of FAO indicate that most of the countries of 3rd world have no chance of becoming self reliant in food product and it is therefore most important, that the valuable land resources should be saved from desertification. For combating desertification problem following mitigating measures are to be taken.

5.7.14.1 Afforestation and improvement of range lands

Afforestation plays vital role in combating the process of desertification in arid areas, specially the areas which come under high wind velocity. The process of Afforestation/ reforestation and rotational system of grazing lands is required to be developed on a long term planning of 25 years.

It has been found from the experiments that it is possible to grow plants and trees on saline water and therefore, the available ground water in the desert area can be utilized properly. The Xerophytic trees and plants are another alternative for increasing vegetative cover in arid areas. Both indigenous and exotic plant species may be tried to know their viability in controlling the process of desertification. The indigenous xerophytic trees like Acacia Senegal (Konbhat), Prosopis Cineraria (kandi), Tecoma, Undulata (Rohero), Zizyphus, Mauritania (Ber), Capparis Decidua (Kirir) are capable of surviving in drought conditions and can be planted as wind breaks and shelter belts to control desertification. Similarly the ranges can be improved by reseeding the grasses like Cenchrus Ciliaris, (Dhaman), Cenchrus Biflorus (Bhurt), Lasiurus Sindicus (Sen) Panicum Antidotale (Gramina) and Panicum Turgidum (Murt) survive and flourish luxuriantly in climatic conditions of sandy arid areas. All interventions and projects must be initiated with full participation of local people by forming village organizations and Range land improvement committees so that positive results could be achieved.

5.7.14.2 Conservation of water resources

Canal Water

Fairness in distribution of Canal Water is must to save the fertile lands from becoming barren and prune to desertification Efficient irrigation systems, like Drip, Trickle and Sprinkler must be introduced in water deficient canal irrigated areas for conserving water and increasing Agricultural productivity.

Ground Water

Exploration of ground Water is required to be made to ascertain its quality and quantity. Even if water with a salinity up to 5000ppm / mg/l is found in plenty, it can be utilized for cattle consumption and growing many types of useful plants.

Rain Water Conservation

Appropriate techniques may be adopted for conservation of rain water, in Thar area for which the inhabitants of these areas may be trained and sufficient financial assistance may be provided for construction of structures to conserve rain water on individual and community basis.

1. **Proper and productive livestock**

   To decrease the burden of livestock on range lands and pastures it is necessary to rear and maintain the animals of productive breeds only. Both milk and meat animals of reputed breeds should be introduced in the area and herdsmen may be motivated through extension services and demonstration farms, to understand the cost-benefit ratio of rearing livestock and their effect on the range and agriculture land. The arid area, being most suitable for increasing livestock productivity, it can be further developed to fulfill the needs of livestock products like milk, meat, hides etc. Proper planning of livestock farming will surely aid in combating the desertification process.

2. **Saving infrastructure from sand dune encroachment**

   Roads, Railways and other infrastructure must be saved from the encroachment of sand dunes by planting trees to stop blowing sand, and create bearers on the sides of roads and railway. All types of vegetation on sides of roads must be protected and cultivation on steep slopes and

lands in vicinity of roads in the direction of winds must be stopped through enactment of proper legislation.

For peace, prosperity and dignity of the generations, we must plan to develop and conserve the fertility of our vast potential land areas, irrigated as well as rain fed and combat the desertification process with long term planning. The strategies for development should be aimed at alleviating the socioeconomic condition of the people of these areas and all efforts should be made to motivate and involve the local people in the development process.

5.7.15 Core Programs

Environmental Conservation / Tree Planting

A nationwide campaign should be led to conserve local biodiversity, enhance natural beauty and prevent soil erosion. Experts say that a forest cover of 15% is required for a country to sustain life naturally, availability of rain, availability of underground water, soil fertility, and clean air and prevention of soil erosion and beauty. At present Pakistan's forest cover is less than 4%. Planting of indigenous trees be promoted in forest catchment areas, private farms and public spaces to preserve local biological diversity.

Civic & Environmental Education

Recognizing the need to strengthen civil society's concern for the environment, civic education and advocacy projects are to be established to raise public awareness on the need to protect the environment.

Training Workshops

Through a systematic approach to the deforestation challenge, the environmental problems could be addressed by organizing training workshops for the stakeholders and development workers

Trees and shrubs (Indigenous Germplasm)

One of the main cause of depletion of ranges and desertification of dry lands in Sindh is the practice of cutting and uprooting trees and shrubs for use as fuel by the rural population because wood is the principal source of available energy. Efforts have to be made to select multipurpose trees and shrubs which could be used for providing food, feed and fuel wood to domestic cooking and greening of our dry lands. Following indigenous tree/shrub species are recommended:

Table 5. 4: Indigenous tree/shrub species for plantation in areas affected by desertification in monsoon season

Local Name	English Name	Botanical Name	Family
Babul	Acacia	Acacia nilotica	Leguminosae/Mimosoideae
Kunbhat	Gum Arabic	Acacia Senegal	Leguminosae/ Mimosaceae
Bavri	----	Acacia Jacquemontii	Leguminosae/Mimosoideae
Phulai	Amartasar gum	Acacia modesta	Leguminosae/ Mimosoideae
Nim	Neem	Azadiradita indica	Meliaceae
Gugur	Indian Bdellium	Commiphora mukul	Burseraceae
Phog	Calligonum	Calligonum	Polygonaceae
Lyar	Narrow leaf sepistan	polygonoides Cordia	Ethretiaceae
Kirir	Caper	latifolia	Capparidaceae
Kandi	berry	Capparis	Leguminosae/ Mimosoideae
Devi	Prosopis	deciduas	Leguminosae/ Mimosoideae
Jaar	Mesquite	Prosopis	Salvadoraceae
Mithi	Tooth brush Tree	cineraria	Salvadoraceae
Jaar	Tooth brush Tree	Prosopis juliflora	Bignoniceae
Rohiro	Tecoma	Salvadora	Coniferae
Lai/Lao	Tamarix	persica	Rahmnaceae
Ber	Jujube	Salvadora	Rahmnaceae

Source: B.A. Sheikh and G.H. Soomro "desertification: causes, consequences and remedies". Pak. J. Agri., Agril. Engg., Vet. Sc. 22(1)2006

5.7.16 Conclusions

Desertification challenges faced by Pakistan are enormous and undermine our efforts for sustainable development. There is urgent need to address land desertification through multi- disciplinary approach based on scientific principles. The research networks for assessment and monitoring of land use planning and management is essentially important. The activities and efforts already underway by public and private sector organizations to combat desertification should be strengthened and supplemented by well coordinated system. Partnership among government agencies, donors, non-governmental organizations and local communities is a key factor for the successful control of desertification. A high priority is needed to cope with land degradation problem whose neglect the country cannot afford. Afforestation is the key approach to address the desertification issue.

5.8 Flow Downstream Kotri

5.8.1 Flow downstream Kotri and Sustainability of Indus Ecosystem

Reduced river flows below Kotri barrage since last three decades have made the deltaic environment fragile and has resulted in quite unsustainable ecosystem endangering the fauna flora, forests and mangroves, fisheries directly affecting the livelihood of thousands of the populations residing in coastal areas. The Indus Delta is listed under the Ramsar Convention on Wetlands, 1971, and is classified as the fifth largest delta in the world (Pamela Stedman-Edwards).

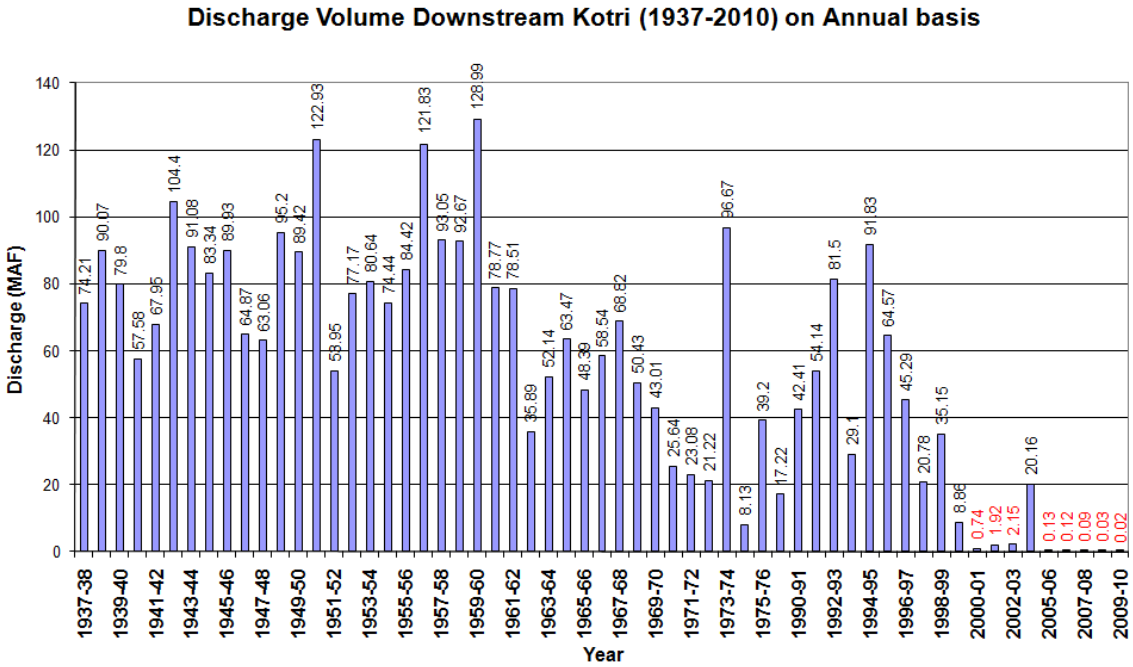


Figure 5. 8: Flow downstream Kotri Barrage from 1937 till 2010

The Indus Delta and surrounding habitats constitute diverse ecosystems including; riverine forests, irrigated plains, fresh water lakes and brackish wetlands. The land along the main course of River Indus is very fertile and supports a diversity of agricultural crops such as wheat, maize, cotton, sugarcane, rice and a variety of fruit orchards such as bananas, mangoes, date palm jujube and coconut palm. Significant fisheries resources include Indus Baril, Indus Garua, Golden Mahasheer and the famous Palla fish. Riverine forests along the banks of river provide sanctuary to a variety of birds, mammals, reptiles and amphibians. Keenjhar, Haleji and Hadero are three important fresh water lakes lying at the apex of the coastal region. The Delta is also home to a significant number of lagoons such as Jhubo and Nurari lagoons.

One of the paramount anthropogenic causes of ecological degradation in the Indus Delta is the reduction in fresh water flows. The survival of the Indus Delta is dependent on the silt-laden freshwater discharges from River Indus which has been curtailed due to diversion of water for primarily agricultural use and power generation in the upper reaches. Freshwater flow has been reduced from 150 million acre feet MAF) annually to 0.02 MAF in 2009-10. Release of freshwater into the delta in recent years has been inconsistent and below the minimum annual requirements to sustain the ecological health of the Delta.

The IPOE recommended a continuous flow of 5000 cusecs of water downstream Kotri throughout the year or 5 MAF in a year distributed as per need. According to the provisions of the 1991 Water Accord, 10 MAF is committed for downstream Kotri flows, however environmentalists believe this is insufficient. The IUCN Pakistan has calculated essential release of 27 MAF for the continued wellbeing of the Indus Delta. The reduction in water release has enhanced natural forces of degradation in the coastal areas such as the increase in salinity which creates unfavorable conditions for mangrove growth and associated biodiversity. Due to these stresses the catches of two commercially important (migratory) finfish species, Palla (*Tenualosa ilisha*) and Dangri (*Cates alcrifer*) have declined from 600 tons in 1986 to 200 tons in 1995. Palla used to dominate the fish catch of Sindh with a record catch of eight thousand mt in 1959 (Pamela *et al*)

5.8.1.1 Irrigation Infrastructure and Inefficiency

The 25 year average (1975-2000) rim station inflow of the Indus River and its tributaries is estimated to be approximately 154 MAF per year. However, the inflow of water varies drastically from year to

year. The Water Accord of 1991 assumes 114.35 MAF per year plus a 3 MAF for ungauged civil canals, making a total of about 117 MAF. The provision for environmental flows for the downstream and delta of the Indus is mentioned in the Water Accord at 10 MAF as a demanded by, but these flows have not yet been finalized or included. In recent years, the annual supply of 114.35 MAF, as agreed in Accord is not being complied with. Water losses between canal heads and watercourses, and losses within water courses, are equal to one third of the total amount of water delivered. Another 25 percent is lost within the farms. Pakistan's crop productivity per unit of water is very low at 0.13 kilograms per cubic meter (Simi Kamal 2009 presentation at the University of Nebraska).

5.8.1.2 Environmental Repercussions of System Inefficiency

Due to water scarcity, the sixth biggest mangrove forest in the world has been reduced from 0.6 million to 0.25 million acres. Although the 1991 Water Accord recognizes a fixed quantum of environmental flows (39.5 MAF per year), these are not released in a consistent way each year (1991 Water Accord, Pakkissan.com)

Recent satellite images indicate that mangroves in the delta cover about 160 thousand ha. On the one hand these forests produce wood, provide habitat for wildlife, place for grazing animals and on the other hand supports fisheries and shrimps production, and earns about Rs. 4 billion annually from exports. About 100 thousand fishermen are engaged in fishing and shrimp industry. Factors responsible for the degradation of Indus delta mangroves are: i) reduced flow of fresh water and silt from river Indus, ii) inflow of pollutants from Industries, navigational activities and intermix of industrial effluents, iii) browsing or grazing by livestock, iv) over harvesting of wood and fodder causing meandering and erosion of creek banks, v) over fishing; and vi) gradual rise in the sea level (Amjad *et al*). The recommendations of the International Panel of Experts with respect to a bare minimum flow of 5 thousand cusecs are not being followed. For eight to ten months, the flows downstream of Kotri are almost negligible, causing devastation of the ecosystem in the area.

5.8.1.3 The economic significance of the Indus Delta

The human population on the coast of Pakistan is estimated to total 1.2 million people; of them nearly 900 thousand reside in the Indus Delta. More than 135 thousand people depend on mangrove resources for their livelihoods. An IUCN study (IUCN 2005) estimates the total value of losses at US$125 million.

5.8.1.4 Environmental Impacts of Reduced Downstream flows include

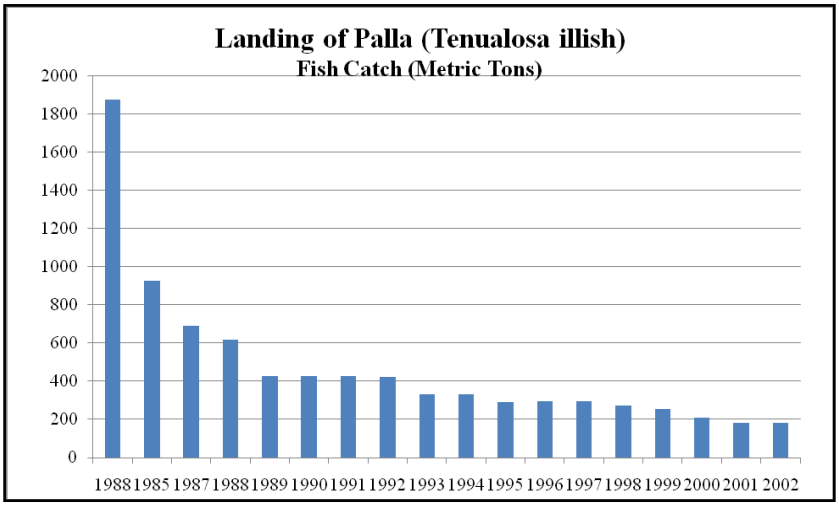
a) Ecological Impacts: The ecological impacts include disappearance of endangered fauna, reduction in riverine and mangrove forests, loss of biodiversity, gradual inland movement of the sea due to global warming, and increased marine and coastal pollution together with seawater intrusion.

b) Economic Impacts: There is a tremendous economic loss and as a result, unemployment, migration of people to other areas, and crime rate has grown exponentially in this region. Fertile lands have been turned into barren lands due to seawater intrusion. Results of the studies by the government of Sindh indicated that 480 thousand hectares (1.2 million acres) of the land is lost to the sea.

c) Social and Public Health Impacts: Water borne diseases have registered an increase of 200% in the last two decades. Due to the scarcity of water and resulting economic downturn, people of Sindh find it very hard to make the ends meet. Unemployment, poverty, crime rate, and other social problems are all on the rise. According to Asian Development Bank, 40 to 45% people in Sindh are below poverty line (Altaf A Memon World Water and Environment congress 2004). The rate of suicides in Sindh has sharply risen in the years after the water shortage started.

d) Decline in Palla Fish (*Tenualosa ilisha*): The famous Palla fish (*Tenualosa ilisha*) has migratory habits and for breeding it ascends upstream in River Indus from the Arabian Sea.

Due to very low discharge of Indus and lack of flooding, the fish has been unable to migrate upstream for breeding and, hence, the stocks of Palla fish have depleted at an alarming pace during the last 15 years Figure 4.3.5. In the past, it reportedly comprised of 70% of the total catch. However, presently it hardly constitutes 15 % of the total catch. The decline in the catch of this fish can be visualized from the chart below.



(Source: WWF Pakistan Indus for All Program)

Figure 5. 9: Decline in Pala Fish catch

5.8.1.5 Quantity of water essentially needed for sustenance of ecosystem

It is estimated that the losses in conveyance and in the field are to tune of 60% (Pakistan Water Sector Strategy 2002). Since the recommended deliveries do not account for these losses, therefore, if these losses are taken into account, then the minimum quantity of water needed as per the IPOE recommendations would be 12,500 cusecs (over 9.0 MAF per year) and as per study-II it will be 21MAF per year. Pamela Stedmans Edwards Pakistan Mangroves (WWF) Pakistan recommended about 6.8 MAF for sustaining mangroves. Waheed Bhutto (2006) , Tahir Qureshi of IUCN, Zulfiquar Halepoto and Rajab Memon (undated) quoting the study conducted by the IUCN experts have suggested that a discharge of 27 MAF of water is required to pass through Kotri barrage to prevent further damage to Indus delta. Various recommendations range from as low as 3.6 MAF to 40 MAF /year. From these findings, it is believed that quantity less than 21 MAF/year may not sustain the ecosystem which has been damaged to an extent that seems irreversible.

Studies undertaken by the Federal Flood Commission Pakistan in 2005 to ascertain the quantity of water to flow downstream Kotri are:

Study-I -Water escapages below Kotri Barrage to check seawater intrusion

Study-II-Water escapages downstream of the Kotri Barrage to address environmental concerns

Study-III-Environmental concerns of all the four provinces. (Federal Flood Commission 2005)

5.8.2 Environmental Use of IBIS System Waters

A source of contention since the IWA has been the fact that, in drought years, there is almost no water downstream of Kotri, causing immense damage to the Indus Delta. In order to get agreement on the 1991 Inter Provincial Accord, this issue was deliberately left unaddressed to be determined later by "expert studies." Subsequently, studies were commissioned which came up with the following findings: (i) downstream Kotri requirements and recommended associated environmental flows from the Indus were estimated at 3.60 MAF in dry or average years with 25 MAF additional every five years in times of flood, or alternatively, 8.60 MAF as an average for all years to be provided from the overall share; (ii) the recommended environmental flow allocation for the Indus, Chenab, Ravi, Sutlej, and Jhelum to maintain a minimum water depth of 0.5 to 1 meter were 8.25 MAF to be provided from the overall share; (iii) recommended environmental flows allocation for Punjab's lakes, water bodies, and riverine areas, etc., were 6.22 MAF to be provided from

Punjab's share; (iv) recommended environmental flows allocation for Sindh's lakes, water bodies, and riverine areas, etc., were 2.53 MAF to be provided from Sindh's share (Shahid Amjad Choudhry 2010) .

Table 5.5- summarizes the expert consultants' recommendations.

Table 5. 5: IBIS Environmental Flow Requirements

	Dry Year			Average Year			Every 5 years (Flood Year)		
	Total	Rabi	Kharif	Total	Rabi	Kharif	Total	Rabi	Kharif
Downstream Kotri[1] alt [1]				8.60	1.80	6.80			
(alt 2)	(3.60+)	(1.80)	(1.80+)	(3.60+)	(1.80)	(1.8+)	(25.0)	(0.0)	(25.0)
Indus, Jhelum, Chenab, Ravi, Sutlej[2]				8.25	2.25	6.00			
Punjab Inland Water Bodies [2]				6.22	1.82	4.40			
Sind Inland Water Bodies[2]				2.53	0.43	2.10			
Total Average Year Requirement [2]				25.60	6.30	19.30			

Source: 1 "Study on Water Escapes Below Kotri". 2005, op. cit. p.57.
2 "Environmental Concerns of all Four Provinces, 2005, op.cit. p.1.

a) Study-I consultants recommended:

The consultants recommended a minimum flow of 10,000 cusecs to stop seawater intrusion. Interface location with Option-2 (Q=10,000 cfs) is 35 km from the river mouth near Dandho (Sherazi Bander). The consultants noted that this option would eliminate seawater intrusion about 92% of the riverine area in the tidal reach. It is very strange to mention that the recommendations of 10,000 cusecs were kept aside and the opinions of the IPOE were highlighted in the report.

Table 5. 6: Recommendations of the Study-I Consultants

Season	Volume in MAF		
	Dry Year	Average Year	Wet Year
Rabi	0.53	2.11	3.61
Kharif	2.56	3.35	3.63
Annual	3.09	5.46	7.24

Study-II consultants calculated the Kotri downstream flow requirements of riverine forests, mangroves, agriculture, fisheries, and domestic use. The total requirements came as 8.42 MAF. The water application efficiency as given by WAPDA (Water Sector Strategy Vol 5 2002) is 40%. As such total required flow downstream Kotri would be 21 MAF. This requirement would be distributed as per the water availability in the river. Following breakup of water flow is suggested round the year on 10 daily bases to meet the requirement of all sub-sectors. Normally the flows in river are better during four months (June-September) and less in the months (October-May). Table below gives the flow on 10 daily basis round the year.

b) Study –II consultants recommended

Table 5. 7: Minimum Water Requirements for various Interventions proposed by the Study-II

Discipline		Riverine Forests	Delta Mangroves	Agriculture	Palla fishery	Other fish species	Domestic use

Water Requirement	Main River Channel	-	4.7 MAF	0.62 MAF	0.30 MAF monthly 0.9 MAF for 3 months	0.20 MAPF Monthly 1.8 MAF for 9 months	0.000696 MAF
	Canals	0.40 MAF			Total water demand for fish: 2.7 MAF		0.000851 MAF
Season/Month		April September	April September	Round the Year	June - August	September - May	Year round

The proposed Total Flow Downstream Kotri: 8.42 MAF (equals to 21 MAF at 40% Efficiency) Downstream Flow below Kotri Barrage recommended by Study-II consultants is 8.42MAF per year.

On 40% Water Application Efficiency, the actual requirement is calculated as 21.0 MAF per year

Table 5. 8: Suggested outflow downstream Kotri on 10 daily basis (Flow in cusecs)

Cusecs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
I	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	100,000	280,000	280,000	100,000
II	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	100,000	280,000	280,000	100,000
III	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	100,000	280,000	280,000	100,000

5.8.2.1 Impact of the development interventions on the eco-system in the Indus downstream of Kotri

No development interventions took place with regard to the ecosystem development. Releases downstream Kotri have practically stopped during 8-10 months of the year. The rate of degradation of mangrove forests in the Indus Delta has been estimated at 6 percent between 1980 and 1995. At present, only 15 percent of mangroves here are considered healthy. (Pamela Stedman-Edwards, WWF Pakistan).

5.8.2.2 Impact of Flow Downstream Kotri in the Light of Imagery of the last 21 years

Satellite imageries were obtained from the internet for the years 1989-90, 200-01 and 2006-07. These imageries were taken in the months of October-November (www.landcover.org). The flow in the river was 17.22 MAF in 1989-90, 0.74 MAF in the year 2001-02 and 0.12 MAF during the year 2006-07. Except in 2003-04, there existed drought conditions from 1999 till August 2010 where as in the decade 1989-90 to 1998-99 the flow downstream Kotri was adequate. Therefore, the imagery of 1989-90 showed dense vegetative growth and the covered area under vegetation was estimated 5800 sq.km. In 2001-02 there was drought and the flow downstream Kotri was just 0.74 MAF, reducing the vegetative area to about 3800 sq.km (65%). In 2006-07 vegetative cover increased to 5200 sq.km. This was due to better flows in 2003-04. This suggested a direct correlation between flows and vegetative cover.

The construction of the barrages and the link and irrigation canals has, over the years, led to a systematic abstraction of water from the Indus. The Tarbela dam and Chashma reservoirs have resulted in the siphoning off 74 percent of Indus waters before it reaches Kotri Barrage, the last barrage point on the Indus in the southern Sindh province. The deltaic area has been estimated to have reduced from 3,000 square kilometers (km) to 250 km (Hassan,1992).

The present situation is much more alarming due to below average rainfall in the Indus River catchment area as there are only two months (August-September) in a year when Indus flows downstream Kotri Barrage.

During a period of three years (2001-2003) NIO scientists regularly monitored the Indus River downstream Kotri Barrage. Zero discharge was observed during most part of the year. The Indus River is currently contributing hardly any sediment now, consequently, there has been intrusion of sea

water upstream of the delta - at places extending up to 80 km in the coastal areas of Thatta, Hyderabad and Badin districts. Sindh's Irrigation and Power Department (IPD) has revealed that seawater intrusion has resulted in tidal infringement over 1.2 million acres of land in the Indus Delta.

It is very clear that the trend started decreasing right from post Kotri period followed by post-Tarbela period till 2010 (Chart-1 and Table- 2). During the last 10 years the flow has remained almost negligible except in 2003-04. This has confirmed that no water is available for delta and coastal region. Due to this reason the people of the delta and coast are crying for saving their livelihood and ecosystem. They do not have water for their household use. From the interviews, the respondents informed that one adult member from each household is merely engaged for collecting household use water from far distant places. The recommendations of the International Panel of Experts with respect to a bare minimum flow of 5000 cusecs are not being followed. The river is empty for 8-10 months of the year. This has ruined the ecosystem of the area.

5.8.3 Conclusions

1. Considering the mass water divergence of the Indus River System in upstream areas causing acute depletion of Indus water-flow into the downstream Kotri barrage, it is inferred that the present climate changing trends are being more augmented due to the critical depletion of the Indus environmental-flows in the lower Indus basin. Reduction in inflow of freshwater from Indus together with added inflow of pollutants from industries, navigational activities and intermix of industrial effluent, and human and livestock population pressure for fuel wood and fodder collection have exposed this complex ecosystem to severe environmental and social stresses in the form of loss of habitat and biodiversity, decline in fish productivity and social problems for coastal communities.

2. The life of the delta is dependent on the availability of freshwater and sediment. The severe reduction of both as a result of dams, barrages and associated structures upstream has resulted in the pronounced erosion in parts of the delta and consequently in the reduction of the mangroves. Coastal erosion is increasing also due to unplanned coastal development in the area. The well-being of the delta requires a realistic assessment of the minimum volume of river water and sediment needed round the year to prevent the near-disappearance of the Indus Delta. The management of the delta should become part of an integrated coastal zone management in a holistic fashion. Not only the coastal environment should be managed integrally but environmental studies also need to be extended to the entire Indus ecosystem from the mountains to the Arabian Sea.

3. The Indus River, that has created one of the world's largest delta and submarine fan system, is currently contributing a fraction of fresh water or sediment in to the Arabian Sea. Consequently, the seawater intrusion has resulted in tidal intrusion in the prime agricultural land in the Indus deltaic region. Construction of barrages, dams, and link canals has further reduced the freshwater flow downstream Kotri Barrage from 146 MAF/year to less than 10 MAF/year. In last decade, the Indus River downstream Kotri Barrage has practically zero discharge. As a consequence, the river below Kotri shows increased braiding and sand bar development. Sediment passing down the system tends to be deposited in the section south of Kotri, rather than maintaining the growth of the delta. As a result the Indus Delta that used to occupy an area of about 6,180 km^2 consisting of creeks, mudflats and mangrove forest is now reduced to 1,192 km^2 after upstream diversions.

4. If a sincere effort is not taken to reverse the water shortage problems, the lower Indus basin will be moving towards an ecological disaster and a famine like situation. In the present state of environmental awakening and global acceptance of lower riparian rights, Sindh deltaic region may be considered in the light of the international norms.

5.8.4 Recommendations

Short term measures

a. The 1991 Water Accord should immediately be re-visited so that the amount of water being released downstream Kotri Barrage is assessed and minimum critical need to maintain deltaic ecosystems in a healthy state should be determined.

b. Holistic policies ensuring conservation of mangroves and the associated biodiversity in the area should be formulated to maintain a biological wall on the coast to face the cyclones and tsunamis and to stop coastal erosion and seawater intrusion

c. Livelihood opportunities for the local communities with particular focus on fisheries resource should be enhanced.

d. Shortage of drinking water for local population is a serious problem and needs to be resolved on priority basis to make community's life easier.

e. Disaster relief and mitigation measures need to be taken up on war footings. Cyclones, sea storms and tsunamis will be now frequent than ever before because of the global climate change. There is need to establish Elevated Platforms on the entire coastline at appropriate locations for timely rescue and relief of the affected people.

Long term measures

a. A comprehensive land-use plan focusing clearly on the areas fit for different developmental and environmental interventions now and in future is seriously required. This plan must be built and later monitored through satellite data.

b. Fisheries sector plays a vital role not only for the well being of the local communities but, also contributes significantly to the national income. This important resource has not received attention from the government for its long-term sustainability. A comprehensive plan is required to address the issues hampering the development of this vital resource with particular focus on proper jetties, ban on use of illegal nets, fish storage and processing facilities and elimination of fisher folks' debt cycle.

c. Social services sector needs to be critically examined as the entire Indus Delta region lacks proper facilities of education, health and communication.

5.9 Water Quality in the Project Area

5.9.1 Water Quality Deterioration:

Irrigation water is the main source of drinking water in many towns and villages, especially where the ground water is brackish. Thus, the downstream residents especially in southern Sindh are exposed to adverse health effects due to both biological and chemical contamination of water bodies. Of course, local practices such as washing clothes in irrigation channels and livestock wallowing add to the problem. Further, there is an increasing trend for municipal bodies to contract out municipal waste water to farmers for vegetables cultivation. While such recycling is income generating, adverse health effects occur both directly, through ingestion of the produce and bore worms and indirectly, via seepage of such water into the groundwater table and runoff into the irrigation system. Water pollution also adversely affects biodiversity, particularly aquatic life of the wetlands and water bodies.

The use of chemical fertilizers, pesticides, insecticides, and fungicides has increased tremendously over the years. The run-off from irrigation feeds into surface water and also seeps into sub-soil water, as crops do not utilize all chemicals and or drains into water bodies resulting in water pollution. Deterioration of surface water quality also occurs when raw sewage and industrial toxic wastes and effluents are discharged into rivers, irrigation canals and drains. Untreated municipal sewage discharged into river Indus or canal systems of IBIS beyond the natural cleaning capacity of waters thereby affecting the fish and biotic life.

Ground water mining and lowering of water table are taking place in Irrigated areas of Indus Basin, Partially due to drought period, but largely due to development of private tube wells for irrigation purposes about 100,000 tube wells in Sindh (both public and private) have caused deterioration of ground water quality in sweet water areas by salt water intrusion as there exists a fringe of sweet water overlaying the saline water that comes up and mixes with sweet water due to up coning resulting in brackish water delivery in few days of the tube well installation.

None of the three major consuming sectors of water: agriculture, industry and household/ municipalities have proper wastewater disposal systems. As a result the effluent/ run off contaminate water bodies / reservoirs creating serious health and environmental problems. Not only are the poor, even more vulnerable to their impacts, they also contribute heavily to water pollution. This vicious circle originates in the deprivation of social and infrastructure services, being essentially rooted in a development process, which tends to bypass the poor.

In most of the cities, water is provided without any treatment or with inadequate treatment. Corrosion in pipes during conveyance adds to the contamination. The problem is further exacerbated by seepage from contiguously laid sewerage pipes as a result of pressure fluctuations. In slums, poor localities and villages the standard water supply sources are community stands posts. A recent World Bank report demonstrates that when a tap or a well is shared with neighbors, the likelihood of child or infant mortality is much higher compared to access from a residential piped water system.

5.9.2 Surface and Groundwater Quality - its impact on Ecosystem and Environment

The Pakistan Council of Research in Water Resources (PCRWR) launched “National Water Quality Monitoring Program” in 2002 through 2006 that aimed at undertaking water quality monitoring of major cities, rivers and storage reservoirs, canal, drains and natural lakes. Different organizations including Pakistan Council of Research in Water Resources (PCRWR), Water and Power Development Authority (WAPDA), Environmental Protection Authority (EPA) and some individual consultants have conducted short-term studies on water quality. Results from various investigations and from the studies carried by various organizations such as PCRWR, WAPDA, and EPA indicate that water pollution has increased. The pollution levels are higher particularly in and around the big cities where industrial estates are present. The water quality deterioration problems are caused by the discharge of hazardous industrial wastes including persistent toxic synthetic organic chemicals, heavy metals, pesticide products, municipal wastes and untreated sewage water to natural water bodies. These substances mixed with water cause widespread water-borne and water related diseases.

Over pumping of groundwater due to extended drought has adversely affected the water quality. According to a recent study about 70% of the about 560 thousand tube wells in the Indus Basin are pumping sodic water (PCRWR Water Quality Monitoring Program). Such water is highly injurious to the soils resulting in reduced permeability and infiltration rates, particularly in the heavy textured soils. Surface-water from most of our rivers is also polluted due to dumping of solid wastes and industrial pollutants.

5.9.2.1 The Status of Drinking Water Sources

Pakistan Council of Research in Water Resources (PCRWR) generated the first detailed water quality profile of 23 major cities of the country. About 357 water samples from 364 selected water sources were collected adopting the uniform sampling criteria and analyzed for 79 physico-chemical parameters including, trace, ultra trace and bacterial indicators. The analytical findings were compared to the World Health Organization (WHO) guidelines and Pakistan Standards Quality Control Authority (PSQCA) standards for drinking water.

Analysis revealed the presence of three main water quality problems i.e. bacteriological (69%), arsenic (24%), nitrate (14%) and cities had a considerable percentage of bacteriological contamination (40-100%). A higher percentage of arsenic contamination was found in 9 cities, nitrate in 14 cities and fluoride in 4 cities. In Sindh province, all the 14 sources monitored in Hyderabad were found unfit mainly due to bacteriological contamination (93%), excessive levels of iron (47%), and turbidity (93%). Karachi the largest metropolitan city and capital of Sindh province revealed (93%) unsafe water sources due to bacteriological contamination, TDS and fluoride (4%), sodium, chlorides and sulphate (7%), nitrate (11%), and iron (18%); only 2 out of 28 samples were safe. In Sukkur, 11 out of 12 sources were unfit because of bacteriological contamination, turbidity (50%), hardness, sodium, chlorides, potassium, arsenic and fluoride (8%), nitrate (25%), sulphate and TDS (17%). Twenty two water samples including 6 dams, 9 rivers, 2 canals, 4 lakes and 1 drain, LBOD and RBOD; all were found microbiologically contaminated. Main cause of microbiological contamination was due to the disposal of untreated sewage into water bodies.

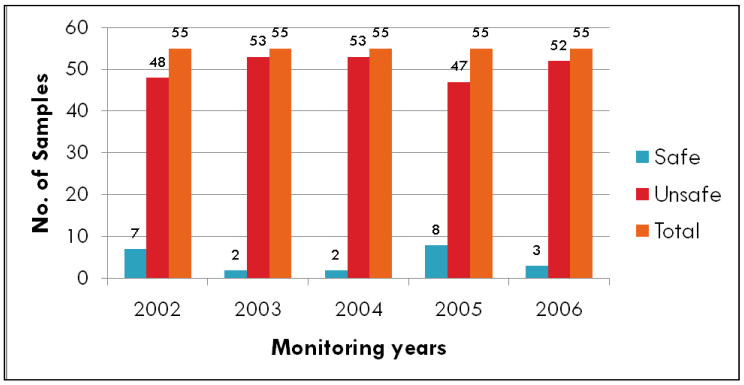


Figure 5.10: Water Quality of Sindh Province

(Source: PCRWR 2002-2006)

5.9.3 Water Quality in Southern Sindh

About 300 water samples from water bodies of three southern districts Thatta, Badin and Tharparkar were tested measuring physical, chemical, and biological (total coliform) quality parameters. All four water bodies (dug wells, shallow pumps, canal water, and water supply schemes) exceeded World Health Organization (WHO) MPL for turbidity (24%, 28%, 96%, 69%), coliform (96%, 77%, 92%, 81%), and electrical conductivity (100%, 99%, 44%, 63%), respectively. Iron was major problem in all water bodies of district Badin ranging from 50% to 69%. Some common diseases found in the study area were gastroenteritis, diarrhea and vomiting, kidney, and skin problems (Memon and Soomro, 2010).

It is estimated that 20 million residents of Sindh depend on irrigation water for their domestic use, especially in areas where the groundwater is brackish. The contamination of irrigation water by coliform bacteria exceeds the limits set by W.H.O.

5.9.4 Groundwater Scenario of Left Bank area

A recent study conducted by the Indus Institute for Research and Education (IIRE) on groundwater quality in Sindh has portrayed the groundwater situation of Sindh at large. The scenario of the groundwater quality with respect to the left bank area is presented in Table-5.9.

Table 5. 9: Level of TDS of the Groundwater in Left Bank area

Sr.#	District	Samples Tested	Samples TDS mg/l <1000	Samples TDS mg/l >1000	% samples with High TDS
1	Ghotki	8	8	0	0
2	Sukkur	15	13	2	13
3	Khairpur	15	12	3	20
4	Nosharo Feroz	15	13	2	13

Sr.#	District	Samples Tested	Samples TDS mg/l <1000	Samples TDS mg/l >1000	% samples with High TDS
5	Hyderabad	20	17	3	15
6	Thatta	16	10	6	38
7	Badin	19	9	10	52
8	Tharparkar	18	3	15	83
9	Umerkot	10	6	4	40
10	Mirpurkhas	11	7	4	36
11	Sanghar	17	11	6	35
12	Nawabshah	14	11	3	21

Source: Shafique Ahmed Junejo (IIRE) Research Report. www.iire.org.pk/documents/groundwater_quality_insindh.pdf
Maximum Permissible Limits: TDS=<1000 mg/l, Arsenic=0.05 mg/l, Lead= 0.05 mg/l, Zinc=5.0 mg/l, Cadmium= 0.01 mg/l

Only Ghotki district had good quality water at all locations where the samples were taken. Whereas in other locations, the percentage of samples with higher TDS were 13% in Sukkur, 20% in Khairpur, 13% in Noshahro Feroz, 15% in Hyderabad, 38% in Thatta, 52% in Badin, 83% in Therparkar, 40% in Umerkot, 36% in Mirpurkhas, 35% in Sanghar and 21% samples in Nawabshah district. This had confirmed that lower Sindh districts have brackish underground water in most locations. Adjoining areas of river Indus have good quality water.

The heavy and trace elements (i.e., As, Cd) in the subsurface waters of Sindh area are generally above the permissible limits. The Arsenic contents are found higher at Maripur Mathelo, Rohri, Sukkur VI, Tando Mohmmad Khan II, Mirpur Bathoro, Diplo, Nagarparkar, Bhalwa, Tandojam, Nawabshah I, Sanghar I.

The Lead concentration in groundwater is found high at Nousharo Feroz II 0.087 mg/l, Badin I 0.076 mg/l, Lakho pir 0.092 mg/l, Mithoro Chachar (Meghwar para) 0.068 mg/l, Mithoro Chachar (Bhel para) 0.078 mg/l, Nagarparkar 0.08 mg/l, Nagarparkar 0.062 mg/l, Bhalwa 0.071 mg/l, Mithi 0.065 mg/l, Tando Allahyar 0.074 mg/l, Umarkot, 0.084 mg/l, Sakarand 0.07 mg/l, Samaro 0.064 mg/l, Mirpur Khas North 0.069 mg/l. This may be due to Lithology, agricultural waste, municipal waste water percolation. The lack of proper outlet to rain water to its natural courses cannot be ignored, because due to this, water table rises which brings soluble minerals with it, which never go back after the water table fall down. Cadmium was also higher than permissible limits in groundwater.


Women in Rural areas getting water from a watercourse for house hold use (Asian Water Development Outlook 2007)

The concentration of Zinc was found within the allowable limits of WHO (2004) except the sample collected from Sakrand which showed higher contents of Zn.

5.9.5 Extent of Arsenic Contamination in groundwater

Preliminary analysis of the freshwater samples collected from nine districts of Sindh including Jamshoro, Qambar-Shahdadkot, Matiari, Shaheed Benazirabad Naushero Feroze, Khairpur, Ghotki,

Sukkur and Dadu districts and analyzed for total dissolved solids (TDS) and arsenic contamination. The results indicated that 10% of the samples had arsenic contamination of 100ppb or above. Use of the arsenic polluted water may cause skin cancer if used continuously (Khuhawar 2006).

5.9.6 Impact of water pollution

The high pollution level of rivers and groundwater lead to different environmental consequences such as reduction of biodiversity, increase in water related diseases and decrease in agricultural productivity. The health of rivers, lakes, estuaries, coastal systems as well as marine resources is threatened by water pollution issues, such as eutrophication, toxics pesticides, heavy metals, acidification and siltation. Their main effects are ecosystem dysfunction, loss of biological diversity, alteration of aquatic habitats and contamination of downstream and marine ecosystems. The cost of water pollution is higher than the cost of its prevention, and neglecting water pollution control entails high social and environmental costs. In rural areas of Sindh, due to consumption of polluted water for domestic use, 70% patients suffer from waterborne diseases. 3-4 million people die each year of waterborne diseases world-wide, including more than 2 million children who die from diarrhea (Bauder et al 2007). The degradation of water resources reduces social security. The impairment of water resources in regions where poverty already affects a great part of the population, can lead to greater social inequity and poverty intensification.

5.9.7 Sources of Water pollution in Sindh

The main sources of water pollution include: i) disposal of untreated sewage and city garbage into canals and river; ii) disposal of untreated industrial effluents into freshwater bodies; iii) seepage of fertilizers and pesticides from agriculture fields and soil; iv) disposal of highly toxic and high BOD laden sugar mill effluents into surface drains of the main drainage system; v) seawater intrusion from the river mouth towards the land (upto Thatta-Sujawal Bridge) carrying hyper saline water that percolates from river bed into the deep aquifers rendering the groundwater saline and unsuitable for domestic use; and vi) effluents of Kotri industrial area into river and canals.

5.9.8 Water Quality of Surface Drains Out Falling in LBOD System

The data of the drainage effluent of the surface drains of the LBOD system from 2005-06 to 2007-08 (Appendix on EIA) indicated that the Total Dissolved Solids (TDS) of the drains out falling in spinal drain from Shaheed Benazirabad onwards are in the range of 3,000 to 14,000 ppm. The SAR of the effluent ranges from 10 to 23. The allowable ranges for TDS are 2,000 ppm and SAR up to 18. The effluent shows higher values; therefore is not fit either for household use or for irrigation. However, if used in conjunction with canal water within permissible limits can be used if so desired. However, for bio-saline agriculture, the effluent can be used for growing salt tolerant grasses, trees and crops within acceptable ranges but there exist risk to the soil system. It is therefore proposed that the effluent of Kotri Barrage surface drains including Tando Bago Drain, Luwari Drain, Serani Drain, Fuleli Guni Drain, Karo Gungro and other surface drains which carry only the drainage water from adjacent fields and pancho water from rice fields including storm water of the monsoon rains is relatively better in terms of TDS and SAR within reasonable limits and therefore can be used for bio-saline agriculture or for irrigation of crops under severe water scarcity conditions.

5.9.8.1 Survey of the Project Area for Water Quality during 2012

Water bodies of the project area were surveyed to evaluate the quality of water. These included the water of the drains carrying the drainage effluent of the LBOD drainage infrastructure and the water bodies used for human consumption. Drains discharging their effluent into the Spinal drain right from Nawabshah (Benazirabad) downwards mostly carry sugar mills effluent from distilleries not only during cane crushing season but almost round the year. Thus the drain water mostly remains polluted with sugar mill distillery effluent. Being organic in nature, it is oxygen consuming. This depletes the oxygen content of the drainage effluent thereby adversely affecting the biotic life of the drains specially the fish on which the communities living around the drains depend for their food needs. The data presented in Graph-1 and Table-2 is the detail of the samples collected from the drainage infrastructure and the analysis of certain important parameters to evaluate the quality of drain water flowing in our drains.

Adequate dissolved oxygen is the basic requirement for good quality water. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. Lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills.

Only two drain samples out of 28 samples tested were found having little more than 2 mg/l dissolved oxygen. The remaining 26 samples had DO below 2 mg/l and most of them possessed just 1mg/l. The dissolved oxygen level depicted that the entire drainage infrastructure is not favourable for the fish population in the drains. At many places, fish were found either dead or were dying of the short of DO. (*Data given in Appendix on EIA*)

Farmers use drain water to save their crops under severe drought conditions when irrigation water is scarce. The analysis of the water samples collected from drains indicated that the TDS level of almost all samples was above 2000 ppm. Maximum allowable level of TDS for irrigation is 2000 ppm. Thus the water of the drains is not normally suitable for the crops. However, it could be used in conjunction with the canal water with suitable dilution. The samples ranged from 920 to 14630 ppm and averaged as 3919 ppm. Likewise the EC of the samples was in the range of 2.00 to 28.00 mS/cm. The maximum permissible level of EC for irrigation water is 3.00 mS/cm. Almost all samples were higher than the permissible limit. Therefore, the drain water is not suitable for irrigation. The TSS was however, within the acceptable range.

5.9.9 Water quality of Drinking Water Samples:

Eighty two (82) water samples from water bodies in domestic use of the communities living in the project area were collected for evaluating the water quality of the water bodies. The data presented in Table-2 and Figure-2 depicted that 48 (60%) water samples were within the maximum permissible range of 1000 ppm (TDS) for drinking water category. The remaining 40% samples had TDS above the maximum permissible range. All the samples had pH in the permissible range of 6-10. However, the EC values of the samples ranged between 0.3 to18. Similar to TDS, the EC values of 48 (60%) samples were equal to or below 2.0 mS/cm, while the rest had higher EC values ranging from 2.0 to 18 mS/cm. Thus the water bodies having TDS above 1000 ppm and EC above 2.0 ms/cm are not suitable for drinking as per the NEQs for drinking water in Pakistan.

5.9.9.1 Sugar Mill effluent pollution on water bodies.

Environmental team of the LBG/Indus consultants visited ten sugar mills of district Badin and collected the data regarding the status of pollution of the sugar mill effluents discharged from the mills and most of these disposed off into the drainage infrastructure. The drains that receive the effluent of the various sugar mills are given in the following paragraphs.

Dead fish lying on the banks of the drain

5.9.9.2 Sugar Industry

Out of 33 sugar mills in Sindh, 30 are located on left bank of Indus. Three out of 33 sugar mills use the molasses to produce industrial alcohol (ethyl alcohol) a significant quantity of which is exported. Mills in Sindh have crushing capacity ranging from 4-9,000 metric tons per day. It is estimated that these mills discharge untreated effluents of about 25 million cubic meters per year in the irrigation and drainage systems (SDPI 2006). This untreated effluent have high BOD, COD and TDS levels which pollute the water and are hazardous for humans and other biotic life. The sugar mills in Sindh mostly dispose off their effluents into the LBOD drainage system that kills the fish and induce toxic chemicals in the drainage system. Table-xx below gives the name of sugar mill, the soiurce of water supply to the mill and the effluent disposal into the drain / water body.

The Consultants have analyzed water samples from various sugar industries to estimate the physico-chemical parameters to assess the quality of the effluent Table 5.10

Table 5. 10: Results of Sugar Mill Effluent Analyses of Sugar Mills of Badin District during the year 2011

S. No.	Source/Sample ID	D.O mg/I	BOD mg/I	COD mg/I	TSS mg/I
1.	Lar Sugar Mills Sujawal	2.1	980	1740	1250
2.	Deewan Sugar Mills	1.8	840	1690	1080
3.	Army Welfare Sm#01	2.4	390	780	800
4.	Shah Murad Sugar Mills	2.4	1100	1800	2600
5	Pangrio	2.2	740	1180	1800
6.	Bawani Talhar	2.7	180	260	340
7.	T.M.K Sugar Mills	2.6	210	300	450
8.	Sindh Abadgar	2.5	800	1200	2400
9.	Seri Sugar Mills	1.9	920	1490	350
10.	Khoski Sugar Mills	-	330	500	300
Permissible Limits		>4	80 WHO	150 WHO	150 WHO

Analyses were made at the Drainage Research Centre Tando jam
WHO= World Health Organization.

Table 5. 11: Water samples Sugar Mill effluent laden Drain water collected in April 2012 from the various drains of LBOD and Kotri Surface Drainage System

S. No	Description of Site	GPS Reading	TDS (mg/l)	pH	EC mS/cm	TSS mg/l	DO mg/l	COD mg/l	BOD mg/l
1	M.M.D RD 152+040	25 12 18.0 N 69 10 12.2 E	4670	7.0	9.57	650	0.69	83	40
2	Karo Ghunghro main drain RD	24 38 16.6 N 68 23 6.6 E	13630	7.6	>range	5300	1.38	378	168
3	Guni Fuleli Main Drain RD 105	24 39 8.6 N 68 39 11.7 E	10730	7.6	>range	1950	0.79	728	340
4	IR sub drain of kapoor RD 29	24°40'4.11"N 68°11'50.20"E	13900	5.4	>range	8900	1.33	1685	>range
	WHO limits for waste water		3500	6-10	7.0	150	>4	150	80

The data presented in Table-5.10 and Table-5.11 indicated that the effluent discharging from the sugar mills is highly polluted. The Dissolved Oxygen level is far below the normal (above 5 mg/l) that depicts that it may cause the death of the biotic life in drains specially fish. Likewise, the BOD_5 and COD are also very higher than the WHO permissible limits. High BOD and COD have depleted the DO level in the effluent. This effluent when discharged in the drains provides food for the microbes thereby severely depleting the DO level in the drains. The Total Suspended Solids are also higher than the permissible limits that hinder the sun light to penetrate in water to help photosynthesis to increase the oxygen level of waters. The data presented in Table-5 is the analyses of the samples collected from the LBOD and Kotri surface drains in 2012. The results do match with the results of the previous analyses presented in Table-5.11 and 5.12. All the parameters are above the permissible limits except sample 1 whose BOD is within permissible range because of heavy dilution in MMD drain. Therefore, the results of the analyses of the samples collected from sugar mills or from the drains do

suggest that the disposal of sugar mills effluent in drainage infrastructure is totally hazardous for the health of the humans, livestock and fish. It has therefore, been recommended that the EPA must enforce the EPA act 1997 and make it mandatory for the sugar mills to install in-house treatment plants to treat the out coming effluent before discharging into the water bodies

5.9.10 Water Quality of the Province of Sindh with respect to Canal Command:

Water quality of the project area was monitored in 2010 and 2011 on the basis of the canal command area on the left bank canals of river Indus. The summary of the data is given in Table-5.12.

Table 5. 12: Percentage of Canal Command Area with Useable, Marginal and Hazardous Water Quality in all Three Barrages.

Sr. No	Barrage	2010			2011		
		Usable	Marginal	Hazardous	Usable	Marginal	Hazardous
1	Guddu	48	45	06	78	20	02
2	Sukkur	40	53	08	54	34	12
3	Kotri	32	59	09	43	44	13
	Total	39	53	8	54	35	11

Useable=<1500 µS/cm, Marginal=1500-2700 µS/cm, Hazardous=>2700 µS/cm

The data in Table-4 gives the percentage of the area with useable marginal and hazardous water of each canal command. It shows that in all barrages the percentage of useable water has increased in 2011 as compared to 2010. Whereas, the area under marginal water was reduced in all barrage commands. The percentage of hazardous water was reduced in Guddu, but increased in Sukkur and Kotri barrages. The overall picture is satisfying due to a remarkable (15%) increase in useable water percentage. This increase has resulted in lowering the marginal water percentage from 53% to 35%, a decrease of 18%. However, the hazardous water slightly increased from 8% to 11% just an increase of 3% on overall basis. Remarkable increase in useable water is a good sign for promotion of agriculture in all canal commands.

5.9.11 Conclusions

The groundwater in 78% area of Sindh is brackish while 22% area has fresh groundwater. Therefore majority of people use surface water of canal system for domestic use. Secondly entire southern Sindh comprising of districts Badin, Thatta, Tando Muhammad Khan and Tharparkar exclusively use canal water for domestic purpose. The water in canals is highly polluted due to the fact that all the municipal sewage and garbage is dumped into canals. The agro-chemicals spayed on crops also find their way into the canals and other depressions being used as drinking water bodies. Thus, a sizeable percentage of population is under direct threat of polluted water and their health is always on stack. Surprisingly the report of PCRWR on the water quality of cities of Sindh is not different from the position stated above. The report claims that over 90% samples tested were polluted and found unfit for human consumption.

The analysis of the samples collected from drains in three consecutive years 2005-07 were found having Total Dissolved Solids (TDS) of the drains out-falling in spinal drain from Nawabshah onwards are in the range of 3000 to 14000 ppm. The SAR of effluent ranges from 10 to 23. The allowable ranges for TDS are 2000ppm and SAR up to 18. The effluent shows higher values; therefore is not fit either for household use or for irrigation.

The water of drains was tested in 2012 again to determine the quality of the drainage effluent. It was observed that except one drain, the TDS was in the range of 2000 to 6000 ppm. This has confirmed the claim of the stakeholders that most of the drainage tube wells are non-functional therefore, the TDS dropped significantly as compared to 2006-07. Secondly most of the sugar mills dispose off their untreated effluent into the LBOD drainage infrastructure. This has created tremendous difficulties for the villagers, their livestock and the fish in the drains.

The report of the SMO WAPDA who monitors the water quality of canal commands have encouraging remarks that the quality of water in canal commands have improved and the quantum of useable water has increased from 39% to 54%, an increase of 15% in all canal commands.

About 80 samples from water bodies in project area were collected to ascertain the quality of drinking water in the area. The analysis indicated that 48 samples had TDS within the acceptable range of 1000 ppm where as 42 samples had TDS above the maximum allowable limit. This showed that almost half of the population using underground water use brackish water for domestic use.

In general the position of surface and groundwater is not satisfactory. Steps have been suggested to keep the water quality safe at least for human use. It is also proposed to avoid the disposal of sugar mill effluents directly into drains but in house treatment of the effluent must be carried out to utilize the sugar mill effluent for agriculture use under water scarcity conditions, simultaneously creating a favorable environment for fish, livestock, birds and other fauna dependent on these waters.

5.10 Impacts of Climate Change

Climate change is today's reality and it represents one of the greatest environmental, social and economic threats facing the planet. It is a serious environmental challenge that will undermine the Millennium Development Goals. Since last 200 years, the mean surface temperature of Earth has increased on an average of 2° Celsius due to the accumulation of greenhouse gases (GHG) in the atmosphere. Most of this change has occurred in the past 30 to 40 years, and the rate of increase is accelerating. The global rise in temperature was 0.6 ^{o}C in the previous century while it is estimated to rise to a level of 1.4 to 5.8^{o} Celsius by the end of the century, if appropriate mitigation measures to reduce GHGs emissions, are not adopted. The global sea level has increased by about 15 to 20 cm. According to Rajendra Pachauri, the Chairman IPPC; the impacts of climate change are clearly turning out to be much worse than what we had anticipated earlier. The governments, communities, and civil society are increasingly concerned with anticipating the future effects of climate change while searching for strategies to mitigate and adapt to its current and future effects.

Global climate change, especially in biophysical environment, is impacting the lives of all inhabitants. Ramifications of global warming are having disastrous consequences in the form of drought, floods, low and high temperatures extremes and hurricanes. Recent data reveals that 1990s was the warmest decade, and 1998 was the warmest year. Unprecedented heat wave in 2004 resulted in large number of deaths. Similarly, high intensity typhoons in the USA and the Tsunami in Indonesia, the prolonged and severe drought in Southern Pakistan and then unprecedented rains in southern Sindh confirm a trend in global climatic change. In our region, the monsoon season has been shifting both in intensity and time resulting in heavy losses to national economies. Therefore, comprehensive and careful research studies are needed to understand the nature and the extent of this climatic change and develop plants and animals types and farming systems, which are less vulnerable to such climatic changes.

Climate change models show that Pakistan will grow warmer by 1.0 degree C by 2030; this may require extra water for wheat. We will also need wheat varieties which are more drought as well as more flood resistant. On the whole, wheat yield is likely to go up, even though its geographical distribution will change, while rice will not be affected. Pakistan also expects more water in our rivers because of greater melting of glaciers.

It is possible to achieve the vision of an efficient and competitive agriculture sector which will be able to meet on sustainable basis, the food security and agricultural product needs of a developed, industrialized and prosperous Pakistan envisioned in the Vision 2030. This can be attained through the application of science and technology and sustainable management of natural resource base, which in turn requires major investment in human resource, reforms in agricultural practices and rural institutions, infrastructure, and management of challenges from globalization, biotechnology and climate change. However it will be managed only if the economics of ecology and biodiversity is firmly embedded in our young people’s minds as a part of inter- generational equity, and as a part of their inheritance.

The most recent report of the Intergovernmental Panel on Climate Change (IPCC) of February 2007, believed to be very authentic, has confirmed that climate change is "unequivocal," and linked with human interventions. The greenhouse gas emissions, principally carbon dioxide (CO_2) that lead to global warming mainly stem from the smoke coming out from the chimneys of the industrial countries. The CO_2 concentration for hundreds of thousands of years was stable at the range of 270-280 ppm but at present it is at 385 ppm. The NASA research team has concluded that Earth's atmosphere couldn't support above 350 ppm of CO_2. If we are committed to prevent things from going worst, the global leaders must think and agree to limit the CO_2 emissions within 350 ppm. Climate change is emerging as a major driver of disaster, with frequent and extreme weather events, unusual flash floods, and tsunamis, heightened drought risks, rising sea level, desertification, shifting in crop pattern, resulting in lower productivity and production. Outbreak and spread of diseases, increased trans-boundary movements of pests and diseases are some of the serious challenges of climate change. A recent report of UN University and Columbia University has predicted that environmentally induced migration and displacement has the potential to become an unprecedented phenomenon-both in terms of scale and scope. An international organization has cited an estimate of 200 million environmentally induced migration by 2050.

Climate change is recognized as a major threat to prosperity. China and United States alone contribute to 41.7% of the total global emissions of CO_2 where as Pakistan contributes to just 0.5% of the total global releases. This confirms that we are not polluters but are victims of climate change. Asian Development Bank modeling studies show that climate change will hit south Asian countries hard and assume that sea levels in the region will rise up to 70 cm. The IPCC has recently established a clearer human induced link to the growing climate changes we witness in the world today. There is now increasing evidence that the current extreme events like Tsunami and recent three major storms in Philippines in just 5 weeks claiming more than 1100 lives are the human effects on climate. Pakistan is going to be drastically affected by the Climate Change even though Pakistan contributes a very little to global pollution. It ranks 135th among the carbon emitting nations but it would be among top ten Asian countries to face the serious consequences of climate change. Pakistan, having its economy based on agriculture, is facing major challenges of climate change on its land and water resources. Rather, it is already facing severe crisis situation especially in agriculture sector. Water supply, which is already a serious concern throughout the country, will decline dramatically and it will affect food security thresholds.

There are chances of decline in yields from 9 to 30% if global temperature rises by 1 to 4°C. Glaciers are receding due to rise in global temperatures causing floods but later the water resources shall deplete, adversely affecting the agricultural produce through droughts. Arid and semiarid regions of Sindh and Balochistan experienced severe droughts (1996-2003). This is evident from the fact that rainfall has decreased 10-15% in coastal belt and hyper arid plains over the past 40 years while there is an increase in summer and winter rains in northern Pakistan. Crops cannot sustain frequent weather changes and this is going to reduce crop yields to the extent up to 50%. Population is growing at 2.69%per annum while the crop productivity is expected to decline due to climate change. This challenges our food security plans and deserve immediate action to avert poverty and food shortage.

The fragile ecosystem of coastal belt is under severe threat due to climate change. Fourteen cyclones are recorded from 1970 to 2001 on Sindh coast. Mangrove forests have declined from 260,000 hectares in 1970 to just 86,000 hectares in Sindh (95%) and Balochistan (5%) coast. Mangroves absorb 70-90% of wave energy and effectively stop sea encroachment in deltaic region. The sea has encroached in Indus delta spoiling around 2 million acres fertile land in districts Badin and Thatta.

The vulnerable coastal belt and communities in Karachi,Thatta and Badin and their livelihood resources like fisheries, shrimps etc will be severely affected. The coastal areas being inundated due to rise in sea level, shall pose risk of flooding the homes of millions of people of coastal areas. Climate change endangers our health and well being of our children.

Given the enormity of the impact of climate change, adaptation and mitigation measures are critically important. It is the government's prime responsibility to take measures to reduce the impact of such climate changes as are likely to hit Pakistan and the lives of its people. But nothing serious is being

done by the government, protection agencies, or industrial associations despite the World Bank's 2006 assessment report ("Pakistan Strategic Country Environmental Assessment") that Pakistan environmental degradation is equivalent of 6% of its GDP (around Rs. 356 billion) and causes deaths of 50,000 people annually. It is in Pakistan's own national as well as international interest and obligation to mitigate and adopt measures to control the climate change effects.

Among the most effective measures to face the climate change are i) Mitigation ii) Adaptation iii) Capacity Building iv) Mainstreaming. The task of capacity building is the responsibility of the Ministry of Environment and sister organizations working on climate change. Universities are higher seats of learning and capacity building endeavors can successfully be undertaken in the universities as well.

Realizing the importance of this burning global issue, following Recommendations are proposed to face the challenge of climate change and to counter its effects on the vulnerable Ecosystems of Pakistan.

5.10.1 Task Force on Climate Change

Climate Change is by far the biggest environmental concern of the world, especially in last two decades. Scientific research, observations and records have established that global temperature is rising, glaciers are melting, sea levels are rising, hurricanes and coastal storms are becoming more frequent, there is a reduction in quantity of monsoon rains with a change in their timings and place of occurrence and signs of prolonged droughts are visible. (9)

A Task Force on Climate Change (TFCC) was set up by the Planning Commission of Pakistan in 2008 with the view to take stock of country's situation in relation to climate change to address climate change threats so as to ensure water security, food security and energy security of the country; and to recommend policy measures for promoting large scale Adaptation and Mitigation efforts, raising awareness of various stakeholders; and enhancing the capacities of relevant national institutions.

The Task Force recommended appropriate adaptation and mitigation policy measures, and highlighted various ongoing and planned activities that implicitly address the issues of climate change. The existing capacity of various national and international organizations in the country identify the needs for international cooperation in terms of capacity building, technology transfer and financial support for major Adaptation and Mitigation activities.

Figure 5. 11: Cyclone Hitting the Cost of Sind and Resulting Flood Impacts on Stakeholders

5.10.2 Pakistan's Status as a GHG Emitter

Pakistan's total GHG emissions in 2008 amounted to 309 million tons (mt) of Carbon dioxide (CO2) equivalent, comprising about 54% CO2, 36% Methane, 9% Nitrous Oxide and 1% other gases. The biggest contributor is the energy sector with 50% share, followed by the agriculture sector (39% share), industrial processes (6% share), and other activities (5% share).

Pakistan is a small GHG emitter: It contributes only about 0.8% of the total global GHG emissions. On per capita basis, Pakistan with 1.9 tons per capita GHG emissions stands at a level which corresponds to about one-third of the world average, one-fifth of the average for Western Europe and one tenth of the per capita emissions in the U.S., putting it at 135th place in the world ranking of countries on the basis of their per capita GHG emissions.

5.10.3 Past and Expected Future Climatic Changes over Pakistan

Analysis of past depicts that our climate is changing. The rate of change and the nature of the resulting impacts will vary over time and across the country, affecting all aspects of our life. In conjunction with efforts to reduce greenhouse gas emissions, it will also be necessary to adapt to the impacts of a changing climate. Understanding what climate change will mean for Pakistan is only one step in that process.

Future changes in climate of the magnitude projected by most global climate models would cause a major impact on our water resources, and subsequently affect food supply, health, industry, transportation and ecosystem sustainability. Problems are most likely to arise to southern parts of country where the resources are already under stress, because that stress would be exacerbated by changes in supply or demand associated with climate change.

Figure 5. 12: Severe Drought with Soil Showing Severe Cracks

During the last century, average annual temperature over Pakistan increased by 0.6 °C, in agreement with the global trend, with the temperature increase over northern Pakistan being higher than over southern Pakistan (0.8 °C versus 0.5 °C). Precipitation over Pakistan also increased on the average by about 25 %.

Studies using Global Circulation Models (GCMs) project that the average temperature over Pakistan will increase in the range 1.3-1.5 °C by 2020s, 2.5-2.8 °C by 2050s, and 3.9-4.4 °C by 2080s, corresponding to an increase in average global surface temperature by 2.8-3.4 °C by the turn of the 21st century. Precipitation is projected to increase slightly in summer and decrease in winter with no significant change in annual precipitation. Furthermore, it is projected that climate change will increase the variability of monsoon rains and enhance the frequency and severity of extreme events such as floods and droughts.

5.10.4 Climate changes and their impacts

There has been an increase in the incidence, frequency, and intensity of extreme climatic events: more intense and heavier rainfall in coastal areas, more intense cyclones, more intense flooding in flood-prone areas along the Indus, and more pronounced droughts in the arid areas.

- In coastal areas, the sea has intruded inland without this being due to a rise in sea level. The increased volume of “heated” water on the continental shelf could intensify cyclones in the Arabian Sea.

- In most areas, rainfall patterns have become very erratic, making it difficult for communities to predict local rainfall patterns.
- The duration of the cropping period has shrunk perceptibly in southern Punjab and Balochistan, with a forward shift in sowing time and an earlier harvest.
- Summers have become hotter and winters much warmer across the areas studied. In some areas, communities have noticed some degree of cooling during the monsoon season over the last 30 years.

5.10.5 Major Climate Change Related Concerns

The most important climate change potential threats to Pakistan are identified as:

- Increased variability of monsoon;
- Rapid recession of Hindu Kush-Karakoram-Himalayan (HKH) glaciers threatening water inflows into the Indus River System (IRS); reduction in capacity of natural reservoirs due to glacier melt and rise in snow line;
- Increased risks of floods and droughts;
- Increased siltation of major dams resulting in greater loss of reservoir capacity;
- Severe water-stressed and heat-stressed conditions in arid and semi-arid regions, leading to reduced agriculture productivity and power generation;
- Increased upstream intrusion of saline water in the Indus delta, adversely affecting coastal agriculture, mangroves and breeding grounds of fish; and
- Threat to coastal areas including the city of Karachi due to sea level rise and increased cyclonic activity due to higher sea surface temperatures.

The Manchar Lake, Pakistan's largest shallow sweet water lake is in trouble. The dumping of effluents collected from the Right Bank Outfall Drain project into the Main Nara Valley Drain that is linked to the Manchar Lake has raised the level of pollution. The fish production has gone down, agriculture is suffering and even the migratory birds have stopped visiting the lake. The native fisher folk have been forced to migrate and those left behind barely make enough to live on. They also suffer from varied diseases due to lack of clean drinking water.

5.10.6 Sectors at Risk in Pakistan

Water, Agriculture, Energy, Biodiversity and Human Health are all at risk from climate change in Pakistan and Sindh.

5.10.6.1 Impacts on water Sector

- Changes in Water Cycle
- Floods
- Salt intrusion in Coastal Areas
- Droughts

5.10.6.2 Impacts on Agriculture

- Declining Yields
- Decreasing viability of Farming
- Crop Destruction in Extreme Weather Conditions

5.10.6.3 Impacts on Biodiversity

- Damage to Ecosystems
- Loss of Habitat
- Biodiversity loss
- Biodiversity threats from sea level rise

5.10.6.4 Impact on Human Health

- Greater incidence of Climate Sensitive Diseases
- Health risks from Extreme Events
- Risks from Climate Induced Environmental changes

5.10.6.5 Impacts due to Natural Disasters

- Higher probability of Extreme Events
- Cost of damages will rise

5.10.6.6 Impacts due to Migration

- Poverty induced Migration
- Greater Rural Urban Migration

Some other climate change related concerns of Pakistan are identified as: Increase in deforestation; loss of biodiversity; increased health risks (heat strokes, pneumonia, malaria and other vector-borne diseases) and risks to other vulnerable ecosystems (e.g. rangelands, degraded lands, mountainous areas etc.).

Rapid population and industrial growth may also be one of the factors for the temperature rise in addition to the greenhouse effects mentioned above whereas the climatic changes are considered mainly associated with the influence of water scarcity caused by the enormous depletion of Indus water-flow into the downstream areas and the delta as a result of massive water divergence in the upstream areas.

5.10.7 Mitigation and Adaptation Measures

The Task Force report recommends a number of measures to address both Mitigation and Adaptation aspects of climate change. Salient recommended as well as ongoing and planned measures are listed below:

5.10.8 Mitigation

Pakistan would like to contribute to the global GHG mitigation efforts without compromising on its basic minimum energy and food needs consistent with its socio-economic developmental requirements, energy security considerations, and financial and technological constraints.

5.10.8.1 Energy

Ongoing and Planned Actions: Energy Security Action Plan 2005-2030 envisages large roles for hydropower, renewable energy technologies (in particular, windmills), nuclear power and imported natural gas in future energy supplies; one windmill of 6 MW capacity made operational while work is underway on 18 wind power projects of 50 MW capacity each; construction of third nuclear power plant is in progress; approval given for construction of 4,500 MW Bhasha dam; agreement finalized with Iran for construction of a gas pipeline from Iran to Pakistan with capacity to transport 750 million cubic feet of gas per day; effort is being made to increase the number of vehicles using CNG as fuel from 380,000 in 2005 to 800,000 by 2010 and to 920,000 by 2015; approval given for construction of a mass transit system (circular railway) for Karachi metropolitan area; a number of projects on energy efficiency improvement, energy conservation and use of decentralized renewable energy technologies are being implemented by National Energy Conservation Center (ENERCON), Water & Power Development Authority (WAPDA), Karachi Electric Supply Company (KESC), Alternative Energy Development Board (AEDB) and Pakistan Council of Renewable Energy Technologies (PCRET).

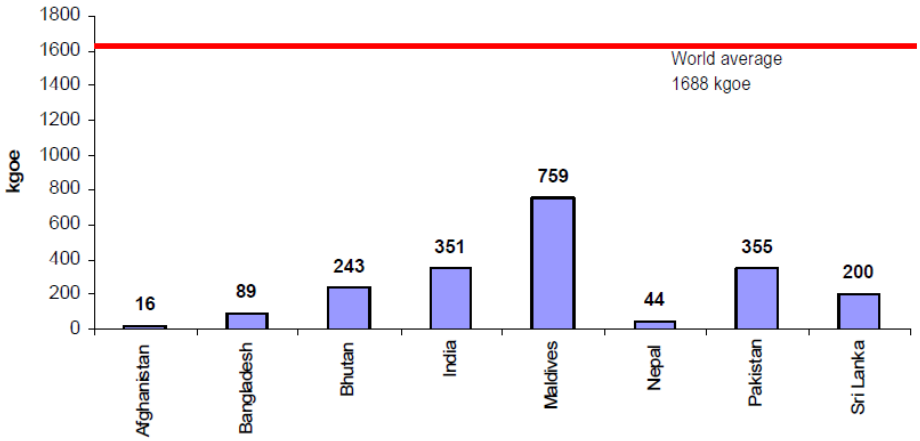


Figure 5. 13:Highest Per Capita Energy consumption is less than half of the World's average

Recommended Measures: Energy efficiency improvement at all levels in the energy system chain; energy conservation measures and use of energy-efficient devices; rapid development of hydropower resources; large scale use of various renewable energy technologies; expansion of nuclear power program; acquisition and adoption of clean coal technologies such as Coal Bed Methane Capture (CBMC), Integrated coal Gasification Combined Cycle power generation (IGCC), and CO2 Capture and Storage (CCS); development of mass transit systems in large cities; and greater use of CNG as fuel for urban transportation.

5.10.8.2 Agriculture and Livestock

Issues arising from Climate Change pertaining to Agriculture include:

- Reduced water availability, which is altering the crop rotation and cropping patterns
- Drastic reduction in cereal production, e.g. wheat and rice, as well as in cotton and sugarcane
- In southern Pakistan yields of major cereals predicted to decline by 15-20% by Regional Climate Change Models
- In the northern area minor improvements in yield due to increased duration of growing period
- Livestock production predicted to decline by 20-30%, creating crises in milk, meat and poultry supplies and pushing prices beyond reach of the average Pakistani
- Rangelands will be over-stressed from prolonged droughts and shifting human and livestock populations around riverine areas and in mountainous regions. This will reduce tree and shrub cover. Pakistan is already amongst the most forest/tree resource-poor countries in the world with a meager 5.2% forest cover, and even that sparsely stocked.
- Inland fisheries predicted to be reduced due to decreased water availability and changing river flows

Ongoing and Planned Actions: Not much attention has so far been paid in Pakistan to address the GHG emissions from the Agriculture and Livestock sector.

Recommended Measures: Development and adoption of (i) new methods of rice cultivation that have lower methane emissions, (ii) new methods for reducing Nitrous oxide releases from agricultural soils, (iii) new breeds of cattle which are more productive in terms of milk and meat but have lower methane production from enteric fermentation, and (iv) new economical feeds that reduce methane production activity of cattle besides providing them with better nutrition.

5.10.8.3 Forestry

Ongoing and Planned Actions: It is envisaged to increase forest cover from 4.9% of the total land area in 2005 to 5.2% in 2010 and 6.0% by 2015; several afforestation projects like Rachna Doab Afforestation Project is underway; tree-planting campaigns being launched each year during spring

and monsoon seasons (as many as 541,176 saplings were planted in one day on 15 July 2009, which is a world record for any country).

Recommended Measures: Promotion of afforestation and reforestation activities to the maximum possible extent.. The overall impact of climate change on the forest ecosystems of Pakistan could be negative. A number of adaptation strategies are needed to be taken to cope with climate change impacts on forest ecosystems. (10)

5.10.9 Adaptation

Water Resources

Ongoing and Planned Actions: It is planned to construct a series of large hydropower projects to add 18 MAF of new storage capacity by 2030 to the existing 12.5 MAF capacity (which is decreasing by 0.2 MAF annually due to silting); approval accorded for the construction of 4,500 MW hydropower plant at Bhasha with 6.4 MAF water storage capacity (the construction work will start in 2010); planned to complement the large storages by a comprehensive programme of small and medium dams as well as measures for recharging underground reservoirs; investigations for using groundwater aquifers as water storage facilities; a major programme underway for lining the water channels; plans to monitor continuously the movement of glaciers in northern Pakistan.

Recommended Measures: Addition of sufficient reservoir capacity on IRS rivers so that during high flood years, local rain harvesting and building of surface and sub-surface storages for agriculture and other local needs; adoption of stringent demand management and efficiency improvement measures in all water-use sectors, particularly in the supply, distribution and use of irrigation water; reuse of marginal quality irrigation effluent.

5.10.10 Agriculture and livestock

Ongoing and Planned Actions*:* It is planned to: (i) develop through biotechnology, heat-stress resistant, drought- and flood-tolerant, and water-use efficient high yielding crop varieties, (ii) increase irrigation water availability by reducing losses in the irrigation water supply network, (iii) implement "More Crop per Drop" strategy through improved irrigation methods and practices, water saving techniques in combination with the use of high yielding and water-efficient crop varieties, and (iv) increase milk and meat production by developing animals breeds which are less vulnerable to climatic changes, and by improving animal feedstock.

Recommended Measures*:* Development of new breeds of crops of high yield, resistant to heat stress, drought tolerant, less vulnerable to heavy spells of rain, and less prone to insects and pests; improvement of crop productivity per unit of land and per unit of water by increasing the efficiency of various agricultural inputs, in particular the input of irrigation water; improvement of farm practices by adopting modern techniques such as laser land leveling, crop diversification, proper cropping patterns, optimized planting dates etc; development and introduction of better varieties of livestock which would have higher productivity of milk and are less prone to heat stress and more drought tolerant.

5.10.11 Coastal Areas and Indus Deltaic Region

Ongoing and Planned Actions: It is planned to implement the recommendations of a study by local and foreign experts to identify what minimum water escapages below Kotri Barrage are required [not implemented in last five years] (a) to check seawater intrusion and (b) to address other environmental concerns; plans formulated to restore the degraded mangroves & marine system; major interventions are planned to boost fisheries; a major intervention underway to use brackish water for aquaculture; a National Disaster Management Authority (NDMA) established and made responsible for both disaster preparedness and disaster management in respect of all major disasters including cyclones.

Recommended Measures: Provision of regulated flows down Kotri to conform to minimum necessary environmental flows; restoration and protection of mangroves; construction of proper engineering structures (like barrage, dikes and seawalls) to protect beaches and other facilities along the coast; development of capacity to deal with natural disasters such as cyclones, floods, etc.

5.10.12 Forests and other vulnerable ecosystems

Ongoing and Planned Actions: Besides the afforestation and reforestation activities, it is planned (a) to improve the rangelands by proper range land management, and (b) to reclaim nearly 6 million hectare of salt affected waste land and large areas of sandy desert by growing salt tolerant, fast growing grasses, shrubs & trees to be used as fodder; it is envisaged to increase the area protected for conservation of wildlife from 11.3 % of the total land in 2004-05 to 11.6 % by 2009-10 and to 12.0 % by 2015; also planned to develop national database of threatened and endangered species and encourage captive breeding of endangered species to promote ex-situ conservation of biodiversity.

5.10.13 Recommended measures for forestry:

Aggressive forestation and reforestation programmes with plantation suited to the looming climate change; biological control of forest pests by maintaining viable populations of predatory birds and insects through restricted use of chemical insecticide; preservation of rangelands through proper rangeland management; increase of grasslands using appropriate varieties of grass in saline and waterlogged zones to prevent their degradation; assisting genetically impoverished species or those that have important ecosystem functions by providing natural migration corridors as well as assisted migration; use of gene banks, seed banks, zoos and botanical gardens for preserving genetic diversity and conserving species out of their natural environment.

5.10.14 Organizational Structure to Address Climate Change

The Task Force recognizes the role of various national and international organizations operating in the country in the formulation of Pakistan's Climate Change Policy and Plan of Action and in the implementation of the corresponding activities. It then makes recommendations to improve the effectiveness of the organizational set up. Most notable among them are: (i) the Prime Minister's Committee on Climate Change may serve as the apex body for policy guidance and overview, (ii) the Ministry of Environment may be renamed as Ministry of Environment and Climate Change and provided with appropriate organizational infrastructure to reflect the increased importance of climate change in environmental issues, (iii) following the approval of the federal cabinet for establishment of Global Change Impact Studies Centre (GCISC) as an autonomous research organization under the Ministry of Environment, GCISC should now be adequately staffed and financed to serve as an effective research arm of the ministry and undertake high quality climate change related research and modeling pertaining to cross-sectoral topics, and (iv) steps should be taken by the Ministry of Environment on priority basis to formulate a formal National Climate Change Policy along with a Plan of Action

5.10.15 Clean Development Mechanism (CDM) Activities

It is noted that so far Pakistan's effort to take advantage of the CDM of the Kyoto Protocol for obtaining financial support and advanced technologies to reduce its GHG emissions has been lagging behind those of the neighboring countries. The report recommends appropriate strengthening of the CDM Cell in the Ministry of Environment and its capacity building through international support.

5.10.16 Education, Communication and Awareness

The ongoing effort on communicating climate change related information to the intelligentsia as well as the general public and raising their awareness of the critical issues be expanded very substantially making use of a variety of channels and tools such as print and electronic media, publications, portal website, discussions and advertising, targeted dissemination of briefs, showcasing model practices, specific campaigns, etc.

5.10.17 Institutional Capacity for Addressing Climate Change

There are several organizations in the country which could make useful contribution towards addressing climate change. It recommends: (i) capacity enhancement of all such organizations, (ii) introduction of climate change related scientific disciplines in Pakistan's leading universities so as to ensure a regular supply of trained manpower, and (iii) establishment of a National Data Bank for

climatological, hydrological, agro- meteorological and other climate change related data to cater for the needs of all relevant institutions.

5.10.18 Needs for International Cooperation

Being a developing country, Pakistan lacks technical capacity and financial resources to address climate change related issues. Following are the salient areas where it needs international cooperation and support for addressing climate change:

Mitigation Effort: Extensive use of renewable energy technologies (windmills, solar cells etc.); introduction and use of Clean Coal Technologies (e.g. CCS, IGCC, CBMC); use of advanced nuclear power technology; introduction and use of Mass Transit Systems in large cities; infrastructure development for large scale import of natural gas; increase in hydropower generation capacity; large scale afforestation and reforestation activities.

Adaptation Effort: Sufficient expansion of large reservoir capacity; improving efficiency of water supply and distribution in the irrigation system; development of capacity to deal with disasters like floods, droughts and cyclones; construction of structures like dikes and seawalls at strategic points on the coast.

Capacity Building: Expansion of meteorological monitoring stations in various parts of the country, in particular in the northern mountainous areas and over the Arabian sea adjoining Pakistan's coastline, to the level recommended by the World Meteorological Organization; development of a cohort of professionals in the field of climate change by getting a group of young scientists trained with the help of reputable foreign institutions in fields such as regional climate modeling, watershed modeling and crop growth simulation modeling; forecasting of seasonal and inter-annual climatic changes and extreme events; monitoring of temporal changes in glacier volumes and land cover using satellite imagery and GIS techniques.

Funds are needed to be mobilized to bail out the banking sector so far committed to protect civilization from the threat of climate change. In dithering over international climate negotiations, rich governments turn a blind eye to the impact of global warming on the world's poorest households. This moral predicament demands a rapid transition to low carbon economics together with resource transfer on an unprecedented scale. (2)

5.11 Recommendations to address the issue

i. On the international level, the developing nations must urge on issue of 'climate justice', demanding the developed nations (polluters) to pay more for the mitigation and adaptive actions to combat against climate change.

ii. A National Climate Change Policy should be formulated and implemented. A National Data Bank may be established to provide climate change related authentic data for use of the planners, policymakers, scientists, university students and workforce engaged in climate change related activities.

iii. The density of Met stations should be enhanced and brought in line with World Meteorological Organization (WMO) standards. Vulnerability of ecosystems of different areas and communities to climate change should be assessed, through reliable analytical tools and simulation models.

iv. Capacity enhancement of research institutions, government functionaries, media, vulnerable communities and stakeholders should be carried out to enable them to combat against climate change effects.

v. An Early Warning System should be developed and Disaster Management Cell should be strengthened.

vi. A systematic study of the dynamics and snow volume of HKH (Hindu Kush-Karakoram-Himalaya) region, and changes in river flows, should be carried out.

vii. Expertise in modeling of climate change impacts be developed in the provinces and specialized disciplinary training imparted to relevant departments in the government and amongst civil society to cover specific ecologies.

viii. Improvements in Weather Warning Systems are underway. What is required is linking this information with the user and allowing universities to undertake academic research that provides long term monitoring and evaluation of the data.

ix. Illegal deforestation be stopped through legislation. An effective afforestation campaign should be launched through print and electronic media. It should be made mandatory for all government organizations to actively participate in such campaigns to make others to follow in real spirit.

x. Continuous and analytic monitoring of floods resulting from glacier melt should be done and contingent plans to store the excess water in suitable reservoirs for future use be prepared.

xi. Rainwater harvesting technologies should be adopted in vast catchments to minimize soil erosion and conserve rainwater for agriculture, livestock and groundwater recharge

xii. Agriculture research should be problem oriented for development of new heat/water stress tolerant crop varieties, high yielding/low delta crop varieties for dry-lands. The research for crop diversification, new cropping systems, monitoring of land use changes, soil and water conservation measures, etc should be done on priority basis in agriculture sector.

xiii. Protection of existing vegetation and extensive afforestation of fodder and fuel wood trees/shrubs is proposed along water conservation structures. In addition, high efficiency irrigation techniques such as sprinkler, bubbler and trickle irrigation may be introduced for planting fruit and fodder trees in arid areas.

xiv. Nutritious seasonal/perennial grasses may be propagated in arid areas for improving degraded range lands, supporting livestock and control of soil erosion.

xv. Controlled and adequate release of river discharge into sea may be ensured to stop incursion of sea water in Indus delta and for sustainability of marine and delta ecosystems. The areas likely to be severely hit may need resettlement. Costing and formulating adaptation plans should be given priority for such areas.

xvi. Universities in the provinces should urgently establish climate change departments and international partnership should be sought through joint programs with universities abroad. HEC should provide guidance and financial support in this matter.

xvii. The media should play its role in capacity building to educate and create awareness among masses about the Climate change effects and measures to face the disaster.

5.12 International Negotiations for Future Climate Change Regime

Salient recommendations of the Task Force regarding Pakistan's position in international negotiations for a post-2012 climate change regime are: (i) Global temperature should not be allowed to exceed 2° C, (ii) Strive for the continuation of the Kyoto Protocol, (iii) Call for deep cuts in GHG emissions by developed countries, (iv) Avoid any onerous binding GHG emission reduction obligations on Pakistan, (v) Insist that, based on the principle of equity, any cap on GHG emissions should be on a universal per capita level basis and apply equally to all countries, (vi) Project Pakistan as a responsible and constructive member of international community and seek access to advanced Carbon-free, low-Carbon and Clean Coal technologies, (vii) Emphasize adaptation as a key priority for Pakistan, (viii) Call to define and establish vulnerability on scientific basis, (ix) Reject linkage between climate change and international trade, (x) Seek substantial increase in international funding for adaptation and call for new financial and technological mechanism, (xi) Seek approval for nuclear power as an admissible CDM technology, (xii) Continue to support the position of the G77 and China.

David Grey, the World Bank's senior water advisor in South Asia said "There is insufficient data to say what will happen to the Indus, but we all have very nasty fears that the flows of the Indus could be

severely, severely affected by glacier melt as a consequence of climate change," and reduced by perhaps as much as 50 percent. "Now what does that mean to a population that lives in a desert [where], without the river, there would be no life? “But we need to be concerned about that.

6 Disaster Management

6.1 Definition and Concepts Used

The definitions and distinctions used in addressing this chapter follow the standard definitions and examples prepared by the United Nations International Strategy for Disaster Reduction (ISDR 2004).

Throughout this report the distinction of *disaster management* and *disaster risk management* are used interchangeably. Disaster risk management is:

> *The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.*

Disaster risk reduction is used to implement *disaster reduction*; the term disaster reduction is used interchangeably with *disaster risk reduction*. Disaster risk reduction is:

The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.

The disaster risk reduction framework is composed of the following fields of action, as described in ISDR's publication 2002 "Living with Risk: a global review of disaster reduction initiatives", page 23:

- *Risk awareness and assessment including hazard analysis and vulnerability/capacity analysis;*
- *Knowledge development including education, training, research and information;*
- *Public commitment and institutional frameworks, including organisational, policy, legislation and community action;*
- *Application of measures including environmental management, land-use and urban planning, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments;*

Early warning systems including forecasting, dissemination of warnings, preparedness measures and reaction capacities are an element of disaster risk reduction

Disaster management is not the same as *relief*. Relief is only one component of disaster management. Relief, also more recently termed emergency management, and is defined as:

The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation

This involves plans, structures and arrangements established to engage the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. Common activities associated with this distinction are emergency communications; search and rescue; emergency medical services; provision of food, clothing and shelter; and other services to stabilize civil society that has experienced a disaster.

Following figure 6.1 explains the cycle of disaster management, starting from preparedness before the disaster, response after the occurrence of the disaster, rehabilitation or reconstruction, after response and prevention for mitigation for further disasters to come.

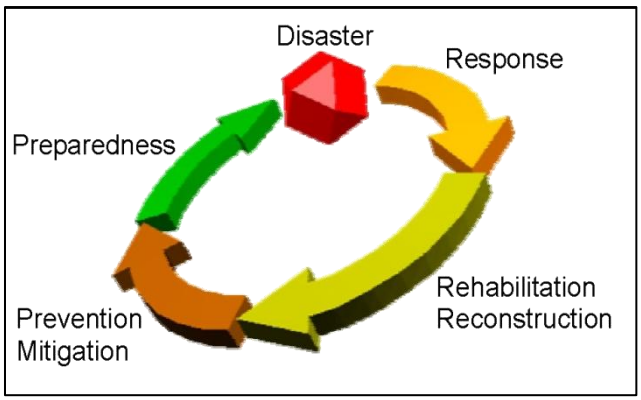


Figure 6.1: Disaster management cycle

6.2 Natural Hazards in Pakistan and Sindh

6.2.1 Hazards Affecting the Project Area

Pakistan's exposure to natural hazards and disasters internationally is ranked between moderate to severe. Natural hazards including avalanches, cyclones and storms, droughts, earthquakes, epidemics, floods, glacial lake outbursts, landslides, pest attacks, river erosion and tsunami pose risks to Pakistani society. A variety of human-induced hazards also threaten the society, economy and environment. They include industrial, transport, oil spills, urban and forest fires, civil conflicts and internal displacements of communities. High priority hazards in terms of their frequency and scale of impact are: earthquakes, droughts, flooding, wind storms and landslides that have caused widespread damage and losses in the past (NDMA 2007).

Sindh's exposure to natural hazards and disasters is a subset of the natural hazards of Pakistan. For example, the northern mountainous areas of Pakistan are at risk from glacial outburst floods and avalanches; while Sindh is not. On the other hand coastal Sindh is at risk from cyclones, tsunamis and sea water intrusion; while the northern parts of the country are not. For this reason, this section of the report will only consider natural hazards that are of concern to Sindh and the Lower Indus Basin.

There are three classes of hazards applicable to the existing risk conditions in Sindh and the Lower Indus Basin: Geological hazards, water hazards and man-made hazards. Within each class of hazards there are several subsets of hazards as shown in Table 6.1.

Table 6.1: Primary Disaster Hazards in the Lower Indus Basin and Sindh

Class of Disaster Risk	Disaster Risk
Geological hazards	
	Earthquakes
	Landslides
Water hazards	
	Drought
	Flood
	Water logging
	Salinity – Irrigation induced and saltwater intrusion up estuaries and into ground water
	Cyclones and storms
	Tsunami
Man-made and other hazards	

Class of Disaster Risk	Disaster Risk
	Famine - Caused by flood or drought
	Forest fires
	Industrial pollution
	Environmental accidents
	Civil conflict

6.2.2 Water Hazards Affecting the Project Area

6.2.2.1 Drought

The incidence of drought is becoming increasingly common in Pakistan and Sindh with substantial consequences upon sustainable development in the sectors of food security, livestock, agriculture, water resources, environment and hydropower. Low rainfall and extreme variations in temperature characterize the climate in Pakistan and Sindh. About 60 per cent of the total land area of Pakistan is classified as arid, which annually receives less than 200 mm rainfall. The main arid rangelands include lands in Sindh and Balochistan.

Average annual precipitation in Sindh province is about 160mm as compared with 400 mm in Punjab province and about 630mm in NWFP province. Rainfall variability during different seasons is also very high. Climate in the lower southern half of the country, including Sindh, is arid and hyper-arid. Some areas remain drastically dry in each region and are always vulnerable to drought with only a small negative deviation from low mean rainfall. Certain areas experience two to three drought years in every decade. The drought pattern in Pakistan and Sindh at the end of December 2000 (a very bad recent drought year) is illustrated in Figure 6.2.

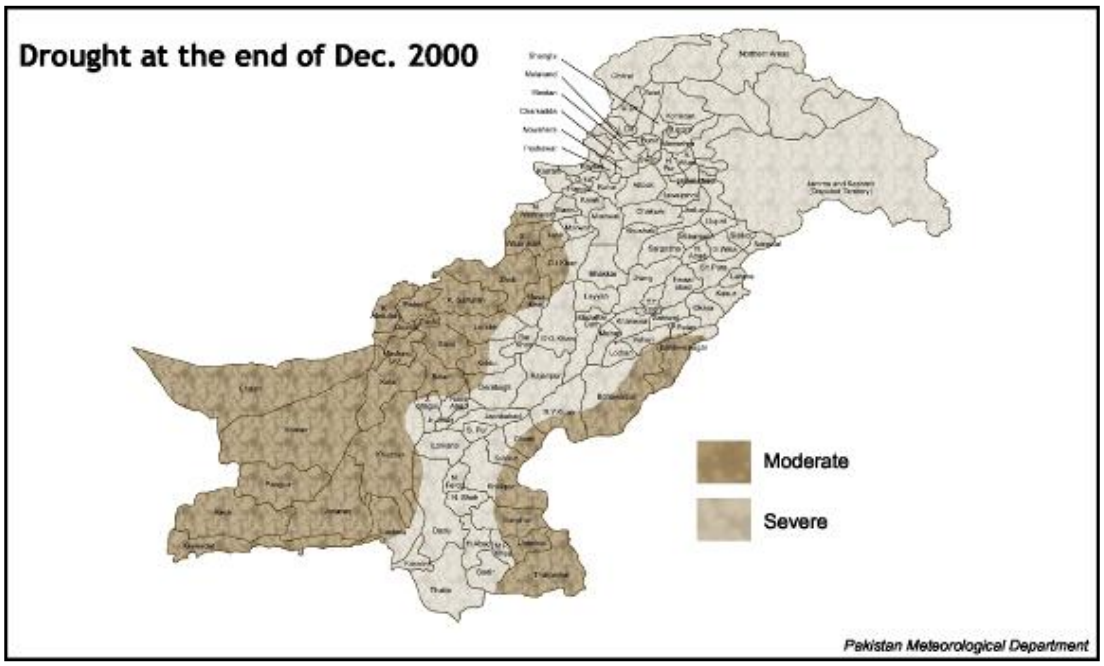


Figure 6.2: Pattern of Drought in Pakistan and Sindh in Year 2000

6.2.2.2 Flood Discharges and Frequency

Pakistan is one of the five South Asian countries with the highest annual average number of people physically exposed to floods, which occur normally due to storm systems that originate from Bay of Bengal during the monsoon from July to September. Storms originating in Bay of Bengal passing over lower Central India and Rajasthan enter Pakistan and continue towards the North into Kashmir.

The mountain ranges in the extreme north of Pakistan provide a perennial source of inflow into the Indus river Basin.

Fifty six (56%) percent of the Indus river basin lies in Pakistan and covers approximately 70 % of the country's area. Generally major floods in the Indus basin occur in late summer (July-September) when South Asian region is subjected to heavy monsoon rains. In upper to mid reaches of the Basin, generally tributaries like Jhelum and Chennab are mostly the cause of flooding. Major flooding is mainly associated with the monsoon low depression that develops in the Bay of Bengal and move across India in west/north-westerly direction to enter Pakistan.

River floods particularly hit Punjab and Sindh while hill torrents tend to affect the hilly areas of NWFP, Balochistan and northern areas of the country. Flash floods can also hit hilly and mountain areas of Sindh, which may cause landslides and road erosion. Cloud Burst Flash Floods (CBFF) could also occur over Karachi (as happened in Lahore in 1996). Floods in Sindh can also occur due to dam bursts (as for example the floods in Pasni due to Shadi Kot dam burst in February 2005).

Also, in recent years, vulnerabilities of large cities to flooding have increased. Cities including Karachi have experienced flooding due to inability of sewerage system to cope with heavy rains.

Fourteen major floods that have impacted Pakistan since 1947 caused economic losses and damage worth Rs. 570 billion (USD 6 billion) (Table 6.2). This historical damage was overwhelmed by the super-flood of year 2010 that is estimated to have caused economic losses and damage worth Rs. 902.5 billion (USD 9.5 billion) (NY Times, 15 November 2010). The 2011 flood caused about Rs.351.5 billion (USD 3.7 billion) in losses (GOP Ministry of Finance. Pakistan Economic Survey 2011-2012)

Table 6.2: Major Flood Events in Pakistan

Year	Lives Lost	Villages Affected	Estimated damage (US$)
1950	2,910	10,000	Rs. 570 billion ($6 billion)
1955	679	6,945	
1956	160	11,609	
1973	474	9,719	
1975	126	8,628	
1976	425	9,150	
1978	393	9,200	
1988	508	1,000	
1992	1008	13,208	
1995	591	6,852	
1998	47	161	
2001	201	0.4 million[1]	
2003	230	1.266 million[1]	
2010[2]	2,000	17,553	Rs. 902.5 billions ($9.5 billion)
2011	481	38,078	Rs. 351.5 billions ($3.7 billion)

[1] *Number of persons affected*

Table 6.3: Major flood events affected and flooded area

Year	Direct losses (US$ million)*	Lost lives (No)	Affected villages (No)	Flooded area (Sq-km)
1950	227	2,910	10,000	17,920
1955	176	679	6,945	20,480
1956	148	160	11,609	74,406
1957	140	83	4,498	16,003
1959	109	88	3,902	10,424
1973	2,388	474	9,719	41,472
1975	318	126	8,628	34,931
1976	1,621	425	18,390	81,920
1977	157	848	2,185	4,657
1978	1,036	393	9,199	30,597
1981	139	82	2,071	4,191
1983	63	39	643	1,882
1984	35	42	251	1,093
1988	399	508	100	6,144
1992	1,400	1008	13,208	38,758
1994	392	431	1,622	5,568
1995	175	591	6,852	16,686
2010	10,000	2,000	17,553	160,000
2011	4,000	481	38,078	27,118
Total	22,923	11,368	165,453	594,250
** 1995 Price Level*				

Flooding 2011 and the super-flood of 2010 are treated in more detail in later sections of this Chapter.

6.2.2.3 Salinity and water logging

Salinity and water logging are the major developmental disaster risks in the Lower Indus Basin and Sindh. It presents a major risk to the critically important agriculture economic sector of Pakistan and Sindh.

Salinity and water logging are covered in detail in separate Chapters of this report.

6.2.2.4 Salt water intrusion

Salt water intrusion is the major developmental problem in the Delta and Coastal Zone of the Lower Indus Basin and Sindh.

Salt water intrusion is covered in detail in separate Chapters of this report.

6.2.2.5 Cyclones and storms

The coastal belt of Pakistan and especially in Sindh is highly vulnerable to cyclones and associated storm surges. Fourteen cyclones were recorded between 1971 and 2010. Cyclones can cause large scale damage to coastal areas of Sindh and Balochistan. The cyclone of 1999 in Thatta and Badin districts wiped out 73 settlements and killed 168 people and 11,000 cattle. Nearly 0.6 million people were affected. It destroyed 1800 small and large boats and partially damaged 642 boats, causing a loss of Rs. 380 million. Losses to infrastructure were estimated at Rs. 750 million.

6.3 Hazard Variables

6.3.1 Seismic Hazards and Drainage Infrastructure

The Indian Plate upon which Pakistan, India and Nepal lie, is continuously moving northward and sub-ducting under the Eurasian Plate, thus triggering earthquakes in the process and forming the Himalayan mountains and the coastal plains. Within Sindh and Balochistan, the Makran coast including Gwadar and Pasni are located in high or very high risk areas. Karachi is located on the edges of high risk areas and the left bank of Indus is located in low risk seismic and hazard zone (Figure 6.3).

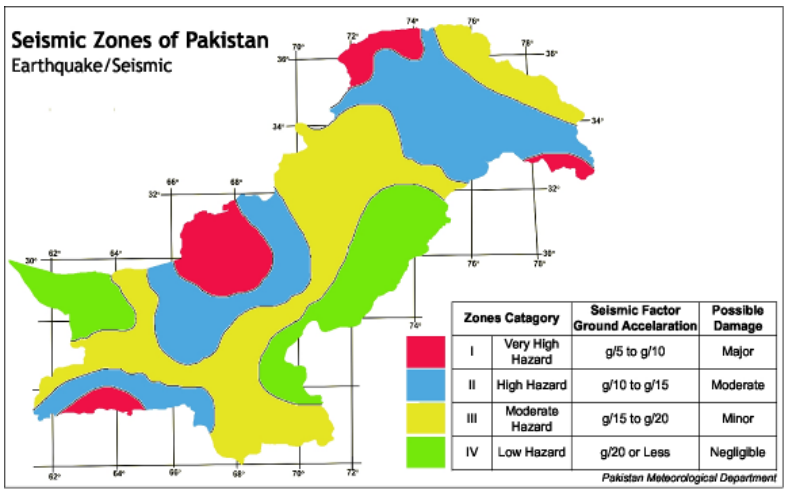


Figure 6.3: Seismic Risk Map of Pakistan

6.3.1.1 Seismic Activity in Sindh

The potential for extremely strong seismic shaking and damage from earthquakes in Sindh is very high. Much of the literature on the seismicity of Pakistan concentrates on the damage caused by historical earthquakes the past century (from 1900 to the present) in the northern part of the country as shown in Figure 6.4. However, the largest modern earthquake ever recorded in Pakistan was on the Makran Coast in 1945 with an intensity measured in Richter scale – M = 8.1 when 4,000 fatalities were recorded. Figure 6.4 indicates the recent earthquake events recorded in Sindh and adjoining areas.

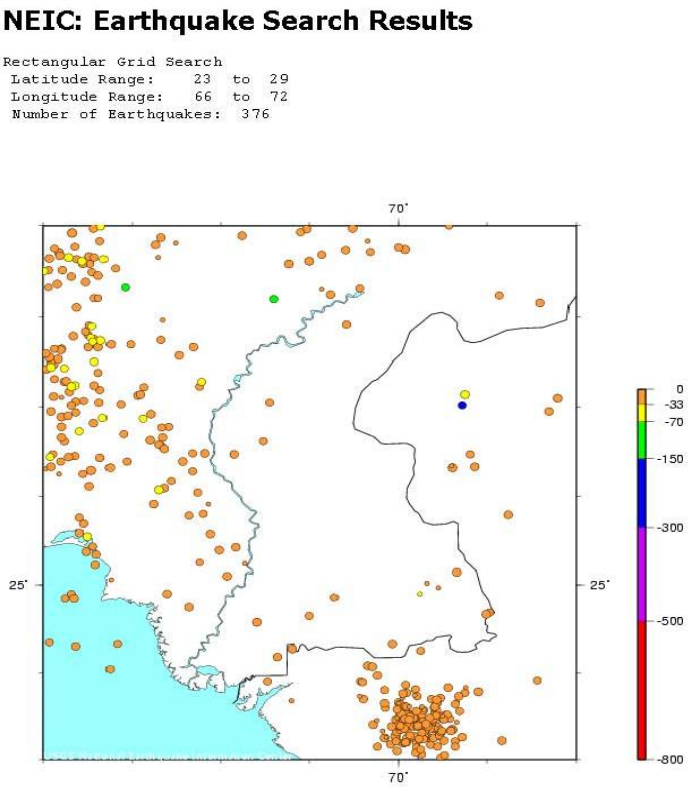


Figure 6.4: Recent Earthquake Events (2150 BC to present) Recorded for Sindh (USGS)[15]

Equally important to the major shaking in the North of Pakistan is the historical record of major shaking in the Indus River Basin of Sindh going back several centuries. For hundreds of years the

[15] http://earthquake.usgs.gov/earthquakes/eqarchives/epic/

well developed thriving cities in what is now Sindh province of Pakistan have been leveled as a result of major earthquake events. Even if the local city was spared earthquake destruction, tectonic movements of the entire Indian Plate upon which Sindh is located has repeatedly caused the Indus River to change course making once prosperous cities no longer viable because of the loss of water resources for agriculture, domestic water supply and water-born transportation.

Also important were findings from a study of the major earthquake event of 27 November 1945 on the Makan coast west of Karachi (Figure 6.5). This earthquake is the largest modern earthquake to impact anywhere in Pakistan. The tidal wave generated by this earthquake devastated the Indian Ocean region.

Figure 6.5: Map of the Makran Coast West of Karachi Showing the Epicentre of the 1945 Makran Earthquake in Red

A further major finding was that sophisticated seismic risk analysis has been performed for the coastal zone of Sindh as part of the analysis of the safety of nuclear power generation in the coastal zone of Sindh. The results of these studies are detailed seismic zonation maps of the Left Bank Indus, Delta and Coastal Zone of Sindh. Additional findings were that the Delta and Coastal Zone of Sindh is at high risk from tsunamis, but –as far as the Consultants could find out– there is no tsunami monitoring or warning program developed or currently in place to mitigate or manage the impact of tsunami disasters.

A NESPAK report[16] (March 2011) about the geomorphology of the Tidal Link indicates the following: *"Earthquakes in the region have created sand volcanoes on the lower delta in the past, a result of soil liquefaction whereby saturated sand loses its shear strength and flows like a liquid".* In reference to the potential earthquakes on the drainage infrastructure the report concludes as follows: "*Partial collapse of Cholri Weir began immediately after completion of the Tidal Link and prior to any major storms events, suggesting that the driving of sheet piles may have created the requisite rapid and repeatedly applied force necessary to induce liquefaction of the soils where it was built*". The designs of the foundation structures in this project all include a seismic factor *g* (peak ground acceleration).

6.4 Climate Change and Potential Impacts on Water Disasters

Based on observations of the WWF in Pakistan, global warming is causing damage to Pakistan's environment (WWF 2004). Among the impacts felt and seen are biodiversity loss, shifts in weather patterns and changes in fresh water supply. All of these impacts will change the magnitude, intensity and return period of water disasters and floods.

[16] Field, J. Geomorphology Review of Redesign of LBOD Stage-I Badin Area Drainage System. NESPAK. March 2011

The Tibetan Plateau contains the world's third-largest store of ice. The Chinese National Meteorological Administration has stated that the recent fast pace of melting and warmer temperatures will be good for agriculture and tourism in the short term, but issued a strong warning for the future:

> *"Temperatures are rising four times faster than elsewhere in China, and the Tibetan glaciers are retreating at a higher speed than in any other part of the world. In the short term, this will cause lakes to expand and bring floods and mudflows. In the long run, the glaciers are vital lifelines of the Indus River. Once they vanish, water supplies in Pakistan will be in peril."*

World Bank Water Resources Advisors in South Asia have warned that there are insufficient data to say what will happen to the Indus in the future. But there is the possibility that the flows of the Indus could be severely affected by glacier melt as a consequence of climate change, and be reduced by perhaps as much as 50 percent.

A study carried out by GTZ for WAPDA to analyse trends in temperature and precipitation in the Northern Areas for the last century (Archer, et al, 2001) found that at Skardu, seasonal and annual temperatures have raised more than in the last century. Mean annual temperature has increased by 1.4 ^{o} C with the mean annual daily maximum rising more than 2.35 ^{o} C. The winter temperatures have risen far more than summer with an increase of up to 0.51 ^{o} C in winter maxima per decade since 1961. Temperature increase might cause an upward shift of almost 400 meters in the frost line. This might be impacting upon the snow and rain patterns and the availability of snow for melt during summers, which is a major source of water in many rivers and the cause of severe super-floods.

Observations of the World Glacier Monitoring Service based in Switzerland indicate that mountain glaciers in the Karakorams have been diminishing for the last 30 years. Experts believe the flow of water in rivers increased during the decade of 1990-2000 in comparison to 1975-1990, which means melting of more ice upstream. Researches also indicate that some of the Glaciers in Pakistan have retreated significantly in the recent past. Scientists believe this is an indicator of climate change, resulting in more snow melt.

Changes in the climate denote that the incidence of flash flooding and extreme flooding can increase during the next few decades. Studies conducted also indicate that with a doubling of CO_2, average rainfall in South Asia will increase between 17 to 59 %. This will be associated with a doubling in the frequency of high rainfall events. Variable monsoons, also anticipated, could mean more droughts. Experts also believe that further desiccation of arid areas due to warming will endanger food production in the plains unless significant numbers of trees are planted.

Also, climate change may increase the frequency and intensity of storms and could cause changes in their tracks. Although the frequency of cyclones along Pakistani coast is low, they cause considerable damage when they occur.

Climate change has impacted the Sindh Province and the study areas in the form of Sea Level rise, droughts due to water shortages in river and less/ no rainfall, sea water intrusion in the coastal areas and water shortages in the canals and wetlands. This has resulted in loss of bio-diversity, crop productivity, rise in poverty level and overall deterioration and socio-economic imbalance.

6.5 Increased Vulnerabilities to Water Hazards and Floods

The main causes of vulnerability to water hazards and floods in Sindh include: poor quality construction of housing, buildings and infrastructure (particularly rural); fragile natural environment; poor agriculture and irrigation management practices; weak early warning systems; lack of awareness; poor education; and high levels of poverty. Lack of communications infrastructure and critical facilities further aggravate vulnerabilities of communities in post-water disaster situations.

Much of the rural housing in Pakistan is adobe, which is extremely vulnerable to hazards like water disasters and floods. The indigenous practice of light-weight, timber-laced construction has given way to more massive masonry and reinforced concrete construction; this construction provides adequate protection against weather but is often poorly constructed to withstand flooding. Also, urban housing and infrastructure suffers from lack of implementation of building codes. The growth of slums and

urban poverty has further compounded unsafe construction practices in Karachi and possibly in Hyderabad. Even a relatively prosperous city like Karachi does not follow safe construction practices. Reasons lie in lack of political will, business interests, corruption, lack of information and lack of trained man-power.

Fragility of natural environment in areas of the Indus River Basin has also exacerbated conditions of vulnerability. Due to massive deforestation, the rate of soil erosion is very high in the Northern region for the Indus River Basin. Pakistan has been left with only 4 % forest and vegetative cover, in contrast to the required 25 % percent, thereby experiencing an intense and uninterrupted discharge of flood water, especially during monsoon seasons. This coupled with increasing snowmelt in the Himalayan glaciers has intensified flood risks.

Pressures upon forests and other natural resources need to be released in order to reduce water disaster vulnerabilities. This is especially true in the delta and coastal zone of Sindh where the loss of mangrove forests has opened large tracks of land to storm and cyclone damage and salt water intrusion.

Overgrazing of marginal lands in Sindh and cultivation of water-intensive crops, such as rice and sugar cane, has worsened drought conditions. A many-fold increase in livestock population in arid zones has led to overexploitation of range-lands without providing them the time to recover. Simultaneously, extensive installation of tube-wells in Sindh has accelerated extraction of ground water, which is lowering the water table quickly. Solutions to drought and water shortage problems in arid zones require modifications in agricultural and livestock management practices; including reduction in the size of livestock population to make it compatible with carrying capacity of rangelands and replacement of water-intensive crop varieties with drought resistant crops.

A little less than one-third of Pakistani people are living under the poverty-line, many of whom inhabit water hazard prone areas. This social segment which struggles to cope with daily life risks cannot be expected to make water disaster risk reduction a priority, and therefore suffers severely from water disasters.

6.5.1 Dynamic Population Pressures and Water Disasters and Floods

Population growth, urbanization, industrialization, the resultant environmental degradation and climate change/variability and gender power imbalances are working as major pressures behind the increasing vulnerability of Pakistani society and economy to water disasters.

6.5.1.1 Population growth and size

Growth and size of Pakistan's population have become a major dynamic pressure, negatively affecting all aspects of social, economic and environmental life. Population has grown by 350 per cent since independence in 1947. At the present rate of population growth, Pakistan in 2025 will be the second largest contributor to global population, after China, with a contribution of 133 million people.

Population growth works in multiple ways to create and exacerbate water disaster vulnerabilities. Increased population has caused people to move and live in water hazard prone locations, which were traditionally considered as un-inhabitable; including the lower Indus River flood plain, delta and coastal zone. Population growth in upstream areas of the Indus River Basis has increased the demand for fuel wood, fodder and timber, which leads to uncontrolled forest cutting, and causes intensified erosion and higher peak flood flows. This results in more severe flooding in densely populated plains of the Lower Indus Basin and Sindh.

Population density in water hazard prone regions also means greater loss of life and property in case of water disasters. If the population growth trends continue at current rates, a far greater number of people will be living in areas prone to floods, storms and droughts in the coming years.

6.5.1.2 Urbanization, Industrialization and Environmental Degradation

Pakistan is in transition from an agricultural and rural to a modern industrial economy. This gradual shift entails rapid urbanization, infrastructure development, environmental degradation, soil erosion, water pollution and air pollution. Urban expansion is happening faster due to high rural-urban

migration. The preference for development of infrastructure and services in urban centres coupled with opportunities for jobs and higher incomes have acted as pull factors in attracting educated and uneducated rural lots to cities. With urbanization, consumption patterns shoot-upwards drastically. City life demands better services and more natural resources (land, water, forest) to sustain life styles.

Growing industrialization also require more water resources. This leads to accelerated exploitation of natural resources in countryside and upstream, thus degrading the environment; including cutting of forests, depletion of ground and surface water resources and land clearance for development. Studies indicate that environmental degradation in Pakistan may lead to even more land erosion and soil degradation. It could also increase the impact of torrential rains and result in more flooding.

The clearing of mangroves along with reduced volumes of water discharge in the ocean in coastal Sindh has led to sea water intrusion. The loss of this natural barrier could expose coastal communities and infrastructure to escalated frequency of storms and flooding.

6.5.1.3 Gender Power Imbalance and Water Disasters and Floods

Countries having experienced large water related disasters demonstrate that the cost of ignoring gender in disaster response, recovery and preparedness is significant. This results in overlooking the damages, needs and priorities of most vulnerable in times of disaster and worsens existing poverty and inequity. Lack of gender sensitive assessments and programming intensify the existing political, social and economic inequality. But in-spite of devastation they cause, water disasters provide opportunities for social and economic change. Women should be empowered as equal stakeholders to act as key resource, before, during and after water disasters in reducing loss to lives, household economy and in reducing break-down of social safety-nets.

6.6 Disaster Management

6.6.1 Legal Framework for Water Hazard and Flood Management

An understanding of the legal framework for water disaster and flood management in Pakistan and Sindh is an important point of departure for understanding how the flood management system works - or does not work. A summary of the major forms of disaster legislation in Pakistan is given in Table 6.4.

Table 6.4: Principal Legal Instruments Concerned With Disaster Management and Disaster Risk Reduction in Pakistan

Year	Name of Legal Instrument	Emphasis
Pre-1947	Indian Famine Codes	Relief
1952 (Amended 1993)	The Civil Defence Act, 1952 As Amended in 1993	Response
1958	The West Pakistan National Calamities (Prevention and Relief) Act, 1958	Response and relief
2001	Local Government Ordinance (LGO)	Response and relief
2002	Emergency Services Ordinance (ESO)	Response
2002	Sindh Water Management Ordinance, 2002 (SWMO)	Preparedness and mitigation
2007	National Disaster Management Ordinance, 2007	Disaster Risk Management

6.6.1.1 Pre-Independence Era

The Indian Famine Codes, developed by the colonial British in the 1880s, were one of the earliest forms of disaster management legislation. The Famine Codes defined three levels of food insecurity: near-scarcity, scarcity and famine. *Scarcity* was defined as three successive years of crop failure, crop yields of one-third or one-half normal and large populations in distress. *Famine* further included a rise in food prices above 140% of *normal*, the movement of people in search of food, and widespread mortality. This was possibly the earliest recorded form of disaster risk assessment.

In order to address the issues of famine in India the British Government created an Indian Famine commission to create ways to prevent and avoid future famine in India. In 1880 the secretary of the commission wrote a draft of the Indian Famine Code. This famine code, successively updated, became the basis of famine prevention until the 1970s. The Indian famine codes were one of the first attempts to predict famine, and since they could predict it, they could also prevent it or mitigate it.

6.6.1.2 Modern Era

Emergency response has remained a predominant approach in Pakistan to deal with disasters until recently (Table 6.4).

1. The Civil Defence Act, 1952 -As Amended in 1993

The Civil Defence Act of 1952 established legislation to respond to disasters and emergencies related to war and civil disturbance. In 1993, as a result of the fall of Communism, the law was amended to include response to disasters and emergencies related to natural disasters.

2. The National Calamities (Prevention and Relief) Act, 1958

The *Calamity Act of 1958*, the major national policy for disaster management for almost 50 years prior to the passing of the *National Disaster Management Ordinance of 2006*, was mainly concerned with emergency response and relief. The Calamity Act, 1958 provided for the maintenance and restoration of order in areas affected by certain calamities and for the prevention and control of and relief against such calamities. Provincial Relief Commissioners (who also are Senior Members of the Provincial Board of Revenue) were given the responsibility of relief. The calamities most concerned with in the act were the water disasters of floods and drought.

3. Local Government Ordinance (LGO) 2001

The Local Government Ordinance (LGO), provided new avenues for effective and context-specific disaster management, but there also existed a few legal and administrative inconsistencies in relation to disaster response at provincial and district levels. Functions and powers related to emergency response and disaster management at District, Tehsil and Union level provided in the act included:

i. **Zila Nazim**: Being the head of the District, the Zila Nazim is responsible to "*take charge, organize and prepare for relief activities in disasters or natural calamities*".

ii. **Zila Council**: The Zila (District) Council is to "*make recommendations to the District Government for enhancement of the care of disabled persons, paupers, aged, sick, persons of unsound mind, abandoned minors, juvenile delinquents, drug dependents, abused children, needy and disadvantaged person*".

iii. **Zila Council in a City District**: In case of a City District, the Zila Council has the responsibility and powers to (a) approve master plans, zoning, land use plans, including classification and reclassification of land, environment control, urban design, urban renewal and ecological balances; (b) review implementation of rules and bye-laws governing land use, housing, markets, zoning, environment, roads, traffic, tax, infrastructure and public utilities; and (c) review development of integrated system of water reservoirs, water sources, treatment plants, drainage, liquid and solid waste disposal, sanitation and other municipal services.

iv. **Tehsil Municipal Administration (TMA):** Under the LGO, the TMA is to provide, manage, operate, maintain and improve the municipal infrastructure and services, including the water related activities of:

- Water supply and control and development of water sources, other than systems maintained by the Union and Village Council
- Sewerage, sewage and sewage treatment and disposal
- Storm water drainage

v. **Tehsil Council:** The Tehsil Council was to approve land use, zoning and master planning of the Tehsil development and maintenance programs or projects proposed by the Tehsil Municipal Administration. The Town Council has also got similar powers and responsibilities to be executed under the LGO.

vi. **Union Administration**: The Union Administration was to assist the relevant authorities in disasters and natural calamities and assist in relief activities, including de-silting of canals

vii. **Union Nazim**: The Union Nazim is to report to the concerned authorities in respect of:

- Encroachment on State and local government property and violation of land use and building laws, rules and bye-laws
- Environmental and health hazards

viii. **Union Council (UC)**: The Union Council is to promote plantation of trees, landscaping and beautification of public places in the Union.

ix. **Village Council (VC):** The Village Council is responsible to (a) develop and improve water supply sources; (b) make arrangements for sanitation, cleanliness and disposal of garbage and carcasses; and (c) take measures to prevent contamination of water

The LGO further states that the City District Government may set up district municipal offices for integrated development and management of the following water resource related services:

1. Water source development and management, storage, treatment plants, and macro-distribution
2. Sewage tertiary and secondary network, treatment plants, and disposal
3. Storm water drainage network and disposal
4. Flood control protection and rapid response contingency plans
5. Natural disaster and civil defence planning
6. Solid waste management, treatment and disposal, including land fill sites and recycling plants
7. Industrial and hospital hazardous and toxic waste treatment and disposal

4. Emergency Services Ordinance (ESO), 2002

The Emergency Services Ordinance (ESO) established emergency service to deal with emergencies in an effective manner and to combat threats to the public from modern warfare, terrorism and disasters; and defines responsibilities at each level of government. A National Council was established to regularly monitor the performance of this service and ensure continuity in the process of rule making in the management of emergencies and disasters during peace time. According to the ESO, provincial governments have the effective administrative power to implement emergency service. Likewise, the District Emergency Officer was made responsible for the functional management of the emergency service.

5. Sindh Water Management Ordinance of 2002 (SWMO 2002)

The Sindh Water Management Ordinance of 2002 (SWMO, 2002) establishes The Sindh Irrigation and Drainage Authority (SIDA) as an instrument of change for the management and financing of the irrigation and drainage infrastructure of the Lower Indus Basin in Sindh.

Table 6.5 identifies relevant sections of the Ordinance and identifies the relevant disaster management responsibility assigned to SIDA.

Table 6.5: Disaster Management and Related Environmental Responsibilities Assigned to SIDA in the Sindh Water Management Act of 2002

Section of Ordinance	Sub-section	Legal requirement	Comment
Chapter II – The Sindh Irrigation and Drainage Authority			
10. Functions of SIDA	a.	Operate and maintain the parts of the irrigation system such as Barrages and outlets assigned to it	
	b.	Operate and maintain the parts of the drainage system assigned to it including spinal drains and inter-AWB drains	
	c.	Carry out river flood protection and maintain the infrastructure in the Province of Sindh	
	d.	Advise Government on any matter strategic or tactical. Related to its functions and tasks or to the water management system as a whole e.g. irrigation or drainage contribution rates, drought management and sea water intrusion	
11. Tasks of SIDA	Strategy a.	To develop, on a periodic basis a strategy statement for improvement of irrigation and drainage services, integrated water management, flood protection, prevention of sea water intrusion, water distribution in times of drought and wetland management within its command and catchment areas setting goals and objectives, formulating implementation policies and identifying priority and other actions	Requires continued updating of strategies for flood protection, prevention of sea water intrusion and drought management
	Operation and Maintenance c.	Subject to the provisions agreed with the Indus River System Authority, to receive Irrigation Water of the Barrages within the Province and/or from the inter Provincial/link canals and deliver the same in agreed quantities to various AWBs, FOs or , as the case me be to other agricultural users, local Councils, industries or wetlands, guaranteeing the minimum discharge below Kotri Barrage to prevent sea water intrusion, in the manner and on the terms and conditions as may be negotiated between the SIDA and the parties concerned and to receive drainage effluent at the designated points and convey the same to the sea	Requires minimum release of water quantity below Kotri Barrage
	d.	To maintain the irrigation, drainage and flood protection infrastructure located within its territorial jurisdiction	Requires O&M of flood protection infrastructure
	Capital Projects and Schemes g.	In consultation with the various stakeholders, to plan, design, construct improvements to the irrigation and drainage system, storage reservoirs and flood protection infrastructure including development work for irrigation of	Requires design, analysis and construction of new flood

Section of Ordinance	Sub-section	Legal requirement	Comment
		lands	protection infrastructure
	Research and Development j.	To draft, implement and regularly update policies, studies and research programmes it considers relevant to its functions and tasks; e.g. integrated water management, control of water logging and salinity. Prevention of sea intrusion, water distribution during drought	Requires prevention and mitigation of disaster risks of: water logging, salinity, sea water intrusion and drought
	l.	To conduct studies into the impact of the operations and policies of the SIDA on the ecology and on the environment including protection of wetlands with a view to appraising the various available options for minimizing the adverse impact of such operations and policies and to adopt the best alternatives for further action	Requires environmental impact assessment of all operations and policies
	m.	To coordinate/regulate the measures being undertaken/required to be undertaken in the total water management system e.g. the recording/gauging of surface waters. Monitoring of the ground water table and the quantity of water, with compilation of date relevant thereto, flood protection and in this regard, to establish and regularly maintain proper liaison with the relevant authorities in other Provinces.	Requires the ability to monitor and measure ground and surface water resources; including flood water flows
	Public Disclosure and Information n.	To issue flood warnings and warnings to all parties likely to be affected, if it has cause to believe that damage or harm shall result from the use of any water flowing within it command area	Flood warning capability required for Basin
	Administration s.	To maintain records, registers and data banks as may be necessary for its effective functioning under this Ordinance	Makes necessary the development of data base and GIS capability
26. Coordination by SIDA in case of calamities	1)	In case of calamities, such as breaches, floods or extreme weather conditions such as cyclones, the SEDA shall have a coordinating role in taking all necessary measures	The nature of disaster management (coordination) is not specified
	2)	The Managing Director shall decide whether a calamity has occurred making such a coordinating role necessary and shall communicate such decision immediately to all AWBs concerned	SIDA Managing Director is focal point for disaster management
	3)	The Managing Director may request all assistance or give any instructions to the AWBs to which he has sent the communication mentioned in sub-section (2) either the purpose of contravening the adverse effects of the occurring calamity	
	4)	The AWB shall provide without delay all assistance requested for and carry out all instructions given by the SIDA	
	5)	The managing director shall report to the SIDA as soon as possible the measures that he has taken	

Section of Ordinance	Sub-section	Legal requirement	Comment
Chapter III – Area Water Boards			
32. Functions of an AWB	c.	Carry out flood protection and maintain infrastructure within its command area	AWB level flood management required
33. Tasks of an AWB	Strategy a)	To develop, on a periodic basis, a strategy statement for improvement of irrigation and drainage services, integrated water management including drinking water, water distribution in times of drought, flood protection within its command and catchment areas setting goals and objectives, formulating implementation policies and identifying priority and other actions	
	Operation and Maintenance e.	To operate and maintain the irrigation, drainage and flood protection infrastructure located within its territorial jurisdiction	
	Capital Projects and Schemes o.	In consultation with the various stakeholders, to plan, design, construct improvements to the irrigation and drainage system, storage reservoirs and flood protection infrastructure including development work for irrigation of lands within its territorial jurisdiction	
	Public Disclosure of Information v.	To issue flood warnings and warnings to all parties likely to affected, if it has cause to believe that damage or harm shall result from the use of any water flowing within its command area	Regional flood warning
38. AWB's power in respect of toxic or noxious effluent	1)	To monitor the disposal of toxic or noxious effluent safely and with minimum pollution of water resources	Specifies control of water pollution
	3)	To notify the Regulatory Authority of offences in respect of toxic or noxious effluent committed with the AWB's jurisdiction	
Chapter IV – Farmers' Organizations			
45. Functions of an FO	c.	Carry out flood protection and maintain infrastructure within its command area	FO level flood management required
46. Tasks of an FO	Operation and Maintenance e.	To operate, maintain, protect and improve the irrigation, drainage and flood protection infrastructure…	
	Public Disclosure and Information n.	To issue warnings to all parties affected if it has cause to believe that damage or harm shall result from the use of any water flowing within its command area	Local flood warning
Chapter VII - Regulatory Authority of Irrigation, Drainage and Flood Protection			
74. Functions of the Regulatory Authority	1)	The main responsibility of the Regulatory Authority shall be to ensure compliance with the statutory provisions laid down in this Ordinance	

Section of Ordinance	Sub-section	Legal requirement	Comment
78. Powers in respect of drought	1)	The Regulatory Authority, after consulting the SIDA, or the AWB(s) or FOs concerned, may make an order prohibiting or limiting the taking by any body (including a AWB) of water from a source specified in the order if the regulatory Authority is satisfied that the taking of water from that source shall affect seriously the volume or quality of water available to any other AWB	Specifically authorizes mitigation of drought conditions
Chapter VIII – The Transition			
95. Succession of the properties, assets, liabilities and staff	2)	Government shall transfer to an AWB irrigation, drainage and flood protection infrastructure, office premises, stores, plant and machinery situated in its command area	
97. Transfer of Barrages and other assets	1)	The Irrigation and Power Department shall transfer its barrages, outlets, existing spinal drains and flood protection infrastructure including staff, budgets and assets to the SIDA before 30 June, 2005	
98. Continuity until vesting in AWB		The Irrigation and Power Department shall continue to manage the irrigation, drainage and flood protection infrastructure in the area where no AWBs have yet been appointed	
Chapter XI - Miscellaneous			
105. Transfer of Powers		The powers conferred on Canal Officers under the Sindh Irrigation Act 1879 and the Financial Delegation of Powers Rules 1962, relating to Infrastructure, Water Management, Flood Protection and Finances, shall be exercised by the SIDA and the AWBs in their respective areas of jurisdiction	

It may be seen from Table 6.5 that the Sindh Irrigation and Drainage Authority (SIDA) has legislated responsibility within the Sindh Water Management Ordinance of 2002(GOS 2002) for water disaster and flood management. Legal responsibilities for disaster management for SIDA are for the following classes of water disasters:

- ✓ Drought
- ✓ Floods
- ✓ Water logging
- ✓ Sea water intrusion
- ✓ Severe weather and cyclones
- ✓ Discharge of toxic or noxious effluent [water pollution]

The Ordinance empowers SIDA to implement two new institutions through which to effect this change:

1. Area Water Boards (AWBs)
2. Farmer Organizations (FOs)

The SWMO, 2002 also gives SIDA the authority for flood management; but is silent on how this authority is to be implemented.

6. National Disaster Management Ordinance, 2007 (NDMO, 2007) and National Disaster Management Framework (NDMF)

National Disaster Management Ordinance, 2007 (NDMO, 2007)

A new National Disaster Management Ordinance, 2007[17] (NDMO, 2007) has established a modern legal framework for Pakistan for the internationally recognized concept of Disaster Risk Management.

The Ordinance is designed around implementation of a new National Disaster Risk Management Framework (NDMF) formulated to guide the work of the entire Government of Pakistan (GOP) bureaucracy in the area of disaster risk management (NDMA, 2006). The NDMO, 2007 and the underlying NDMF is based on the concept that Pakistan is in transition from a predominantly rural and agrarian to an industrial, service based and urban economy. Natural disasters threaten sustained economic growth by causing shocks to the economic system.

For water disasters, the drought of 1998-2001 demonstrated that water disaster shocks have serious political, economic and social repercussions. Sustainable development in agriculture, livestock, water resources, food security and environment sectors all are seriously threatened by drought. The drought of 2001 reduced the economic growth rate to 2.6 % as compared to an average growth rate of over 6 % before the drought. Similarly, economic damage suffered from 14 major floods, since 1947, has been estimated to be Rs.570 Billion (USD 6 billion). This is completely overshadowed by the economic damage of Rs. 855 billion (USD 9 billion) suffered by the country in the year 2010 super-flood. Economic damage from this one year 2010 flood event is many times combined value of economic damage caused by over 50 years of flooding.

It is not a coincidence that areas which experience water and frequent flood disasters are among the poorest regions of the country. In order for Pakistan to ensure continuity of current economic growth and poverty reduction in the medium to longer terms, it is considered fundamental that the country address risks posed by water and flood disasters. A reactive, emergency response approach has remained the predominant way of dealing with water disasters in Pakistan till 2006. The Calamity Act of 1958 was mainly concerned with organizing emergency response. A system of Relief Commissionerate at provincial level was established. An Emergency Relief Cell (ERC) in the Cabinet Secretariat was responsible for organizing water disaster response by the federal government.

None the less the awareness of policy makers, media, civil society, NGOs, UN agencies and other stakeholders remained low about rapid onset storm and tsunami disaster risk management. The situation is relatively better with regards to flood and drought mitigation. A number of government agencies and NGOs have been implementing mitigation measures for these water hazards. However, until recently, the country lacked a systematic approach towards water disaster risk management. Realizing the importance of water disaster risk reduction for sustainable social, economic, and environmental development, the GOP embarked upon establishing appropriate policy, legal and institutional arrangements; and implementing strategies and programmes to minimize disaster risks and vulnerabilities. In this regard, the National Disaster Management Ordinance, 2007 was passed with implementation legislated by a new National Disaster Management Agency (NDMA).

7. National Disaster Risk Management Framework (NDMF)

The National Disaster Management Framework (NDMF) has been developed in harmony with the Hyogo Framework of Action (HFA) 2005-2015, which was agreed by all nations in January 2005 in Kobe Japan during the UN-World Conference on Disaster Reduction (WCDR). The expected outcome of the HFA is "*the substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries*".

[17] In some references, the National Disaster Management Ordinance is referenced as 2006. However in the published Ordinance the date is given as 2007. For consistency, this report uses the title NDMO, 2007.

In order to attain this output, HFA calls for adopting the following goals:

1. The effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction
2. The development and strengthening of institutions, mechanisms and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience to hazards
3. The systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programmes in the reconstruction of affected communities

A National Disaster Risk Management Framework (NDMF) has been formulated to guide the work of entire government system in the area of disaster risk management. It has been developed through wide consultation with stakeholders from local, provincial and national levels. The Framework has the goal:

> ***"To achieve sustainable social, economic and environmental development in Pakistan through reducing risks and vulnerabilities, particularly those of the poor and marginalized groups, and by effectively responding to and recovering from disaster impact".***

Nine priority areas have been identified within the Framework to establish and strengthen policies, institutions and capacities in the near future. These include:

- Institutional and legal arrangements for Disaster Risk Management (DRM)
- Hazard and vulnerability assessment
- Training, education and awareness
- Disaster risk management planning
- Community and local level programming
- Multi-hazard early warning system
- Mainstreaming disaster risk reduction into development
- Emergency response system
- Capacity development for post disaster recovery.

The principles established in the framework are (i) promoting multi-stakeholder, multi-sectoral and multi-disciplinary approaches, (ii) reducing vulnerability of most vulnerable social groups (iii) strengthening community and local level risk reduction capacities (iv) combining scientific and people's knowledge (v) developing culturally, socially, economically and environmentally relevant technologies (vi) Strengthening sustainable livelihood practices (vii) Acquiring specific capacities in view of the hazard-risk profile of the area and country, and working with other countries, and the international community to promote disaster risk reduction

Roles and responsibilities of key national, provincial and local stakeholders have also been defined in the Framework. All stakeholders are expected to undertake actions to promote disaster risk management; such as (i) Integrate risk assessment in the planning and design stages of all new infrastructure/projects (ii) Assess vulnerability of people, infrastructure, assets and services related to their sector (iii) Develop disaster risk management plans (iv) Integrate vulnerability reduction measures in their programmes (v) Develop technical capacities of their departments/sectors to

implement (vi) disaster risk management strategies (vii) Allocate funds for disaster risk management in annual development budgets

Other responsibilities of the stakeholders include, (i) conduct post disaster damage and loss assessments (ii) organize emergency response as per the mandate of the department (iii) organize recovery and rehabilitation as per the mandate

Process of Establishment of the NDMF

The NDMF was developed through an extensive consultation process. Consultations were undertaken by UNDP (the sponsor for the development of the NDMF) between February-April 2003 to seek inputs from national and provincial stakeholders to prepare a Pakistan National Disaster Management Programme (NDMP). This process identified gaps in the disaster management system in Pakistan and provided recommendations to address them. Providing support to this initiative, the Cabinet Division of Government held consultations with large number of provincial and national stakeholders.

The Draft Framework was circulated among provincial and national stakeholders in early November 2006 by the NDMA. Written comments were received from more than 30 government agencies, NGOs and donors. Besides written feedback, a national consultation workshop was held on in November 2006 to seek opinions and inputs from government departments, UN agencies and donors. A consultation meeting was also organized with NGOs in December 2006. A special meeting with donors was also organized in December 2006.

The stakeholder consultations provided important inputs regarding gaps, priorities and capacity building needs. The Framework was revised based upon feedback from stakeholders. During its inaugural meeting held in March 2007, the highest policy making body on disaster risk management in the country, the National Disaster Management Commission (NDMC), approved this framework.

6.6.2 Water Sectoral Policies and Protocols with Links to Disaster Risk Management

An important component of the legislative framework for Disaster Risk Management in Pakistan is associated Sectoral Policies and Protocols, and their close links with all development sectors. Given below in Table 6.6 is a list of national sectoral policies and international protocols that have implications for water disaster and flood risk management. The NDMA has the goal to build linkages with these policies and protocols for the implementation of the Framework.

Table 6.6: Protocols Concerned with Water Disaster and Flood Disaster Risk Management

Sector / Agency	Legislation / Document
Agriculture	Agricultural Perspective and Policy
Bio-diversity	Convention for Biodiversity (CBD), June 1992
Climate Change	Framework Convention on Climate Change (UN FCCC), June 1992
Desertification	Convention for Combating Desertification, October 1994
Development	Medium Term Development Framework 2006-2010, Planning Commission
Development	Ten Year Perspective Development Plan, 2001-2011, Planning Commission
Development	Millennium Development Goals (MDGs), 2000
Disaster Risk Management	Hyogo Framework of Action 2005-2015
Environment	National Conservation Strategy 1992
Environment	National Environment Action Plan (NEAP), 2001
Environment	National Environment Policy 2005

6.6.2.1 Impact of the NDMO, 2007 and NDMF on SIDA and the Proposed Master Plan

The Sindh Irrigation and Drainage Authority (SIDA) is not specifically referred to in the National Disaster Management Ordinance of 2007 (NDMO, 2007) and the National Disaster Management Framework (NDMF). Even though it is considered to be appropriate for SIDA to adopt procedures and modalities that conform to the NDMO; and conform to the concepts given in the NDMA, the Master/Regional Plan Consultants were instructed not to go beyond a pre-feasibility study for the creation of a SIDA Disaster Management Unit.

6.6.3 Disaster Management Institutions

A number of government institutions are currently working on disaster risk management in Pakistan. Their place in the Disaster Cycle is shown in Table 6.7.

Table 6.7: Agencies Concerned with Disaster Risk Management in Pakistan:

Phase of Disaster Cycle	Agency
Disaster Risk Management	
	National Disaster Management Agency
Mitigation/Prevention	
	Federal Flood Commission (FFC)
	Provincial Irrigation Departments
	Water and Power Development Authority (WAPDA)/ Dams safety council
Preparedness and Response	
	Armed Forces
	Civil Defence
	Emergency Relief Cell
	Fire Services
	National Crisis Management Cell (NCMC)
	Pakistan Meteorological Department
	Police
	Provincial Communication and Works
	Provincial Food Departments
	Provincial Health Departments
	Provincial Relief Commissioners
	Provincial Agriculture and Livestock Departments
	Rescue 1122
	Space and Upper Atmospheric Research Commission (SUPARCO)
Recovery & Reconstruction	

	Earthquake Reconstruction and Rehabilitation Authority (ERRA)
	Provincial Irrigation Departments

6.6.3.1 Institutional Framework for Water Disaster and Flood Management

The current institutional framework for Disaster Risk Management in Pakistan, established by the National Disaster Management Framework (NDMF) and to be implemented by the National Disaster Management Ordinance of 2007 (NDMO, 2007), is illustrated in Figure 6.6. The institutional framework as it relates to water disaster and flood management is described below.

Disaster Risk Management is a multi-sectoral, multi-discipline and timely response undertaking. For this reason the current institutional framework of Disaster Risk Management in Pakistan is a multi-sectoral undertaking.

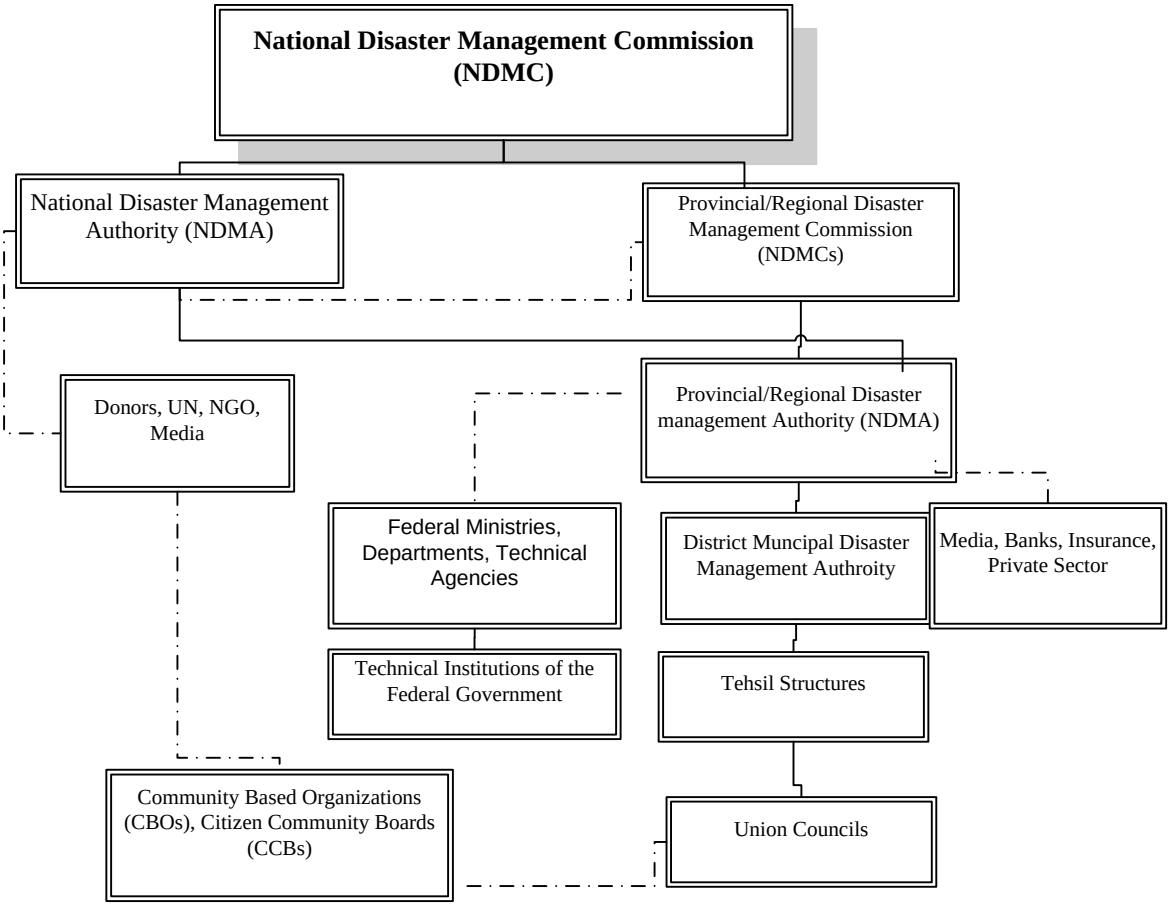


Figure 6.6: Structure for Disaster Risk Management Established by the National Disaster Management Ordinance, 2006

6.6.3.2 National Disaster Management Commission[18]

The Government of Pakistan has established the National Disaster Management Commission (NDMC) as the highest policy and decision making body for disaster risk management. The NDMC is responsible to ensure coordination in its broadest sense; to oversee the integration of disaster risk

[18] National Disaster Management Authority: Prime Minister's Secretariat, Constitution Avenue, Islamabad, Pakistan Ph: 92-51-9222373, Fax: 9204197, www.ndma,gov,pk

management issues into sectoral development plans, and to oversee the implementation of this policy through the NDMA.

6.6.3.3 National Disaster Management Authority (NDMA)

The National Disaster Management Authority (NDMA) has been established to serve as the focal point and coordinating body to facilitate implementation of disaster risk management strategies. This necessitates NDMA to directly interact/ communicate with all stakeholders, including Ministries, Divisions, and Departments in relation to normal communication channel.

NDMA is charged to develop sustainable operational capacity and professional competence to undertake the following tasks:

1. Coordinate complete spectrum of disaster risk management at national level,
2. Act as Secretariat of the NDMC to facilitate implementation of DRM strategies,
3. Map all hazards in the country and conduct risk analyses on a regular basis,
4. Develop guidelines and standards for national and provincial stakeholders regarding their role in disaster risk management,
5. Ensure establishment of DM Authorities and Emergency Operations Centres at provincial, district, and municipal levels in hazard-prone areas,
6. Provide technical assistance to federal ministries, departments and provincial DM authorities for disaster risk management initiatives,
7. Organize training and awareness raising activities for capacity development of stakeholders, particularly in hazard-prone areas,
8. Collect, analyse, process, and disseminate inter-sectoral information required in an all hazards management approach,
9. Ensure appropriate regulations are framed to develop disaster response volunteer teams,
10. Create requisite environment for participation of media in DRM activities,
11. Serve as the lead agency for NGOs to ensure their performance matches accepted international standards, including the SPHERE standards.
12. Serve as the lead agency for international cooperation in disaster risk management. This will particularly include, information sharing, early warning, surveillance, joint training, and common standards and protocols required for regional and international cooperation,
13. Coordinate emergency response of federal government in the event of a national level disaster through the National Emergency Operations Centre (NEOC),
14. Require any government department or agency to make available such men or resources as are available for the purpose of emergency response, rescue and relief,
15. Declare a National Disaster Awareness Day (to commemorate 08 October Earthquake) and conduct awareness raising activities at the occasion,
16. Establish a National Disaster Management Fund, and
17. Perform any other function as may be required by the NDMC.

NDMA Technical Committees

The NDMA will establish Technical Committees in order to facilitate coordination and enable optimum use of available skills and resources. Technical Committees will focus on specific disaster threats and issues, which may not have been covered as part of the stakeholder responsibilities in the Framework. Technical Committees could assist local, provincial or national authorities in identifying

issues and problems and devising solutions. The water disaster and flood specific areas that could be covered through the establishment of Technical Committees are:

1. Cyclones, storms, winds
2. Disaster risk communication
3. Drought
4. Water disaster early warning systems
5. Floods
6. Industrial accidents – Including pollutant discharge into irrigation canals and drains
7. Marine disasters, including oil spills
8. Tsunamis
9. Any other water related calamity

Tehsil and Town Authorities

Institutions at the local level are considered to be the frontline of disaster risk reduction and response. For many departments this is the lowest level of administration where they interface directly with communities; agriculture, education, health, police, revenue and others.

Extension workers of these departments are expected to play a significant role in promoting disaster risk reduction. For example agriculture extension workers should promote awareness of drought, flood or cyclone resistant crops. Health workers should raise people's awareness about potential diseases that may occur after a flood or drought and how to prepare for them. Education officials should work on school disaster preparedness. Similarly Tehsil Authorities have an important role in organizing emergency response and relief; including damage and loss assessment, and recovery needs assessment. Tehsil and town Nazims will lead the risk reduction and response operations with the help of Tehsil or Town Municipal Officer in consultation with the DDMA. Other key players include; extension workers, police, fire services, community organizations (COs), traditional leaders and NGOs. Appropriate local structures will be established for risk reduction and preparedness.

Union Councils

Union Councils are the lowest tier in the governance structure. Elected representatives from village and ward levels form these bodies. These bodies have an important role in allocation of resources for local development works.

Union Councils can play an important role in advocating demands of communities to the District Councils and Disaster Management Authorities. Community demands may include requests for allocation of resources from local budgets for hazard mitigation and vulnerability reduction activities; e.g. spurs for flood control, rainwater harvesting structures for drought mitigation, vocational training for livelihoods to reduce vulnerability etc. Therefore, it will be important to develop orientation and knowledge of local political leadership at this level. More capable Union Councils may develop local policies and guidelines for vulnerability reduction.

Community Based Organizations (CBO)

In order to promote community level disaster risk management activities, the capacity of existing Community Based Organizations (CBO) will be developed and enhanced by district and Tehsil authorities. In the absence of community organizations, new groups should be established to work on disaster risk management. CBOs will be trained about local early warning system, evacuation, first aid, search and rescue, fire fighting etc.

Linkages will be developed between CBOs and relevant local agencies; e.g. agriculture, banks, health and veterinary services to promote disaster preparedness. Skills and knowledge of CBO leadership will also be developed in financial management, people management, resource mobilization, interpersonal communication and presentation and negotiation skills. The provision of Citizen

Community Boards (CCBs) in Local Government Ordinance (LGO) provides a good opportunity to organize communities and mobilize resources for local level disaster risk management.

6.6.4 Policies and Mandates of the Disaster Management Institutions in Pakistan

Water Disaster and Flood Disaster Risk Management is a multi-sectoral, multi-disciplinary and timely response undertaking. As discussed above, the National Disaster Management Authority (NDMA) has been established to serve as the focal point and coordinating body to facilitate implementation of all disaster risk management strategies. This necessitates NDMA to directly interact and communicate with all stakeholders, including Ministries, Divisions, and Departments in relaxation to normal communication channel.

The task responsibility of Ministries, Agencies and Departments concerned with water disaster and floods with potential direct involvement with WSIP-I are given below:

Ministry of Water and Power

1. Develop disaster risk management plan with regards to the mandate of the Ministry
2. Monitor and manage the dams and reservoirs for irrigation releases from the point of view of specific hazard peculiar to that area
3. Assess disaster vulnerability of existing dams, reservoirs and power sector infrastructure in hazard-prone areas
4. Implement strategies to reduce vulnerability of existing dams, reservoirs and power sector infrastructure against disasters
5. Incorporate disaster vulnerability assessment in design and planning of future projects on water and power sector infrastructure development
6. Include vulnerability reduction measures in the construction of water and power sector infrastructure in hazard-prone areas
7. Provide telemetric data from rain gauge stations and flood data from Indus River Basin to the Flood Forecasting Division of the Pakistan Meteorological Department
8. Conduct studies on possibilities of dam failures and develop contingency plans

Federal Flood Commission (FFC)

1. Prepare flood protection plans for the country
2. Review and approve flood protection schemes prepared by provincial governments and concerned federal agencies
3. Make recommendations regarding regulation of reservoirs for flood control
4. Review damage to flood protection works and review plans for restoration and reconstruction works
5. Implement measures to improve flood forecasting and warning system
6. Prepare a research program for flood control and protection
7. Standardize designs and specifications for flood protection works
8. Evaluate and monitor progress of the National Flood Protection Plan implementation

WAPDA (Dams Safety Council)

1. Carry out periodic inspections of dams and advise WAPDA and provincial governments regarding repairs and maintenance of dams and reservoirs
2. Review the plans of new dams to ensure adequate safety of structures
3. Review the plans and specifications for enlargement, modifications, major repairs, revival or abandoning of dams / reservoirs

4. Keep close liaison with International Commission on Large Dams based in Paris

Ministry of Environment

1. Develop disaster risk management plan with relation to Ministry's mandate
2. Incorporate Natural Disaster Risk Assessment in the Environmental Impact Assessment (EIA) guidelines;
3. Develop technical capacities of the staff of ministry to undertake disaster risk assessment and disaster risk reduction activities in the environment sector;
4. Undertake assessment of vulnerability of natural resources (forest, lakes, streams, mangroves, coral reefs, protected areas, coastal areas) to natural and human induced hazards;
5. Implement programmes for conservation and rehabilitation of natural resources in order to reduce risks of natural hazards; e.g. reforestation, mangrove plantation, combating desertification, conservation of special natural resources; e.g. wetlands, lakes, reefs, mangroves, and coastal areas;
6. Allocate resources for implementation of programmes to conserve and rehabilitate the natural resource base, particularly in up-stream areas of the Indus River basin;
7. Develop mechanisms for assessment of environmental losses and damages in the aftermath of disasters and their rehabilitation;

Local Government and Rural Development

1. Develop disaster risk management plan with regards to the mandate of the Ministry;
2. Undertake vulnerability analysis of the local government property and infrastructure located in hazard-prone areas;
3. Incorporate disaster risk assessment in planning of projects for construction of local government and rural development infrastructure;
4. Integrate vulnerability reduction strategies in the construction of new infrastructure located in hazard prone areas;
5. Allocate additional funds for disaster risk assessment and vulnerability reduction for local government infrastructure;
6. Organize orientations for staff of the Ministry and local authorities in hazard-prone areas on disaster risk assessment and vulnerability reduction;
7. Monitor the performance of local authorities in integrating disaster risk assessment and vulnerability reduction in local development projects;
8. Provide its training institutions namely AHKNCRD and MTRI Karachi for training of district, municipal authorities and line ministries.

Planning and Development

1. Base planning upon hazard risk maps available with the NDMA and other technical agencies; e.g. PMD, FFC, WAPDA, SUPARCO and circulate these to all development ministries and departments;
2. Develop guidelines on incorporation of disaster risk assessment (and vulnerability analysis) in project identification, design and planning;
3. Organize orientations for line ministries about the guidelines on risk assessment;
4. Issue policy directive to all line ministries about incorporating disaster risk assessment (and vulnerability analysis) in project design and planning;
5. Make mandatory the inclusion of vulnerability reduction measures in implementation of development projects, if located in hazard-prone areas;

6. Monitor the progress on implementation of vulnerability reduction measures in all development projects in hazard-prone areas;
7. Obtain and maintain data on public sector infrastructure in hazard-prone areas in order to plan vulnerability reduction initiatives and organize reconstruction operations;
8. Assist the NDMA in evaluation of losses and damages;

Provincial Irrigation Departments

1. Develop capacities of the irrigation department to mitigate floods and droughts;
2. Complete repairs of flood protection works in the pre-flood season;
3. Assist local authorities and communities in building rainwater harvesting tanks and systems in arid zones;
4. Review the plan for regulation of water supply;
5. Position machinery and materials near vulnerable points for emergency repairs;
6. Inspect breaching of sections and carry out final survey;

Pakistan Meteorological Department (PMD)

1. Observe hazards and generate meteorological, geophysical and phonological data;
2. Analyze data for issuing forecasts and warnings for aviation, agriculture, shipping, ports, irrigation etc
3. Issue forecasts and warnings for any approaching events that might cause damage and loss to life and property;
4. Disseminate warning about hazards to relevant users through timely communication and coordination with NDMA;
5. Scrutinize, compare and publish data for appraisal of long term weather trends and seismic events;
6. Analyse extreme events observed in the past and their future trends; e.g. climate change, weather modification, land-ocean-atmosphere interaction, seasonal weather prediction.

Space and Upper Atmosphere Research Commission (SUPARCO)

1. Provide services of Pakistan Communication Satellite (PAKSAT) for communications with disaster-hit areas;
2. Provide services in disaster forecasting, monitoring and damage assessment using satellite and remote sensing technologies for floods, cyclones, oil spills, dust storms, droughts, earthquakes, tsunami and glacier depletion;
3. Establish appropriate facilities to acquire and process satellite data for study of storms, monsoons, cloud movements, dust storms, cloud top, land and sea surface temperatures, and other meteorological atmospheric processes;
4. Undertake studies / surveys on environmental conditions;
5. Provide remote sensing and satellite maps after disasters in order to show their impact;
6. Provide remote sensing and satellite maps for hazard risk zones to enable relevant agencies to take measures for minimizing damages to population and property;

Non-Governmental Organizations

Non-government Organisations (NGO's) are considered to be important partners in water and flood disaster risk management. They can contribute in mobilizing communities and developing local level

capacities in early warning, disaster preparedness and response. They also implement programmes for community vulnerability reduction; including strengthening livelihoods, safer construction practices, flood mitigation and drought mitigation. A number of NGOs are currently working on water and flood disaster risk reduction, preparedness and response in Pakistan. In specific terms NGO's will be encouraged to participate in training, public education, damage assessment, rehabilitation and construction projects in water and flood hazard prone areas. A list of NGOs active in Disaster Risk Management in Pakistan is given as under.

1. Action Against Hunger
2. Aga Khan Planning and Building Services (AKPBS)
3. Anjuman-e-Islah
4. Association of Physicians of Pakistani Descent of North America (APPNA)
5. Balochistan Environmental Foundation
6. CARE International
7. Church World Service (CWS)
8. Citizen’s Foundation
9. Concern Worldwide Pakistan (CWP)
10. Doaba Foundation
11. Eco Friends Society
12. Focus Humanitarian Assistance (FHA)
13. GTZ (German Technical Cooperation)
14. Hamdam Development Organization
15. International Organization for Migration (IOM)
16. International Union for Conservation of Nature (IUCN)
17. International Rescue Committee (IRC)
18. Islamic Aid
19. Islamic Relief
20. Jhelum Valley Human Welfare Society (JVHWS)
21. Khwendo Kor
22. Laar Humanitarian Development Programme (LHDP)
23. Mercy Corps
24. Muslim Aid
25. OXFAM
26. Pakistan Fisher Forum (PFF)
27. Pakistan Participatory Development Initiatives (PPDI)
28. Pakistan Red Crescent Society (PRCS)
29. Pattan Development Organization
30. Plan International
31. Roots Work
32. Rural Development Policy Institute (RDPI)
33. Sangi Development Foundation
34. Sangi Welfare Society
35. Sindh Agricultural and Forestry Workers Coordinating Organization (SAFCO)
36. Tharparkar Rural Development Programme (TRDP)
37. Worldwide Fund for Nature
38. World Vision
39. Young Sheedi Welfare Organization

6.6.5 Role of Other Disaster Management Related Agencies

Historically, prior to the introduction of the NDMO, 2007 and the NDMA, the Federal Flood Commission (FFC), Emergency Relief Cell (ERC) and Pakistan Meteorological Department were the key agencies for disaster management in Pakistan. However, in case of a disaster, almost all federal and provincial ministries, departments and divisions participate in managing the disaster.

A summary of these organizations' relationship with NDMA and the NDMF is shown in Table 6.8; and a brief description of the current and historical disaster management responsibilities of each organization is given below. Also noted is the relationship between each of these agencies and SIDA in the implementation of water disaster and flood management.

Table 6.8: Relationship of Historically Concerned Disaster Management Organizations and the New National Disaster Management Agency (NDMA) and the National Disaster Management Framework (NDMF)

No.	Agency	Responsibility given in NDMF	Shown on the NDMA organization chart	Relationship with SIDA	Discussion
1	Emergency Relief Cell (ERC)	Yes	No	TBD	Historical and new disaster management responsibilities are similar
2	Indus River System Authority (IRSA)	None given	No	TBD	The relationship with NDMA is not clear
3	Federal Flood Commission (FFC)	Yes	No	TBD	Historical and new disaster management responsibilities are similar
4	Water and Power Development Authority (WAPDA)	Yes	No	TBD	Responsibility only for dam safety through Dam Safety Council
5	Pakistan Meteorological Department (Met)	Yes	No	TBD	Historical and new disaster management responsibilities are similar
6	National Crisis Management Cell (NCMC)	Yes	No	TBD	The relationship with NDMA is not clear
7	Civil Defence (CD)	Yes	No	TBD	The relationship with NDMA is not clear
8	Provincial Relief Departments	Yes	No	TBD	Provincial coordination is now through PDMC's and PDMA's
9	Provincial Irrigation Departments	Yes	No	TBD	Provincial coordination is now through PDMC's and PDMA's

Emergency Relief Cell (ERC)

The current responsibilities of the Emergency Relief Cell (a Cabinet Division) under the new National Disaster Management Framework are to:

1. Develop policies and arrangements for procuring relief items on a fast track basis
2. Procure relief items, when needed
3. Stockpile relief items in collaboration with national and provincial EOCs, Civil Defence, Red Crescent, and other stakeholders
4. Make arrangements for receipt of international assistance
5. Make arrangements for receipt of international response teams

The Emergency Relief Cell (ERC) was established by the West Pakistan National Calamities (Prevention and Relief) Act, 1958 in the format of and with the responsibilities of the famine acts enacted during the time of the British in India. The ERC responsibilities in connection with disaster relief were:

1. To provide in cash as well as in kind to supplement the resources of the provincial governments in the event of major disasters
2. To coordinate the activities of the federal Division, Provincial Governments, as well as governmental, semi governmental, international and national aid-giving agencies, in the conduct of operations for relief of disasters
3. To maintain contact with international aid-giving agencies/ voluntary organizations and donor countries for disaster relief measures
4. To administer Relief Funds, being maintained at the Federal Level
5. To stockpile certain items of basic necessity and establish central inventory of resources
6. To provide assistance to calamity stricken friendly countries

The ERC operates an Emergency Control Room, which coordinates the situation during calamities by liaising with relevant agencies such as the Federal Flood Commission, Meteorological Department, and Provincial Governments.

The ERC maintained a warehouse in the capital, Islamabad, stocking essential non-perishable relief item such as medicines, blankets, clothing and tents. In addition, there is a Relief Goods Dispatch Organization (GDO) located in Karachi. This is responsible for receiving and dispatching all relief goods from foreign and local agencies in the event of a disaster. The ERC also maintains an Aviation Squadron with a fleet of 4 helicopters, whose task is to assist rescue operations and enable officials to visit the affected areas.

The current relationship between the ERC and SIDA for water disaster and flood is not clear.

Indus River System Authority

Indus River System Authority (IRSA) was created in 1992 to implement the historic Water Apportionment Accord agreed among the Provinces in 1991. At the time of the Accord the Indus Basin system consisted of the Tarbela reservoir on the main stem of the Indus, the much smaller Mangla reservoir on the Jhelum River, the network of link canals constructed under the Indus Replacement Works program as a part of the Indus Water Treaty, and the system of barrages to divert water into the canals, some of which have existed since the 19th century

The agreement among the provinces on apportionment of Indus water and the establishment of IRSA to implement the apportionment agreement was historic achievements because it addressed

the politically contentious division of Indus waters. Since that time, IRSA has functioned effectively to allocate available supplies and smooth disputes between the provinces.

The IRSA also serves to coordinate the sharing of Indus River Water between India and Pakistan (Ahmed, 2009).

No role for the IRSA is given in the National Disaster Management Framework. The relationship between IRSA and SIDA for water disaster and flood management is not known.

Federal Flood Commission (FFC)

The current disaster management responsibilities of the Federal Flood Commission (FFC) given in the NDMF are as follows:

1. Prepare flood protection plans for the country;
2. Review and approve flood protection schemes prepared by provincial governments and concerned federal agencies;
3. Make recommendations regarding regulation of reservoirs for flood control;
4. Review damage to flood protection works and review plans for restoration and reconstruction works;
5. Implement measures to improve flood forecasting and warning system;
6. Prepare a research program for flood control and protection;
7. Standardize designs and specifications for flood protection works;
8. Evaluate and monitor progress of the National Flood Protection Plan implementation;

The Federal Flood Commission (FFC) was created in 1977. Until the end of 1976, the Provincial Irrigation Departments (PIDs) were responsible for the planning and execution of flood protection works. But after the massive floods of 1973 and 1976 and huge losses to human life, land and property, the federal government deemed it necessary to have a federal agency in place for flood protection and preventive measures across the country.

Previous disaster management responsibilities of the FFC included:

1. Preparation of flood protection plans for the country
2. Approval of flood control / protection schemes prepared by provincial governments and concerned federal agencies
3. Recommendation regarding principles of regulation of reservoirs for flood control
4. Review of damage to flood protection works and review of plans for restoration and reconstruction works
5. Measures for improvement of flood forecasting and warning system
6. Preparation of a research programme for flood control and protection
7. Standardization of designs and specifications for flood protection works
8. Evaluation and monitoring of progress of implementation of the National Flood Protection Plan
9. Monitor the provincial government's implementation of the national Flood Protection Plan. The federal government provides the resources for meeting the capital cost of the project (s)

The Federal Flood Commission (FFC) currently has the responsibility of adjudicating the distribution of water from the Indus River Basin among the Provinces of Pakistan. The major disaster management responsibility of the Commission is the management of irrigation and hydropower related water releases from the main dams in the Indus River Basin.

The current relationship between the FFC and the SIDA for water disaster and flood management is not clear.

Water and Power Development Authority (WAPDA)

The role of the Water and Power Development Authority (WAPDA) for the management of disasters is now only delegated by the NDMA to the WAPDA Dam Safety Council through the following activities:

1. Carry out periodic inspections of dams and advise WAPDA and provincial governments regarding repairs and maintenance of dams and reservoirs
2. Review the plans of new dams to ensure adequate safety of structures;
3. Review the plans and specifications for enlargement, modifications, major repairs, revival or abandoning of dams / reservoirs
4. Keep close liaison with International Commission on Large Dams

Historically, WAPDA was the fundamental agency responsible for development of the water and power sector of Pakistan. Outside of the responsibility of the Dam Safety Council given above, the relationship between WAPDA and the SIDA is not clear.

However, the Sindh Water Management Ordinance of 2002 gives SIDA the responsibility to manage the three Barrages of Guddu, Sukkur and Kotri. This also may give SIDA responsibilities under Pakistan legislation related to implementation of the Dam Safety Programme for these three barrages.

Pakistan Meteorological (Met) Department

The Pakistan Meteorological Department as stated above has the following responsibilities under the new National Disaster Management Framework:

1. Observe hazards and generate meteorological, geophysical and phonological data;
2. Analyze data for issuing forecasts and warnings for aviation, agriculture, shipping, ports, irrigation etc
3. Issue forecasts and warnings for any approaching events that might cause damage and loss to life and property;
4. Disseminate warning about hazards to relevant users through speedy communication in coordination with NDMA;
5. Scrutinize, compare and publish data for appraisal of long term weather trends and earthquakes;
6. Analyse extreme events observed in the past and their future trends; e.g. climate change, weather modification, land-ocean-atmosphere interaction, seasonal weather prediction.

The Pakistan Meteorology (Met) Department is both a scientific and a service department, and functions under the Ministry of Defence which is the common in many countries. It is responsible for providing meteorological service throughout Pakistan. Apart from Meteorology, the Department is also concerned with agro-meteorology, hydrology, astronomy and astrophysics, seismology, geomagnetism, atmospheric electricity and studies of the ionosphere and cosmic rays.

The disaster management functions of the Met Department are to provide information on meteorological and geophysical matters with the objective of disaster mitigation due to weather

and geophysical phenomena, agriculture development based on climatic potential of the country, prediction and modification of weather forecast. The Department has established:

1. A network of observing stations to generate meteorological, geophysical and phonological data.
2. A telecommunication system for speedy dissemination of data
3. Meteorological offices to analyse data for issuing forecasts and warnings for aviation, agriculture, shipping, sports, irrigation etc.
4. Climate and data processing units for scrutinizing, comparing and publishing data for appraisal of long term weather trends and earthquakes.

The department has introduced a modern flood forecasting system, earthquake and nuclear explosion detection system, radar, satellite, computer technology, flight safety consultancy services in seismic design of dams, buildings and other development and disaster relief schemes.

The relationship and linkages between SIDA and the Met Department for water disaster and flood management is not clear. However

National Crisis Management Cell (NCMC)

The disaster management responsibilities of the National Crisis Management Cell (NCMC) of the Ministry of the Interior under the NDMF are to:

1. Manage a round the clock Operational Control Room;
2. Collect information on emergencies of all sorts in the country;
3. Coordinate with Provincial Crisis Management Cells (PCMCs);
4. Coordinate with other agencies to gather relevant information; e.g. casualty figures etc
5. Coordinate plans for emergency response in case of crisis situations;

The National Crisis Management Cell, under the Ministry of Interior, has a round-the-clock operational control room for collecting information on emergencies of all types in the country. It coordinates with the Provincial Crisis management Cells (PCMC) and other security agencies to gather relevant disaster related information. It is also responsible for coordinating plans for emergency response services in case of emergency situations and disasters.

The current relationship between the NCMC and SIDA for water disaster and flood management is not clear.

Civil Defence

The responsibilities of Civil Defence (CD) under the NDMF are to:

1. Assist local administration / armed forces in rescue, evacuation and relief measures;
2. Supplement disaster-response equipment of the armed forces;
3. Save lives by rapid extrication of persons trapped beneath debris or in buildings damaged by a natural or manmade disaster;
4. Render first aid to injured persons and transport them to nearest hospitals;
5. Ensure evacuation of damaged buildings/structures including demolition of damaged structures to avoid further loss of life and properties;
6. Provide quick and effective search and rescue coverage, protection and operation in case of any disaster;

7. Build public confidence by introduction of more effective measures for their protection and ensure adoption of requisite preventive measures by the community;
8. Assist in restoration of essential traffic so as to carry out rescue work without any hindrance or obstruction;
9. Assist in debris clearance and restoration of essential services to the affected buildings;
10. Search and defuse unexploded bombs in the affected areas;
11. Recruit/induct operational staff for SAR teams with required specialized skills;
12. Enhance capabilities of the existing Search and Rescue teams of Pakistan;
13. Coordinate airlifting of relief goods from abroad by the PIA;

The Civil Defence Department was established through the Civil Defence Ordinance of 1951. It is now governed through the 1952 Civil Defence Act. Before 1993, it was mandated to "*take measures not amounting to actual combat, for affording defence against any form of hostile attack by a foreign power or for depriving any form of hostile attack by a foreign power of its effect, wholly or in part, whether such measures are taken before, during or after the time of the attack*". Subsequent to 1993 it was assigned the additional task during peacetime to perform remedial measures against natural or man-made disasters. Specifically, Civil Defence was to:

1. Assist local administration / Army in rescue, evacuation and relief measures
2. Supplement anti-flood equipment of Army
3. Provide personnel for anti flood training in rescue and relief work

The current relationship between Civil Defence and SIDA for water disaster and flood management is not clear.

Provincial Relief Department

The Sindh Provincial Relief Department responsibilities under the new NDMF are to:

1. Provide adequate support to local administration through co-ordination with provincial departments and agencies;
2. Provide necessary funds to the area administration for relief work;
3. Supervise the work of area administration regarding relief provision;
4. Assess losses and request federal / provincial governments for providing relief;

The Sindh Provincial Relief Department have historically acted in parallel with the Emergency Relief Cell at the national level. The specific duties of the Provincial Relief Department have in the past been to:

1. Provide adequate resource support to area Administration through co-ordination with Provincial Government Departments / Agencies
2. Provision of necessary funds to the area administration for relief work
3. Oversee the working of area administration for relief work
4. Obtain field reports of losses and apprise the Provincial Government / Federal Government
5. Assess and evaluate losses and suggest to the Federal / Provincial Governments for providing relief to the affected persons

The current relationship between the Sindh Provincial Relief Department and SIDA for water disaster and flood management is not clear. But it is assumed that coordination is through the Sindh Provincial Disaster Management Council (PDNC) and the Sindh Provincial Disaster Management Agency (PDMA).

Provincial Irrigation Department

The Sindh Provincial Irrigation Department is given the following disaster management responsibilities under the new NDMA and the NDMF:

1. Develop capacities of the irrigation department to mitigate floods and droughts;
2. Complete repairs of flood protection works in the pre-flood season;
3. Assist local authorities and communities in building rainwater harvesting tanks and systems in arid zones;
4. Review the plan for regulation of water supply;
5. Position machinery and materials near vulnerable points for emergency repairs;
6. Inspect breaching of sections and carry out final survey;

The Sindh Provincial Irrigation Department was the historical agency responsible for local flood protection. This was performed by:

1. Complete repairs of the flood protection works in the pre-flood season
2. Provide funds to the Army for replenishment of stores
3. Review the plan for regulation of water supply
4. Position requisite machinery and material at safe localities near vulnerable points for emergency repairs
5. Inspection of breaching sections and carrying out final survey

It appears that the new and the historical disaster management responsibilities of the provincial disaster department are similar.

The summary of the Sindh Water Management Ordinance of 2002 (Table 21-7) clearly states that SIDA is to assume the responsibilities of the Sindh Provincial Irrigation [and Power Department] for flood management within the command areas of its three Area Water Boards shown in Figure 21-12.

That implies that by law in Sindh Province, SIDA is to assume the flood management activities of the Irrigation Departments in other provinces; and within the command areas of its three AWBs is responsible to the National Disaster Management Agency for the following flood management activities:

- ✓ Develop capacities of SIDA to mitigate floods and droughts
- ✓ Complete repairs of flood protection works in the pre-flood season
- ✓ Review the plan for regulation of water supply
- ✓ Position machinery and materials near vulnerable points for emergency repairs
- ✓ Inspect breaching of sections and carry out final surveys

6.6.6 Water Disaster and Flood Management for SIDA

As described above, the Sindh Irrigation and Drainage Authority (SIDA) its Area Water Boards (AWBs) and Farmers Organizations (FOs) have legislated responsibility within the Sindh Water Management Ordinance of 2002(GOS 2002) for water disaster and flood management. Legal responsibilities for disaster management for SIDA are for the following classes of water disasters:

- ✓ Drought
- ✓ Floods
- ✓ Water logging
- ✓ Sea water intrusion
- ✓ Severe weather and cyclones
- ✓ Discharge of toxic or noxious effluent [water pollution]

SIDA Flood Management Programme

The Sindh Irrigation and Drainage Authority (SIDA) have developed a basic approach to flood management that was deployed during the year 2010 super-flood. The flood management approach relies on:

- ✓ Flood Management Pre-planning
- ✓ Flood Emergency Cell
- ✓ Press and public information services

Flood Disaster Management Plan

SIDA has prepared a flood management plan for protection of the bunds managed by the Badin Left Bank Canal Area Water Board (SIDA, 2010)[19]. This plan describes the characteristics of the bunds (flood dikes) being protected, emergency communications to be established, the role of the concerned agencies for assistance in protecting the bunds against catastrophic flooding, and emergency contact information. This flood plan is published in the SIDA website and flood management plans are available on-line from SIDA.

Flood Emergency Cell (FIC)

During the year 2010 super-flood, SIDA established a Flood Information Cell (FIC) in the SIDA Secretariat in Hyderabad to monitor day to day flow and disposition of flood waters. The information cell was fully functional and being run under the Coordinator, FIC. The cell is equipped with toll free and land line emergency telephone numbers through which day to day information was being disseminated to local communities and individuals making enquiries concerning flood conditions.

During the height of the flood, the Flood Information Cell started its work from morning to midnight; and was eventually activated for work round the clock. Due to emergency situation, SIDA and Area Water Board staff was available in their offices during Government Holidays. At the height of the flood, all SIDA officials were deputed in offices to perform flood management duties on a day-night shift basis.

Press and public information services

For the year 2010 super-flood, SIDA maintained continuous coordination with the media through press briefings and flood related statements issued by the SIDA Media and Communication Cell on a daily basis. This communication channel with the media was also used to correct published information, followed by rebuttal, if incorrect information appeared in the media.

[19] SIDA (2010), Flood report of River Protective Bunds, Year 2010, Left Bank Canal Area Water Board Badin, Sindh Irrigation and Drainage Authority, Hyderabad, 2010

6.6.7 Plans for Flood Management Improvement

SIDA management has plans to accurately document the entire year 2010 super-flood scenario for the record of its flood fighting; and as a basis of lessons learned to be able to better respond to and to fight future super-flooding. This documentation is being coordinated by both SIDA technical staff and by the SIDA Media and Communications Cell.

6.6.7.1 Assessment of SIDA Water Disaster and Flood Management Institutional and Legal Framework

SIDA under its legal framework in the Sindh Water Management Ordinance of 2002 (SWMO 2002) has formed the following two institutions to manage irrigation and drainage in the project area:

1. Area Water Boards (AWBs)
2. Farmers Organizations (FOs)

The SWMO, 2002 gives a legislated responsibility for SIDA, its AWBs and its FOs to undertake water disaster and flood management activities. Also as discussed above, the SWMO, 2002 gives SIDA the responsibility for the water disaster and flood management responsibilities formerly assigned to the Sindh Department of Irrigationa and Power. It is Therefore considered appropriate to bring SIDA under the mandate of the National Disaster Management Framework as a significant output of WSIP-I.

6.6.7.2 Assessment of SIDA Flood Management Programme

The current disaster management approach followed by SIDA appears to be only for flood management, and not for the entire range of water disaster risks faced by the Authority under its legal charter to provide comprehensive irrigation and drainage management on the Left Bank of the Indus; as well as in the Delta and Coastal Zones of Sindh. The full range of water disaster risks that SIDS should be concerned with are (Table 6.9):

- ✓ Drought
- ✓ Flood
- ✓ Water logging and salinity
- ✓ Salt water intrusion (Up estuaries and into coastal groundwater aquifers
- ✓ Cyclones and storms
- ✓ Tsunami

Additionally SIDA is legislated to manage the man-made disaster risk of water pollution in the form of the release of toxic and noxious pollutants into its canals and drains.

Table 6.9: Primary Disaster Hazards in the Lower Indus Basin and Sindh Affecting SIDA

Class of Disaster Risk	Disaster Risk
Water Hazards	
	Drought
	Flood
	Water logging
	Salinity – Irrigation induced and saltwater

Class of Disaster Risk	Disaster Risk
	intrusion up estuaries and into ground water
	Cyclones and storms
	Tsunami
Man-made and other hazards	
	Industrial pollution

6.6.7.3 Assessment of SIDA's Published Flood Management Plans

The flood management plan protecting the bunds of the Left Bank Canal of the Badin Area Water Board is assessed as not designed for active implementation. It lacks active instructions on what to do when different flood conditions are encountered. The Plan would offer a good case history for staff training on how to prepare a modern, flood disaster risk management orientated Flood Plan.

The Approach for Water Disaster and Flood Management in Pakistan

Previous Approach to Water Disaster and Flood Management

At the federal level, the Emergency Relief Cell (ERC) in the Cabinet Division, since its inception in 1976, served as the focal point during emergencies. At the provincial level, the ERC coordinated with provincial relief departments / relief commissioners who are responsible for effective distribution of relief items in respective provinces. The ERC was also responsible for dealing with institutional donors and receives grants, donations and funds for distribution through the Prime Minister's Disaster Relief Fund.

In 1950, Pakistan witnessed first severe flood disaster that claimed 2910 lives and affected more than 10,000 villages. The need for a flood control programme in the then East Pakistan (Bangladesh) was realized only in the late 60s that subsequently led to the incorporation of a flood management programme in the Fourth Five-Year Plan (1970-75) but efforts in this direction remained insignificant. Three years later, the Government's Emergency Relief Cell prepared a draft National Disaster Plan in 1974, which intended to deal with various components of disaster management. The Plan was to establish procedures, organizational set-up, fix primary responsibilities and support functions of implementing agencies and standard procedures for the monitoring of disaster operations. However, it was never been finalised or implemented.

Pakistan therefore until recently, has followed the conventional relief and response oriented model for coping and managing the risk of water disasters and floods. Since inception, the record of managing water disasters and flooding in Pakistan can best be described as casual and incoherent; largely focusing on the reactive strategy of relief and response. Since the 1960's when Pakistan faced its first major flood disaster in terms of life and livelihood - floods claimed more than 2900 lives and affected more than 10,000 villages - water disasters and floods are a regular incidence. Yet the consecutive governments are considered to have failed to formulate a more cohesive strategy for managing water disasters. Floods, being the most frequently occurring disaster condition, managed to take the attention of policy makers in late 60's and a Flood Control Programme was launched for the first time. Flood control also made its way into the 4th Five Year Plan (1970-75).

The drafting of a National Disaster Plan in 1974 by the Federal Emergency Relief Cell can be considered as the first effective effort to address different aspects of disaster management in Pakistan. The plan envisaged procedures, organizational structures, primary responsibilities, responder agencies, and procedures for monitoring relief operations. But the Plan was neither finalised nor implemented.

The National Calamities (Prevention and Relief) Act 1958, can also be considered as a major instrument for local water disaster and flood management, but its focus was limited to relief and compensation. Other major building blocks of Pakistan's disaster management system including; the Federal Emergency Relief Cell, a central disaster management structure working under the Federal Cabinet Division, the Civil Defence department working under Civil Defence Act 1952 (as amended in 1993), have failed to deliver whenever confronted with a major water related catastrophe or calamity.

Current Approach to Water Disaster and Flood Management

Up until 2005 it is possible to trace only fragmented and isolated efforts for developing a national level interest in disaster risk management. But year 2005 proved to be a watershed in the context of disaster management. Pakistan faced a devastating earthquake in October 2005 which exposed the vulnerability of the existing emergency and disaster response system and capabilities. The 2005 earthquake changed Pakistan's perceptions about how to manage disasters. Besides this horrific event, Pakistan also became a signatory of the international disaster risk reduction protocol – the Hyogo Framework for Action 2005-15. Both these developments worked as a catalyst leading to the promulgation of National Disaster Management Ordinance in and the adoption of the National Disaster Management Strategy in 2007.

Structural versus Non-structural Disaster Risk Management Options

Historically Pakistan – and almost all countries – have addressed water disaster and flood risk management using structural methods. This includes:

1. Construction of dams
2. Construction of bunds (dikes)
3. Construction of physical river training works

Alternatively modern concepts of water disaster and flood risk management focus more on non-structural water disaster and flood risk management methods. This includes:

1. Water disaster and flood risk forecasting
2. Water disaster and flood risk mapping
3. Water disaster and flood risk warning
4. Water disaster and flood risk community awareness programs
5. Water disaster and flood risk drills and evacuation exercises

It is considered that the benefits of non-structural water disaster and flood risk management procedures are economically viable and socially acceptable in the context of the Lower Indus River Basin. For that reason it is recommended that SIDA consider the design and implementation of non-structural over structural water disaster and flood management projects for the new Master Plan project.

Flood Management Strategy in the Lower Indus Basin

Since floods are almost a routine annual feature in the monsoon season in areas lying along the country's rivers and their basins, the GOP has a flood management strategy based on structural and non-structural measures for flood management in the Indus River Basin.

Structural measures include:

1. Construction of embankments
2. Construction of spurs or batteries of spurs
3. Construction of dikes, gabion walls and flood walls
4. Construction of dispersion ad diversion structures
5. Channelization of flood waters

6. Construction of flood retardation dams
7. Construction of bypass structures

Non-structural measures include:

1. Improved flood forecasting system
2. Effective data collection and dissemination system
3. Real time rain fall and river flow data collection
4. Weather radar prediction
5. Modern Information Communication Technology (ICT) of transmission of flood forecasts and warnings

An improved early flood warning system is being followed based on:

1. Effective flood forecasts, early flood warning is issued
2. Reliable interaction between all related flood control and relief agencies
3. Timely warning and evacuation arrangements by provincial relief departments and district administrations

Water Disaster and Flood Management Projects in the Lower Indus River Basin and Sindh

Almost uncountable numbers of national, provincial and local water resources projects with water disaster and flood management components have been designed and performed in Pakistan and Sindh. Countless water disaster and flood management projects have been performed, both before and after independence. None-the-less it is insightful to highlight the most important water disaster and flood risk management projects within and separate from their underlying water resource development programmes to provide lessons learned for the development of the water disaster and flood management components of the new water resources Master Plan for the Left Bank Indus, Delta and Coastal Zone.

A summary of the major Water Disaster and Flood Management Programmes undertaken and currently on-going within recent history in Pakistan and Sindh is given in Table 6.10. Included is an assessment of the lessons learned from the programmes.

Table 6.10: Summary of Modern Water Disaster and Flood Management Programmes undertaken in Pakistan and Sindh

No.	Dates	Agency	Title	Types of projects	Lessons learned
1		ADB	First Flood Protection Sector Project		
2	1999-	ADB	Second Flood Protection Sector Project		
		World Bank	Sindh Water Sector Improvement Phase-I Project (WSIP-I)		

One of the major lessons learned from these historical and on-going water resource projects is the fact that the irrigation and drainage sector of Pakistan has difficulty absorbing and implementing new projects. This is considered to be caused by:

- ✓ Lack of sufficient trained personnel with the skills necessary for the design and analysis of structural water disaster management infrastructure

- ✓ Lack of sufficient trained personnel with the skills necessary for the implementation and construction management of structural water disaster and flood management infrastructure
- ✓ Lack of trained personnel with skills necessary for the design and implementation of non-structural water disaster and flood management projects
- ✓ Lack of Geographic Information System (GIS) and remote sensing capability needed for the design, implementation and on-going performance of non-structural water disaster and flood management projects
- ✓ Lack of internal and external controls to prevent or minimize corruption – Corruption is both financial corruption and staffing corruption (using un-qualified personnel incapable of performing required tasks)

6.7 Lessons Learnt

6.7.1 Lessons Learned from the Year 2010 Super-flooding

The major lesson learned from the year 2010 super-flood is that the institutions envisioned under the National Disaster management Ordinance, 2007 and the modalities called for from the National Disaster Management Plan are not functioning.

1. Natural flood retardation basins can be used instead of breaching of bunds to protect barrages from damage or failure from extreme values of flood water flows.
2. It is considered by many knowledgeable flood management experts that it is politically and socially impossible to intentionally breach bunds during the height of a flood if a preparedness plan based on community consultations has not been prepared before the flood event. Also as a minimum, the breaching plan must break bunds on both sides of the river to show the local population that the breaching is not done to favour any one landowner or community

There exists a competent plan. It is assessed that the National Disaster Management Strategy is clear, compressive, and right-thinking. However, there is a clear need for a new approach to water disaster and flood management in the country, in the Lower Indus River Basin; and in Sindh. This perception of need is present at all levels of government and within all classes of society.

It is not clear that there is sufficient, or any political will, to implement the National Disaster Management Ordinance or establish the methodologies called for in the National Disaster Management Framework. Even at the height of the recent national grief resulting from the year 2010 super-flooding not spokesperson was heard to say that the dis-functionality of the present disaster management system will be fixed.

Summary of the Year 2010 Super-flooding

Wide spread heavy rains in July and August 2010 resulted in high runoff in the Kabul, Swat, Chenab, and Indus Rivers. Flash floods in western streams aggravated the peak Indus flows. The average annual rainfall in Peshawar is 400 mm, but in only six same days 333 mm of rain feel on the city. Rainfall data for 18 stations in Khyber Pakhtunkhwa (KP) – the upper catchments of the Swat, Kabul and Indus Rivers, shows two pre-flood major rainfall events from 27 to 30 July and from 3 to 9 August 2010. The 24-hour rainfall on 29 July varied from 21 to 280 mm at various stations with an average of all stations equal to 128 mm. These two rainfall events deposited approximately 4.75 cubic kilometers (km^3) of water onto KP.

The Tarbela flood peak (835,000 cusecs) was the highest value in its history (682,159 cusecs), but lower than its design flood (1,500,000 cusecs). The flood peak at Chashma (1,036,673 cusecs) was also the highest on record (1,028,723 cusecs) and higher than the design capacity of the barrage (950,000 cusecs; 9% higher). The flood peak at Kotri was also very high (964,897 cusecs) and higher than its design capacity (875,000 cusecs); but the year 2010 flood peat was lower than the

historical flood peak (981,000 cusecs; 10% higher). The year 2010 flood peaks at Kalabagh, Guddu and Sukkur were lower than their historical peaks, as well as lower than their design capacity (Table 6.11).

Table 6.11: Historical and 2010 flood peaks at Barrages on Indus

Location	Design Discharge Cusecs	2010 Flood Peak	Historic Peak	
		Cusecs	Year	Cusecs
Tarbela inflows	1,500,000	835,000	1929	682,159
Kalabagh	950,000	937,453	1929	1,200,000
Chashma	950,000	1,036,673	1929	1,028,723
Taunsa	1,100,000	959,999	1929	999,920
Guddu	1,200,000	1,148,738	1976	1,176,150
Sukkur	1.5 million as originally designed; Reduced to 900,000 subsequently	1,130,995	1976	1,161,472
Kotri	875,000	964,897	1956	981,000

The first high flood peak at Tarbela was 700,000 cubic feet per second (ft^3s^{-1}) (19822 cubic meter per second; m^3s^{-1}) on 30 July. This peak increased to 975,000 ft^3s^{-1} (27,609 m^3s^{-1}) at Chashma on 2 August due to inflows from the Kabul River.

At the Taunsa Barrage, the flood peak was observed as 780,000 ft^3s^{-1} (22,087 m^3s^{-1}). This peak moved downstream to the Guddu and Sukkur barrages on 9 and 10 August and increased to around 1,175,000 ft^3s^{-1} (33,275 m^3s^{-1}) as the western hill torrents poured more water into the Indus River. The highest peak at Kotri – the most downstream barrage on the Indus River, was 964,000 ft^3s^{-1} (27,298 m^3s^{-1}).

The two highest flood peaks reached the Taunsa Barrage from Tarbela in 12 days time and remained high for 3-4 days for each flood peak. The flood peaks at Guddu and Sukkur Barrages remained high for more than 10 days. High flood peaks, multiple flood peaks and long duration peak flood values over time combined together to cause repeated and high damage to the irrigation and drainage infrastructure of Sindh.

Most of the barrages in Sindh experienced their near highest or highest historic flood levels; which in many cases was above their design discharge value. These high flood values were in spite of large scale upstream flooding due to breaching of bunds (dikes) in the upper reaches of the Lower Indus Basin in Sindh. Without this breaching of the bunds, the flood levels at the barrages in Sindh would have been even higher and would have certainly severely damaged the already flood impacted barrages.

6.7.2 Lessons Learned from the Year 2011 storm water -flooding

Flooding was caused due to unusual intense rainfall that occurred 9 through 17 August 2011 and was further exacerbated by the rains during the first 9 days of September. High rain events occur frequently in the coastal zone and lower Indus region. However, the intensity and duration of flooding, inundation and damages in 2012 year have been more severe than during previous rainfall events because of operational difficulties and wide spread breaching of canals. Some breaches of branch, distributary and minor canals continued flooding the countryside for four days after the major August precipitation events, because the canals could not be closed and because there were inadequate deployable personnel of IPD and entities of SIDA including AWBs and FOs for managing breach closure.

Main Field Observations in August

a) The most wide spread and prolonged flooding was caused by delay and accumulation of rain fall runoff in low lying areas and settlements. Field teams observed, in the badly affected areas, two to six feet of water accumulated in different parts of the drainage service and adjacent areas. In some areas of Mirpurkas, there was however little evidence of flooding due to rainfall. In addition to wide spread inundation of agricultural land, formal residential areas, informal settlements, roads, electric and communication suffered damages due to prolonged inundation.

b) The movement and evacuation of the storm-flows was slow due to multiple factors, mainly because of the insufficient drainage potential of the network, topography and blockages caused by infrastructure (roads, railway lines, canal banks). A delay in evacuation of the storm runoff was compounded by the breaches in the irrigation and drainage network.

c) Functioning of the Drainage System
   a. Spinal Drain LBOD

      The spinal drain performed fairly well despite breaches, over-topping in some areas, rain cuts on the banks and sloughing of the banks. Three breaches occurred in the spinal drain and the repair by the Government and public was relatively quick and affective.

      The KPOD component was breached. Some 60 percent of the flow of the LBOD Spinal Drain discharged to KPOD, and it additionally received high flood flows from Badin through six large and several smaller branch drains.

   b. The field teams observed insufficient capacity of the sub-drains throughout the area.

   c. The surface ditch and culvert systems were observed to be inadequate to the requirement of conveying ponded water toward drains.

d) Functioning of the Irrigation System
   a. On 11th of August, AkramWah (Lined Channel) was closed, while, flows of Fuleli and Pinyari were reduced. The Pinyari and Fuleli canals canals were closed subsequently on 12th August. However, Jamrao and Rohri irrigation systems were not closed during the floods. Later on, as a response to the breaches and reduced water demand, some of the branch and many distributary canals were closed but a number of breaches had to be repaired while the canals were flowing because of tardy upstream operations.

   b. Farmers respond by closing watercourses in all flood affected areas, while the upstream system was running at different levels.

   c. Canal escapes continued to discharge large flows into LBOD because, as noted above, the canal head works were not closed although many distributaries had been closed in upstream areas of the Nara and Rohri Canal Commands.

e) Community risk factors include:
   a. The community was largely distressed due to lack of their ability to guess and availability of official information about evolving flood situation. The outcome of flash-floods was not predicable based on their limited knowledge.

   b. Large numbers of scattered settlements in low lying areas should be an issue of concern. Refer to the provincial Government' plans for the "proper village planning in Sindh".

c. Disaster prone cropping patterns with higher risk factor. New high value crops (like BT cotton) are associated with higher risk factor.

d. Limited local shelters: It was witnessed that the people took shelter in marginally safe locations, like roads, which often were flooded.

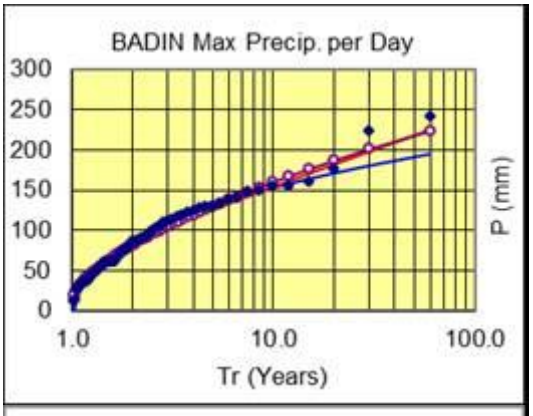
f) Community Response

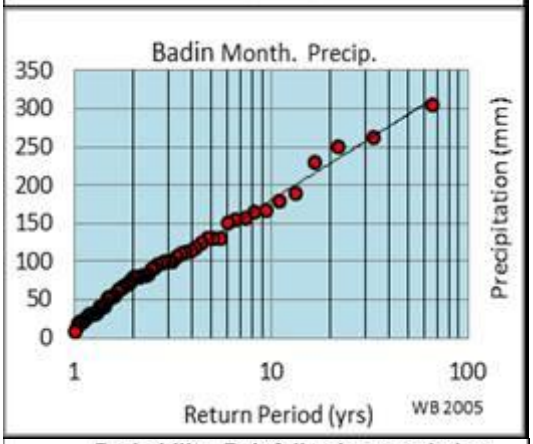
Efforts to protect individual property and land: The communities tried to manage rain runoff and flood damages at their level, essentially with limited training and resources. It may have resulted in some harm to infrastructure, however, it was a natural response to take protective measures and get rid of the flood flows as early as possible.

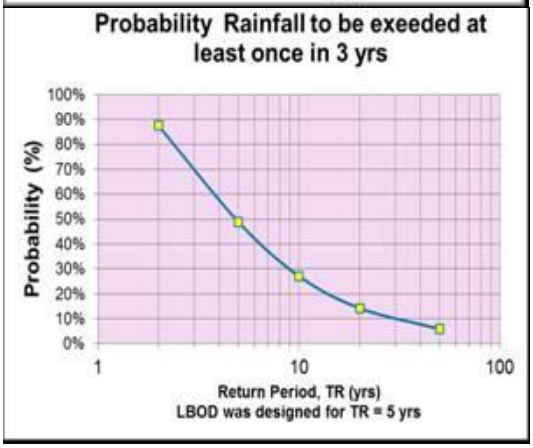
Estimation of the Drainable Flows from the Sub-catchments

August Rainfall

Precipitation recorded in Badin on August 11 and 12 were 148 mm and 147 mm respectively. A max-daily precipitation frequency analysis prepared by LBG for 59 years data (the years when the data was missing were ignored) is consistent with the analysis prepared by the WB International Panel of Experts May 2005. According to this analysis (presented on the chart) each event if observed independently have a minor period of return. However, since the two days rainfall seem to be the same event, the precipitation observed on August 11 and 12 together add up to 297 mm, which correspond to a much larger period of return because the probability of having two events combined (48 hrs) is small.







If we look at the monthly precipitation recorded during August 2011, 331.2 mm it corresponds to a return period of about 80 years, more than the August 2003 events, which makes it the largest month ever recorded.

The September events if analyzed independently they are minor, except the September 7 event. Now, if we look at the precipitation fallen between August 10 and September 9, a total of 512 mm, which if checked against the maximum monthly rainfall frequency chart, the return period would be huge. This clearly explains the overwhelming effect of the rainfall in year 2011.

Probability of events occurrences

The original LBOD design was for 5 years return period flow, which implies a probability of 50% of having at least one similar or greater storm to occur in a period of 3 years. The chances that the maximum capacity will be reached or exceeded every three years are the same as tossing a coin into the air every three years and hoping for it to fall heads up.

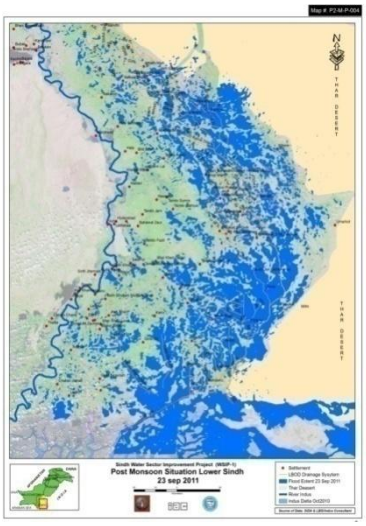
The 2003 storm experienced has a return period of 6.6 years. This implies a probability of 56% of having at least one similar or greater storm to occur in a period of 5 years. The discharge proposed by WAPDA/NESPAK corresponding to 10 years return period implies a probability of 52% of having at least one similar or greater storm to occur in a period of

7 years and 80% in a period of 15 years. Increasing the capacity of LBOD has significant implications and is rigorously opposed by some of the stakeholders.

The Irrigation Secretary and SIDA have instructed that LBOD should be designed to accommodate a 20 years return period storm. However, since the magnitude of the flooding is so large, even with a 20 years return period some flooding will be experienced and the evacuation time will be from 10 to 15 days. Hazard maps are being prepared by the Master/Regional Plan Consultants, where the land use will be recommended according to these evacuation times. For larger precipitation events, some measures shall be planned for the people to be prepared to react during flood events, because flooding will be part of their lives. There is no way to have a flood free Sindh.

Inundated area during the 2011 floods

The following satellite imageries were taken before the monsoon season, on 23 September 2011when the flooding was at its peak and, 29 October 2011 when the waters were receding.

		
Before the monsoon Season	23 September	29 October 2011

7 Institutional and Drainage Arrangements

7.1 Primary agencies concerned with water, drainage, and flood management in Sindh Province

Initially identified were the two agencies that will: i) determine the success or failure of the Reform Program begun in 1995 with enactment of the SIDA Act and ii) that are involved in operation, maintenance, and management (OM&M) of canal and drain systems and management of flood works and floods affecting the left bank area of the Indus River. Further identified were other agencies that perform project implementation and then hand over projects to Provincial Agencies for operation and maintenance.

Two agencies are responsible for operation, maintenance and management (OM&M), IPD and SIDA and its two operating units, AWBs and FOs. Two other agencies, WAPDA and DGAEWM, implement programs and projects and then turn them over to the owners.

A third group NGOs and RSPs are involved in the largely non-structural activities associated with social, economic, and cultural conditions that prevail in irrigated areas and the Delta and Coastal Zone.

Revenue, staffs and operations of IPD, SIDA, AWBS and FOs were determined through interviews with SIDA, FOs and IPD Circles and through discussions at workshops with stakeholders. Specific information was gleaned from review of public and official documents, in particular, the Provincial Budget for 2010-2011.

Considerable information and perspective was gained through review of documents and reports for earlier and on-going programs including LBOD, SCARPS, NDP, SOFWM, and WSIP-1. Public records including the Provincial Budgets for IPD and SIDA, 2009-2010 and 2010-2011, were analyzed to assess personnel and mechanized capacities for maintenance and for flood protection and remediation.

Library resources of SIDA were accessed, information for organizations and NGOs were assessed through the internet and follow up was accomplished by visits, telephone and email contact. Personnel, equipment and transport capacities and legal and financial standing of NGOs were secured for use during implementation to facilitate short listing.

Consultation methods used and stakeholder inputs to the assessment

Stake holders were contacted and consulted on institutional matters through workshops, during interviews in the countryside and by interviews of FOs and staffs of the IPD at Division and Circle levels. Individuals and NGO stakeholders generally were highly critical of the ineffectiveness of IPD and the lack of willingness of IPD operational staff to provide support to the FOs even though IPD retains control of Daroghas, Beldars and Abdars who are budgeted by the Province for transfer to SIDA.SIDA is largely unrecognized by people of the villages.

Key findings of the assessment

Revenue and budget capacity of the two primary water, drainage and flood management agencies, IPD and SIDA and associated AWBs and FOs, were assessed. It was determined that: i) they are not well organized, located, staffed and equipped (mechanized) to carry out even routine operation and maintenance functions, and ii) have few specifically allocated reserves for coping with floods and other disasters. There is no identified budget and organizational capacity of IPD is inadequate for effective conduct of O&M of the Tidal Link and LBOD. This situation will be even more critical to sustainability once rehabilitation works are accomplished under WSIP-1.

Beneficiary Drainage Groups have not been formed and consequently there is no on-going emphasis on drainage operations and management at the local level.

Authorities concerned with water, drainage, and flood management

National and provincial responsibilities are inter-related

National authorities including WAPDA are responsible for storage, transmission and distribution among provinces water of the Indus River. Also they regulate river flows during periods of high and low river discharges and flooding. Once water arrives at Guddu Barrage, IPD is responsible for: 1) diverting and delivering water into the canal systems for agricultural and Municipal and Industrial (M&I) use; 2) management and operation of tubewells and subsurface and surface drains that collect agricultural drainage effluent and storm water for discharge through branch and spinal drains for outfalls to the sea; and 3) management of the Indus River and its bunds and barrages. During floods the interaction among national and provincial agencies responsible for operations of the river, canals and barrages, and the populace of Sindh Province has been documented in tasks of this Phase I report that addresses floods and disaster management.

7.2 Two operating agencies, IPD and SIDA

Two agencies, IPD and SIDA, are responsible for operation, maintenance and management of the Indus River and its barrages and for the canal water delivery and drainage systems. During this period of Transition SIDA is functioning administratively within the Secretariat of Irrigation, Organization Chart, Figures7.1 and 7.2, and the MD SIDA reports directly to the Secretary of Irrigation as do five Chief Engineers.

However, the Water Sector Improvement Project (WSIP-I), executed by the Sindh Planning & Development Department, and implemented by SIDA, (Figure 7.3), is designed to bring about reform through transfer of operation and management functions to irrigators by beginning with transitional funding of SIDA and the AWBs. SIDA and the AWBs are to become self-managing, self-financing utility type organizations. By direction of provincial government, some 5,000 personnel of IPD and a budget approximating Rs.1.25 billion are to be transferred to SIDA and to the three AWBs -- Ghotki Feeder, Nara Canal, and Kotri Left Bank. IPD has not, however, transferred personnel and budgets to SIDA.

Personnel to be transferred have two functions, management of the canal divisions and those who manage TW and surface drainage systems including LBOD. For 2010-2011 there were no construction or maintenance funds in the budgets for canals and drains. However, the drainage divisions are budgeted Rs. 124 million for civil works during 2009-2010. Offices expenses for the three drainage divisions are barely enough to pay for electricity.

Table 7. 1: Summary – Staffing And Budget of IPD Left Bank 2010-2011

Divisions / Circles	Unit	Officers		Other Staff					Allowances (Rs)	Office Expenses (Rs)	Civil Works (Rs)	Total (Rs)	Total Staff
IPD Secretariat Director Regulations	Sum - Budget (Rs)	1,698,300		3,048,100					5,477,200	104,250,200		**114,473,800**	**43**
	Sum - Staff (No.)	**E**	**TH**	**T**	**C**	**JT**	**SK**	**L**					
		2	5	9	9	4	2	12					
MD SIDA Hyderabad	Sum - Budget (Rs)	2,451,100		4,424,400					10,274,500	4,815,000		**21,965,000**	**47**
	Sum - Staff (No.)	4	3	15	8	0	3	14					
Chief Engr. Sukkur, Left	Sum - Budget (Rs)	4,087,400		8,685,300					9,777,200	2,351,100		**24,901,000**	**110**
	Sum - Staff (No.)	2	13	31	34	7	4	19					
Ghotki Feeder Canal & AWB	Sum - Budget (Rs)	2,461,400		36,894,800					26,718,600	2,760,500		**68,835,300**	**427**
	Sum - Staff (No.)	2	8	17	27	49	49	275					
NARA Canal & AWB Mirpurkhas (Grant-In-Aid)	Sum - Budget (Rs)	9,030,200		173,544,100					160,967,900	176,876,600		**520,418,800**	**2,485**
	Sum - Staff (No.)	3	31	73	97	236	651	1394					
Rohri Canal Nusrat Benazirabad	Sum - Budget (Rs)	8,400,900		108,779,100					108,177,900	19,695,300		**245,053,200**	**1,559**
XEN Hala Irrigation Hala Sakro MirpurSakro	Sum - Staff (No.)	4	28	60	93	205	196	973					
Chief Engr. Kotri Hydraulics Lab Hyderabad	Sum - Budget (Rs)	5,991,700		36,247,200					31,164,600	59,183,700		**132,587,200**	**400**
	Sum - Staff (No.)	4	18	49	52	35	76	166					
Upper Pinyari T. M. Khan @ Hyd	Sum - Budget (Rs)	6,888,000		148,649,600					119,900,000	6,935,300		**282,372,900**	**1,777**

Table 7. 1: Summary – Staffing And Budget of IPD Left Bank 2010-2011

Divisions / Circles	Unit	Officers			Other Staff				Allowances (Rs)	Office Expenses (Rs)	Civil Works (Rs)	Total (Rs)	Total Staff
Feeder Hyderabad Lower Pinyari Sajawal Pinyari Hyderabad	Sum - Staff (No.)	4	22	48	160	207	360	976					
Left Bank Badin AkramWah Badin Guni Canal Badin Fuleli Canal Badin	Sum - Budget (Rs)	13,195,600			228,745,800				171,085,500	77,591,000		**490,617,900**	**1,228**
	Sum - Staff (No.)	4	22	50	83	193	222	654					
Thatta Drainage Lower Sindh Drainage Drainage Tando Mohd Khan	Sum - Budget (Rs)	9,530,700			115,504,200				92,764,400	8,903,000		**226,702,300**	**885**
	Sum - Staff (No.)	3	17	60	49	50	121	585					
Total (Rs)		**57,743,600**			**828,275,400**				**705,143,200**	**404,178,000**		**1,995,340,200**	**8,961**
Total Staff (No.)		**32**	**167**	**412**	**612**	**986**	**1,684**	**5,068**					

Source: Budget 2010-2011, Finance Department Govt. of Sindh

Foot notes:

E/ BPS: 18-20 = MD, PD, GM, CE, SE, XEN;
TH / BPS: 16-17 = TECHNICAL HEADS, AE, AXEN, SUPERINTEDENT, HEAD CLERK;
T/BPS: 10-14 = TECHNICIANS, DRAFTSMEN, PHOTOGRAPHER;
C/BPS: 6-9 = CLERKS, PA, ASST;
JT/ BPS: 5 = JUNIOR TECHNICIANS;
SK /BPS: 2-4 = SKILLED CRAFTSMEN;L /BPS: 1 = LABOR;

Table 7. 2: Summary – Staffing and Budget of IPD Earmarked For SIDA and AWBS 2010 – 2011 (Except Land Reclamation)

Summary Report, Regional Master Plan Phase – I

Div/Circles	Staff / Budget	Officers		Other Staff					Allowances (Rs)	Office Expenses (Rs)	Civil Work (Rs)	Total	Total Staff
MD SID Hyderabad (Grant-in-Aid)	Budget (Rs)	2,451,100		4,424,400									47
	Category	E	TH	T	C	JT	SK	L					
	Staff (No)	4	3	15	8	0	3	14	10, 274, 500	4,815,000	-	21,965,000	
NARA Canal & AWB Mirpurkhas (Grant-in-Aid)	Budget (Rs)	9,917,700		174,839,9000									2, 505
	Staff (No)	4	33	76	103	237	651	1401	163,047,700	177,545,200		525,350,500	
Ghotki Feeder Canal & AWB Sukkur	Budget (Rs)	2,461,400		36,894,800									421
	Staff (No)	2	8	17	27	49	49	269	26,718,600	2,760,500		68,835,300	
Left Bank Canal & AWB, Badin	Budget (Rs)	6,202,900		106,9111,3000									1, 345
	Staff (No)	4	22	93	157	193	222	654	93,267,000	40,054,200		246,435,400	
Total (Rs)		**21,033,100**		**323,070,400**					**293,037,800**	**225,174,900**		**862,586,200**	
Total Staff (No)		**14**	**66**	**201**	**295**	**479**	**925**	**2,338**					**4,318**

Source: Budget 2010-2011, Finance Department Govt. of Sindh

Foot notes:

E/ BPS: 18-20 = MD, PD, GM, CE, SE, XEN;
TH / BPS: 16-17 = TECHNICAL HEADS, AE, AXEN, SUPERINTEDENT, HEAD CLERK;

T / BPS: 10-14 = TECHNICIANS, DRAFTSMEN, PHOTOGRAPHER;
C / BPS: 6-9 = CLERKS, PA, ASST;
JT/ BPS: 5 = JUNIOR TECHNICIANS;
SK / BPS: 2-4 = SKILLED CRAFTSMEN;
L / BPS: 1 = LABOR;

Table 7. 3: SIDA Allocated Budgets 2010-2011, Drainage Divisions, For Land Reclamation

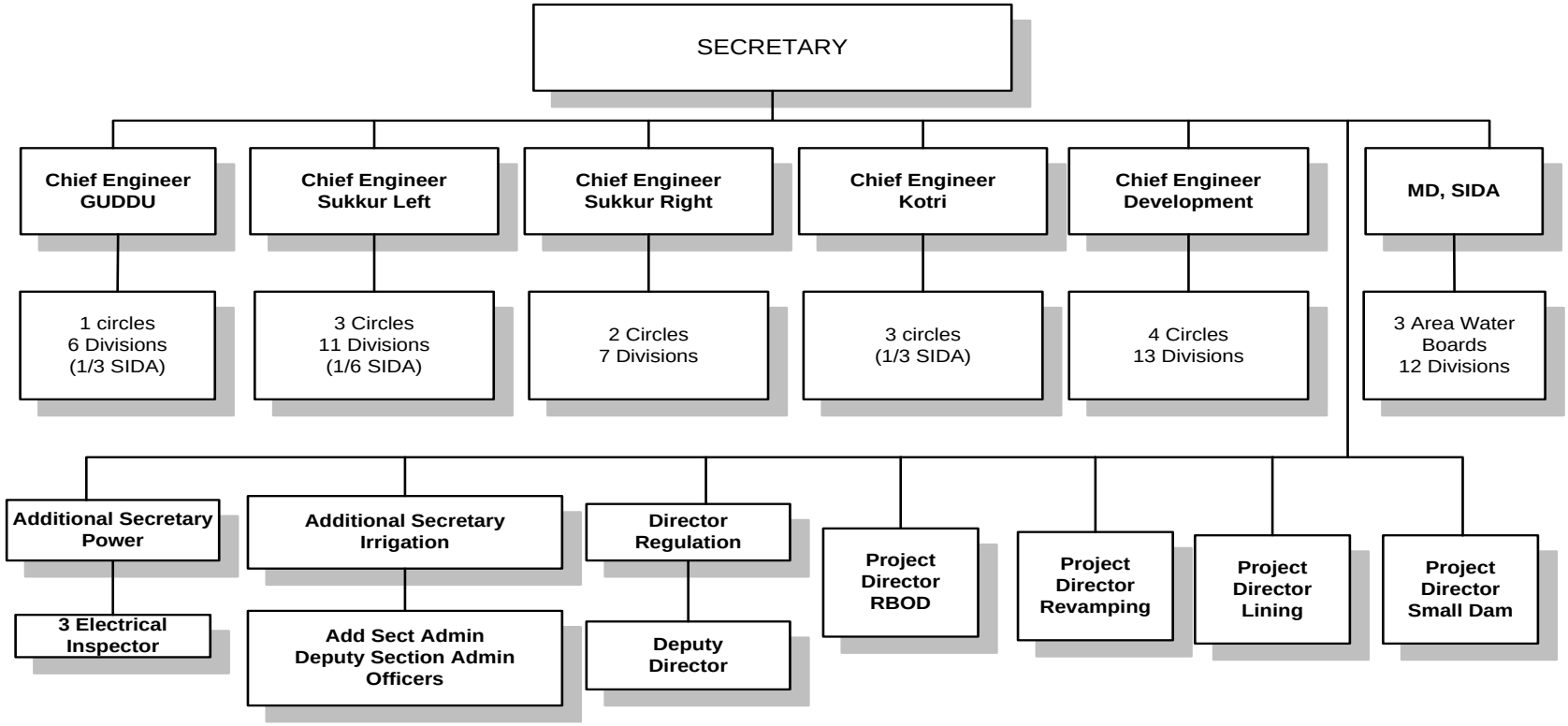
Unit	Name	Officers (Note 01)		Other Staff (Note 02)					Allowances (Rs)	Office Expenses (Rs)	Civil Works (Rs)	Total (Rs)	Total Staff
DIV	Drainage Div (LBOD) Benazirabad (SIDA)	E	TH	T	C	JT	SK	L					
No	Staffing	1	4	12	15	80	59	239					410
Rs	Budget 2010-2011	2,009,900		28,197,900					23,716,800	87,127,900		141,052,500	
DIV	Drainage DivSanghar (SIDA)												
No	Staffing	1	6	17	24	5	33	15					101
Rs	Budget 2010-2011	1,730,100		7,761,500					6,941,800	185,167,500		201,600,900	
DIV	Drainage DIV. Mirpurkhas (SIDA)												359
No	Staffing	1	5	22	21	13	61	236					
Rs	Budget 2010-2011	1,502,900		25,465,000					16,994,400	24,082,400		68,044,700	
Rs	Sum – Budget (Rs)	5,242,900		61,424,400					47,653,000	296,377,800		410,698,100	
No	Sum – Staff	3	15	51	60	98	153	490					870

Source: Budget 2010-2011, Finance Department Govt. of Sindh

Note 01:
E = ENGINEER, CE, SE and XEN (BPS: 18-20);
TH = TECHNICAL HEADS, AE, AXEN, SUPERINTEDENT, HEAD CLERK (BPS: 16-17);

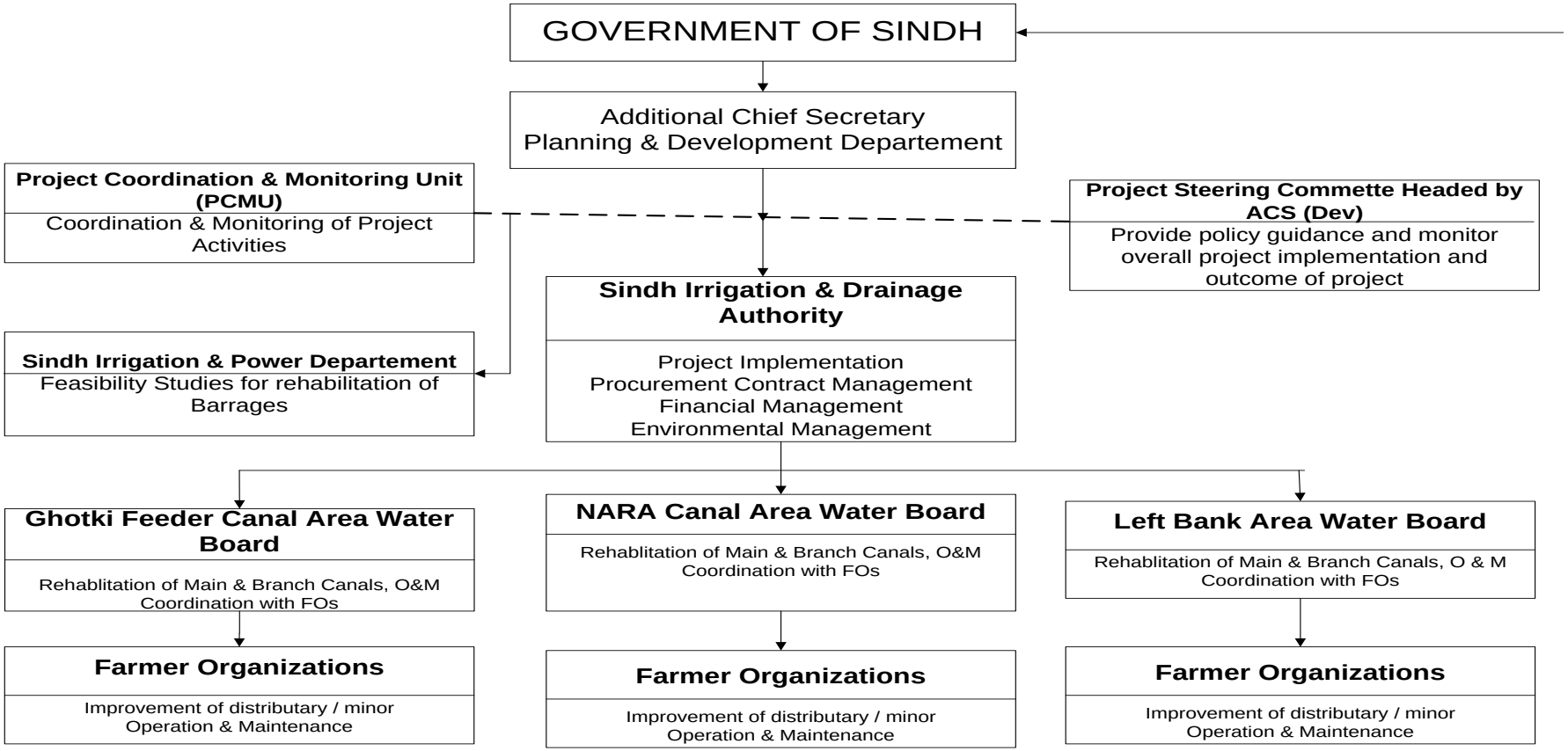
Note 02:
T = TECHNICIANS, DRAFTSMEN, PHOTOGRAPHER (BPS: 10-14);
C = CLERKS, PA, ASST (BPS: 6-9);
JT = JUNIOR TECHNICIANS (BPS: 5);
SK = SKILLED CRAFTSMEN (BPS: 2-4);
L = LABOR (BPS: 1);

Figure 7. 1: Organizational Chart of Irrigation & Power Department, Sindh



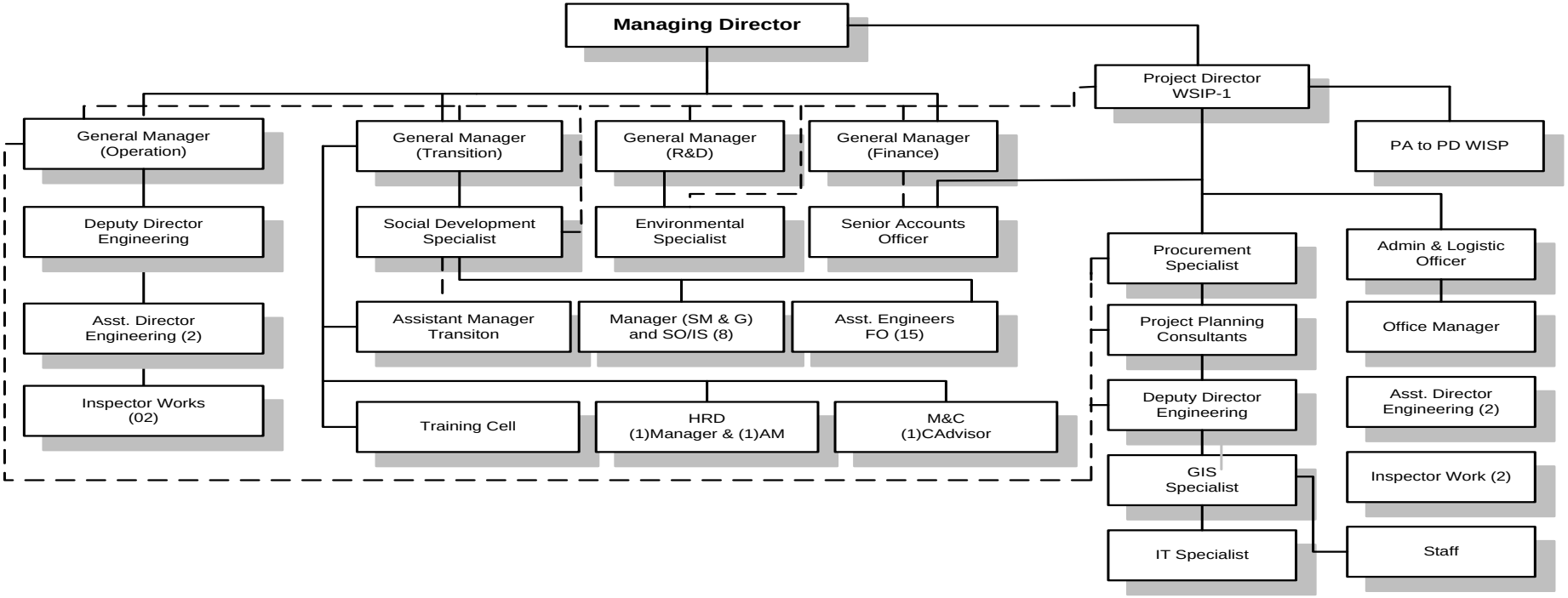
Source: IPD, Official website

Figure 7. 2: Functional Relationships within Sindh Water Sector Improvement Project (WISP –I)



Source: 12th Meeting, Project steering Committee, 22 Oct 2010

Figure 7. 3: Sindh Water Sector Improvement Project Organogram, SIDA Headquarters



7.3 Non-Operating Agencies with Responsibilities for Program Implementation, DGAEWM, WAPDA and NGOs

Directorate of Agricultural Engineering and Water Management (DGAEWM)

Below the *Moghas* where IPD is not engaged, the Directorate General of Agricultural DGAEWM is administering programs of watercourse upgrade and associated extension service. Currently DGAEWM is managing an IDA credit of $50 million for extension of the Sindh on Farm Water Management Project (SOFWMP)[20]. Of the 42,000 water courses in Sindh some 17,000 watercourses had been improved between 2005 and 2009 under the National Program for Improvement of Watercourses (NPIW)[21]. It is expected that 2,500 additional watercourses will be improved as a component of the current credit extension. Additionally, there will be increased emphasis for, "enhancing the long-term financial sustainability of the irrigation system by fostering self-sustaining farmer organizations – Watercourse Associations *(WCAs)* – at the watercourse levels".

Watercourse Associations are active in areas administered by FOs and in areas that remain with IPD. Thus the programs for watercourse improvements are vital both to success of the Reform Program of SIDA and to upgrading of water use efficiency in areas administered by IPD.

Water and Power Development Authority WAPDA

WAPDA, a national organization, has been responsible for large provincial infrastructure developments, including SCARPs and LBOD on the left bank of the Indus River, but it has no operational role in water management and drainage of agricultural areas. Beyond water and drainage operations and management, however, WAPDA is a key organization for the management of floods of the Indus River and other disasters since it has operational authority at dams and has active offices in Sindh and the other provinces.

NGOs for Implementation

Use of the term NGOs herein includes both NGOs and GONGOs (government organized NGOs). They are well suited to partner for the conduct of economic, social and environmental elements of the Regional Master Plan at district, Taluka, village and household levels. Generally, a number of NGOs are promoting and executing programs that have an objective of sustainable community development for achieving equitable economic, social, political, and cultural development. Twelve listed NGOshave submitted information and have ongoing programs. They are staffed and equipped to carry out education, training and organization of local persons and communities.

7.4 Organizational Review, Resources and Capacity

During the 1980s the Government of Pakistan recognized that the rapidly expanding systems for delivery of irrigation water and for drainage of irrigated lands could not be maintained by institutions that were organized to administer simple canal systems that originally delivered a low duty of water. Problems of water logging and salinity and the need for costly drainage works intensified after partition because water supply was greatly increased with the construction of river reservoirs and installation of large numbers of tubewells.

[20]Project information Document (PID), Appraisal Stage, Report No: AB4779, "Additional Financing for Sindh On-Farm water Management", PID, prepared May 7, 2009 Directorate General, Agriculture Engineering and water Management, Department of Agriculture

[21]Sindh On-Farm Water Management Project (SOFWMP) Project, Monitoring and Evaluation (M&E) Consultants, 2009

The Ministry of Water and Power and the World Bank stimulated the central government to adopt, in the mid1990s, an institutional program of reform, based on participatory irrigation management (PIM), that would lead to decentralization through participation and transfer of water management from bureaucracies to self-sustaining utility like entities. The National Drainage Program of 1995 was framed to promote institutional reform within each province with the intent of converting the Provincial Irrigation and Power Departments (IPDs) into Provincial Irrigation and Drainage Authorities (PIDAs) that would manage intra-provincial bulk water transfers at the heads of main canals and manage main drains. Self-governing, self-financing Area Water Boards (AWBs) were to transmit water along main and branch canals to distributaries and minors where the water would be delivered to the Farmer Organizations (FOs) that would deliver water to watercourses and recover costs of operation and maintenance through collection and retention of the Abiana (water user charge).

Revenue and budget capacity of the two primary water, drainage and flood management agencies, IPD and SIDA and associated AWBs and FOs, were assessed. It was determined that: 1) they are not well organized, located, staffed and equipped (mechanized) to carry out even routine operation and maintenance functions, and 2) have few specifically allocated reserves for coping with floods and other disasters. There is no identified budget and organizational capacity of IPD is inadequate for effective conduct of O&M of the Tidal Link and LBOD. This situation will be even more critical to sustainability once rehabilitation works are accomplished under WSIP-1.

Beneficiary Drainage Groups have not been formed and consequently there is no ongoing emphasis on drainage operations and management at the local level.

7.5 Resources and Technical Capacity

A: Irrigation Sector Issues

Technical

- Low operational efficiency of Cross-regulators on main and branch Canals.
- Safety of Barrages in view of super Floods passing capacity and operational efficiency in view of the sedimentation on up-stream side of the barrage, centralization of flow and other problems.
- Low water availability at tails.
- Operation of the system with more discharges than design capacities.
- In-equitable distribution of water.
- Low water use efficiency.
- Excessive use of water in upper command of channels as compared to lower command (tail areas).
- Direct outlets withdrawing water more than entitlement thereby increasing Water shortage problems in the system.
- Waste full on-farm water use.
- Illegal withdrawal of irrigation water by influential people.
- Low delivery efficiency.
- Tampering of modules

Management

- Institutional weakness, exclusive control of public sector in irrigation management.
- Lack of corporate skills and lack of accountability system.
- Indiscipline in administrative set up of agencies responsible for operation of the system.

- Non-compliance of rules/ duties by operators of system as per O&M manual.
- Less involvement of the farmers in the management and Operation of the water systems.
- Less Budget release for operation maintains of the system.

Fiscal

- Less recovery of water charges due to poorly managed recovery system.
- Non-release of funds for development schemes

B: Drainage Sector Issues

Technical

- Out of 5338 tube wells in Study area 1931 (36.17%) are non-operational.
- Deferred Operation and Maintenance of Tubewells and other infrastructure.
- Theft of transformers and 11 KVA line conductors.
- Frequent brake down of electric power supply affecting operational efficiency of tube wells.
- Intrusion of Saline ground water into fresh ground water aquifers due to over exploitation of fresh water or less pumpage from adjoining saline ground water areas.
- Intrusion of Saline drainage effluent from SCARP VI project into Ghotki area.
- Poor O&M of Surface Drains.
- Weed problem in surface Drains.
- Out fall of canal escapes into LBOD system.
- Issues/ problems in LBOD Outfall System.
- Water logging and salinity problem in study area including the areas where drainage has not been yet provided. (Planned project areas under LBOD Stage II).
- Water logging problems in the vicinity of Chotiari Reservoir.

Management

- Institutional weakness, lack of corporate skills and lack of accountability system.
- In-discipline in administrative setup of agencies responsible for Operation and Maintenance of Drainage Systems.
- Less involvement of beneficiaries/ Stakeholders in planning, implementation and Operation and Maintenance of Drainage Systems.
- Lack of Coordination among various government agencies.

Fiscal

- Insufficient budgetary provision by Government for Operation, Maintenance and replacement of closed components of the projects.
- Gap between O&M funds requirement and cost recovery

7.5.1 Provincial Irrigation Department

Sindh IPD, as depicted on figure 7.1, operates three barrages, Guddu, Sukkur, and Kotri, and Main and Branch canal systems under the supervision of four Chief Engineers (CEs). Additionally, the CE Development has responsibility for 4 Circles and 13 Divisions and his portfolio includes administration of the Reclamation Budget as distinguished from the Circles that are dedicated to operation and management of canals. Three of the 13 Divisions manage tubewells and horizontal drainage systems; their budgets have been assigned to SIDA as tabulated in Table 7.3. Although, Rs. 125 million was allocated to these divisions for civil works in the budget year 2009-2010[30], there is no budget for maintenance and upkeep allocated in 2010-2011, likely due to stringency measures being imposed by the International Monetary Fund. This impacts tubewells more than any immediate

effects on canal systems that result from program cuts. Some 40% to 60% of tubewells are "dead lined", some due to theft and vandalization, and others for lack of spare parts.

Staff of the IPD that manage canals on the left bank of the Indus River and in the Secretariat at Karachi total 8,961 Table 7.1. Additionally IPD, Left Bank includes three drainage divisions, with staffs numbering 870 that deal with public sector tubewells and horizontal drainage including LBOD. Nearly 60% of the IPD staff for left bank canal and drainage systems are budgeted as SIDA, yet after 10 years they still are controlled by IPD. At Distributaries within the jurisdiction of the AWBs, FOs are struggling to manage delivery of water to watercourses. Local water users, FO office bearers and staffs and NGOs report that IPD personnel often obstruct operations of the FOs by not providing timely assistance during canal breaches and by arbitrary restrictions on water deliveries.

The following observations and findings regarding IPD were identified during the review of the organization and staffing of IPD and as collected during more than 4,000 interviews by the social, environmental and economics teams of LBG/Indus.

1. Table 7.4 lists units of IPD that that have dedicated budgets for maintenance of machinery and to carry out bund upkeep, desilting and other maintenance operations at barrages and along the bunds. The combined budget totals about Rs.310 million.
2. About Rs. 1.1 billion is provided for the maintenance, repair and desilting of the Main, and Feeder Canals of the Left Bank, Table 7.5. These funds are assigned to specific canals in amounts varying from Rs 4.3 million to Rs. 55.9 million, presumably for "force account" or in-house work.
3. There is little to no budget for conduct of routine Preventative Maintenance in the budgets of operating Divisions. Budgets for each Division and unit lack monies for POL, vehicle and tool purchases and repairs, Tables 71, 2, and 3. Table 7.3 identifies that about Rs 296 million is available as Office Expenses. Most of these funds are for payment of electricity charges for tubewells and pumps.
4. Repairs to bunds breached during the flood of 2010 have generally been delayed until special budgets for consultants and construction companies could be authorized and provided.
5. Although IPD is the only organization in Sindh that has personnel and apparent capacity to manage delivery of water, budgets of canal divisions and circles lack resources other than for personnel, allowances and routine office expenses. Thus, as noted in 3 above, maintenance languishes and deferred maintenance grows progressively worse until there is need for replacement and rehabilitation system wide.
6. Assigned resources and personnel are inadequate to maintain the LBOD system.

The following observations and findings regarding IPD were compiled during the above noted review of the organization and staffing of IPD and primarily as collected during more than 4,000 interviews by the social, environmental and economics teams.

1. Stakeholders are divided, some recognize benefits of LBOD, i.e. shorter periods of inundation after storms and as an outlet for discharge of saline groundwater and agricultural drainage; while other stakeholders are negative, especially with respect to the quality (often poisoned by industry and agricultural pesticides and fertilizers) of the drain water which often is the only available water supply.
2. Villagers draw water from wells by hand pumps and from irrigation canals and ponds, when these sources are available.
3. Irrigation water is in short supply.
4. Adequate water is not released downstream of Kotri to "push back the sea".
5. Water logging and salinization of agricultural lands is spreading.

6. Health problems result from poor quality drain water.
7. Women are acutely affected by poor water quality and the resulting decline of livestock which they attend. Numbers of livestock have declined across the region, and particularly in flood prone areas, due to lack of fodder and other pressures.
8. Fish cannot survive the changed environment due to water pollution.
9. Sugar Mills are primarily responsible for the LBOD and other drain channels becoming toxic during periods of low runoff; there were repeated demands that sugar mills be forced to stop discharges of processing water to drains.
10. Communities consulted generally held the view that Farmer Organizations (FOs) are dysfunctional. Observations were:

FO's do not have enough power to ensure a proper share of water for their communities,

- Powerful local individuals and "*waderas*" control the work of the FOs to the detriment of the rest of local people.
- A majority of the stakeholders and communities consulted believe that IPD staff is corrupt and they sell water first to the rich and powerful.
- There is malpractice by powerful landlords in the majority of the villages where consultations were held.
- The IPD does NOT maintain the irrigation system regularly and properly, funds that are available are mismanaged.
- Development Committees should be formed among local communities for monitoring of projects to help assure that bureaucracy and corruption do not dominate.

11. Villagers surveyed with respect to recent catastrophic floods hold views that are relevant to institutional reform:

- Government response was too little, too late.
- Displaced communities lost homes, crops livestock and jobs.
- A system for early warning is non-existent or ineffective.
- Government provided rations were insufficient.
- No fodder was provided for surviving livestock.
- Procedure for issuance of Watan Cards was ineffective and often a source of harassment in that flood victims repeatedly traveled to issuing offices and were day-after-day told to return tomorrow.
- Communities ask that Government prepare a complete plan for relief and rehabilitation of flood affected villages including replenishment of livestock.
- Stakeholders want strengthening of river banks and bunds through tree planting, construction of rain and flood channels, clearing of "katcha" areas and ***better management and coordination among responsible government departments and agencies.***

7.5.2 Sindh Irrigation and Drainage Authority

The Sindh Irrigation and Drainage Authority (SIDA), Figure 7.3, was initially established under the SIDA Act of 1997 and the program of reform was further defined in the Sindh Water Management Ordinance (SWMO) 2002, as amended in 2005. SIDA is authorized and planned to be a semi-governmental utility. It also is an umbrella organization for formation and nurturing of Area

Water Boards (AWBs). AWBs are designed to be independent utilities for administration and management of Main and Branch Canals that deliver and ultimately will sell water to Farmer Organizations (FOs). FOs are small utilities that have been designed, chartered and formed for operation, maintenance and management of distributaries and minor canals that deliver water to watercourses and collect water charges (Abiana) from farmers.

SIDA is receiving considerable financial support, during an as yet undefined Transition Period, through: 1) Grants-in-Aid 2) pass through financing of components of the Sindh Water Sector Improvement Program, WSIP-1, and 3) allocations of the Provincial Budget. Both SIDA and the AWBs currently receive budgetary support through Provincial allocations to IPD[31], as tabulated in Table 7.2 entitled "Staffing and Budget of IPD Earmarked for SIDA 2010-2011" and Table 7.3 sub-titled, "Drainage Divisions for Land Reclamation". The two tables show that SIDA and the AWBs have allocated budgets that total about Rs.1.3 billion for staffs of 4,181 for canal divisions and additional staff of 870 in three divisions of the Reclamation group of the CE Development.

Staff budgeted for headquarters in Hyderabad, total 47 including the Managing Director (MD), Project Director (PD), and four General Managers (GMs). Directors of AWBs have been appointed under WSIP. Upper level managers are directly supported by 41 specialists at Headquarters and indirectly by the Directors of the AWBs who are former SE (Nara) and XENs (Ghotki and LB Kotri). IPD personnel who operate canal systems in the name of the AWBs remain under the administrative control of IPD and range from Directors (SE and XENs) to support staff (Daroghas and Beldars) and *Abiana* collectors (*Abdars*). It is significant that the AWBs are tightly under the control of the Directors at the top and that FOs have no control over Abdars who are key for the collection of water charges and Daroghas and Beldars for the maintenance of the Distributaries and Minor canals. Also FOs have little to no input to gate operations at the points of diversion from the Branch Canals to Distributaries.

The distribution of the budget among Officers, Other Staff, Allowances, Office Expenses and Civil Works (WSIP-1 funds) is summarized in Table 4.8.2. There is no budget allocation for Civil Works in 2010-2011; there was a small allocation in 2009-2010 totaling about Rs. 58 million. This amount illustrates the severe lack of funds in the budget for other than personnel, allowances, and office expenses. Monies are not allocated or are miniscule in these line items of the Provincial Budget for POL, transport, preventative maintenance or for rehabilitation of facilities considering the backlog of deferred maintenance.

The Nara Canal AWB (NCAWB) was formed in 1999 and the Ghotki Feeder Canal AWB (GFAWB) and Kotri left Bank Canals AWB (LBCAWB) were inaugurated in 2001. No additional AWBs have been formed subsequently due to the slow pace of reform implementation. However by 2010, 354 of 383 potential FOs had been registered.

It is significant that operating budgets for SIDA and AWBs are earmarked in the "Government of Sindh Finance Department Budget of 2010-2011". The budgets of the Managing Director and for the Nara AWB and the XEN Nara Canal are detailed on pp 631 to 643 of the Provincial Budget as Grants-in-Aid. Whereas budgets for the Ghotki Feeder Canal Circle and for the Left Bank Circle, Badin and for three left bank divisions, Fuleli, Akram Wah, and Guni, are specified as normal IPD budgets, not as grants-in-aid. MD SIDA also has a budget for Operation and Maintenance which provides for minor works in the jurisdictions of each of the three AWBs. Former Superintending Engineers or XENs of IPD have been re-designated as Directors of the AWBs and they manage, through XENs and AXENs, the traditional divisions of IPD that now operate with budgets earmarked by the Finance Department as agencies of SIDA. The management by traditional IPD staffs and procedures still prevail down to the jurisdictions of the FOs. Thus there are tensions that result from stakeholder complaints about the lack of cooperation or even obstruction by IPD staff at distributaries and minors.

SIDA and AWB operations benefit from funding through the Water Sector Improvement Programme, WSIP-I. Administration of that program under P&D and as guided by the Steering Committee is as shown in Figure 7.2.

The audited income of SIDA in 2009 (The Sindh Irrigation and Drainage Authority, Financial Statements for the Year Ended June 30, 2009, A. F. Ferguson & Co., Chartered Accountants, Karachi, transmitted to SIDA January 31, 2010.) was grants that totaled Rs 14.7 million. This was the same as was allocated in the Provincial Budget of 2009-2010.The audit report shows that Rs. 4.8 Million was expended for projects and Rs. 9.9 Million was non-operational expenditure used to pay salaries, office and travel expenses. This total dependence on grants needs to be reexamined after a decade long period of Transition. Of even more dire concern is the situation with the AWBs who, in theory, have budgets totaling more than one billion rupees but are totally controlled by IPD personnel appointed to direct the AWBs and to administer all the circles and divisions of the three systems.

7.6 Abiana, Funding Requirement Incidence and Repayment Capacity

Revenue, funding requirement incidence and budget capacity of the two primary water, drainage and flood management agencies, IPD and SIDA and associated AWBs and FOs, were assessed. The information collected is presented in tables 7.1 to 7.7 these contain:

- IPD and SIDA staffing and budget Left Bank
- SIDA allocated budgets
- Budget allocated for upkeep of equipment, machinery
- Budget allocated for maintenance & rehabilitation of main and feeder canals and lift irrigation & silt clearance
- Number of staff
- Income and expenditure account

The analysis regarding funding determined that:

i. PID and SIDA are not well organized, located, staffed and equipped (mechanized) to carry out even routine operation and maintenance functions and;

ii. PID and SIDA have few specifically allocated reserves for coping with floods and other disasters. There is no identified budget and organizational capacity of IPD is inadequate for effective conduct of O&M of the Tidal Link and LBOD. This situation will be even more critical to sustainability once rehabilitation works are accomplished under WSIP-1.

The examination of the data collected and presented in the tables on the present chapter, clearly indicate that there is no financial muscle for accomplishment of drainage and flood management in the irrigated areas and along the LBOD. Sustainable entities likely can be made functional only after IPD and SIDA functions are rationalized and fully implemented such that users pay a fair share for drain and river works and operations. It is only with financial muscle that organizations can become sustainable. Otherwise government bureaucrats who set budgets have little sympathy for budgetary needs and resulting budgets are modified to suit political rather than business goals. The management of floods is the business of the Nation and the Province, therefore direct identified users of agriculture and industry should be required to pay only a part of total costs.

The variables that conform the institutional aspects and activities of PID and SIDA clearly depend on the availability of funding. Specific comments about the different parameters and the relationship with funding are made:

- *Abiana* is the primary revenue collected by the FOs. It is not adequate to operate and maintain distributaries and minors. By law sixty percent of the *Abiana* collected by FOs is passed to AWBs. Sixty percent also is inadequate for O&M of the Main and Branch Canals. *Abiana* is crop and acreage based and does not encourage efficient water use. This is a major impediment to reform and achievement of water use efficiencies and consequent potential increase of National income. Of equal importance to shortfalls of revenue collection is that the *Abiana* system of crop acreage assessment and adjustments for yields lends itself to broad

interpretation and reduced payments. There is an urgent need to rationalize the collection of a water fee.

Although SIDA is making a maximum effort to collect *Abiana* through expansion of the *Abdar* staff and is conducting intensive programs of training, the collection of *Abiana* likely will continue to fall far short of OM&M needs.

Revenue being derived from Abiana is inadequate for OM&M for canal systems of FOs and AWBs.

- IPD is not carrying out routine maintenance and has only a limited program of reconstruction and rehabilitation that is constrained by inadequate budgetary allocations. A well-organized program of Preventative (routine) Maintenance requires that a complete inventory be made of each structure and its hardware, of each canal and drain reach, by sections of road and for cross drainage structures, buildings and other infrastructure. Frequency of each level of inspection for each structure is determined and work tasks are issued daily to mobile teams whose vehicles are equipped with tools and stores for on-the spot maintenance. Major problems are written up and repairs are made by "Force Account" involving in-house staff or by subcontracting.

  Review of the budgets of Table 7.1 illustrates the severe lack of funds in the budget for other than personnel, allowances, and office expenses. Monies are not allocated or are miniscule in these line items of the Provincial Budget for POL, transport, preventative maintenance or for rehabilitation of facilities considering the backlog of deferred maintenance.

  IPD is a bureaucratic organization that has lost much of its capacity to perform because of inertia and reluctance to self-examine and innovate. Perhaps the most serious of the problems of the Department is that the Divisions are not staffed, Table 7.6, or equipped to carry out routine every day maintenance, and compounds and offices are sited as they were decades earlier when needs were different.

  IPD is not organized, equipped, and staffed to carry out a routine program of maintenance

  Neither SIDA nor IPD has organization, staff, or budget to manage rehabilitation, operation, and management of LBOD. It is urgent that an effective entity with financial muscle be empowered, organized and dedicated to manage a rehabilitated LBOD/DPOD/ KPOD/Tidal Link/Dhand system. This can be accomplished with consolidation and restructuring of divisions of IPD that are programmed to be passed to SIDA.

  IPD and SIDA have no operational program or staff for maintaining the LBOD

- The transformation of SIDA, AWBs and FOs into utilities began well but has been halted/ stalled due to the reluctance and active opposition to formation of utilities by IPD. The legal authority, budgetary allocations, and formation of FOs and AWBs provide the basis for early release of the administrative restraints that bind SIDA and that are preventing its development into a series of utilities. It is important at this juncture that consideration of roles appropriate to a self financing Utility and a government bureaucracy like IPD be sorted through. A utility cannot become self financing if it has to manage floods, bunds, and barrages on the Indus River. This is more appropriate to IPD which leads to a second point that needs resolution before SIDA and AWBs can become successful utilities. What are the appropriate roles for each of the two organizations, should IPD retain control and carry out maintenance of larger components of the river and canal systems while SIDA has operational input and buys and sells water, at some agreed point in the canal systems.

- Tubewells. Large numbers of tubewells are not operational mainly due to lack of funding. Tubewells are not maintained properly due to lack of funds and once they break down the motors and transformers are cannibalized. Tubewells currently are mismanaged and not functioning as needed to supply supplemental irrigation water and to provide the drainage

necessary to reduce water logging. The problem is complicated because tubewells are sited in fresh water zones, in zones where skimming is taking place and in areas where saline groundwater is discharged directly to drains.

Many public tubewells are not operational and consequently water logging and salinity are spreading.

7.7 Beneficiaries Participation in the Project and Implementation of O&M Systems

Basis of the Need of Users Participation in O&M

According to IWMI[22], Pakistan's irrigation systems are built and managed by the government and they are steadily deteriorating and performing far below users expectations. IWMI also expresses that *"… there is a great mistrust between the agency and users"*. IWMI points out the following causes of ever declining system performance and growing mistrust:

- *"Centralized irrigation bureaucracy;*
- *Under-investment;*
- *Neglect in operation and maintenance;*
- *Inequity in water distribution;*
- *Lack of information sharing;*
- *rent-seeking behavior;*
- *Lack of accountability;*
- *Disregard towards operational rules and;*
- *High level of political interference."*

To balance out the effects of some of the causes for mistrust and to enhance performance of the irrigation systems, action on three specific areas have been identified as potential solution: *i)* the participation of the beneficiaries in conceptualizing the projects; *ii)* implementation of projects and; *iii)* in the operation and maintenance of the system. A brief introduction about the participation of beneficiaries in the O&M of irrigation canals is described below and a proposal for the beneficiaries' participation in the O&M of agricultural drains is presented. The present document concentrates on the beneficiaries' participation in flooding and drainage because among the objectives of the Master/Regional Plan[23] are:"*… addressing flooding issues and providing proper drainage …"*

Background of Beneficiaries Participation in O&M

Skogerboe et al.[24] mentions that during the 70s a research program was launched by Colorado State University with the funding of the U.S. Agency for International Development in Pakistan, when numerous watercourse conveyance efficiency were measured, disclosing that the watercourse losses varied from 20 to 70% against a 10% losses assumed at that time. Skogerboe further indicates that by reconstructing the earthen watercourses, the losses could be initially reduced by 70%. However, this encouraging reduction in losses would become less effective over time, unless good maintenance practices were sustained.

Colorado State University research program showed that rebuilding a watercourse required about 45 days of hard farmers work of all the farmers in the chak (about 300 acres of land and about 50 to 75 farmers). This fact imposed the question of whether the farmers would be willing to or not to undertake this arduous work as part of their contribution of the maintenance of the system.

Skogerboe reports that an On-Farm Water Management Directorate was established in each of the Provinces of Pakistan. The U.S. Agency for International Development funded a program in 1976

[22] Mirza, Z.I., Hassan M.U., Bandaragoda, D.J. Social Mobilization and Management Transfer Guidelines for Large Canal Systems. IWMI. Lahore Oct. 2000

[23] Contract for Consultant's Services for Sindh Water Sector Improvement Project Phase-I Preparation of Regional Plan for the Left bank of Indus Delta and Coastal Zone. SIDA. Hyderabad, March 2010

[24] Skogerboe, G.V., Merkley, G.P., Rifenburg, R.F. Establishing Sustainable Farmer-Managed Irrigation Organizations. Utah State University. Logan, UT Sep. 2002

with the main aim of organizing the users on a watercourse into a water users association. The chack farmers reconstructed 90% of their katcha watercourse and brick and mortar lined the remaining 10% of the same. Following this successful intervention, the World Bank, the Asian Development Bank and the Japan International Cooperation Agency also funded the program.

Skogerboe mentions that after the initial five years the program commenced to deteriorate as the emphasis shifted more and more towards the lining of the watercourse. Skogerboe describes the situation as follows:

"Almost universally, the lining was done at the head of the watercourse to gain support from the head farmers, who had much less interest in participating as compared with farmers at the tail. At the same time, organizing the farmers was becoming a farce; instead, only a few influential farmers participated as the water users association leaders. Although this is a highly popular program throughout Pakistan, it has steadily become corrupted. First of all, many of the government staff have now entirely emphasized watercourse lining because they personally benefit from the purchase of materials in a variety of illicit ways. Secondly, the "rural elite" are capturing much of the benefits resulting from the program."

Skogerboe mentions that during 1997, the irrigation departments were reorganized into semi-autonomous Provincial Irrigation and Drainage Authorities, changing the management of irrigation canals by area water boards with government and farmer representatives, where the farmers are organized into water users' federations at each secondary canal (distributary).

Skogerboe reports that there has been opposition to this effort: *"... most of the resistance comes from Provincial Irrigation Department staff, who have always benefitted in operating the canals to maximize rent-seeking rather than agricultural productivity."*

Finally, Skogerboe concludes: *"This is an extremely hostile environment for expanding the role of farmers. First of all, any project design that includes much civil works wil almost assuredly result in extremely weak implementation of any institutional measures. Secondly, there is a serious question about having an agency with such strong vested interests in the status quo being entrusted in turning over their management responsibilities to farmers, let alone being responsible for organizing farmers."*

On-farm Drainage - OFWM

Ashraf et al.[25] indicate that the construction and management of the drainage systems has been the exclusive controlled by the public sector, that they are gradually deteriorating and performing below users expectations: *"The public sector has, however, failed to ensure proper operation and maintenance of the drainage system due to the lack of physical and financial resources*". They conclude that there is the need to include the participation of the beneficiaries in the operation and maintenance of the drainage systems: "*There is, therefore, dire need that benefitting communities should be involved to participate and share their responsibility with the government agencies*."

Ashraf mentions that at the tertiary level of the irrigation systems, improved on-farm surface drainage with the participation of beneficiaries has been effective. He further reports that with the financial support of the Asian Development Bank, in the early 90s, a pilot project for on-farm drainage was launched in Dera Ghazi khan.

According to Ashraf the project was successful. He reports the assessment of the beneficiaries' perceptions as follows:

"*As per the Final Evaluation Report of M/S Euroconsult, the first monitoring results showed that most farmers are quite happy and satisfied with the system that has been constructed and see definite*

[25] Ashraf, C.M, Mushtaq, R.Q. Participatory On-Fram Drainage for Improved Water Management and Increased Agricultural Production. Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan. IIMI. Islamabad November 5-7 1996.

improvements in the pilot area. The farmers appear to have a clear understanding of about the use of the tertiary drains and realized the importance of clearing the drains."

Beneficiaries Participation in Project Implementation and O&M Systems

According to IWMI, Pakistan does have significant experience on the participation of beneficiaries at tertiary (watercourses) level under the On-Farm Management (OFWM) and Command Water Management Projects (CWM). IWMI further enlighten the fact that the OFWM is probably the only program in Pakistan where contractors were not engaged (in the late 90s) and civil works were supervised and carried out by the farmers themselves.

Evaluations conducted during the late 90s indicated that the work conducted by the WUA was outstanding by undertaking improvements on cost sharing basis. However, IWMI warns that the viability of these organizations after renovation was questionable.

Given the fact that there is limited experience in Pakistan in the participation of beneficiaries in the operation and maintenance of drainage systems and; since the experience in the participation of farmers in the operation and maintenance of secondary irrigation systems is still evolving, the Master/Regional Plan Consultants recommend developing some experience with the O&M of field drains at on-farm water management level before moving into the beneficiaries participation on the O&M of sub-drains/branch drains (secondary drains).

Proposal for beneficiaries' participation on the O&M of field drains at on-farm level

IWMI's idea about the planning the participation of stakeholders on the O&M of irrigation systems is adapted to the requirements for field drainage. This is summarized in the following chart:

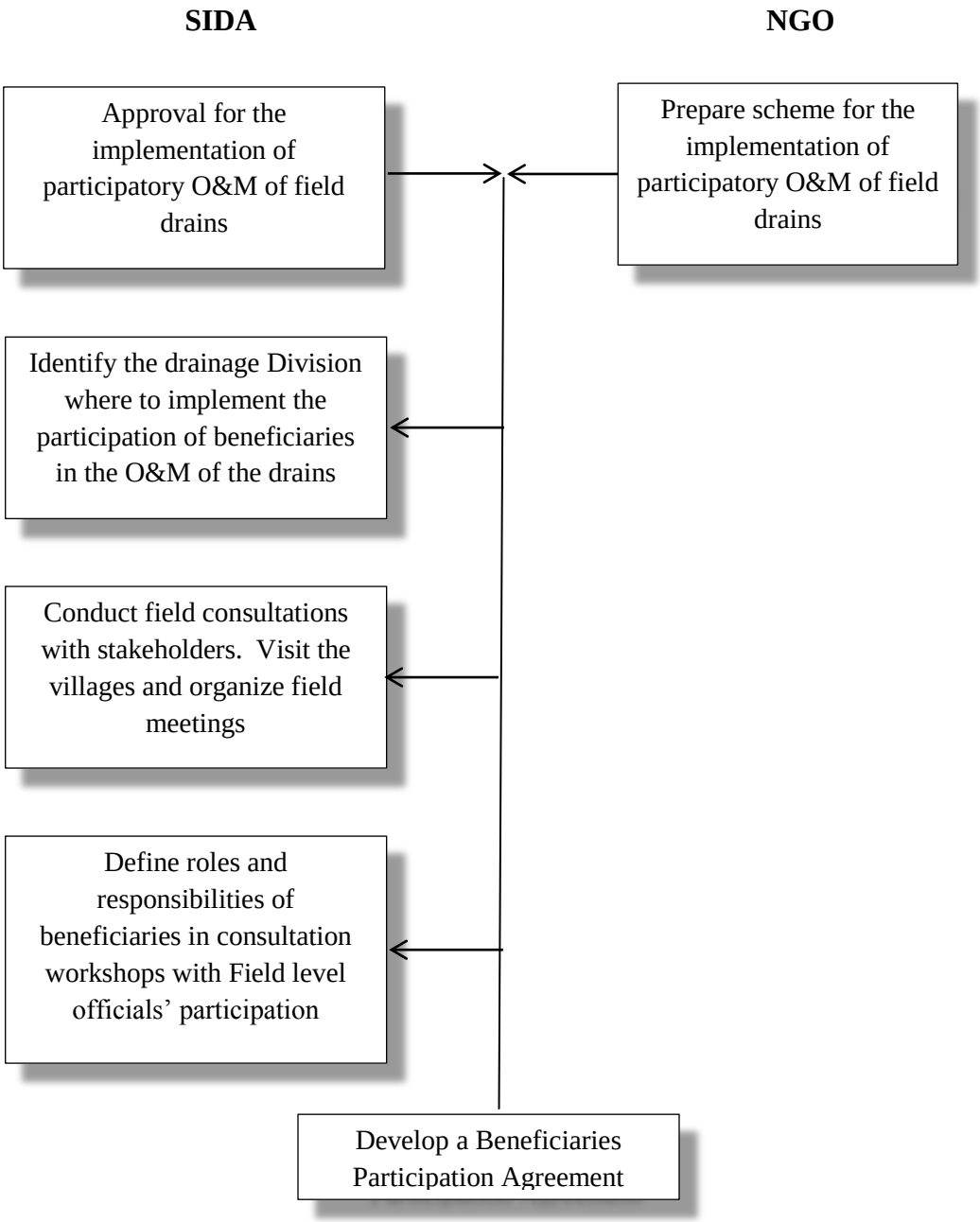


Figure 7. 4: Project Planning Process

Beneficiaries Participation Agreement

The agreement between SIDA/AWB and the drainage system beneficiaries is composed of two segments: i) development of an action plan and; ii) agreement on participation responsibilities.

Action Plan

The Action Plan activities are presented in the chart below, adapted from Skogerboe.

Beneficiaries Role	Activities	SIDA's Role
Beneficiaries' leaders participate in "Walk-Through" surveys	1. Routine Maintenance Plan Preventive maintenance 2. Operations Plan 3. Monitoring, Evaluation and Feedback Program 4. Deferred Maintenance Plan ✓Conduct the diagnostic "Walk-Through" maintenance survey ✓Prioritize deferred maintenance needs	SIDA provides training SIDA field staff participate in training and "Walk-Through" surveys SIDA develops an Action Plan

Figure 7. 5: Action plan for roles and activities

Routine maintenance

Routine maintenance activities are the normal undertakings done every year to keep the system running trouble free. It includes the preventive maintenance, which are the actions needed to solve minor problems, rather than allowing them to go unattended until the malfunctions become major problems.

Operations Plan

Plan for the operations of any type of structure that might require human intervention.

M&E and Feedback Program

A series of monitoring parameters should be identified, such as vegetative growth in the drains, sediment deposition, scouring, choking, number of acres of land benefitted, number of farmers participating in the program, etc. and it should be monitored on specific time intervals. The data collected should be transmitted to SIDA/AWB, who should evaluate the performance of the exercise.

Deferred Maintenance

Deferred maintenance has been defined as the accumulation of maintenance needs being accrued under the routine maintenance program.

Information has to be obtained from the users of the drainage systems, as they are the ones who better know the system and can express the problems they face and their opinion about possible solutions. The diagnostic "Walk-Through" maintenance survey should be conducted jointly between the beneficiaries and the SIDA/AWB field personnel.

Agreement on Participation Responsibilities

The activities of the agreement on participation responsibilities are presented in the chart below, adapted from Skogerboe.

Beneficiaries Role

Consensus by the Beneficiaries to the Action Plan

Activities

1. Responsibilities
   - ✓ Beneficiaries
   - ✓ SIDA
2. Implementation Schedule
   - ✓ Routine Maintenance
   - ✓ Operation
   - ✓ M&E and Feedback
   - ✓ Deferred Maintenance
3. Resources
   - ✓ Labor
   - ✓ Kind
   - ✓ Cash/budget
   - ✓ Equipment
   - ✓ Materials
4. Training

SIDA's Role

Commitment of resources

Provide the training needed

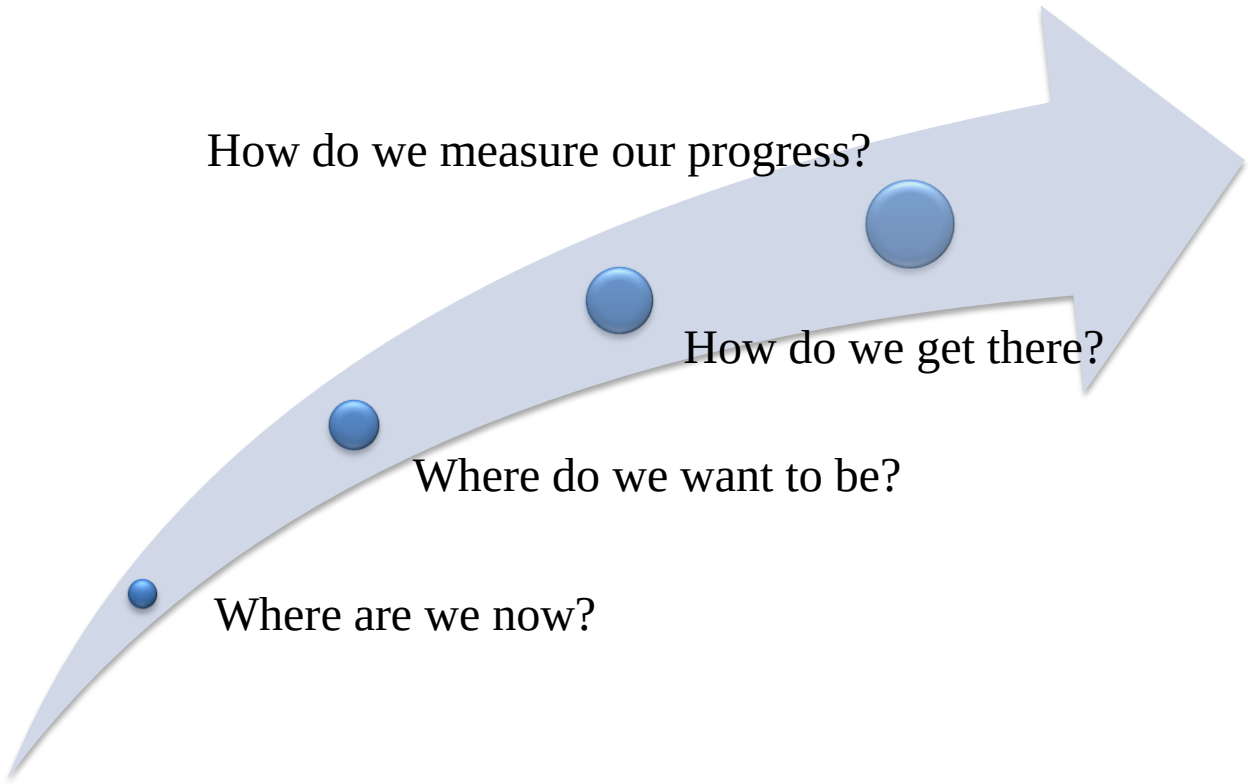
Figure 7. 6: Agreement on Participation Responsibilities

DEVELOPMENT PLAN

8 Regional Development Plan for the Left Bank of Indus

8.1 Strategy for formulation of Plan

Understanding that a Master/Regional Plan is a proposed organizational strategy of a specific territory, of a consented vision of a group of stakeholders that look at the development of the territory in the long term, the four questions recommended by the Department of Finance of California[26] State for strategic planning are adopted:



These four basic components of the strategy were started and identified by the Sindh Irrigation and Drainage Authority and the World Bank when the terms of reference and scope of work were prepared. These are:

WHERE ARE WE NOW?	**Phase – I of the Study** Inventory and assessment of existing conditions and identification of issues and problems through extensive consultations with the population, water users, and stakeholders in area.
WHERE DO WE WANT TO BE?	**Phase – II of the Study** Identification of solutions covering structural and non-structural options, and institutional and management measures and their technical

[26]Department of Finance.Strategic Planning Guidelines.State of California. May 1998

	environmental and social feasibility. This phase would also include consultations with the stakeholders in order to identify the solutions.
HOW DO WE GET THERE?	**Phases III** Preparation of detailed feasibility including technical, economic, environmental and social viability and implementation/institutional arrangement for the solutions identified under Phase II as high priority. **Phase-IV** Preparation of detailed designs and bidding documents for the most preferred solution for implementation.
HOW DO WE MEASURE OUR PROGRESS?	**M&E Plan** Implementation of a SIDA M&E Cell/Unit to monitor and evaluate the project implementation performance, mechanisms for feedback to the implementing agencies, mechanisms for ensuring that the lessons learned are accounted for, and for development of management information systems to monitor project performance effectively.

8.1.1 Proposed Regional Plan preparation Process

The four planning components previously discussed were undertaken by the Consultants in close coordination with SIDA and partner NGOs. A consultative process which emphasizes the active participation of stakeholders from each of the regions was designed and implemented. This allowed the direct participation during the process of consultations through 35 workshops, visits to 231 villages and the direct involvement of 9,077 participants. Among the stakeholders there were government officials, community leaders, villagers, representatives of different institutions and NGOs, universities and private sector.

The consultation process took place in two phases. A first phase of diagnosis, in which the stakeholders defined the fundamental issues, and problems they have to face in their daily lives and a second phase, in which the stakeholders were consulted again to validate the proposed strategies and determined the priority of each of the actions. With the interactive sessions with the stakeholders, high priority interventions were identified, thus building from a systemic approach achieving participatory

consensus facilitated the Consultants to formulate the proposed Master/Regional plan strategy. Figure 8.1 below presents the different activities conducted in the preparation of the plan.

8.1.2 Proposed Regional Plan Strategy

As guided by the scope of work and terms of reference for the regional plan study for the left bank of Indus, delta, and coastal areas, the Consultants propose a following strategy to combat waterlogging and salinity and to ensure safe and timely disposal of drainage effluent, and storm water into the sea and or natural depressions in the Thar desert.

Since last three decades, consequent to extreme weather changes, localized and widespread riverine and storm water flooding has frequented the province of Sindh. The unprecedented rains experienced in the year 2011 exposed the inadequacy and inability of the drainage infrastructure to cope with the massive runoffs. This resulted in loss of life, substantial damage to urban and rural property and infrastructure, public utilities and colossal loss of agricultural crops and lands. The main causes were simultaneous heavy rains in most of the drainage basins, deferred maintenance of the drainage network, encroachments of natural waterways, and trapping of water. Despite the construction of reservoirs and major investments in flood protection, there is still a considerable flood hazard. It is estimated that the total losses from floods were about Rs.454 billion and about 500 lives lost.

In developing the proposed regional plan strategy, the Consultants followed an extensive stakeholder consultative approach, and organized consultative workshops at community, district, and regional levels to register their perceptions about the drainage disposal related issues and problems, and to solicit their perceived solutions and aspirations and identification of priority interventions. The findings were disseminated widely through print and electronic media for wider awareness and feedback. Based on this, the prefeasibilities were prepared and prioritized in consultation with stakeholders, and this lead to the formulation of regional plan and action/implementation plan.

The five main pillars of the proposed strategy are:

1. Safe and timely disposal of surplus drainage effluent, and storm water flood.
2. Combating waterlogging and salinity in non-LBOD areas.
3. Environmental mitigation
4. Institutional Strengthening and capacity building of SIDA
5. Livelihood support to water hazard affected communities.

The graphic representation of the strategy is depicted in the following figure, followed by brief explanation of rationale of the abovementioned five pillars of the strategy.

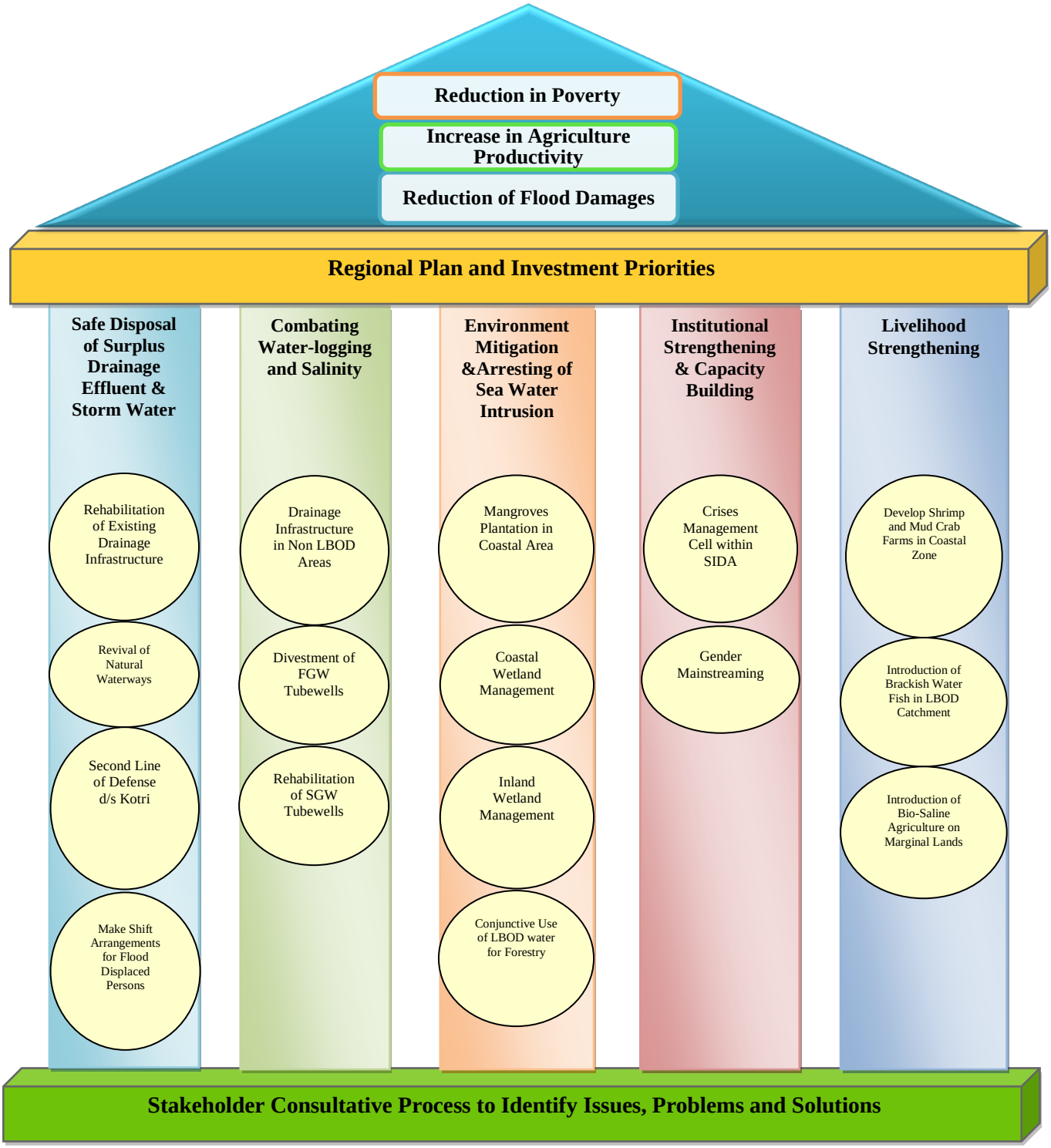


Figure 8.1: Strategy for Regional Plan for the Left Bank of Indus Delta and Coastal Zone

8.1.3 Pillars of the Strategy

8.1.3.1 Safe and timely disposal of surplus drainage effluent, storm water, and riverine flood

The main reasons that exasperated the losses in 2011 include the lack of reduction of disposal capacity of the drainage and flood protection system over time due to clogging of the system due to deferred maintenance, relief cuts, unauthorized tampering of the system, and constrictions due to physical infrastructure and encroachments. This warrants rehabilitation of existing drainage structure

and revival of natural waterways to relieve pressure on the LBOD, and divert and harvest surplus storm water flows in the depressions in the desert areas.

The main interventions/elements of the strategy include strengthening and rehabilitation of the LBOD system, revival of natural waterways. These structures will ensure safe and timely disposal of the storm water and avert the massive losses to the economy, if similar extreme precipitation pattern re-occurs or persist.

The plight of the 2011 flood displaced persons suggest that the drainage system be complemented with raised make shift shelters on higher grounds, and along the canal banks, roadside, etc. to provide relief from marooning.

8.1.3.2 Combating waterlogging and salinity in non-LBOD areas

The increasing water table and the associated salinity in areas outside the LBOD catchment is a tale tell for the declining farm productivity. The situation is precarious not only where there is absence of drainage structures, but also in areas where existing saline and freshwater drainage tubewells are nonoperational. The major reason is deferred maintenance and vandalizing of the more than 50-60 percent of the tubewell machinery, and electrical hook up system.

To control the water logging and salinity and to revive farm productivity, the need for installing drainage system in the areas outside SCARP and LBOD, rehabilitation of the nonfunctional tubewells, in the saline groundwater zones, and divestment of public sector tubewells in the fresh groundwater areas and its replacement with a fostering program development of private tubewells.

8.1.3.3 Environmental mitigation

The LBOD system had some unintended negative consequences, due to failure of the outfall structures, mainly the collapse of Cholri weir, and tidal link, due to onslaught of the 1999 cyclone, and high tide trends. This led to intrusion of the seawater that degraded the freshwater bodies and agricultural lands in the coastal areas, and to some extent in the lower reaches of the LBOD system. This resulted in loss of farm productivity and salinization of the freshwater bodies eroding the fish catch potential.

To arrest the seawater intrusion would require control structures in the lower reaches, and biological screening through the plantation of mangroves and other salt tolerant species in the potential coastal areas including around the tidal link and coastal wetland complex.

In addition to this the inland and coastal wetlands also require attention to ensure improvement of the local environment. Similarly, forest plantation will be established in LBOD network areas and Kotri drainage system by using saline and fresh water in either conjunctive of cyclic ways. This would serve as an instrument for improving the local climate.

8.1.3.4 Institutional Strengthening and Capacity Building of SIDA

During the 2011 floods, SIDA played an important role in managing the disposal of the storm water floods, and coordination with a vast array of agencies. The responsibility was not commensurate with the available resources. It highlighted the need for creating a crisis management cell with the SIDA, as a hub for coordination between agencies, and serve as clearinghouse for the storm water flood related information system, including early warning system, and rescue and relief operations. In addition to this, the women stakeholders felt that most of the SIDA field staff is not adequately gender sensitive, and gender concerns need to be mainstreamed for inclusive participatory irrigation management.

8.1.3.5 Livelihood support to rural communities

The livelihood of stakeholders, particularly those residing in the lower reaches of the LBOD system, were adversely affected due to degradation of agricultural land due to seawater encroachment and decrease in the fish production due to salinization of freshwater bodies. This has rendered many household into economic deprivation. Stakeholders emphasized the need for introducing appropriate

income generating enterprises to gainfully engage the unemployed persons. Following this exigent need, various income generating activities need to be supported.

8.2 Stakeholder Voices, Perceptions, and Aspirations

8.2.1 Approach and methodology

In order to be able to determine the first component of the strategy described above as *Where Are We Now?*, the relevant issues/problems, voices, perceptions and aspirations of the stakeholders were identified by following a qualitative approach. Everet and Louis (1981) define qualitative approach as "inquiry from the inside" and quantitative approach as "inquiry from the outside".

> *"These approaches differ in the degree of the researcher's immersion in terms of experiential engagement, direct contact with the subjects, and physical involvement in the setting. In the "inside" or qualitative approach, the researcher aims for a holistic picture from historically unique situations, where idiosyncrasies are important for meaning. The researcher uses an inductive mode, letting the data speak. In contrast, traditional "outside" or quantitative researchers aim to isolate the phenomenon, to reduce the level of complexity in the analysis and to test hypotheses derived previously."*(Cited in Sonia Ospina, 2004)

In order to cover a large geographical area and a number, diversity and complexity of issues, a multi-dimensional methodological approach was adopted for the consultations with communities and poverty assessment. The approach focused on:

i. ***Location***

The Project area is divided in three Area Water Boards. Each Area Water Board is represented in the sample by the number of consultations with stakeholders at district level and number of villages from different districts. The districts located outside the Area Water Board are also represented in the sample.

ii. ***Persisting issues***

Population residing in different parts of the province faces different problems. To ensure representation of villages facing different problems, a focus on persisting problems was applied.

iii. ***Current flooding issues***

The enormous current flooding affected a countless number of villages and settlements across the Project area. A number of currently affected villages are included in the sample.

iv. ***Extreme poverty***

Poverty has remained one of the most serious problems of Pakistan- over one third of the population is living under the poverty line. About forty-four percent of population is below the poverty line on the human poverty index (UNDP, 2002). Although governmental bodies, local and international NGOs, and international organizations operating in Pakistan have made eradication of poverty a top priority and have operated many social development programs, poverty has been on a rise when compared to the level of 26 percent in 1988 (GoP, 2003). A significant proportion of Pakistan's population does not have adequate quantity and quality of food, access to basic services and opportunities and hence are particularly vulnerable to economic, environmental and political shocks. Sixty five percent of Pakistan's population lives in rural areas and majority of them live below the poverty line (World Bank, 2002). Poverty is especially spread in the Lower Sindh region.

8.2.2 Sampling Design and Sample Size

A feature of qualitative sampling is that a small number of cases are sampled. The data aim for depth as well as breadth in understanding Project related issues as seen through the eyes of the affected people. The corresponding sample methodology involved non-probability sampling as it did not aim to produce a statistically representative sample or draw statistical inference. The targeted phenomenon

/ issue needs only to appear once in the sample. Nevertheless, relevant quantitative data on the village level were also collected and analyzed in this study.

In order to fairly cover the whole Project area (including the districts outside the Area Water Boards) and to ensure representation of rural and urban/semi-urban population which faces different problems, a purposive sampling within a multi-dimensional approach was considered as one of the most applicable approaches to address the aims of the defined tasks. The combination of methodological tools enabled reasonable insight into communities' perceptions about contemporary problems, causes of the persisting poverty and problems and their concerns and suggestions about the effects of Project related issues on their livelihoods.

A broad range of issues and corresponding villages were identified across the Project area. Identified issues were grouped into a few main categories which served as the selection criteria for villages which could comprise the village sample. Overall, pre-identified issues were grouped into seven major categories: water shortage, water logging, safe disposal of drainage water, salinity, sea intrusion, LBOD/drainage effects and current flooding. Consequently, seven village sample selection criteria were set.

Each of the seven major issues are represented by one or two villages (depending on severity of issues in a particular area). The largest sample was assigned to the Left Bank Area Water Boards mainly due to the most severe effects from the LBOD and the recent flooding in districts Badin and Thatta. Districts outside the Area Water Boards are represented by one or two villages. In total, 36 out of 61 identified villages were chosen to comprise the sample for the LBOD/Drainage issues/problems study. The selection of a sample village within identified villages was determined according to issues prevailing in each area.

All eight districts in the Lower Sindh are covered by consultations on poverty. Based on the criteria for identification of rural areas, stakeholders, UC offices and local NGOs helped to identify rural Union Councils in each district. One Union Council in each district and one Deh in the sample Union Council were selected randomly. Representatives from each village in a sampled deh participated at consultations. Overall, 40 villages from the area were consulted in the poverty assessment.

More is discussed about sample size in Chapter 9 the sub-chapter corresponding to social issues.

8.2.3 Stakeholder consultations

The process refers to the full and equal involvement of men and women of all ages, backgrounds and social status in the decision making processes, especially in activities which affect their lives and lives of their communities. Women and other vulnerable groups are often excluded from the decision making process particularly in the public spheres. The meaningful community participation assumes systemic learning processes which will lead to action and change.

It was essential that all major stakeholders were identified and given the opportunity to be involved and informed regarding the Project, the irrigation and drainage issues and potential structural and non-structural solutions for the current issues/problems. Open public consultation sessions, workshops and other systems for receiving comments are indispensable for encouragement and opportunity for any interested parties to access information about the Project and to express their opinions, suggestions and recommendations relevant to the Project.

As already underlined, a meaningful community and stakeholders' engagement goes beyond formal dissemination of the Project information or people's pro-forma voicing their opinions. It should build trust, rapport and understanding between the stakeholders and to ensure that the perspectives and realities of the Project beneficiaries are integrated into longer-term strategies and concrete actions.

The consultations with communities and other major stakeholders were conducted on five levels: grassroots level, district level, Area Water Board level, regional level (to be conducted) and national level (to be conducted).

Identification of issues and problems: There are 3,259 villages/settlements in the Project area (UNOCHA 2010 and PCO). The Consultant accessed 148 villages, which represent about 4.5% of the

sample universe. Each of fifteen districts in the Project area, and each of the three Area Water Boards were represented in the consultations on the Project issues and problems. The consultations involved the collection of primarily qualitative data from primary sources. The consultations were conducted at five levels: grassroots level, district level, Area Water Board level, and regional and national levels.

Community consultations were conducted topically for specific issues. Consultations were conducted for: 1) LBOD/drainage issues and problems in 36 villages, 2) poverty issues in 40 villages of Lower Sindh, 3) economic and livelihood issues in 60 villages and 4) environmental issues in 12 villages**.** More than 300 different organizations, NGOs, CBOs etc. were represented at consultations and over 5,000 stakeholders were directly consulted. The area directly accessed for consultations represents over 300,000 residents.

Identification of solutions: The workshops at the district level were organized in the following districts: Ghotki, Sukkur and Khaipur, NousheroFeroze, Nawabshah, Mirpurkhas and Tando Allahyar, Sanghar, Hyderabad and Matiari, Badin, Thatta, Tando Muihammed Khan, Tharparkar and Umerkot. In addition, one workshop was organized for each of the three Area Water Boards (Ghotki Feeder Canal AWB, Nara Canal AWBs and Left Bank Canal AWB). The final wrap up workshop was conducted in Karachi with participation of regional and national stakeholders.

The consultations with stakeholders and affected communities include the following: workshops with stakeholders, open community consultations with sample village population, focus group discussions, and key informant interviews:

Workshops with stakeholders

In order to cover a geographically large Project area, the Consultant organized and conducted stakeholders' workshops in the following districts: Badin, Thatta, Umerkot, Tando Muhammad Khan, Hyderabad, Mirpurkhas, TandoAllahyar, Matiari, Sanghar, Ghotki, Sukkur, NausheroFeroze, Shaheed Benazirabad, and Khairpur. The stakeholders came from a variety of organizations and groups such as farming communities, fishermen, villagers, urban populations, non-government organizations (NGOs), water user groups, groups interested in environmental and social issues, women's groups, civil society organizations, universities, local media and others. Over 300 organizations, NGOs and Civil societies were represented at the stakeholders' workshops.

To achieve transparency, continuity in the stakeholders' participation and to encourage ownership of the Project, the Consultant shared the workshop records, notes and photographs with the participants and asked them to review the records, fill in the gaps in the information and give additional comments and opinions. These actions were taken for the sake of thoroughness and partly in response to specific observations of those consulted.

Open community consultations

Open community consultations were conducted in 36 sample villages in the fourteen districts of the Project area. Villagers were informed about intended community consultations a minimum of one day prior to consultations. Usually, an NGO working in the area was engaged to inform villagers about the consultations and to help in organizing the meeting. The participants were verbally informed about the Project and the objectives of the consultations with them. Overall, 70 open community consultations for 36 villages in fourteen districts were conducted.

Focus Group Discussions

Focus group discussions were planned to be conducted with village women. The objective of these discussions was to ascertain women's perceptions of problems and issues related to the Project benefits. Out of the 36 visited villages, only two focus group discussions on Project related issues with women were conducted. In the rest of the sample villages, open community consultations were conducted with women as great number of women requested to participate. Poverty assessment was based on the focus group discussions with representatives from each village in a sampled deh. In total, the poverty assessment included 8 focus group discussions with men and eight with women.

Key Informant Interviews

Additional information on the village population, available basic services in the villages, distance and access to services outside the villages, information on the village poor, landless, education, health etc, was collected from the key informants. The Consultant conducted 36 such interviews; one in each of the sampled villages. In addition, eight key informant interviews were conducted at eight dehs for assessment of poverty. The matrix for village data collection was prepared in advance. Usually, the key person was the village headman, a wadera, a local teacher or any other educated and/or well informed person.

Case Studies

To complement findings obtained through the focus group discussions on poverty, the Consultant conducted 16 case studies, 8 with women and 8 with men. The focus group participants chose the poorest members among the participants for the case studies. The case studies thus are narrative and document life in poverty as experienced by the poorest.

In addition, 10,000 Project pamphlets in Sindhi and 1,000 in English were distributed. A hotline number for public questions and comments and an email account for stakeholders' comments/ opinions were established. Individual feedbacks were incorporated into community consultations records and in the final analysis of the stakeholders/community consultations. The stakeholders request continuity in meaningful engagement and consequential actions to follow.

8.2.4 Stakeholder Perceptions about the Issues and Problems

The majority of the consulted villages and stakeholders report the absence of meaningful consultations with the communities. There is disbelief that anyone will consult locals at all, and a deeply embedded distrust about the outcome of the consultations prevailing in the visited villages. The information from the villages and the stakeholders consistently indicate that people want genuine consultations, appropriate actions and feedback on any action taken.

In areas where some consultations with the stakeholders were conducted in the past, the stakeholders stated that no value was given to their opinions and suggestions. People do not believe that any of their suggestions will be considered at all: *'At least, please forward these suggestions to the concerned quarters'.* Stakeholders, Sanghar

The stakeholders requested transparency and accountability in any project in their area and, in particular, that the projects' cost and expenditure are published in the newspapers, so, that the population is properly informed.

The significance of consulting men and women equally about any of the issues related to their lives is of ultimate importance. In each of the visited villages, women were genuinely surprised that anyone asked for their opinion and recommendations. An absence of social inclusion of women in voicing their opinions and participating in the decision making process in public spheres of their lives is persistent.

The following were the main issues brought up at the community consultations.

8.2.4.1 LBOD/ Drainage System

The opinions of the stakeholders and communities about the LBOD are divided. Those who benefited from the LBOD expressed a positive opinion, while those who experienced negative effects, the communities from Badin and Thatta districts in particular, are angry and frustrated. According to the communities experiencing negative effects, the LBOD water became poisonous, it has deprived thousands of families of their source of livelihood, caused displacement of the villagers and affected agricultural production. The intended purpose of LBOD was to drain out saline and storm water and to alleviate water logging and salinity. However, the adversely affected people strongly feel that the LBOD has failed to fulfill its objective. The communities claim that LBOD always brings flood, it was not constructed appropriately, it does not drain rain water properly, and it has caused substantial losses to the people, ecological system, fisheries and agriculture in many areas.

Some stakeholders believe that The World Bank has its own interests in giving loans. *'Keenjhar and Haleeji lakes projects were financed by the IMF and the World Bank and both projects have failed. We know consultations were also conducted before for LBOD but the suggestions of the local community were not given any value'.(Stakeholders, Thatta)* In addition, there were some opinions that that the World Bank should compensate the population for lost lives, livelihoods and degraded environment caused by the LBOD.

Some communities expressed serious reservation against any future drainage/irrigation projects. Their arguments range from the total rejection of any extension of the drainage system because of the bad experience of some villages with LBOD, to contentions that no drains should be built across the land of small growers because they cannot afford to lose any more land. In addition, people apprehend that such a project would bring contaminated and poisonous water from the factories. For these reasons, they prefer to be without vital drains rather than to suffer from poisonous chemical effluent that would flow from the factories and sugar mills.

8.2.4.2 Access to Drinking Water

Drinking water is one of the main problems in most of the consulted villages. In such villages drinking water is brackish and contaminated. The villagers mostly draw water from wells by hand pumps from irrigation canals and ponds. A number of villages do not have enough water for their daily needs. In some villages the village ponds are filled in once a month. In such villages, people strictly ration water usage, fearing that the ponds may run out of water before the new supply arrives. The Consultants witnessed the people drawing muddy water for drinking, cooking, washing and for animals. Villagers cannot afford a basic purification system which costs around PRs 1000 per month. Usually, only *wadera's* homes have some system for water purification.

8.2.4.3 Shortage of Irrigation Water

In most of the sampled villages, the consulted people report that unavailability or shortage of irrigation water is one of the major issues. The greatest impact of water shortage is reported in the villages located at the tails reaches of the irrigation canals. Unavailability or shortage of irrigation water has caused an increase in the salinity of the soil, turned pastures and arable land into barren and unproductive land and devastated the livestock and fishery. In the opinion of the consulted villagers, the shortage of irrigation water is mostly man-made, caused by unfair water distribution; lack of equity. They stated that because the big landlords in the area have closed the canals to villages the land became dry and impossible to cultivate. According to the villagers, other powerful individuals in the area also divert water to their land and the villagers cannot get it back.

Stakeholders at Ghotki district pointed out that they were in dire need of irrigation water for their rice fields while plenty of water was available in dams. No water was delivered to meet their requirement. Their perception is that, if the requirement for water was fulfilled from dams, the super flood water of 2010 could have been diverted to fill dams and the flood damage could be avoided.

An issue was raised by the stakeholders in a consultative workshop at Sukkur that the drainage water of SCARP-IV together with the effluents from industries is diverted unattended to the Ghotki district. The toxic drainage effluent enters the BagooWah and spreads in the fertile and productive lands damaging the crops and degrading their lands. They demanded the government of Sindh for immediate stoppage of the drainage effluent from Punjab that have degraded their valued land resources.

8.2.4.4 Sea intrusion, water logging and salinity

The issues of sea intrusion, water logging and salinity were brought up at each community consultation, particularly in the coastal area which is reported to be the most adversely affected. The consulted people argue that the LBOD was not constructed properly so the drainage effluent does not flow into the sea. Furthermore, the fresh water from the Indus River was the main source/force for pushing back the sea tides. Due to saline water, fish cannot get enough food and its reproduction is decreasing as a consequence. Arable land has become salinized and unsuitable for cultivating any crops.

8.2.4.5 Agriculture /livelihoods

A great majority of villagers are farmers who depend on farming and livestock husbandry. In some areas people claim that up to 80% of agricultural land has been degraded because of increase in the water table (water logging and salinity). The saline land is not suitable for cultivation. When it rains, the villagers cultivate as much as they can although usually they can only cultivate very small plots of land because they cannot afford to buy seeds and fertilizer.

Livestock has decreased significantly, as there is a shortage of fodder. In most of the villages, people reported having a goat or two, or one or two buffalos/cows - in some 'better off' households. Some villagers try to preserve their livestock by giving their animals to farmers in the districts in which fodder is available and then they share the benefit of livestock productivity.

In the delta and coastal area, more than 90% of the villagers make their living from fisheries. The remaining 10% of the population depends on agriculture. Before the LBOD, the main crop was rice. These communities claim that after the construction of the LBOD, they lost their main source of income because sea intrusion and water salinity haves increased. The Mallah community, which depended entirely on the fishery, became jobless and was forced to migrate. Communities stated that before it was a sin to catch a small fish or a crab, but now they are ashamed that they have to eat and sell anything they can catch.

8.2.4.6 *Health*

Health is one of the burning issues in the sampled villages. Due to brackish, saline, contaminated, poisonous and non-potable water, the villagers suffer mostly from diarrhea, vomiting, stomach pain, high fever, malaria, all types of hepatitis, tuberculosis, liver and skin diseases. They believe that after the construction of the LBOD and the closure of the old DhoroPuran, the diseases became common in the villages. There is a bad smell from the Doro Puran Drain which makes local people dizzy. A lot of the surveyed people report headaches and skin diseases.

In addition, access to women's health care is almost nonexistent. In the majority of the consulted villages there is no Lady Health Worker (a local expression) or a midwife who can help women during deliveries. Many villagers reported high mortality of mothers and babies due to the lack of medical help in the villages, or difficult access to qualified medical assistance.

8.2.4.7 Insecurity and Shortage of Food

The consulted people reported that the extreme poverty in their villages is caused by the low productivity of agricultural land, diminished livestock and fisheries, floods, inflation, landlessness, shortage of irrigation water and lack of access to any other economical resources. Those who have some land cannot cultivate it because of water shortage. The landless people are requesting that the government distributes some land to the poor, so that they can work and feed their families. There is chronic insecurity for the landless people. *'We live on government land and when the government needs the land, we have to go. We only need a home – a place to live'. (A woman from Major Bakar village, Hyderabad).*

The participants of the discussion groups reported a widespread shortage of food and significant increase of poverty in all sampled villages. Women reportedly sit all day in wait for husbands to bring some food so that they can prepare meals for their families. Boiled chilies and bread (rotti) is a common meal for many families. They can afford potatoes once or twice a month, while most people get meat only on the occasion of Eid-e-Qurban, when they are offered meat by the well-off people. A poor person in people's opinion is: *'One who eats at night and starves in the morning is poor'. (Village MureedKhoso, Thatta)*

Food expenditures comprise on an average 90-95 % of the total income of the poor and the hike in prices has severely hurt the people's purchasing power. As a result most of the people suffer from malnutrition. This increased food expenditure means that poor get to spend less money on other facilities like health or education.

Other devastating effects of poverty are loneliness and depression, continuous illness, increased debt for health treatment, debts to overcome droughts and preparing dowry for daughters, which creates a vicious poverty circle.

8.2.4.8 Crop Yield

In the opinion of villagers interviewed, the yields are low because of lack of agricultural inputs. Seeds, fertilizers, pesticides are costly, and quality of seeds is questionable. The fertilizers and pesticides are mixed and very expensive. The Consultants observed that the crop yields are also affected by: depletion in soil quality and erosion, water-logging and salinity, and inadequate input levels.

8.2.4.9 Unemployment and Low Daily Wages

The consulted people reported that the employment opportunities in the public sector are very limited. There are few chances for employment for the rural jobless in the private sector mainly due to the poor standard of education and non-availability of technical training in the rural areas. The sources of livelihood and employment opportunities for rural inhabitants are shrinking and there is no family planning. It is common in rural areas that one family consists of 12 to 18 members, and they depend on only one earner. Consequently, poverty and unemployment is increasing gradually, and more people are sliding in to poverty. Those who are educated are also facing unemployment and this situation has raised the non-importance of education among poor, peasants and small farmers and landless especially. Those who have jobs receive low wages and are unable to meet the basic needs of their families.

8.2.4.10 Lack of Education and Modern Technologies

Stakeholders pointed out that lack of education and technical skills areanother reason of poverty. The literacy rate of Pakistani society is less than fifty percent; the female education rate is at miserable state. The farmers don't know about the scientific ways of farming and the result is low production of yield from their fields. However, in some villages, people do not see any benefits of women/girls education or vocational training as those who have some education cannot get the job or due to cultural constrains, family does not allowed a female member to work outside home.

The majority of the surveyed villages have segregated primary schools for boys and girls. Middle and high schools are rarely located n the villages. The surveyed villagers report that education in the available schools is of low quality. Girls have much lower school attendance than boys.

8.2.4.11 Inflation and price escalation

The consulted people reported that the prices escalation is on the rise. Most of the people demand control on food prices. Families that used to have three meals a day, now can afford food twice a day, while those who used to have two meals a day, now have only one meal daily.

8.2.4.12 Women in the Local Context

The shortage of water, increasing water-logging, land salinity, and adversely affected farm productivity, and livestock decrease, have changed women's lives. They used to work in the fields with their husbands and minded livestock. The loss of these major sources of women's work has had a substantial impact on local women. In many villages, they must walk long distances to fetch drinking water. In others, they sit all day at home without work, caring for children and waiting for their husbands to bring some food for the family. Some women go with husbands to cut wood while others, in villages where some land is cultivated, pick cotton or do some other agricultural work. In addition, population growth puts additional constrains on local women. As a cause of poverty, women in one of the sample villages stated: *'Too many babies, but we cannot do anything as God gave them to us'.*

8.2.4.13 Environment

The community consultations, especially consultations with district stakeholders, revealed that the people are very much aware of the condition of their environment. In their opinion, nobody takes care of the environment and the Government's allocation of funds for this purpose is meaningless. Several

endangered species have vanished, fish cannot survive in the contaminated water and local lakes are dead. Migratory birds do not visit lakes anymore and the indigenous birds population has diminished considerably.

The sugar industries in the area drain poisonous waste into the LBOD and pose a serious threat to the environment, livelihoods and health of the villagers. The natural drain of DhoroPuran is clogged with mud and is connected with the LBOD. During the rainy season (July-August), water overflows LBOD and floods a number of villages with toxic water. Some of the communities allege that some sugar mills have established wine factories within the sugar mill boundaries, and the waste from the wine factory is reportedly released into the natural drainage of DhoroPuran. The adjacent agricultural land has been destroyed and the eco system is badly affected. The affected communities demand that sugar mills immediately stop discharging poisonous chemical water into the natural Dhoro Puran which was the only and last source of their livelihood.

8.2.4.14 Institutions and Government Departments

It is a general impression of the consulted communities that the Farmers' Organizations (FOs) are dysfunctional. In the opinion of these communities, FOs do not have enough power even to ensure a proper share of water for the communities as local powerful individuals and large farmers control their operation.. Moreover, the FOs' chairmen are selected rather than elected. There are widespread complaints about the malpractice of powerful landlords in the majority of the consulted villages.

The majority of the consulted stakeholders and communities believe that most of the staff of the Irrigation Department sell water to the rich and the powerful. The Department does not maintain the irrigation system regularly and properly and some mismanagement of funds is present. In addition, there were some opinions that that the World Bank (because of its own mistakes) should compensate the affected population for lost lives, livelihood and degraded environment caused by the LBOD.

The consulted stakeholders want to see the WSIP free from government and political interference. In their opinion, this should be achieved by establishing development committees at district level, which should include members from all parts of the society, such as landlords, social workers, journalists etc. The committees would monitor the Project and make sure that bureaucracy and corruption do not dominate the Project. People reported that there are a number of projects initiated by the previous government that have not been completed. Every change in the government brings to a closure started development schemes; so many projects have never been finished.

8.2.4.15 Flooding

The recent catastrophic floods of 2010 and 2011 have adversely affected a number of the sampled villages. The displaced communities lost their homes, crops, livestock and jobs. The Government provided food but (according to the consulted people) the rations were insufficient. There was no provision of fodder for the saved livestock. Also, the procedure for the issuing of Wattan cards is ineffective.

The villagers who suffered from the recent mega-flood think that the system for early warning is nonexistent or ineffective. They stated that people were forced to leave because of the catastrophic flood but the government could not inform them in time.. The community suggested that the Government prepares a complete plan for the relief and rehabilitation of the affected villages and the replenishment of the livestock in the post flood period.

The stakeholders demand an extensive awareness campaign about the preventive measures during natural calamities. In addition, they suggest the strengthening of the river banks, tree planting along river and canals, construction of rain and flood canals, clearing katcha areas around the river and better management and coordination between the responsible departments and agencies.

8.2.4.16 Other issues

Innate desire to work at home or near home: Local men tend to seek employment in the village or places closed to their villages. Women prefer an in-house or within-village work providing a women-friendly working environment.

***Difficult Access to Credit*:** Increasing cost of living and agricultural inputs reduce the purchasing power of rural people. It is a general perception that in Sindh people are born in debt, live in debt and die in debt. The availability of credit is a key prerequisite for the farmers, for their production as well as their post harvesting requirements. The majority of growers depend on non- institutional sources, such as friends, relatives, land lords, village merchants and money lenders at local level.

Roads condition: The condition of local roads in the sampled villages is very poor. Because of bad roads, access to basic services is difficult and expensive.

Sanitation: Proper sanitation is not available in most of the villages. People need help to construct latrines in the villages.

8.3 Proposed Interventions as Agreed by the Stakeholders

The proposed interventions and solutions suggested by the stakeholders during the two phases of consultations were presented to the stakeholders in detail during the workshops. The stakeholders were given opportunity of supporting or rejecting those interventions with alternative solutions.

A summary of the solutions identified and agreed by the stakeholders is given below:

Table 8.1: Issues & Solutions

S. No.	Issues & Problems	Proposed Intervention / Solutions
1.	• Overflow of storm water from Main Drains, LBOD Spinal and KPOD • Deficiencies in LBOD Stage-1 and Badin area Drainage systems. • Tidal effects in KPOD and Badin area Drains. • Sea water intrusion in Dhands. • Deficiency in LBOD outfall system. • Flooding in LBOD upper catchment and Badin area.	**Rehabilitation and Improvement of LBOD Drainage System Infrastructure** Proposed solutions under this intervention: • Rehabilitation of Nawabshah, Sanghar, Mirpurkhas components, and Badin area Drainage systems. • Rehabilitation/remodeling of Spinal Drain • Rehabilitation of KPOD • Remodeling of DPOD for 4,000 cfs • Provision of structure with flap gates on KPOD at suitable location to check Tidal effects in KPOD and Badin area Drains. • Flood protections bund for villages and cropped area in north of Achh, Sainhri & Addah Dhands. • Flood Protection Bund for village Bahador Khan Lund located near RD 28 of KPOD. • Protection Bund and Mangroves plantation around Dhands for control of tidal effects and sea water intrusion.
2.	• During 2011 due to rain water storm there was wide spread damage to the cities, town, villages, irrigation and drainage networks, public and private properties, agriculture fields etc. • The LBOD/KPOD outfall infrastructure was not designed properly and has caused miseries to the communities in lower reaches • Stakeholder's are apprehensive of any reconstruction or extension of LBOD and/or KPOD • Communities along the flood protection bunds feel vulnerable to flood havoc • There is inadequate infrastructure to safely dispose off and conserve storm water in case of high rainfall	**Revival of Natural Waterways to Drain out Storm Water** Proposed solutions under this intervention: • Divert storm water from LBOD, reducing the discharge in the main drain, thus making it safer for the people and land in Badin and Thatta Districts. • Provide storm water to the Thar area, which can be stored in the depressions. Storm water will be of acceptable quality, because the LBOD base flow would not be diverted to Thar. • Provide drainage to left over areas to reduce the water logging and increase the productivity of degraded lands through revival of natural waterways.
3.	• Failure of the Cholri Weir and breaches in the bunds. • The brackish water dhands have turned into marine. • The entire ecosystem has changed affecting the fauna and flora of the dhand complex • The livelihood opportunities have dwindled	**Rehabilitation of Coastal Wetlands** Proposed solutions under this intervention: • The dhands shall be provided with a bund about 1 km from the Tidal Link to allow breathing space for the tidal water • This 1 km distance will be occupied by mangrove plantation to minimize the erosion due to rains and tidal effects • The bund shall extend from the northern end of the dhands moving southwards and westward cordoning the entire dhand complex with a protection bund

	• The dhands adjoining fertile lands have turned saline and degraded. • Productivity of dhands have drastically reduced due to sea intrusion and tidal effect	• From the KPOD side at a suitable firm ground, diversion canal shall be provided with a gated structure to allow the storm water from KPOD to enter in dhands to a manageable capacity. • From southern side, a spillway channel shall be provided to evacuate the dhands when the water level in dhands reaches to a risky level.
4.	• A significant proportion of SCARP tubewells are non operational • Dissatisfaction with the overall performance of the drainage project staff • Irrigation shortage is causing low productivity	**Rehabilitation of LBOD and SCARP Tubewells** Proposed solutions under this intervention: • Rehabilitation and replacement of tubewells that are at the end of their economic life with more efficient means of capturing agricultural drainage and mixing it for reuse in the canals. • Review of situation that requires tile and open drains and pumping stations for disposal of drainage in some areas. • Review of water quality aspects of drainage discharges to Rohri Canal.
5.	• A significant proportion of SCARP FGW tubewells are non operational • Dissatisfaction with the overall performance of the drainage project staff • Irrigation shortage is causing low productivity	**Privatization of FGW SCARP Tubewells** Proposed solutions under this intervention: • Rehabilitation of FTWs, especially those of less than 1.5 cusec capacities; • Provision of incentives for construction of private tubewells, especially for tubewells of degraded capacity or of large capacities; • Possible upgrade of workshops and other infrastructure for transfer. • Review of operating rules and legality of private development of groundwater considering social, economic, and environmental concerns and issues;
6.	• Farmers in areas without any drainage infrastructure/network desire that drainage projects are constructed in their respective areas to control water logging and salinity menace, to reclaim culturable waste and to increase their farm productivity. • Because of lack of alternate livelihood opportunities, poverty and food insecurity is increasing	**Ghotki SCARP (Saline Zone)** Proposed solution under this intervention: • To propose the best method for solving the water logging and salinity problems of the Ghotki area by controlling the water table and, to identify the best alternative for the effluent
7.	• Depleting fish resources • Reduced livelihood opportunities • Poverty • Limited fishermen capacity	**Shrimp and Mud Crab Farming in Coastal Areas of Left Bank** Proposed solutions under this intervention: • **Shrimp Farming:** Coastal area has become more suitable for shrimp and fin fish culture including crabs and lobster. Immense potentials exist to start commercial scale fish / shrimp farming.

		• **Fattening of mud crabs:** *Scylla serrata* commonly known as mud crab, green crab or mangrove crab have good potential in the area.
8.	• There is inadequate infrastructure to safely dispose off & conserve Indus River flood water in case of high rainfall. • Communities along the flood protection bunds feel vulnerable to flood havoc • Irrigation shortage is causing low productivity	**Diversion Upstream of Sukkur Barrage and Canal to Thar Area** Proposed solutions under this intervention: • To divert water from Sukkur Barrage, reducing the discharge in the Barrage, thus making it safer and avoiding the present need of breaching the bunds in order to provide some alleviation to the Barrage during floods. • It will also provide sweet water to the Thar area, which can be stored in the depressions.
9.	• Communities along the flood protection bunds feel vulnerable to flood havoc • Lack of proper disaster Management and Preparedness • Communities, particularly along the flood protection bunds and beyond, are apprehensive of unexpected breaches during floods.	**Indus River Disaster Management Infrastructure** Proposed solution under this intervention: • Second Line of Defense for Left Bank of Indus D/S Kotri • Raised platforms for protection from flooding
10.	• Communities along the flood protection bunds feel vulnerable to flood havoc • Disaster Management and Preparedness • Communities, particularly along the flood protection bunds and beyond, are apprehensive of unexpected breaches during floods.	**Establishment of Disaster Management Unit in SIDA** Proposed solutions under this intervention: • Implement a SIDA Disaster/ Crisis management Unit for preparing, training and coordinating plans for emergency response services in case of emergency situations and disasters within SIDA's ordinance. • Coordinating within SIDA's wings and also with the Provincial Irrigation Department, WAPDA, the Provincial Disaster Management Authority (PDMA), etc.
11.	• Water scarcity below Kotri barrage has adversely affected the agro-ecosystems. • The persistent drought conditions since last decade has degraded lands • Leaving the lands without crop for prolong periods induce desertification and reduce productivity • Reduced production resulted in decline in livelihood opportunities.	**Bio-saline Agriculture in Badin and Thatta Districts** Proposed solutions under this intervention: • Bio-saline agriculture can be practiced on marginal saline lands using brackish water for growing salt tolerant food and fodder crops, bushes and trees • Surface drains mostly carry *pancho* water from rice fields that can be used for growing salt tolerant species of crops, grasses and halophytes. • This intervention can best utilize our water resources on one hand and can reduce load on drainage outfall on the other.
12.	• Inadequate and poor O&M of the drainage system, including sub drains and on-farm drains • IPD and SIDA and associated AWBs and FOs need strengthening	**Preventative Maintenance Program (PMP), for SIDA within assigned Canal Commands of three AWBs** Proposed solutions under this intervention: • Non Structural solution, involving equipment purchase, personnel retraining, survey and classification of structures,

	and staffing to carry out their routine operations and maintenance functions.	and scheduling and dispatch of maintenance crews. • Recognized organization-ready, well-equipped emergency crews who can be trained for emergency and disaster response. These crews will be located province wide.
13.	• Sea water intrusion • Degradation of dhands • Natural disasters • Coastal erosion • Deforestation of mangroves • Decline of fish resource • Limited livelihood opportunities • Fragile coastal environment	**Protective Plantation of Mangroves in the Coastal Areas of Left Bank** Proposed solutions under this intervention: • Survey for identification of potential areas for mangrove plantations • Raising of mangrove and salt resistant plant nurseries • Plantation of mangroves to protect wetlands and tidal link • Plant mangroves in blank mudflats in coastal areas (in backwater and frontage of sea) • Raising of salt tolerant tree species in supra tidal zone
14.	• Livelihood for fishermen community of the area has declined • Decline fish production and species • Degradation of fisheries resources due to deterioration of the dhands water quality	**Brackish Water Fish Farming in LBOD Area** Proposed solutions under this intervention: • Construction of earthen fish ponds of on private lands located in the command area of LBOD. • Establish brackish water fish hatcheries • Involve fish farmers in identification of areas for fish ponds • Conduct on the job trainings to fish farmers for capacity building
15.	• Deforestation • Degradation of forest and agro ecosystems • Decline in productivity & composition of forest and farmlands • Shortage of tree resource and associated services • Lack of participatory approach and coordination • Decline in per ha vegetation cover • Limited livelihood opportunities	**Use of Drainage Water for Forestation in the LBOD and Kotri Areas** Proposed solutions under this intervention: • Identification of sites for tree plantation on forest lands and private farmlands. • Grow nurseries of saline water resistant tree species. • Provide drainage water for forestation in nearby forest and farm lands • Supplement fresh water with drainage water to reduce water shortage. • Grow trees in block/linear plantation patterns.
16.	• Drainage effluent intrusion in the Ghotki Area from Southern Punjab	**Position Paper** • Analysis of the problems and identification of potential solutions. • Prepare strategy for Sindh Government
17.	• Safe and clean drinking water is not available particularly in the saline underground water areas and in the delta and coastal areas. • Untreated municipal sewage disposed off into freshwater bodies is used for domestic purposes by thousands of people living in areas	**Position Paper** • By the Relevant Implement Agencies • Water treatment units (filtering, chlorination, reverse osmosis, etc) should be provided. • Wastewater should be treated at source point, complying with NEQ standards. • Training to villagers on water treatment for human consumption.

	with brackish underground water. • Less than 8% of total wastewater released daily is, only partially treated before it is released into the surface water bodies.	
18.	• Water sources, both surface water and groundwater, are increasingly polluted due to unchecked disposal of untreated pollutants emanating from the increasing disposal of urban sewerage and solid waste, leaching of agrochemicals, untreated hazardous industrial waste, particularly from sugar mills. • Despite cost effective available techniques, there is a lack of compliance and ineffectiveness of EPA to control pollution and contamination of water ways and of the drainage system.	**Position Paper** • By the Relevant Implement Agencies • Sugar Industry Effluent Treatment at Source

8.4 Preparation of pre-feasibilities

The sixteen proposed interventions and three position papers favored by the stakeholders were studied at recognition level in Phase-II of the Consultancy agreement. It must be pointed out that three out of those nineteen recommended schemes have been treated as position papers, identifying in detail the issues and problems that the stakeholders pointed out, analyzing the complications and identifying potential solutions. These position papers were not treated as pre-feasibility studies because they were outside the scope of work of the Consultancy agreement.

Table 8.2: Pre-feasibility Studies and Position Papers

Pre-feasibility Studies	
1.	Rehabilitation and Improvement of LBOD Drainage Infrastructure
2.	Revival of Natural Waterways to Drain out Strom Water.
3.	Rehabilitation of LBOD and SCARP Tubewells
4.	Ghotki SCARP (Saline Zone)
5.	Privatization of FGW SCARP Tubewells
6.	Second Line of Defense for Left Bank of Indus D/S Kotri
7.	Elevated Platforms for Flood Displaced Persons
8.	Rehabilitation of Coastal Wetlands
9.	Protective Plantation of Mangroves in the Coastal Areas of Left Bank
10.	Use of Drainage Water for Forestation in the LBOD and Kotri Areas
11.	Bio-saline Agriculture in Badin and Thatta Districts
12.	Rehabilitation of DehAkro II and Chotiari Wetland Complex
13.	Shrimp and Mud Crab Farming in Coastal areas of Left Bank
14.	Brackish Water Fish Farming in LBOD Area
15.	Establishment of Disaster Management Unit in SIDA
16.	Gender Mainstreaming in Irrigation and Drainage
Position Papers	

1. *Drainage Effluent Intrusion in the Ghotki Area from Southern Punjab*
2. *Sugar Industry Effluent Treatment at Source*
3. *Access to Potable Water in the Left Bank*

8.5 Screening, and ranking of selected interventions

The World Bank (2010)[27]defines screening and ranking as two basic complementary processes to condense a list of conceivable alternatives to a one or a set of desired alternatives that matches the budget or any other constraint. The Bank defines screening and ranking as follows:

> ***"Screening**, by analogy with a sieve that lets some items through and holds others back, is the simpler: an alternatives is either accepted or rejected at a screening phase. It might be rejected by being shown to be total unacceptable under just one criteria (this is referred as veto). Or just by falling below some threshold based one or several criteria.*
>
> ***Ranking**, is more subtle than screening in that alternatives are not merely sorted into two classes, the accepted and the rejected, but are placed in order of merit, by whatever measure of merit or preference is being used."*

A ranking procedure with the evaluation criteria for possible solutions, considering, costs, economic returns, technical, social and environmental feasibility was developed and submitted to SIDA and the PCMU for their comments and input. As mentioned above, the method proposed contemplates five major criteria and a number of sub-attributes. These are: i) social accessibility; ii) financial soundness; iii) environmental benefits; iv) Socio-Economic impact; and; v) sustainability. The description and interpretation of each of the criterion and sub-attributes is given as under.

The Ranking Checklist

A. Social Criteria

1. ***Social acceptability:*** Whether the intervention is accepted by the local people? Does it affect the livelihoods or the customs and traditions? Does it affect the routine relations among the people and the whole community? Do they feel that the proposed intervention is going to redress the grievances of the people at large?

2. ***Potential number of families benefited:*** How much percentage of families in the community are benefited by the proposed intervention and how many are adversely affected? What compensation is proposed for the affected families?

3. ***Potential number of jobs created:*** With the proposed intervention, how many jobs are created or how the livelihood of the people is supported. Whether the created jobs are casual or permanent? Also, consider whether the jobs keep expanding by the passage of time or get exhausted gradually.

4. ***Percentage of people below poverty line that benefit from the project:*** How many poor people already below poverty line have been benefited from the proposed project? Whether their socio-economic uplift is sustainable or it will gradually lose its effect. If so, what alternatives are proposed to make their earnings sustainable for future?

5. ***Women's role:*** What extra opportunity is proposed for the women's role in the social setup? Would women get enough opportunity to raise their income to improve the socio-economic conditions of the family? What additional role the women can play in the proposed intervention to extend their role in the socio-economic fabric?

[27]The World Bank.Methodology for Ranking Irrigation Infrastructure Investment Projects. Tashkent 2010

6. ***Beneficiaries' involvement throughout the project phases:*** Would the beneficiaries get involved throughout the project phases? If the proposed project intervention is to be completed in phased pattern, the beneficiaries will get benefit in all the phases of the project completion and beyond. Thus, the benefits to the community will commence right from the project inception and will continue throughout the project tenure and after completion of the project.

7. ***Resettlement:*** Would the proposed intervention create the resettlement issue? If yes, to what extent? Any strategy outlined to address the issue of resettlement and the job security in case of the disturbance of the families?

B. Financial Criteria

1. ***Financial feasibility:*** Is the project intervention financially feasible? Whether the activity satisfies the cost benefit analysis and is economically feasible for execution. How much time it would require to pay back the costs incurred on the project execution.

C. Environmental

1. ***Positive effects on soils:*** Is the project leading to changes in soil characteristics within the project area or the vicinity due to such activities as irrigation, application of fertilizers and agro-chemicals, cultural practices, drainage etc? Changes that may improve or impair soil structure, workability, permeability, fertility and water holding capacity etc.

2. ***Positive effects on water quality:*** Does the proposed intervention lead to improvement / deterioration of water quality? Major concern is related to the health of the population of the vicinity. Secondly, the polluted water also affects the livestock and other wild life including birds. The polluted water is dangerous too for fish as well. Moreover, the stagnant polluted water hibernate the mosquitoes that are dangerous for human health.

3. ***Positive effect on ecology:*** Does the Project cause zoological imbalances (insects, rodents, birds and other field animals) through habitat modification, additional food supply and shelter, extermination of predators, reduced competition or increased diseases. Are crop pests or weeds likely to increase or decrease (particularly those favoured by irrigation/drainage/flood control) affecting yields, cultivation and requirements for pesticides or herbicides?

4. ***Effect of water table rise / fall:*** Does the project intervention increase the water table that hinders the crop growth or it lowers down to the extent that the crop suffers water stress under water scarcity? Rise or fall in water table affects land drainage, soil fertility and soil microbes. Rise in water table encourage weed growth and affects crop yields of those crops that are sensitive to water logging. Excessive fall of water table affects crop germination.

D. Socio-economic Criteria

1. ***People's socio-economic improvement:*** Does the proposed intervention help to improve the socio-economic conditions of the communities? Would it unfold avenues of employment and livelihood for the people of the area? Does the project adversely affect the livelihood opportunities?
2. ***Positive effect on people's health:*** Development projects occasionally affect the health of the people and quite new diseases emerge due to environmental changes in the area. Would the proposed intervention support the occurrence of specific diseases and health issues for the communities? What precautionary measures have been taken so far to address the health issues if such a condition happens?

3. ***Positive effect on livestock and/or fisheries:*** Does the proposed intervention adversely affect the livestock and / or fisheries? If so, what precautionary measures are taken to take proper health care of the livestock and fisheries in the project area?

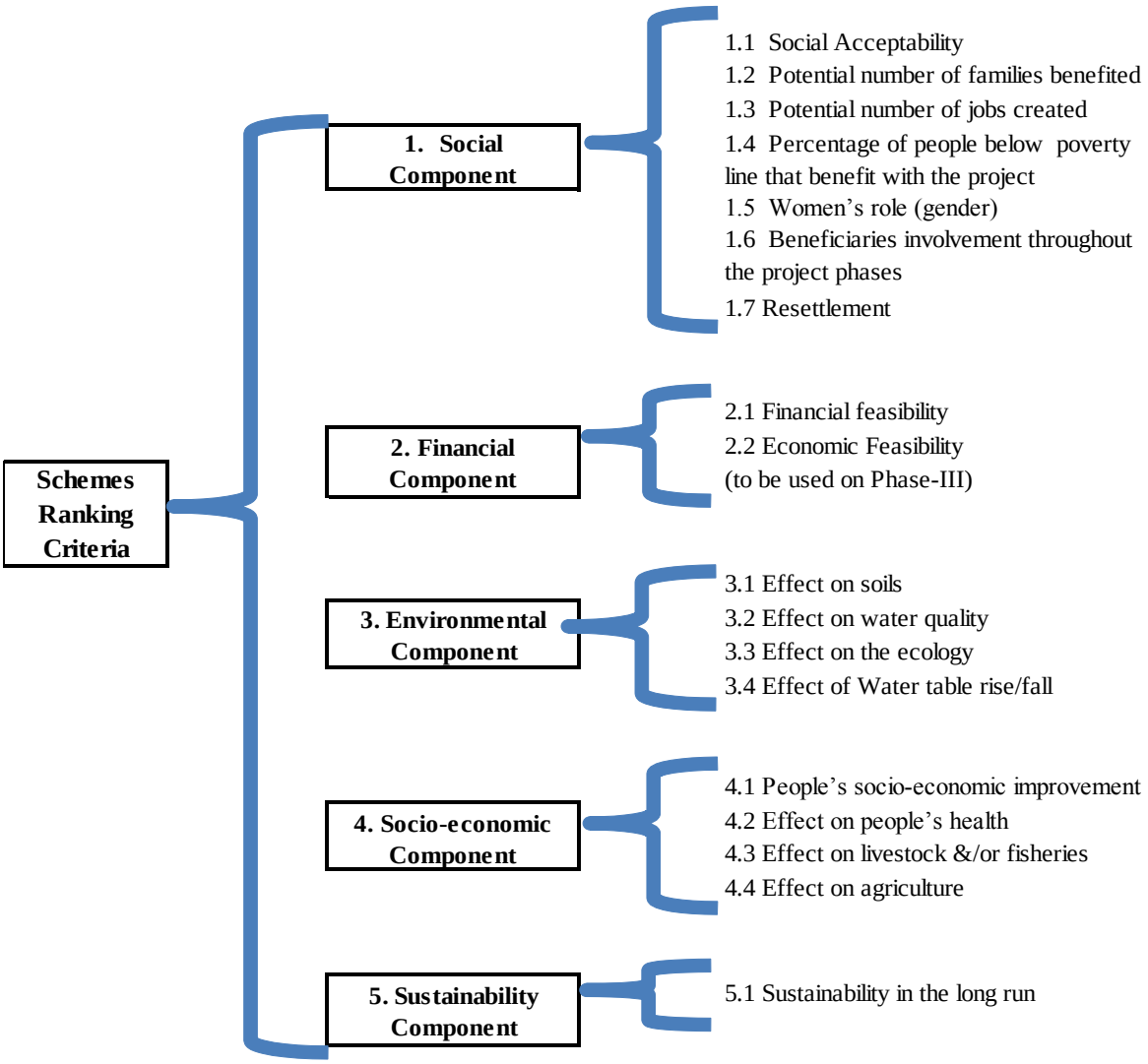
4. ***Positive effect on agriculture:*** What is the effect of proposed intervention on agriculture? Whether there is positive / adverse effect on agriculture production? What steps have been proposed if there is a possibility of having some adverse impacts on agriculture?

E. Sustainability Criteria

1. ***Sustainability in the long run:*** Sustainability[28] is the capacity to withstand overtime. Sustainability is the long-term maintenance of responsibility, which has environmental, economic, and social dimensions, including responsible management of resources. It describes how systems remain diverse and productive over time, a necessary precondition for the well-being of humans and other organisms.

The corresponding ranking tree is presented in figure below:

Figure 8.2: Ranking Tree



[28]Wikipedia http://en.wikipedia.org/wiki/Sustainability

Each of the sub-attribute identified by stakeholders for each of the interventions was evaluated according to the expected impact. The impacts being positive or negative were classified from none to very high in a scale that goes from 0 to +4 for the positive effects and from 0 to -4 for the negative effects expected. The World Bank (2010) follows a similar procedure, but ranks from 1 to 5. In the workshops of Phase-II, the stakeholders input were pursued as part of the evaluation criteria for the ranking method. Input such as the social acceptability of specific schemes.

The ranking is calculated based on the statistical parameter known as "standardization z" (also known as "z score"), which in statistics is defined as a standard score to express the number of standard deviations an observation is above or below the mean. "z" is a dimensionless parameter calculated by subtracting the population mean (μ) from an individual raw score (x) and then dividing the difference by the population standard deviation (σ). This dimensionless value (z) allows us to combine the scores of the five different components of the ranking process, regardless of the total possible points that each component can achieve. In a first instance all components were assigned the same "weight" (W = 1). The results are presented in the table below:

Table 8.3: Ranking Based on Standardized Z scores

N°	Prefeasibility	$W^+ = 1$ Total $w^+ z^*$	Rank
1	Rehabilitation and improvement of LBOD drainage infrastructure	5.850	**1**
2	Revival of natural waterways to drain out storm water	4.842	**2**
9	Protective plantation of mangroves in the coastal areas of left bank	3.002	**3**
5	Privatization of FGW SCARP tubewells	2.302	**4**
3	Rehabilitation of LBOD and SCARP tubewells	2.156	**5**
15	Establishment of Disaster Management Cell in SIDA	0.769	**6**
11	Bio-saline agriculture in Badin and Thatta districts	0.325	**7**
12	Rehabilitation of Deh Akro II and Chotiari wetland complex	0.195	**8**
16	Gender mainstreaming in irrigation and drainage	-0.748	**9**
10	Use of drainage water for forestation in the LBOD and Kotri areas	-0.776	**10**
4	Ghotki SCARP (saline zone)	-1.478	**11**
7	Elevated platforms for flood displaced persons	-2.235	**12**
14	Brackish water fish farming in LBOD area	-2.284	**13**
13	Shrimp and mud crab farming in coastal areas of left bank	-3.007	**14**
8	Rehabilitation of coastal wetlands	-3.404	**15**
6	Second line of defense for left bank of Indus d/s Kotri	-5.509	**16**

* Standardized Index
\+ Weight

Sensitivity analysis was also run increasing the weight of the social component in order to see the effect on the ranking. The social component "z" value was increased by 50% and the other four components were left unchanged. The results show that the first seven schemes continued to have the same ranking position.

8.6 Prioritizing Interventions

8.6.1 First Priority Core Interventions

It is proposed that given the exigency of the intervention, and considering their quantifiable and non-quantifiable benefits, five of the above pre feasibilities are recommended for undertaking detailed feasibilities, as core projects of high priority. They include:

i. Rehabilitation and improvement of LBOD drainage infrastructure (ranked 1);

ii. Revival of natural waterways to drain out storm water (ranked 2);

iii. Protective plantation of mangroves in the coastal areas of left bank (ranked 3);

iv. Establishment of Disaster Management Cell in SIDA (ranked 6); and

v. Gender mainstreaming in Irrigation and Drainage (ranked 9).

The first two have direct bearing on the aversion of flood disaster, if the high rain events relapse. They are expected to ensure timely and safe evacuation of storm water floods, and would save colossal loss and damage to standing crops, livestock, private and public properties and infrastructure, and more importantly human lives, and quality of life of rural communities, and miseries thereof.

The third intervention will complement the safe outfall of the drainage effluent into the sea, protect the outfall drainage infrastructure, and arrest and retard sea encroachment and salinization of productive farm land and water bodies in the coastal areas. It would also support livelihood of the coastal communities through restoration of fish potential.

Given the magnitude of the flooding risk and the inadequate capacity of the SIDA to cope with the water disasters, may it be storm water flood or river floods, the need for creating a vibrant and efficient Disaster Management Cell is overbearing, to coordinate the rescue, relief, and rehabilitation work in conjunction with PDMA and other relevant agencies.

It is proposed that to ensure the role of women in the participatory water management approach, the overarching mandate of SIDA, the social cell within SIDA also assumes the responsibility of ensuring main streaming in the organization, and adopt the recommendations of the pre-feasibility for the purpose which has been ranked nine in the selection criteria mentioned above.

Although the "Gender Mainstreaming in Irrigation and Drainage" sub-project was ranked at 9th place due to no assigned points for financial and environmental components, the Consultant proposed the scheme for implementation due to numerous unquantifiable benefits of investing in the development of human resources. Numerous studies and donor organizations including the World Bank advocate for women's participation in various programs to enhanced efficiency: 'Women who are trained to manage and maintain community water systems often perform better than men because they are less likely to migrate, more accustomed to voluntary work, and better entrusted to administer funds honestly' (World Bank 1992: 113). 'Investing in women' has been critically described as instrumentalist by scholars, noting how women have been taken on board insofar as they could contribute to productivity objectives, yet sidestepping deliberate advances towards achieving gender equality or transforming existing gender/power structures (Jackson 2000; Cleaver 2003)'. (Women and water management: an integrated approach", Dublin Principle 3, International Conference on Water and the Environment Development Issues for the 21st Century, (Dublin, 1992., http://fiesta.bren.ucsb.edu/~idgec/papers/Babette_Resurreccion.pdf)

8.6.2 Second Priority Interventions

i. Privatization of FGW SCARP tubewells (ranked 4); and

ii. Rehabilitation of LBOD and SCARP tubewells (ranked 5).

The review of the feasibility for the divestment of FGW tubewells Project (prepared by Consultants engaged by PID), was undertaken to reassess and evaluate its technical and economic viability in the current situation suggests that the project is still viable. Nonetheless, since the completion of the feasibility, the number of private tubewells has surged, and the demand for additional tubewell should have declined. Therefore the emphasis should be on divesting the existing public sector tubewell and facilitating the farmers to develop their own tubewells.

Similarly, the pre-feasibility of rehabilitation of the dysfunctional and non-operative SGW tubewells suggests that the investment will have a positive payoff. Notwithstanding its benefits the sustainability of investment is in question. It is reported by the beneficiaries, and observed by Consultants during the field visits, that more than 50 per cent of the tubewells are closed, mostly due to vandalizing of the pumps, motors, electrical fixtures, PMT, LTL, and HTL. The farmers apprehend that without safeguards for their protection, they would be closed down before the objective of lowering the water table is achieved. Hence is a risky investment.

Rather than reinventing the wheels, PC-Is, may be formulated by SIDA and PID within their jurisdictions, using the current prices, and submit for approval to the relevant forum, subject to availability of funds and if included in the development plans.

Third Priority Interventions

The following three projects, despite their technical feasibility, are marginally economic viable, and the rate of returns are not robust, and seems sensitive to variations in costs and benefits.

i. Bio-saline agriculture in Badin and Thatta districts;

ii. Use of drainage water for forestation in the LBOD and Kotri areas;

iii. Rehabilitation of Deh Akro II and Chotiari wetland complex.

iv. Brackish water fish farming in LBOD area;

v. Shrimp and mud crab farming in coastal areas of left bank;

vi. Rehabilitation of coastal wetlands;

The pre feasibilities of the first two abovementioned interventions suggest that the investments has modest rate of returns, however are sensitive to changes in cost and benefit structures. As these are directly relevant to the facilitating timely and safely disposal of the storm waters, and also not within the preview and mandate of the SIDA or PID, should be entrusted to the relevant agencies for its development into the respective development programs i.e. (i) above to Agriculture Department and (ii) above to Sindh Forest Department.

The analysis of the prefeasibility for the Rehabilitation of Deh Akro II and Chotiari wetland complex suggests that the main benefits is restoration of wildlife, and ecology of the wetlands, with limited quantifiable benefits from intercepting seepage from the Chotiari lake and preparation of a management plan for above wetlands.

It is recommended that the detail formulation and implementation of these interventions should be entrusted to the relevant agencies i.e. Wildlife Department for Deh Akro II and Irrigation Department for Chotiari. A co-ordinated effort will be required to implement these interventions as for Deh Akro freshwater will be required from Nara Canal to revive the dhandhs and for Chotiari Irrigation department and SIDA will be involved.

Interventions Not Recommended for Implementation

Following pre feasibilities were prepared and the analysis and it is recommended that they do not merit further considerations, for reasons mentioned below. They proposed interventions evaluated are:

i. Ghotki SCARP - saline zone;

ii. Elevated platforms for flood displaced persons;

iii. Second line of defense for left bank of Indus d/s Kotri.

The review of feasibility of Ghotki SCARP (1994), prepared by the Consultants engaged by WAPDA suggests that the proposed intervention is not economically viable now (price level of 2012), and will have enormous negative environmental consequences, mitigation of which will have high cost, which would further depress the economic viability. Moreover, the prefeasibility for the revival of *dhora*s includes construction of surface drainage network to flush out storm water flows from the Ghotki area.

The prefeasibility of the elevated platforms, prepared by the Consultants, suggest the proposed intervention has a very high cost (about Rs.1.2 billion), and would provide refuge to some 20,000 families or about 100 to 120 thousand souls. Moreover, it would be expensive to maintain these elevated platforms when not use. In addition due the threat of unauthorized occupation for other purposes, its sustainability is extremely unlikely. However, the widened drainage banks and canals, and sections of roads, if widened and strengthened could be cost effective, and will be accessible to a large number of flood displaced persons.

The prefeasibility of two interventions i.e. brackish water fish farming in LBOD area, and Shrimp and mud crab farming in the coastal areas of left bank indicate that the interventions have modest rate of return, but sensitive to changes in cost and prices. As the proposed interventions are essentially a private sector activity, the Sindh Fisheries Department could provide back up support to the interested potential fish farmers.

The prefeasibility of rehabilitation of coastal wetlands shows that intervention will not yield enough returns to justify investment, will have high risk of failure due to cyclones of the magnitude of 1999 cyclone 2A and will not be sustainable. In addition, the sugar mills effluent laden water from Karo Ghungro and Guni Phuleli drains will kill the local fish proposed to be promoted in dhand complex. Hence the intervention needs to be dropped for further considerations.

Similarly, second line of defence intervention was found technically viable, but is not socially acceptable. The communities along the proposed alignment vehemently opposed its implementation, as it entails risk of flood disaster. Hence, it is recommended that this does not warrant further considerations.

8.7 Overview of Federal and Provincial Policies and Ordinances

This document provides the Policies, Acts, Ordinances and Rules framed and approved at Federal and Sindh Provincial levels. The document covers above legal instruments for Land, Water (Irrigation and Drainage), Wildlife, Fisheries, Forests, Coastal development and Environment.

With the passage of time there have been amendments, revisions and rules under the purview of these Policies, Acts, Ordinances and Rules. This document does not describe these amendments.

8.7.1 Interprovincial policies and accords

This chapter describes the Water Accords on Indus Waters.

The waters of Indus has been a cause of controversy between the upper riparian and lower riparian areas since 1901. After partition there have been quite a number of agreements and accords on distribution and apportionment of Indus waters amongst the major stakeholders. Some important ones are listed as under:

- The Indian Irrigation Commission (IIC) 1901-03.
- Sindh Punjab Agreement 1945
- The Indus Water Treaty 1960
- The Indus Water Accord 1991

The latest one The Indus Water Accord, 1991 is described as under:

The latest Accord in the series of accords on sharing of Indus wayers was signed on 16th of March 1991 by all the four provincial governments of Pakistan. Under this Accord Sindh, including Karachi other requirement, has been assured water supply of about 48 MAF during the Kharif and Rabi seasons. The Punjab is to get 56 MAF, NWFP now KPK and civil canals 8.78 MAF and Balochistan 3.87 MAF. The balance water supplies are to be distributed in proportions of Sindh 37%, Punjab 37%, NWFP 14%, and Balochistan 12%. This Accord allocated 10 MAF for release beyond Kotri to help survive the mangroves and livelihood of local populace, against the calculated demand of 27 MAF.

After 1991 there have been some disagreements and complaints between the stakeholders on the management of agreed apportionment and water diversions.

8.7.2 Federal Acts/Laws/Ordinances

8.7.2.1 Land

Land Acquisition Act, 1894

This law regulates the acquisition of land to public purposes. The Act does not define the “public purposes” except stating that it “includes the provision of village sites” but a broader interpretation has not been excluded. Land may also be acquired by a “Company which is engaged or is taking steps for engaging itself in any industry or work which is for the public purpose”. In addition the law allows

for the "temporary occupation and use" of waste or arable land for a maximum period of three years. Compensation is to be provided in cash, in the form of an alternative land allocation, or through other equitable arrangements.

Detailed procedures to be followed prior to and during acquisition, and in the determination of compensation, are specified. The government may, however, bypass normal procedures to take possession of land required for a company in case of "urgency". The law provides for a preliminary enquiry to survey land and assess its suitability, allowing government officers to bore into the sub-soil, dig trenches, and cut down or clear standing crops and "jungle" areas. Powers under this Act, including the power to make rules, lie with the provincial government while specified acquisition procedures are administered by local government officials.

Following Acts are also on record with respect to Land Resource:

- Land Reforms Act, 1977
- Land Reforms Regulations, 1972
- Land Improvement Loans Acts, 1883
- Transfer of Property Act, 1882

8.7.2.2 Environment

Pakistan Environmental Protection Act, 1997 (PEPA)

The Pakistan Environmental Protection Act 1997 can be regarded as the most important piece of environmental legislation in Pakistan It provides a framework for environmental law reform and covers three important areas:

- Land, Planning and Development
- Natural and cultural resources, use and conservation and
- Pollution control and waste management

The law is based on the concept of sustainable development, protection, conservation, rehabilitation and improvement of the environment for the prevention and control of pollution. The objective of PEPA is to provide for co-operative environmental governance through a series of principles relating to:

- The procedures for state-decision-making on the environment; and
- The institutions of state which make those rules

PEPAs principles serve as:

- A general framework for environmental planning;
- Guidelines according to which the state must exercise its environmental functions; and
- A guide for the interpretation of the PEPA, 1997 itself and of any other law relating to the environment.

PEPA, 1997 can only be applied to future problems or those problematic decisions and actions that were implemented after 3rd December, 1997. It cannot be applied to environmental problems arising before this date unless the problem still persists.

Following are covered under PEPA, 1997

1. **Institutions established under PEPA, 1997**

- Pakistan Environmental Protection Council
- Pakistan Environmental Protection Agency (EPA)
- Provincial Environmental Protection Agency
- Provincial Sustainable Development Fund
- Environmental Tribunals

2. Discharge of emissions in excess of National Environmental Quality Standards (NEQS)

- Initial Environmental Examination (IEE)
- Environmental Impact Assessment (EIA)
- Prohibition of the import of hazardous waste
- Environmental Protection Order (EPO)
- Offences committed by Companies
- Offences committed by Government Agencies, local Authorities or Local Councils

8.7.3 Provincial acts/ordinances/rules

8.7.3.1 Irrigation and drainage

Sindh Water Management Ordinance, 2002

This ordinance establishes a framework for executing and managing schemes for irrigation, drainage and flood management. Water is defined broadly in section 2(r) as "any water standing or flowing on surface or found in the soil at any place in the province". Water controls all underground water resources.

The law reconstitutes the Sindh Irrigation and Drainage Authority (section 3) and provides details regarding its composition and operational procedures (sections 5-9). The Authority was established under section 3 of the Sindh Irrigation and Drainage Act, 1997, which is replaced by the 2002 Ordinance.

Functions of the Authority include operating and maintaining irrigation and drainage systems and carrying out flood protection (section 10). The Authority advises the provincial government on these matters, along with issues such as drought management and sea water intrusion.

The ordinance also assigns specific tasks to the Authority, including the distribution of irrigation from barrages within the province and from inter-provincial links canals (11 c). The Authority is empowered to levy and collect service fees and surcharges (section 11 e).

Area Water Boards, which may be established or re-constituted by the provincial government (section 28) and farmers Organizations (section 40) established under section 26 A (1) of the repealed 1997 Act, perform within their respective territorial jurisdiction many of the same functions. One notable additional responsibility of the area water boards is to monitor the disposal of "toxic or noxious effluent safely and with minimum pollution of water resources" (section 38(1). Area water boards are empowered to charge fees for monitoring services provided 9section 28(2), and to notify the Regulatory Authority of offences related to the discharge of toxic effluent within its jurisdiction (section 28(3).

The government is required to establish a Regulatory Authority of Drainage and Flood Protection (section 67), the main purpose of which is to ensure compliance with the provisions of this Ordinance (section 74(1)). It performs mostly supervisory functions but is awarded specific powers to enforce compliance (section 81). It is also empowered to determine fees and charges (section 77), institute measures for drought control (section 78), and sanction measures to prevent the "waste, undue consumption and misuse" of water (section 29).

The Ordinance empowers both the Authority and the provincial government to establish various user level boards, committees and associations, and deals almost exclusively with the powers and functions of these bodies. Offences under the law are covered in a single section, and include obstructing a watercourse, allowing cattle or animals to bathe in or near a water source, and permitting the "steeping" of "dangerous material" near or in a water source (section 103).

Maximum penalties specified under the law extend to six months' imprisonment and or a fine of PKR. 100,000. It should be noted that these prohibitions apply only to water resources that "belong" to the Authority, area water boards or farmers' organizations. Rules are to be framed by the provincial government but regulations may be framed by the various bodies established under this Ordinance (section 104).

Sindh Irrigation and Drainage Authority Rules, 1999

These Rules were framed under the Sindh Irrigation and Drainage Authority Act 1997. Although the 1997 Act are not specifically repealed or saved by the 2002 Ordinance.

The Rules provide for the transfer of assets from the irrigation wing of the provincial irrigation and power department to the Sindh Irrigation and Drainage Authority, from the Authority to area water boards, and from area water boards to farmers' organizations, specifying the conditions on which such assets are to be retained (sections 3-5). The Authority grants "concessions" (operating licenses) to area water boards allowing them to operate, maintain, develop and approve the "water management infrastructure [and] associated land" (section 7). Area water boards in turn issue concessions to farmers' organizations for the same purpose (section 7(7)).

In carrying out their functions with respect to infrastructure as well as land, area water boards are required to exercise "all due prudence and care" (section 7(4)). Water boards may be required by the authority to undertake "corrective actions" or pay compensation in cases where they have breached their obligations (section 7(5)).

The rules specify terms and conditions related to the supply of water, including the individual share of each canal command area, and allow the authority to determine charges for water supply as well as "non-water services" provided (sections 8-10). Criteria according to which the aggregate water entitlement of each canal command area is determined include an "increased requirement for industrial, domestic [,] environmental or health-related water usage" (section 10(2)).

Sindh Irrigation and Drainage Authority (pilot Farmer organization) Regulations, 1999

These regulations, framed under the Sindh Irrigation and Drainage Authority Act 1997 provide for the functioning of farmers' organizations. The 1997 Act has been repealed by the Sindh Water Management Ordinance 2002 but regulations framed under the 1997 Act are not specifically repealed or saved by the 2002 Ordinance.

The substantive provisions of these regulations cover matters related to the establishment, performance and jurisdiction of farmers' organizations (sections 3-6). All money received by farmers' organizations are paid into a fund which is used to finance operating costs, service debt, and pay for "capital replacements and improvement charges" (section 11). The Sindh Irrigation and Drainage Authority may suspend the operations of any farmers' organization found to be "working against the public interest" (section 7(1)).

Sindh Irrigation Act, 1879

This Act provides for matters related to irrigation, a subject that is also governed by the Sindh Water Management Ordinance 2002. The 1879 law remains in force to the extent that its provisions do not come into conflict with the 2002 Ordinance. In cases of any inconsistency, the provisions of the 2002 Ordinance have overriding effect (Sindh Water Management Ordinance, 2002 section 105).

The law allows the provincial government to 'apply' and use water from any river, steam, lake or subsoil source for the purpose of canals (Sindh Irrigation Act 1879, section 5). Canal officers are empowered to enter the land on which such a water source is located, remove obstructions and proceed with canal works (section 6). The government and canal officers have similar powers with respect to drainage works (section 15). Canal officers authorized the construction of new watercourses (section 16), and settle disputes regarding mutual rights and liabilities of persons interested in watercourses (section 26). Those requiring the construction of a new watercourse, but unable to arrive at a private arrangement with the owners of the land on which such a watercourse is to be constructed, may apply to the canal officer (section 17). If the application is accepted, the land is acquired under the provisions of the Land Acquisition Act 1894 (section 19).

In cases where an "accident" has befallen a canal or is imminent, canal officers may enter land adjacent to the canal, take trees and "other materials" and undertake works to prevent or repair the damage (section 9). Similarly, where it appears necessary to undertake immediate repairs on a canal in order to prevent "extensive public injury" or "serious public loss", canal officers may request for

labour from residents and land owners in the vicinity, who are "bound to assist" in repair work but are to be compensated at rates "that shall not be less than the highest rates for the time being paid in the neighborhood for similar labour" (section 58).

Where "substantial damage" has occurred as a result of activities carried out under the provisions of this Act, compensation may be awarded (section 31). Compensation cannot, however, be claimed in cases where the damage has been caused by repair work, or by measures "considered necessary" to regulate water flow in a canal or maintain a watercourse.

The law provides for the supply of water from canals (sections 27 and 28) and for various rates that may be levied for water supply (section 44). Charges may also be levied for unauthorized use (section 45) and for wasting water either deliberately or through neglect (section 46).

Penalties under the 1879 Act are for the most part related to interference or damage to canals, although "corrupting" or "fouling" the water is also listed as an offence (section 61 (3)), punishable with imprisonment for a term of up to two years and or a maximum fine of PAK 10, 000. Public servants found to be conniving, either directly or indirectly, in the commission of an offence are considered to be abettors and liable to the same punishment (section 62-A).

Under section 105 of the Sindh Water Management Ordinance, 2002 the powers of canal officers under the 1879 Act are to be exercised by the Sindh Irrigation and Drainage Authority and area water boards in their respective areas of jurisdiction.

8.7.3.2 Land

Sindh Land Revenue Act, 1967

This Act provides for the delimitation of districts, the preparation and maintenance of record of rights and a number of related matters. The law requires that a record of rights is prepared for every estate and all acquisition of land is reported. Revenue officials are empowered to enter and survey land and mark boundaries. Land owners affected by the delimitation are entitled to compensation. Joint holders of land may apply to partition their holdings. The Act allows revenue officials to enforce customary tenure practices in areas where the periodic redistribution of landholdings is an established custom. Similarly revenue officials may also act to remove encroachments from the lands that have been reserved in the revenue records as commons. According to the provisions of law, all unclaimed or un-occupied land, wasteland and any spontaneous produce or any accessory interest in land vests with the government unless ownership is expressly provided for in record of rights completed on or before 18 November 1871. Both the government and Board of Revenue are empowered to make rules under this Act.

Sindh Tenancy Act, 1950

This Act regulates the relationship between the landlords and agricultural tenants. It clearly defines the conditions under which various tenancy arrangements persist. The law provides certain safeguards with regard to land and agricultural labour. For example, tenants who have "improved" the land are entitled to compensation if they are evicted. For the purposes of this law, the term "improvement" is defined as any work which increases the "material value" of the land, including the construction of irrigation and drainage works, and reclaiming, leveling or terracing. The extraction of free labour is declared to be unlawful. The provincial government may make rules to govern a number of matters related to tenancy agreements including the mutual rights and obligations of landlords and tenants.

8.7.3.3 Forests and Trees

Forest Act, 1927

The Forest Act enacted more than 80 years ago remains the basic charter for forest management. Since independence, the Forest Act, 1927 has been in force throughout most parts the country. It was only recently as 2002 that the NWFP government adopted a new forest legislation. In Sindh, Punjab and other provinces forests continue to be governed by Forest Act, 1927 except few amendments. Existing laws governing the forestry sector are designed to regulate the exploitation of forests and plant resources, and contain no clear provisions regarding sustainable use or conservation.

The Act is designed to protect forest areas and regulate forest produce. Forest Act provides for the creation of various classes of forests and allow governments to reserve state owned forest land, assume control privately owned forest land, and declare any government owned forest land to be protected area. The law prohibits grazing, hunting, quarrying, clearing, for the purpose of cultivation, removing forest produce, and felling or lopping trees and branches in reserved and protected areas.

Standing forests and wastelands on government or over which the government has proprietary rights may be declared reserved by the government through notification in the official gazette. Land clearing, felling trees, cultivation, grazing livestock, trespassing, mining and collecting forest produce are prohibited in reserved forests, along with hunting, shooting, fishing, setting traps or snares and poisoning of the water. These offences are punishable with a fine or imprisonment which has been revised from time to time by the government and notified.

The government may assign rights over a reserved forest to a village community. Such forests are known as village forests and government has power to regulate the management of these forests. The government may declare trees or class of trees to be reserved, close entire forests or parts of a forest, and prohibit mining, clearing and removal of forest produce.

The courts may impose penalties for trespassing and other offences on the basis of value of forest produce with the confiscation of equipment and illegally taken produce. There is provision of grant of reward to the persons providing information including forest staff.

The law allows forest officials and police officers a wide range of powers including the authority to arrest suspected offenders without a warrant, release detainees on bond and act to prevent forest offence from being committed. The provincial government also controls the transit of forest produce within and outside the province. Offences in this aspect are also penalized.

The government may make rules and delegate its powers to forest officers who carryout the tasks of policing and enforcement in addition to the responsibility for surveying, mapping, and implementing rules issued under the law.

Following Ordinance and Act are also enacted to manage and control trees, parks, firewood, and charcoal:

- Sindh Plantation Maintenance of Trees and Public Parks Ordinance, 2002
- Sindh Firewood and Charcoal (Restriction) Act, 1964

8.7.3.4 Coastal Development

Sindh Coastal Development Authority, 1994

This Act establishes an Authority that is responsible for the development, improvement and beautification of the coastal areas of Thatta and Badin districts. The Authority may plan and execute schemes related to a number of sectors including fisheries, and assists in the development of fish harbours. The Coastal Development Authority continues to operate under the provincial government hierarchy.

The Authority is also responsible monitoring development schemes, as well as drinking water facilities, communication systems, electricity, drainage, development of fisheries, livestock, livestock, horticulture and forests. It develops marketing facilities and constructs jetties and harbours. It acts as a coordinating agency for the federal and provincial governments, local authorities or autonomous bodies and collaborates with them development and environmental protection activities. The Authority provides technical guidance including services for development activities and carries out research for development planning. It assists in the establishment of coconut palm plantations and the development of fish harbours and oil refineries.

8.7.3.5 Fisheries

Sindh Fisheries Ordinance, 1980

This ordinance regulates fishing operations, and applies to inland fisheries in public waters as well as to territorial waters. The “Fishing” and “public waters” are explicitly defined. The provincial

government has the power to issue leases for fishing licences in any public waaters. Lease holders may in turn issue permits for fishing in leased waters.

The Ordinance lays down restrictions in the case of selected species of fish. Under section 4, the species listed in First schedule may only be caught with a permit or licence, and only during a specified period. There is a prohibition on taking the specimens that are smaller than 12 inches in size. The government may add or remove species from the schedule. A licence is also required to operate a "fishing craft" defined as a "vessel propelld or moved in any manner and used in fishing or for transport or processing of fish" This provision does not apply to recreational fishing. In addition to these regulatory measures, the ordinance allows the government to declare "any public waters" to be a sanctuary for the species mentioned in the First Schedule, and to prohibit the killing, capturing or taking of fish from such waters for a specified period without a "special" permit.

The government regulates various aspects of commercial fishing including the size of mesh that may be employed, the type of fishing equipment that may be used, and processing and marketing operations. The government may appoint fisheries inspectors who are empowered to arrest fishing offenders, seize equipment and fish involved in a suspected offence, "compound" offences and cal for police assistance. The ordinance serve to protect fish species in general, along with aquatic environments use of explosives, poisons and noxious materials for the purposes of catching or destroying fish and aquatic life, and prohibits the discharge of untreated sewage, effluence and factory waste into any waters.

The maximum penalty for carrying out fishing activity without licence is a fine of Rs. 50,000, and or imprisonment for a term of one year. Maximum penalty for employing destructive methods are Rs. 10,000 or six months imprisonment. The government may delegate powers or and make rules to regulate wide range of activities.

Sindh Fisheries Rules, 1983

Rules framed under section 27 of Sindh Fisheries Ordinance 1980, provide for the regulation of fishing operations. They contain procedures related to the issuing of fishing licences and permits, and the registration of fishing vessels. The rules also provide for the leasing of fishing rights in "any public waters". Such leases, issued annually through an open auction, apply in months may and June. During these months no fishing in leased waters may be carried out except by the lease holders. The rules provide for the declaration of sanctuaries within the public waters and such areas are to be clearly marked so that "the person who happens to visit or use those waters should at once know that it is a sanctuary". Limited protections are there for specified species. The rules provide for establishment of fund which is used to finance the development of fisheries. The remaining provisions of the Rules deal with matters related to the landing, processing and sale of fish at markets and collection centers and collection of royalties. Leases, licences and permits may be cancelled for violating the provisions of the 1980 ordinance and the rules. Offences not covered by the 1980 Ordinance are punishable with fine or imprisonment.

8.7.3.6 Wildlife

Sindh Wildlife Protection Ordinance, 1972

This ordinance enables the provincial government to establish protected areasand specifies activities that are prohibited in such areas. The exploitation of forests within a wildlife sanctuary is prohibited, except for the purpose of "reducing the hazards (dic), epidemic or insect attacks or other natural calamities". In national parks felling, trapping, collecting, burning, damaging or destroying any plant or tree is prohibited. At the same time, the ordinance requires that forests inside a national park are "so managed and forest produce obtained as not to impair the object of the establishment of the national park", suggesting that the extraction and use of forest products is permitted. The protections afforded by this ordinance are subject to broad exemptions since the provincial government may authorize any of these activities for scientific purposes, for example aesthetic enjoyment or betterment of scenery in a sanctuary or for the betterment of a national park.

In 2001, the protection clauses of the 1972 ordinance were further limited through the promulgation of two amendment ordinances. New provisos were added to sections 14(3) and 15(4), allowing the government to permit the laying of underground pipelies "using construction techniques other than blasting" in a wildlife sanctuary or national park, and exempting from the provisions of sections 14 and 15 "any activity" in sanctuaries or national parks that is connected with the "exploration or production of oil and gas". Such operations must not "permanently disturb" wildlife or the environment and must be undertaken in accordance with an environmental impact assessment (EIA), as defined in PEPA, 1997. No mention is made of hoe the impact of such activities on wildlife is to be mitigated.

The law requires that the government establish a Wildlife Management Board (section 4), which operates a fund (section 5). Specific functions are responsibilities for the board are not specified, nor does the law state where money in the fund come from or on what they are to be spent. These matters may be addressed by means of rules framed by the provincial government (section 41).

Wildlife, forest and other officials are awarded powers to arrest suspected offenders without a warrant (section 27), search without a warrant premises or persons (section 21), seize wild animals as well as equipment involved in a suspected offence (section 22), release suspects on bond (section 28) and "compound" offences to the tune of PKR. 15,000 (section 33). The government may delegate to wildlife officials additional powers to hold an inquiry, call witnesses, issue search warrants and prosecute a case (section 34).

Originally, maximum penalties under the 1972 Ordinance amounted to two years' imprisonment and/or a fine of PKR.1,000 (sections 17(1), 17(2) and 17(3)). These penalties were increased significantly in 1998, by means of an amendment Ordinance, but only with respect to the hunting of specified species. Penalties in 1998 amendment, added by means of a new section 17(1-A), are as follows: three months' imprisonment or a fine of PKR.100,000 for hunting rabbit; six months in prison or a fine of PKR.150,000 for hunting deer, "hooder" or "para"; and nine month sentence or a fine of PKR.300,000 for hunting ibex (section 17(1-A)). The maximum penalties for other offences under this law remained unchanged until 2001, when an Amendment Ordinance issued in that year brought about a tenfold increase in the fines that could be imposed under sections 17(1), 17(2) and 17(3). This amount now stands at PKR. 10,000. In addition to amendment acts and ordinance, many notifications have been issued over the years to amend the 1972 Ordinance or its Schedules.

Other Wildlife Protection Ordinance and Rules are as under:

- Sindh Wildlife Protection Ordinance, 1977
- Sindh Wild Birds and Wild Animals Protection Rules, 1953

Conclusions

This document provides the Policies, Acts, Ordinances and Rules framed and approved at Federal and Sindh Provincial levels. The document covers above legal instruments for Land, Water (Irrigation and Drainage), Wildlife, Fisheries, Forests, Coastal development and Environment. With the passage of time there have been amendments, revisions and rules under the purview of these Policies, Acts, Ordinances and Rules. This document does not describe these amendments[29].

[29] Huma I K., Citizens Guide to Environmental Rights, Duties and Obligations. Published by WWF-Pakistan-Indus For All Program.

9 The Perspective Plan

A perspective plan is a document supported by illustrations and maps, containing spatio-economic development policies, strategies and general programs of the planning unit. Being a long term plan, the basic purpose of the perspective plan is to provide a policy frame work for further detailing, and it serves as a guide for planning unit in preparation of development plan. The goal of any perspective plan is to guide towards achievement of a better quality of human life for the population as well as the residing in adjoining hinterland subject to resource constraints.

The Regional Master Plan for the Left Bank of Indus mainly concentrates in providing the strategy for ensuring safe disposal of the drainage effluent, storm water, and riverine floods to mitigate damages from water hazards and to agriculture and livestock, productive, physical, and communication infrastructure, vital installations, and most importantly human lives and livelihoods in the left bank of Indus encompassing the command areas of Guddu, Sukkur, and Kotri barrages, and the coastal areas.

9.1 Plan Objectives and Strategy

Objectives

WSIP-I was justified because of the following arguments stated by the World Bank (2007):

i. *"The key challenge for Pakistan is to sustain its recent growth performance in order to generate significant poverty reduction.*

ii. *The infrastructure challenge is particularly acute with respect to water as Pakistan relies on the largest contiguous irrigation system in the world.*

iii. *This massive infrastructure is deteriorating and in need of rehabilitation along with reforms to improve allocation of water as well as the efficiency of its use."*

As expressed before, the World Bank (2007) identifies three inter-linked and mutually reinforcing pillars of the Country Assistance Strategy: i) sustaining growth and improving competitiveness; ii) improving government effectiveness and service delivery; and iii) improving lives and protecting the vulnerable.

Accordingly, the objectives of the Regional Master Plan for the Left Bank of Indus were identified as:

- *Prepare for the Government of Sindh a Regional Master Plan for addressing the flooding issues and providing proper drainage to the area on Left of River Indus through structural and non structural measures.*
- *Recommend remedial measures for any outstanding deficiencies in the Left Bank Outfall Drainage System.*
- *Recommend measures for retention and / or Safe disposal of drainage, Storm and flood Water.*
- *Recommend improvement of wetlands in the delta area and coastal zone recognizing their environmental importance and considerable potential for the local communities.*
- *Studies to be carried out in consultation with the stakeholders starting from beginning to end covering identification of the issues, analysis and design of solutions.*

Proposed Regional Plan Strategy

In developing the proposed regional plan strategy, the Consultants followed an extensive stakeholder consultative approach, and organized consultative workshops at community, district, and regional levels to register their perceptions about the drainage disposal related issues and problems, and to

solicit their perceived solutions and aspirations and identification of priority interventions. Based on this, the prefeasibilities were prepared and prioritized in consultation with stakeholders, and this lead to the formulation of regional plan and action/implementation plan.

The five main pillars of the proposed strategy are:

i. Safe and timely disposal of surplus drainage effluent, and storm water flood.
ii. Combating waterlogging and salinity in non-LBOD areas.
iii. Environmental mitigation
iv. Institutional Strengthening and capacity building of SIDA
v. Livelihood support to water hazard affected communities.

9.2 Core Interventions

During the Phase II of the Study, pre-feasibilities were prepared for eight structural, six quasi-structural, and two institutional interventions that were selected and agreed in the national workshop. In addition to this three position papers were developed to address and recommend actions required to the identified relevant issues. The list of the prefeasibility and the position papers prepared during this phase of the study are shown in Table 9.1:

Table 9.1: Pre-feasibility Interventions / Position Papers

A	**Structural Interventions**
	Rehabilitation and Improvement of LBOD Drainage Infrastructure
	Revival of Natural Waterways to Drain out Strom Water.
	Rehabilitation of LBOD and SCARP Tubewells
	Ghotki SCARP (Saline Zone)
	Privatization of FGW SCARP Tubewells
	Second Line of Defense for Left Bank of Indus D/S Kotri
	Elevated Platforms for Flood Displaced Persons
	Rehabilitation of Coastal Wetlands
B	**Quasi Structural Interventions**
	Protective Plantation of Mangroves in the Coastal Areas of Left Bank
	Use of Drainage Water for Forestation in the LBOD and Kotri Areas
	Bio-saline Agriculture in Badin and Thatta Districts
	Rehabilitation of Deh Akro II and Chotiari Wetland Complex
	Shrimp and Mud Crab Farming in Coastal areas of Left Bank
	Brackish Water Fish Farming in LBOD Area
C	**Institutional Interventions**
	Establishment of Disaster Management Unit in SIDA
	Gender Mainstreaming in Irrigation and Drainage
D	**Position Papers**
	Drainage Effluent Intrusion in the Ghotki Area from Southern Punjab
	Sugar Industry Effluent Treatment at Source
	Access to Potable Water in the Left Bank

First Priority Core Interventions

Given the exigency of the intervention, and considering their quantifiable and non-quantifiable benefits, five of the identified pre feasibilities were recommended for undertaking detailed feasibilities, as core projects of high priority. They included:

- Rehabilitation and improvement of LBOD drainage infrastructure
- Revival of natural waterways to drain out storm water
- Protective plantation of mangroves in the coastal areas of left bank
- Establishment of Disaster Management Cell in SIDA
- Gender Mainstreaming in Irrigation and Drainage.

The Sindh irrigation and Drainage Authority instructed the Consultants that not to proceed forward with the Establishment of Disaster Management Cell in SIDA study. The Panel of Experts expressed hesitation about the Gender Mainstreaming in Irrigation and Drainage study. The same was not further considered for full feasibility study, but might be considered among the studies for which bidding documents for future consultancy works will be prepared in Phase-IV of the present Consultancy Agreement.

Second Priority Interventions

- Privatization of FGW SCARP tubewells
- Rehabilitation of LBOD and SCARP tubewells

Third Priority Interventions

- Bio-saline agriculture in Badin and Thatta districts
- Use of drainage water for forestation in the LBOD and Kotri areas
- Rehabilitation of Deh Akro II and Chotiari wetland complex
- Brackish water fish farming in LBOD area
- Shrimp and mud crab farming in coastal areas of left bank
- Rehabilitation of coastal wetlands

Interventions Not Recommended for Implementation

Following studies are not recommended because they do not merit further considerations:

- Ghotki SCARP - saline zone
- Elevated platforms for flood displaced persons
- Second line of defense for left bank of Indus d/s Kotri

9.3 Outputs

Full feasibility Studies Prepared in Phase-III

The following studies were conducted at full feasibility:

i. Rehabilitation and improvement of LBOD drainage infrastructure
ii. Revival of natural waterways to drain out storm water
iii. Protective plantation of mangroves in the coastal areas of left bank
iv. Bio-saline agriculture in Badin and Thatta districts
v. Use of drainage water for forestation in the LBOD and Kotri areas
vi. Rehabilitation of Deh Akro II and Chotiari wetland complex
vii. Brackish water fish farming in LBOD area
viii. Shrimp and mud crab farming in coastal areas of left bank

ix. Rehabilitation of coastal wetlands

Feasibilities 1 and 2 are being finalized in Phase-III, but both of them are structural interventions and require detailed designs and drawings of the proposed activities, thus will be finalized in the next phase.

The feasibilities from 3 to 9 have been finalized and given in chapter 11 of this report. The rest will be included among the the studies for which bidding documents for future consultancy works will be prepared in the next phase.

9.4 Impacts of Proposed Interventions

9.4.1 Social Impact

Objectives

The purpose of this report is to present the findings of the household surveys and consultations with stakeholders and village communities the Consultant conducted in communities residing along dhoras suggested for revival. The consultations were conducted according to the requirements set out in the Terms of Reference for the following tasks:

Carry out environmental and social assessments in each sub area, and propose clustering of sub-s where these assessments are not cost effective to carry out separately. Undertaking environmental and social assessment in batches of sub-s may also form the basis for broader assessments for the whole study/ area;

Review the social conditions in the subs, and undertake social assessment of the Project;

Have consultations with the beneficiaries to develop appropriate methodology and levels of cost sharing/recovery for the Project works;

Community consultations - approach and methodology

The social impact study is related to the area that is traversed by the major dhoras on the Left Bank of Indus. The study includes the following dhoras and drains: Dhoro Puran, Sonhi Dhoro, Dhoro Naro, Hakro Dhoro, Dhoro Pithoro, Bhai khan Dhoro and D4 Drain. The total length of dhora and the proposed D4 drain is more than 700 km.

The main objective of this phase of community consultations was to discuss with communities proposed revival of dhoras and possible constructions of drains in the leftover areas. The major outcome expected was communities' views and opinions, their perceptions of possible impact of the proposed interventions as well as the mitigation measures as perceived by the communities.

In accordance with the main objective of the study, the following sample selection criteria were determined:

Major dhoras which have inactive parts considered for revival

Dhoras which are running but are partially encroached or blocked

Drains proposed for constructions

Districts which are traversed by the sampled dhoras/proposed drains

Talukas in each district traversed by dhoras/proposed drains

Villages situated within 200m from the dhora/proposed drain

Following the sample selection criteria, a multilevel sampling method has been adopted. The sample included six major dhoras and the longest proposed drain in the area. These dhoras traverse seven districts and 33 talukas. Two to three villages from each taluka (in total 91 villages) were randomly chosen for community consultations and data collections on village profile and household surveys. In each sampled village, the team conducted:

i. Open community consultations (separate for men and women)

ii. Household survey with six respondents (3 men and 3 women) randomly chosen and
iii. One Key Informant interview on village profile

Main Findings

Overall, open community consultations were conducted in **91 sample villages in seven districts**. In total, **2,815 persons** (**1,333 men and 1,482 women)** participated in the community consultations. In addition, data on the socioeconomic profile of local population were collected by semi-structured household questionnaires. In each village, six household questionnaires were completed. Overall, **543 persons (271 women and 272 men)** were interviewed.

The following is the summary of views and opinions brought up at the community consultations:

Perceived positive impact

Surveyed communities reported 9,573flood affected households, which makes 91% of all surveyed households. There are 9,373 households with some structures affected by the 2011 flood and 1,306 with the agriculture land affected. The most stated positive impacts which revival of dhoras would bring were as follows:

- Water will drain out fast
- Water logging and salinity will decrease
- Agriculture production will increase
- Houses and land will be safe
- Livestock will get sufficient drinking water
- Diseases will decrease
- Necessary drainage system will be developed
- Paid local labour will rise

Generally, local communities were satisfied with the proposal. They expect to be saved from flooding, damages and constant relocation during rainy seasons. People expect only rain water to flow in dhoras as they would use it for livestock and domestic purposes. The most cited benefits were that dhoro will enable fast draining of water and that land, houses and livestock will be saved from floods. The most of people's concerns were related to bunds which should be elevated and additionally straightened. In addition, people want to see dhoras revived along the entire length. Communities expect Government's seriousness and honesty throughout the planning, implementation and the monitoring of the Project and post-Project operation and maintenance.

'Puran is our mother; our descendants were always looking at Puran as mother; they saw it running. And that was the time when nearby lands were all green. Now, since many years we see it as our mother has passed away because all nearby lands are facing drought condition day by day.' Ghulam Mohammad Khoso village, Dhoro Puran, Tharparkar

Perceived negative impact

Majority of consulted population (78.1%) think that revival of dhoras will not have any negative impacts at all. The rest of the respondents think that the Project would be successful if it is done honestly and timely. In addition, consulted communities think that, once work is completed, operation and maintenance will be of utmost importance for the project.

Some of the agriculture communities in Mirpurkhas area were reluctant to discuss the revival of dhoro as their villages are almost entirely built in the dhoro and the proposed interventions would affect their structures and crops planted inside the dhoro. People think that it would be a very challenging task but with Government seriousness and dedication, the Project could be accomplished successfully.

Some of the perceived negative impacts of the proposed interventions are summarized below:

- Crops and structures inside the dhoro will be affected
- Access to other sides will be hard if bridges are not constructed
- Possible damage or cut of bunds would harm local communities

- Improper monitoring, maintenance and management will damage the whole area
- Potential overflowing will damage houses and livestock
- Any backflow will affect the area
- It may involve relocation of people

Perceived mitigation measures

More than 85% of consulted persons gave their vision of the mitigation measures which should minimize potential negative impact of the Project. The most common suggestions were:

- Ensure proper deep de-silting of dhoras by advanced machinery
- Make bunds stronger and ensure that villages are not easily flooded
- Build safety bunds around villages
- Have safe place for people if they have to move during the flood
- Ensure proper access from one to the other bank of a dhoro
- Prevent backflow by installation of gates
- Ensure timely and proper compensation for lost crops, structures and other affected assets
- Implement the Project and establish operation and maintenance of dhoras with honesty, sincerity and without corruption
- Involve local communities in every stage of the Project

Communities' readiness to participate in the project implementation

Almost without exception, respondents expressed their support for the proposed dhoras revival as well as the readiness to participate. **95.6%** stated that they are ready to cooperate with Government in every way they could. Most of ordinary people are poor and cannot contribute money, but they suggested paid daily labour, collecting donations, giving information to the working team, looking after construction material etc. Also, if local labour hired on daily wages, villagers would be able to contribute a day or two of work on a voluntary basis. Consulted communities expect the Government to involve them in operation and maintenance activities. *'Each time we have been ignored in development schemes; it is our basic right to get work in all schemes because our youngsters are jobless and they need work.'* Village Dhano Kolhi, Bhai khan Dhoro, Badin. People insist that, before any work, the Government should present them the work plan, consult with affected communities again and fully compensate those who would lose crops and structures due to dhoras revival.

9.4.2 Economic Impact

Separate construction, supervision, and design packages to be tendered during the implementation of the studies are being prepared as part of Phase-IV. Consequently, the economic impact of the interventions proposed in the regional master plan will be presented as part of the fore mentioned packages.

9.4.3 Environmental Impact

An **environmental impact assessment** (EIA) is an assessment of the possible positive or negative impacts that a proposed project may have on the environment. The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts when deciding whether to proceed with a project. It is the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions taken and commitments made.

The Regional Plan for the Left Bank of Indus, Delta and Coastal zone is being prepared by the LBG / Indus Associated Consultants under a study by SIDA. A number of interventions are proposed after detailed consultation and agreement by the stakeholders of the area through field visits, group discussions, seminars, workshops at village, district, AWBs, regional and national level. In first phase, issues and problems of the area were identified through rigorous consultative process. In second phase, solutions of the major issues were sorted out after detailed interaction with stakeholders,

personnel of government line departments, NGOs, technocrats, AWBs and SIDA authorities selecting most appropriate options, initially for preparing pre-feasibilities and later feasibility studies under third phase of the project. The environmental impacts were assessed for the interventions selected for the feasibility studies are as under:

No major negative impacts are expected from the selected projects. However, the anticipated impacts are minor and temporary while the benefits are long lasting and permanent in nature. Following is the summary of the impacts of the individual interventions:

1. **Rehabilitation and Improvement of LBOD Outfall System KPOD, DPOD, Tidal Link**

The proposed intervention will address the issue of drainage in the project area by disposing flood/drainage water into sea. It is environment friendly and supportive in reducing water accumulation thereby helping to address the water logging issue. It has positive effect on environment of the area.

The proposed intervention will also address the issue of overloading of the drainage infrastructure and will divert appreciable quantity of the drainage effluent (mostly storm water) to the thirsty Thar area where it will be utilized for recharging the underground aquifers and also for growing agriculture. Efforts will be made to give passage to water flow through natural water ways under gravity. If unavoidable, the displaced persons of the locality will be compensated by providing alternate livelihood and space provisions by appropriate re-settlement procedures. However, the overall impact of the intervention will be environment friendly.

Positive impacts:

a. Drainage effluent from the project area will find its way to the sea through enhanced drainage system
b. The storm water will be evacuated within a time frame of 3-7 days in most places. This will save the crops from inundation and failure as experienced in the previous design.
c. Agriculture production will increase due to control of water logging and salinity on one hand and threat to the crop damage due to ponding of storm water.
d. Overall environment of the area will improve
e. Tidal control structure will minimize sea intrusion to cropped areas as well as stop backflow of sub-drains out-falling in KPOD.
f. The salinity of the dhands that have tremendously increased due to tidal interference and seawater intrusion will be minimized and dhand ecosystem will be revived by the ecosystem approach.

Negative impacts:

a. More water from the project area will enter the LBOD system. The O&M activities are not taken on regular basis with the result the erosion of the banks of the drains will make the system vulnerable and unstable.
b. The process of erosion of tidal link banks and bed yet continues and may extend with the passage of time. Until the system becomes stable, there is always risk of extended flooding in the inland areas.
c. Under heavy rains as of the intensity of 2011 rains the system may not handle the storm water resulting in damage to crops, people and the property
d. Many isolated pockets exist in various areas of the left bank as pointed out in 5 core engineering report. Such pockets need to be connected to the drainage infrastructure for drainage disposal otherwise; depressions may hold storm water months as observed in 2011 rains.

e. Irrigation system in the event of heavy rains if not closed at least one week before rains, may add to the grievances of the people as in 2011 rains.
f. Culverts of suitable cross section if not provided at places of inadequate discharge may create ponding of water in isolated pockets / depressions.

2. Activation of Natural Waterways (Dhoras)

In pre-LBOD period, mainly the natural waterways were open and used to convey storm water to the sea or depressions evacuating the cropped areas in a couple of days. The LBOD caused dhora blockages at most places that caused ponding of water in isolated pockets resulting in inundation of vast cropped areas and settlements. Activation of the blocked water ways is of paramount value to vacate the storm water from these areas. Suitable siphons are proposed wherever the drainage system blocks these water ways. Moreover, the left over areas are also connected with dhora system so most of the inundated areas are now part of the drainage system.

Positive impacts:

a. Natural waterways (dhoras) are the streams that used to flow under gravity carrying the river water during floods. These dhoras were blocked by the large banks of the spinal drain and other branch drains, roads, and irrigation infrastructure. These waterways will be revived, so all storm water will find its way to sea under gravity.
b. All leftover areas are proposed to be connected with dhoras. Therefore, no storm water will stay in cropped areas but will find its way through dhoras to the sea. Thus the cropped areas and settlements will be saved.
c. Grievances of the storm water flood affectees will be addressed and huge losses to the tune of billions of rupees will be minimized.
d. Communication system will not be affected by the locals who give deliberate cuts in metalled roads and canals to evacuate their lands, villages and towns.
e. The outbreak of contagious diseases could be checked that occurred due to ponding of water in depressions for months that provided breeding places for the mosquitoes and other disease causing organisms.
f. Marketing of agricultural produce will continue thus the chances of failure of the perishable goods due to non-availability of road infrastructure will be avoided.
g. Losses to the common man with regard to the failure of crop, death of animals and loss of housing and property would be minimized.
h. Bypasses to the cities and towns that are located in the way of dhoras are provided to avoid loss of their valued buildings and inundation of the areas of these towns. eg. Naukot, Jhudo, Digri, and Mirpurkhas.

Negative impacts:

Following negative impacts are of marginal nature and most of these are manageable with proper management during the execution of the project.

a. Under heavy monsoons, the storm water flow in dhoras may overtop and flood nearby fields and settlements.
b. Locals have blocked dhoras and made path ways across dhoras for their personal works. Now the foot bridges across dhoras will be at distant places therefore, inconvenience will be created to the locals
c. At a number of places, the dhoras have been filled by the zamidars and are being cultivated. Such cultivated areas will be abandoned.

d. Some places in dhoras are occupied as settlements. These will be vacated, though compensation will be paid to the affectees.

e. At present the natural waterways (dhoras) are full of natural vegetation. Variety of fauna lives and thrives in these natural hideouts. Therefore, the wild life in such places will be affected.

f. Storm water in dhoras was being used for crops under water scarcity conditions, but now after revival of dhoras, the water will flow to its destination thus cannot be used for crops in case gates are not provided to stop the flow of storm water.

g. At some places, the stagnant water in dhoras is used as fish ponds for the local population, but after revival of dhoras, these fish ponds will not work instead, fish nets will be used fishing in dhoras

3. **Rehabilitation of SCARP Drainage Tubewells of LBOD System**

The tubewells were installed to lower down the water table but it reported that about half of the tubewells are non-functional. Rehabilitating the tubewells will lower down the water table and will help increasing the agricultural production. The intervention is environment friendly and beneficial for the community as a whole.

4. Privatization of FGW SCARP Tubewells

This intervention will privatize the public fresh groundwater tubewells. This intervention will increase the water availability for agriculture thereby increasing agricultural production with increase in cropping intensity and yields. This option is environment friendly and will help minimizing water logging and salinity.

5. Rehabilitation of Coastal Wetlands

This intervention shall help to revive the degraded ecosystem of the coastal dhands using internationally accepted “ecosystem approach”. The fish, reed grasses wild life and the migratory birds will occupy the dhands and improve the overall ecology of the area. The salinity of dhands will improve and the storm water will be stored that would supplement the irrigation supplies. This will certainly reduce the seawater intrusion and increase the livelihood opportunities for the communities. The intervention would prove environment friendly and supportive for communities.

6. **Protective Plantation of Mangroves**

The protective plantation of mangroves will help reduce the thrust of the cyclones and storms and will save the coast from degradation providing an effective biological wall against the strong winds and sea tides. Further, the intervention will address the problem of sea intrusion as the mangroves have the capacity to stop the movement of the sea water in the inland areas. The mangroves are also the store houses of biodiversity, breeding grounds for fish breeding and water fowl nesting and staging and, the saviors of coastline. Mangroves also provide livelihood and employment opportunities for the poor coastal communities. Thus the proposed project is environment friendly and socially acceptable.

7. Use of Drainage Water for Forestation in the LBOD Area

The proposed intervention will help utilize the drainage effluent together with irrigation water for growing forests in conjunctive or cyclic forms. A number of tree species utilize saline water for their growth and development and also take up salinity of the water or soil thus reducing the overall salinity of the area. The water of the surface drains is moderately saline and is not hazardous to growing trees. This intervention will add to the income of the people possessing marginal unproductive land.

8. Bio-saline Agriculture for marginal lands of Badin and Thatta Districts

This is an environment friendly intervention and will uplift the socio-economic conditions of the people holding marginal lands. Although the use of brackish water will alter the salinity conditions of the lands but the effect will be minimal because, the lands are already marginal while the drain water will have salinity between 1000-1500 ppm reasonably well suited for growing salt tolerant

agricultural crops, grasses, oil seed crops, trees and bushes as well as grasses as fodder for the livestock without increasing the land salinity.

9. Rehabilitation of Dek Akro II and Chotiari Wetland Complex

The proposed intervention is environment friendly and supportive for wildlife conservation and development of fisheries and other wild animals in both Deh Akro-II and Chotiari wetland complexes. The activities proposed in Deh Akro II are intended to improve the shortage of freshwater for wetland ecosystem and in Chotiari wetland complex due to construction of Moat and Interceptor drains will reduce the water logging in the areas adjoining the Chotiari reservoir wetlands. The proposed intervention is thus environment friendly.

10. Shrimp & Mud Crab Farming in Coastal Areas of Left Bank

The proposed intervention is environment friendly with no apparent negative environmental impact. The intervention shall also add to the livelihood of the people and create employment opportunities for the coastal communities. The socio-economic conditions of the people of the area shall improve. The shrimp and mud crab species are the export commodities and will earn foreign exchange for the country.

11. Brackish Water Fish Farming in LBOD Drainage System

The proposed intervention does not pose any significant threat to the environment and ecology of the project area. The main aim of the intervention is to utilize the drainage effluent for the development of saline fish farms in the vicinity of the LBOD branch drains. This intervention will not have any significant effect on the surrounding soils. The intervention shall create livelihood opportunities for the people of the area.

Other aspects of environmental impact

Drinking water quality: The PCRWR conducted a detailed of 23 cities of the country. About 357 water samples from 364 selected water sources were collected adopting the uniform sampling criteria and analyzed for 79 physico-chemical parameters including, trace, ultra trace and bacterial indicators. Analysis revealed the presence of three main water quality problems i.e. bacteriological (69%), arsenic (24%), nitrate (14%) and cities had a considerable percentage of bacteriological contamination (40-100%). In Sindh province, all the 14 sources monitored in Hyderabad were found unfit mainly due to bacteriological contamination (93%), excessive levels of iron (47%), and turbidity (93%). Karachi the largest metropolitan city and capital of Sindh province revealed (93%) unsafe water sources due to bacteriological contamination, TDS and fluoride (4%), sodium, chlorides and sulphate (7%), nitrate (11%), and iron (18%); only 2 out of 28 samples were safe. In Sukkur, 11 out of 12 sources were unfit because of bacteriological contamination, turbidity (50%), hardness, sodium, chlorides, potassium, arsenic and fluoride (8%), nitrate (25%), sulphate and TDS (17%).

It is estimated that 20 million residents of Sindh depend on irrigation water for their domestic use, especially in areas where the groundwater is brackish. The contamination of irrigation water by coliform bacteria exceeds the limits set by WHO. In all 92% samples were polluted while just 8% were within the permissible ranges of the WHO.

The main sources of water pollution in Sindh include: i) disposal of untreated sewage and city garbage into canals and river; ii) disposal of un treated industrial effluents into freshwater bodies; iii) seepage of fertilizers and pesticides from agriculture fields and soil; iv) disposal of highly toxic and high BOD laden sugar mill effluents into surface drains of the main drainage system; v) seawater intrusion from the river mouth towards the land (upto Thatta-Sujawal Bridge) carrying hyper saline water that percolates from river bed into the deep aquifers rendering the groundwater saline and unsuitable for domestic use; and vi) effluents of Kotri industrial area into river and canals.

About one hundred drinking water samples were tested in 2012 from water bodies from the project area. On analysis it was noted that 48 (60%) water samples had TDS within the maximum permissible

range of 1000 ppm (TDS). The remaining 40% samples had TDS above the maximum permissible range.

Water Quality of drains: The drains carry drainage effluent from saline tube wells, surface drainage from fields, irrigation water from canal escapes, storm water of monsoon rains and effluent from sugar mills. The drainage effluent tested in 2005 to 2007 had TDS in the range from 3,000 to 14,000 ppm and SAR in the range from 10 to 23. The allowable ranges for irrigation are TDS up to 2,000 ppm and SAR up to 18. Drain water tested in 2012 had dissolved oxygen almost 1 mg/l as compared to normal value of >5 mg/l. The fish feel suffocation below 4 mg/l. The TDS of the drain water samples ranged from 920 to 14630 ppm and averaged as 3919 ppm. The EC of the samples was in the range of 2.00 to 28.00 mS/cm. The maximum permissible level of EC for irrigation water is 3.00 mS/cm. Thus the drainage effluent was neither useful for irrigation nor for fish culture.

Extent of pollution of sugar mill effluent:

The sugar mill effluent discharged from 10 sugar mills in southern Sindh was tested. It showed that all samples had DO well below 3 mg/l (normal range of 5 mg/l). The BOD and COD of samples from all sugar mills was well above normal range of 80 and 150 mg/l respectively. Likewise the TSS was also higher than 150 mg/l (normal range). This showed that the effluent from sugar factories was highly polluted, thus if discharged in drains severely polluted the drainage effluent too.

Water Quality of the Province of Sindh with respect to Canal Command

Water quality of the project area was monitored in 2010 and 2011 on the basis of the canal command area on the left bank canals of river Indus. It shows that in all barrages the percentage of useable water has increased in 2011 as compared to 2010. Whereas, the area under marginal water was reduced in all barrage commands. The percentage of hazardous water was reduced in Guddu, but increased in Sukkur and Kotri barrages. The overall picture is satisfying due to a remarkable (15%) increase in useable water percentage. This increase has resulted in lowering the marginal water percentage from 53% to 35%, a decrease of 18%. However, the hazardous water slightly increased from 8% to 11% just an increase of 3% on overall basis. Remarkable increase in useable water is a good sign for promotion of agriculture in all canal commands.

Baseline survey of flora of the project area: Baseline survey of the flora in the project area was conducted. The vegetation available in the project area was identified and reported and the impact of the project interventions on the sustainability of the flora was discussed.

Baseline survey of Fauna of the project area: Baseline survey of the fauna of the project area was surveyed and diagnosed. Protected areas were surveyed and reported. Forest areas, irrigated plantations, game reserves, wetlands and Ramsar sites were reported. The impact of the project interventions was also discussed. Mamals, amphibians, reptiles, and fish species in the project boundary were recorded. Baseline survey of the archeological sites of the project area were identified and reported.

Baseline survey of Archeological and Heritage Sites in the study area

The archeological and heritage sites of the project areas are identified and discussed. No any serious impact is so far noted in the project area specifically for archeological sites. Heritage management plan is suggested with emphasis on mobilizing stakeholders for generating funds to preserve the heritage sites and other places of great cultural value with utmost honesty and dedication. It is proposed that the Federal Government may earmark a handsome budget from the national resources to keep the national heritage of Sindh intact. The Government of Sindh may also contribute optimally towards such a national effort from its provincial budget besides strictly implementing the Antiquity Act within its jurisdiction to safeguard the heritage. In addition, the site museums may be set up at all important excavated archaeological sites. The museums serve both as centers of visual education and dissemination of knowledge.

Field Survey to interview Stakeholders of the project area in June 2012

Field survey of the environmental team to interview the stakeholders of the project area was conducted in June 2012 to have their opinion on their perceptions about the environmental impact of the proposed interventions on the overall local environment, social status, livelihood, agriculture, land and water resources, fauna and flora etc. A total of 40 villages mostly in the vicinity of the dhoras were visited and about 1000 respondents were interviewed. Since, the level regarding the knowledge of the environmental impact of the respondents was limited; their most concerns were about the flood effects of the recent unprecedented floods of 2011. Their replies were recorded and a checklist was developed to see the overall reaction of the respondents with regard to the project interventions. Their reaction with regard to the impact of the project interventions was very positive. They extended open hearted support for the proposed projects and hoped that these interventions will bring revolutionary changes in the lives of the people for whom the projects are being planned. The respondents mostly talked about the damages to their crops, animals, lands livelihood and their settlements. The details are given in appendix on Environmental Impact Assessment. Here, only summary of their response is given.

Perceived Positive impacts

1. The overall impact of the proposed interventions on environment of the area would be positive
2. Revival of dhoras / natural water ways would evacuate the rain water from fields and settlements in minimum possible time
3. Dhoras may be provided with gates so that useable storm water could be used for agriculture when needed
4. Revival of coastal wetlands would bring the migratory birds and develop local fish thus would create livelihood opportunities for local people
5. More livelihood opportunities would be created through the proposed interventions

Social impacts specific to 2011 flash floods

1. Over 60% people responded that in pre-LBOD time, their fields used to be vacated in 2-3 days time Concealed pockets and non existence of drainage outlets have caused extended inundation of crops and settlements
2. Vegetation and trees have destroyed due to water ponding for several weeks in low lying areas
3. Pollution of drains with sugar mill effluents have caused fish mortality thereby seriously affecting the livelihood of the local poor people
4. Water logging and salinity still prevails as most of the drainage tubewells are non-functional due to one or the other reason
5. Over 40% people complained that the underground water is brackish and canal water is highly polluted therefore, their health is always at stack. Government may kindly provide potable drinking water to populace
6. 32% respondents complained about severe water scarcity for irrigation and domestic use
7. Overtopping of drains and dhoras inundated their crops and settlements. Therefore, steps may be taken to minimize the risk to our crops and property
8. Basic education, communication and health facilities to are non-existent as pointed out by 30% respondents
9. Floods compelled some people to migrate for search of livelihood in other areas

10. Stagnant water erupted diseases due to water pollution and mosquito breeding in most areas
11. 40% people responded that shortage of fodder caused animal mortality in their areas
12. In pre-LBOD time, water from our fields used to be vacated in 3-4 days but now it took weeks and months
13. Over 40% respondents viewed that stagnant rain water has degraded their fertile lands

Social Impact Assessment

The purpose of this report is to present the findings of the household surveys and consultations with stakeholders and village communities the Consultant conducted in communities residing along dhoras being revived to carry storm water from leftover areas and other areas somehow blocked by either drainage infrastructure, roads and/or irrigation network . The consultations were conducted according to the requirements set out in the Terms of Reference.

Community consultations - approach and methodology

The social impact study was conducted in the vicinity of the following dhoras and drains: Dhoro Puran, Sonhi Dhoro, Dhoro Naro, Hakro Dhoro, Dhoro Pithoro, Bhaikhan Dhoro and D4 Drain. The total length of dhora and the proposed drains was more than 700 km.

The main objective of this phase of community consultations was to discuss with communities regarding the proposed revival of dhoras and possible constructions of drains in the leftover areas. The major outcome expected was communities' views and opinions, their perceptions of possible impact of the proposed interventions as well as the mitigation measures as perceived by the communities.

In accordance with the main objective of the study, the following sample selection criteria were determined:

i. Major dhoras which have inactive parts considered for revival
ii. Dhoras which are running but are partially encroached or blocked
iii. Drains proposed for constructions
iv. Districts which are traversed by the sampled dhoras/proposed drains
v. Talukas in each district traversed by dhoras/proposed drains
vi. Villages situated within 200m from the dhora/proposed drain

Following the sample selection criteria, a multilevel sampling method has been adopted. The sample included six major dhoras and the longest proposed drain in the area. These dhoras traverse seven districts and 33 talukas. Two to three villages from each taluka (in total 91 villages) were randomly chosen for community consultations and data collections on village profile and household surveys. In each sampled village, the team conducted:

- Open community consultations (separate for men and women)
- Household survey with six respondents (3 men and 3 women) randomly chosen and
- One Key Informant interview on village profile

Overall, open community consultations were conducted in **91 sample villages in seven districts**. In total, **2,815 persons** (**1,333 men and 1,482 women)** participated in the community consultations. In addition, data on the socioeconomic profile of local population were collected by semi-structured household questionnaires. In each village, six household questionnaires were completed. Overall, **543 persons (271 women and 272 men)** were interviewed.

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- Necessary drainage system will be developed
- Paid local labour will rise

Generally, local communities were satisfied with the proposal. They expect to be saved from flooding, damages and constant relocation during rainy seasons. People expect only rain water to flow in dhoras as they would use it for livestock and domestic purposes. The most cited benefits were that dhoro will enable fast draining of water and that land, houses and livestock will be saved from floods. The most of people's concerns were related to bunds which should be elevated and additionally straightened. In addition, people want to see dhoras revived along the entire length. Communities expect Government's seriousness and honesty throughout the planning, implementation and the monitoring of the Project and post-Project operation and maintenance.

'Puran is our mother; our descendants were always looking at Puran as mother; they saw it running. And that was the time when nearby lands were all green. Now, since many years we see it as our mother has passed away because all nearby lands are facing drought condition day by day.' Ghulam Mohammad Khoso village, Dhoro Puran, Tharparkar

Perceived negative impact

A great majority of consulted population (78.1%) think that revival of dhoras will not have any negative impacts at all. The rest of the respondents think that the Project would be successful if it is done honestly and timely. In addition, consulted communities think that, once work is completed, operation and maintenance will be of utmost importance for the project.

Some of the perceived negative impacts of the proposed interventions are summarized below:

- Crops and structures inside the dhoro will be affected
- Access to other sides will be hard if bridges are not constructed
- Possible damage or cut of bunds would harm local communities
- Improper monitoring, maintenance and management will damage the whole area
- Potential overflowing will damage houses and livestock
- Any backflow will affect the area
- It may involve relocation of people

Perceived mitigation measures

More than 85% of consulted persons gave their vision of the mitigation measures which should minimize potential negative impact of the Project. The most common suggestions were:

- Ensure proper deep de-silting of dhoras by advanced machinery
- Make bunds stronger and ensure that villages are not easily flooded
- Build safety bunds around villages

- Have safe place for people if they have to move during the flood
- Ensure proper access from one to the other bank of a dhoro
- Prevent backflow by installation of gates
- Ensure timely and proper compensation for lost crops, structures and other affected assets
- Implement the Project and establish operation and maintenance of dhoras with honesty, sincerity and without corruption
- Involve local communities in every stage of the Project

Communities' readiness to participate in the project implementation

Consulted communities expect the Government to involve them in operation and maintenance activities. *'Each time we have been ignored in development schemes; it is our basic right to get work in all schemes because our youngsters are jobless and they need work.'* Village Dhano Kolhi, Bhai khan Dhoro, Badin. People insist that, before any work, the Government should present them the work plan, consult with affected communities again and fully compensate those who would lose crops and structures due to dhoras revival.

9.4.4 Storm Drainage Impact

9.4.4.1 Overview of 2011 Floods

The monsoon of 2011 was manifested by remarkably high rainfall event in Sindh, particularly in the left bank of Indus. The cumulative rainfall varied between 423 mm to as high as 1,143 mm. The Tharparkar district recorded the highest rainfall, followed by 866 mm in the Mirpurkhas, 628 mm in Shaheed Benazirabad, 615 mm in Badin district, 544 mm at Chorr in Umerkot district, and 423 at Padidan in the NaushehroFeroze district. In Tharparkar district, where the infiltration rate is quite high, the runoff was minimal, compared with the other areas in the left bank. The average intensity during the 8 August to 18 September was about 800 mm. The area inundated in seven severely affected districts of Sindh is shown in Figure 9.1.

As the gradient of the coastal areas is near zero, the disposal of the runoff was inhibitive causing inundation and stagnation of the storm water. In addition to this infrastructure such as rail and road networks, canal and drains, and encroachments in the natural water ways also inhibited the free flow. The delay in the evacuation of the storm water runoff was further compounded by the breaches in the irrigation and drainage network. The situation further exasperated with the gushing influx of storm water into the drainage system beyond its design discharge capacity of 4,600 cusecs.

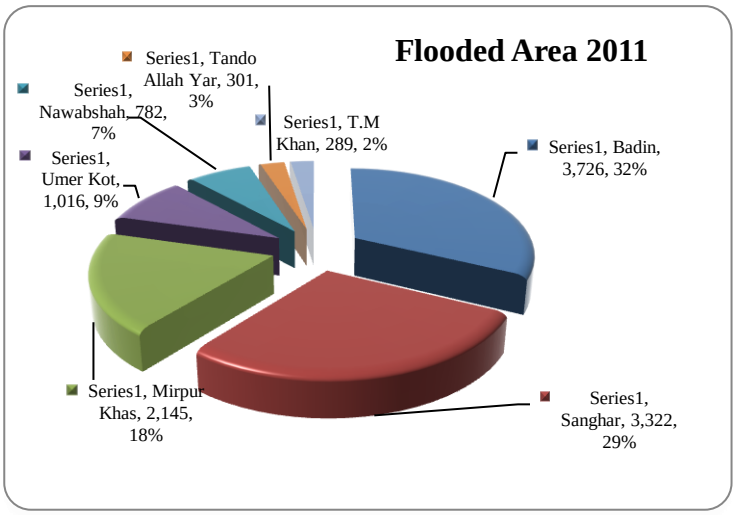


Figure 9.1: Flooded Area 2011 in LBOD Area

Two to six feet of stagnated water marooned the settlements and restricted access to social infrastructure submerged the standing crops including fodder, and a significant number of livestock, particularly milch animals were lost. It also damaged the productive, physical, and communication infrastructure. It is estimated that about 500 people succumbed to the floods.

According to the Provincial Disaster Management Authority (PDMA) estimates about 38.5 thousand villages were affected, mostly in Badin district followed by Shaheed Benazirabad, Sanghar, and

Umerkot districts, causing misery to about 9.3 million flood affectees. PDMA also estimates that about 1.6 million houses were fully or partially damaged. A large number of flood displaced persons had to take refuge on the sparse higher grounds. Of these about 769 thousand people were provided refuge in the relief camps.

PDMA estimates that due to the storm water floods, about one third of the paddy area, half of the area under chilies, and 80 percent of the cotton area, and about 90 percent of the tomato and onion acreage were wiped out. In terms of production, it is estimated that about two million bales of cotton, 250 thousand mt of paddy, 330 thousand mt of onion, 77 thousand mt of chilies, and some 70 thousand mt of tomato were lost to the catastrophe. In addition to this about 117 thousand animals were lost, excluding a significant number of poultry in the houses and the poultry farms.

9.4.4.2 Overview of 2012 Floods

During the flooding experienced in September 2012 Ghotki District was visited, when it was observed that due to lack of storm water drainage system and inadequate capacity of Karo Naro Drain (due to weed growth and narrow crossing structures), one to three feet deep rain water were flooding the crops and settlements all over the area right from Rohri through Ubauro. This area covers Ghotki Fresh and Saline Ground Water zones. Although the Fresh Ground Water zone has been provided with vertical drainage by pumping from tube wells to check the rising water table, they are not suitable to drain out storm water.

Consequently the storm water was being drained out by SIDA and the farmers, by giving relief cuts to irrigation channels wherever gravity flow was possible. Alternately, tractor driven pumps and electric pumps were being utilized to send the water into irrigation channels. But no significant relief to crops or settlements was noticed even after a lapse of seven days since rainfall. Although the water level recorded at the outfall of Karo Naro Drain had shown a decrease of more than one foot (Figure 9.2).

Moreover the storm water pumped into irrigation channels was causing additional flooding in the tail reaches of such channels due to narrowing section at the tails and non utilization of pumped storm water by farmers. As such the flood condition in the tail reaches was the worst of all.

Karo Naro Drain is a combination of natural waterways and manmade channels. It's natural sections are wider than the manmade sections. Weed growth and narrow structures were observed to be causing hindrance to storm water flow although it has an excellent gradient of approximately 1:9,000. In phase-II report the Consultants had proposed storm water drainage for Saline zone. However from the lessons learnt during recent unprecedented rains of monsoon 2012, storm water drainage system is equally important for Fresh zone. As such the drainage network proposed for Saline zone requires to be extended to Fresh water zone. For this purpose the natural waterways including Karo Naro can be utilized. Capacity of KaroNaro allied structures need to be enhanced to accommodate the storm water of additional areas.

It was noticed that at the time of construction of railway lines all the major and minor natural waterways were provided adequate crossing structures. Unfortunately this was not done while constructing roads and canal system, which appears to be the major cause of storm water flooding. However while constructing the drainage net work, the existing unused railway crossings must be utilized to drain out storm water to KaroNaro or any other waterway particularly from the area between Ghotki Feeder and main railway line to avoid construction of costly and time consuming railway structures.

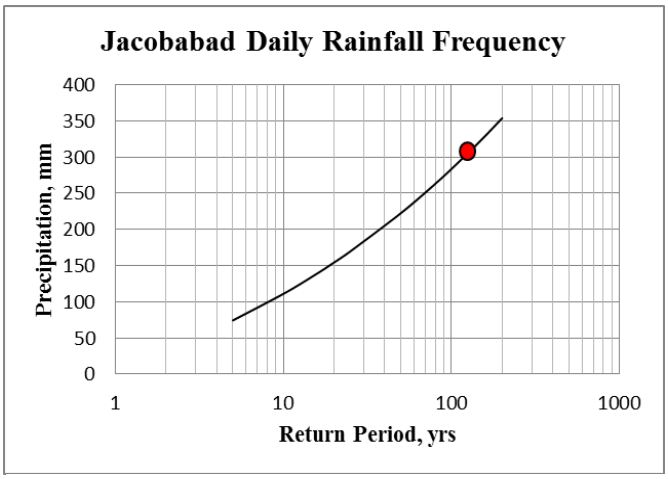


Figure 9.2: Rainfall Frequency Analysis

The Historical Hakro (Rainy River) passage in Thar Desert was plugged by local

community. Its route downstream of the plug is not prominently visible on satellite imagery due to absence of water. Similarly it is not prominent upstream in northern part of Ghotkidistrit and Punjab. However, it is very clearly shown in the historical maps flowing in the east of Bahawalpur, Rahimyar Khan and Alore. Downstream of Alore the existing Nara Canal flows on the same route.

Gurhelo Drain /Dhoro (425 RDs long originates from a lake in the north of Reti railway Station and traverses in the southeast direction until Yaro Lund town and turns east to join Rainee course) flooded many settlements and crops on both sides due to non availability of containing banks in addition to lack of maintenance and weed growth and inadequate crossing structures.

The tail reaches of Ghotki Main Feeder were flooded owing to unavailability of escape channels throughout its length. The existing escape provided at Rd 220 is not functioning due to encroachments on its alignment by locals.

9.4.5 Hydrology Analysis 2012

The precipitation recorded in 2012 in Jacobabad, Rohri and Sukkur Meterological Stations diverted from the average years because the main events occurred mainly in September, rather than in August as has been observed in the past. The September rainfall recorded (305 mm) on the 10th was exceptional for Jacobabad with a return period of more than 100 years, to be followed by an event (143 mm) of a near 20 years magnitude the day after. The combined effect of the two storms caused mayor flooding in the area. The daily precipitation record for September 10 in Rohri (152 mm) was close to 20 years return period. The precipitation recorded the same date in Sukkur was 164 mm.

9.4.6 Lessons Learnt

The natural calamities and disaster despite the destruction and miseries also offers opportunities to plan coping mechanisms for a resilient future. It brings out weaknesses in the system and to adopt corrective measures. Disasters also trigger new dynamics and challenges the status quo of conventional inefficient management and governance of the resources and offers lessons for more responsive and responsible management. The 2011 storm water disaster is not an exception, and offered an opportunity to adopt proactive interventions for future, such as disaster preparedness, and remodelling and rehabilitation of infrastructure for climate proofing against the extreme weather event threats. Some of the lessons learnt are as follows.

Problems observed during the 2011 & 2012 floods	**Storm Drainage Impact**
Under Designed Drainage Network The existing drainage infrastructure was designed for 5 year return period and for a rainfall of 125 mm to be evacuated in 5 days. The last two decades have witnessed more frequent high rainfall events, and the flood disasters. The intensity of 2011 rains was unprecedented; about 5 to 6 times higher than the design capacity of the drainage system. The data on year wise rainfall and daily max/min rainfall suggests that the need to remodel and rehabilitate the existing drainage infrastructure on a 20 year return period basis so as to enable the system to timely and safely dispose the high intensity storm water flows.	The stakeholders of the lower reaches of LBOD have expressed, in different forums, their disagreement with the remodeling of LBOD but, the rehabilitation. The stakeholders oppose any expansion of the capacity and extension of the upper tail of LBOD. The design criteria followed by the Consultants contemplate an average precipitation of 20 years magnitude in the whole catchment area of LBOD. Three thousand cusecs will be offloaded towards the dhoras and the remaining will be evacuated by LBOD. The system (LBOD in combination with the dhoras) : 10 yrs return period storms Qbase = 3,000 cfs Qoff-load = 3,000 cfs Q159 = 9,000 cfs

	Evacuation time: 5 to 7 days 20 yrs return period storms Qbase = 3,000 cfs Qoff-load = 3,000 cfs Q159 = 9,000 cfs Evacuation time: 10 to 15 days
Deferred Maintenance of Irrigation and Drainage Infrastructure The stakeholders complained that the drains are clogged with weeds and siltation, and the banks have numerous rain cuts, and deliberate relief cuts by farmers during previous rains, which were not fixed. This increases the vulnerability and risk of breaches, which were witnessed during 2011 floods.	The World Bank Project Appraisal Document (2007) refers to the maintenance with the following terms: *"The infrastructure challenge is particularly acute with respect to water as Pakistan relies on the largest contiguous irrigation system in the world… However, this massive infrastructure is deteriorating and in need of rehabilitation…"* The Bank also mentions that both Federal and Provincial authorities should develop a culture and practice of asset rehabilitation and management.
Encroachment in the Waterways The major cause of timely disposal of the storm water flood was the obstructions in the natural waterways aka *dhora*s. These *dhora*s used to be operational before the construction of the LBOD system. The blockades include unauthorized construction of adobe and brick walled structures, and cultivation. It was also observed that the inadequate size of the drainage outlets, culverts, also caused ponding of flood water in the depressions and could not be evacuated due to barricades all around. It warrants provision of adequate drainage outlets, culverts, bridges, waterways to facilitate the prompt disposal of flood water. In addition to this the intersecting roads, bridges, and the spinal drain further constrict the gushing storm water flows. This recognizes the need to provide siphons or super passages to facilitate the storm water flows through the *dhora*s. The GoS has recently enacted legislation in this regard, and it needs to be enforced and complied with.	Following the instructions given by the President Mr. Asif Ali Zardari to clear the natural waterways to provide drainage for the storm water, the Consultants prepared the designs of selective representative areas, activating the dhoras by re-shaping the water way prism, removing plugs and, redesigning bridges, causeways, aqueducts and siphons besides a number of minor structures.
Delayed Closure of Irrigation Canals It was noted with grave concern that despite the prior prediction of the extreme rain event, the irrigation infrastructure remained open delivering regular irrigation water supplies in the main canal systems. This resulted in about 55 reported breaches in the main canals and the minors/distributaries while heavy downpour continued generating significant high storm	In 2012, after the 2011 experience, the canals were closed on time following the warnings given by the Meteorological department and as a result no canal breaches were observed.

water flows. Both combined caused miseries for the communities at large. There is exigent dire need for coordination between the Meteorology department and other functionaries responsible for disaster management to be proactive and to timely disseminate the information widely.	
Absence of Trigger Mechanism for Disaster Management Absence of a coordinated flood preparedness plan by the line agencies is one of the major concern, particularly access to space for make-shift shelter or arrangement, boats for rescue operations, pumping sets for evacuating flood water, access to food supplies, potable water, and medical facilities, fodder for animals and similar other supporting items essentially needed for flood affected population. Due to the absence of a trigger mechanism to provide rescue, relief and rehabilitation strategy, timely support could not be provided to the flood affectees. An appropriate advance action would have diluted the miseries created by the floods of this event. Thus the line agencies including the PDMA, Irrigation Department, Food Department, Health Department, Local Government Department, Education Department, Agriculture Department, Pakistan Army, District Governments, Local and International NGOs need to develop preparedness strategies to face such natural calamities.	The Consultants were instructed by SIDA not to pursue further the proposed SIDA Disaster Management Unit with the argument that there are other institutions in charge of disaster and crisis management.
Absence of Make Shift Shelters Based on the reports of Intergovernmental Panel on Climate Change (IPCC), Pakistan is among the top ten countries most vulnerable to climate change. Therefore, as an immediate preventive measure, the raised platforms may be built at suitable places for the affected population to get temporary shelter in case of rain or river flood disaster for the people, livestock and their belongings.	The Consultants prepared at pre-feasibility level a scheme for the provision of raised platforms along canal and drains embankments and also roads. Furthermore, the Consultants have proposed to build raised village roads to serve a dual purpose: as roads all year round and as elevated platforms for people's protection of the floods.
Paradigm Shift (Change in the perception of the stakeholders) Since its construction, a sizeable population of the Badin district maintained that the LBOD drainage network has brought significant miseries to them. They believed that priority was given to improving the productivity of ShaheedBenazirabad, Sanghar and Mirpurkhas districts at their cost. They felt that the disposal of drainage effluent generated from the vertical and surface drainage network, into the sea,	The consultations and workshops held where the stakeholders had a chance to discuss about the issues and solutions, have helped them to better understand the flooding problems and the interaction between LBOD and the dhoras.

passing through their districts has creating significant negative externalities for them. Consequently, this had an adverse impact on the productivity of farmland, fish potential, limiting livelihood opportunities. They also opined that due to the seawater intrusion and back flows in the drains rendering their once fertile lands saline and water logged, thereby severely irreversibly impairing the coastal environment. This resulted in decrease in the natural resource bases, dwindled livelihood thereby significantly increasing the poverty. During the 2011 floods, the consultants made a number of field visits to identify the issues and problems faced by the communities in the flooded areas, and to observe the performance of the drainage system. The devastating floods brought a change in the perception of the stakeholders about the effectiveness of the drainage infrastructure, and its utility, and need for its rehabilitation and remodeling where required. This has softened the opposing stance and negative perceptions amongst the stakeholders in the Badin and Thatta districts. Most people in the field now tacitly acknowledge that the LBOD system played a role in evacuating 2011 flood waters, as the LBOD system accommodated three times more flows than its design capacity, notwithstanding few incidents of overtopping and/or breaches. Most persons now accredit that the drainage network did depress the flooding disaster. They concede that without which the losses to the lives and property would have been manifold. Most of the communities have realized that drainage infrastructure needs to be revamped to provide timely evacuation of the storm water. While talking to the communities, it was noted that the negative perceptions of the stakeholders has been watered down, and has dented the complete rejection of the drainage system, while appreciating is positive aspects.	
Policy Makers Guidelines for the Regional Plan Focus After a briefing to the President of Pakistan by the Chief Minister, Minister for Irrigation, Minister for Food, Secretary IPD, MD SIDA and other senior officials, officers of Military 5 Corp, and the Consultants held on 30 October, 2011, the President commented that '*we cannot afford revisit of such a catastrophe*' and directed that a field visit should be forthwith undertaken to review the situation and preparation of an action plan and its implementation before the advent of 2012 monsoon, so as to ensure a safe and timely disposal of storm water drainage from the left bank of Indus.	In compliance of the directives of the President of Pakistan a perspective plan for the drainage system improvement was formulated by the Consultants in consultation with SIDA, and WAPDA officials, and got approval from the policy makers. The objective of the perspective, as guided by the President is to restore and enhance the discharge capacity of existing drainage system, and restoration of old and existing *dhoras*, both to cater for 20 years return period flood.

After a joint review mission by the ministers, Secretary IPD, MD SIDA, officers of the Engineering 5 Corp, and the Consultants, visited the area. The assessment and recommendations were presented to the President in subsequent meetings for approval. The President desired that the recommendation should be fast tracked and emergency works to be in place by the end of June 2012. He also emphasized that emergency works to relieve from the ponded storm water in the low lying areas, and repair and rehabilitation of critical infrastructure including *dhora*s so as storm water is timely and safely drained in the event if 2012 rains of last year intensity. In a follow up meetings with the Minister of Irrigation, Secretary Irrigation, and MD SIDA desired that the strategy of the regional plan being prepared by the Consultants should now focus on: i) the repair, rehabilitation of LBOD and Kotri Barrage drainage network within the left bank; and ii) diversion and offloading flows in LBOD to Thar Desert through revived *dhora*s.	The salient elements of the strategy are: rehabilitation and strengthening of the existing vulnerable and damaged drainage infrastructure on emergency basis and its completion by the end of financial year 2011/12; clearance of obstructions and encroachment of *dhora*s, and reactivation of the *dhora*s to off load storm water pressure on the LBOD; remodeling and enhancing of the discharge capacity of existing drainage network, and retarding sea water intrusion; and Construction of surface drains to safely pass the storm water in areas outside the LBOD areas.

9.5 Plan Period / Time Frame

The project duration is ten years including emergency works carried out during the first two quarters of 2012.

	10 Years Implementation Plan		1	2	3	4	5	6	7	8	9	10
	Feasible Schemes	Investment (Rs. Millions)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Rehabilitation and Improvement of LBOD Drainage Infrastructure	18,301										
2	Revival of Natural Waterways to Drain out Strom Water.	55,328										
6	Protective Plantation of Mangroves in the Coastal Areas of Left Bank	749										
4	Privatization of FGW SCARP Tubewells	9,285										
3	Rehabilitation of LBOD and SCARP Tubewells	3,098										
8	Bio-saline Agriculture in Badin and Thatta Districts	2,961										
7	Use of Drainage Water for Forestation in the LBOD and Kotri Areas	270										
9	Rehabilitation of Deh Akro II and Chotiari Wetland Complex	637										
5	Rehabilitation of Coastal Wetlands	466										
10	Shrimp and Mud Crab Farming in Coastal areas of Left Bank	193										
11	Brackish Water Fish Farming in LBOD Area	542										
	Total	**91,828**										

9.6 Financial Outlay

The total value of the proposed investment is PKR 91,828 million.

9.7 Implementation Arrangements

SIDA will be the principle agency for the implementation of the proposed project interventions. They will be responsible for tendering, scrutinizing, and bid evaluation, award of contracts, and oversight, hiring of implementation consultants, supervision consultants, performance monitoring and impact evaluation consultants, and design consultants for the proposed interventions in the leftover areas, and performance and quality monitoring of all project related activities.

The SIDA will coordinate with the IPD and PDMA, and other relevant agencies such as agriculture and fisheries departments for agriculture, fisheries, and forestry for related interventions.

The PCMU will provide an interface between the implementing agency and the Planning and Development Department for resolving implementation issues, while the Planning and Development Department will be the executing agency, and will house the Steering Committee of the Project.

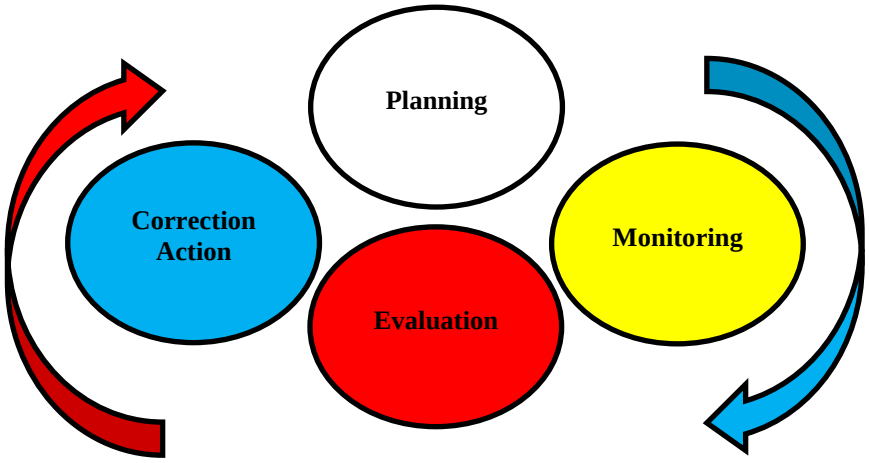
9.7.1 Supervision of implementing agencies through private sector organizations for effective implementation of livelihood activities

The implementation of effective livelihood activities must follow a plan, like any other project of any nature. There must be a goal and to achieve the goal a plan must be prepared clearly identifying the objectives, the inputs, the outcomes and products expected within a given time frame.

The Project Control Cycle

For the supervision of implementing agencies, a clearly understanding of the *Project Control Cycle* is important, where a continual monitoring process must be designed to provide information to the Government of Sindh decision-makers about the progress (or lack of it) of specific livelihood implementation projects (Figure 9.3). It involves checking the progress against pre-determined outputs and products. Besides tracking the implementation progress, the underlying factors and forces that affect the implementation process, efficiency, sustainability, and effectiveness of the intervention and its outcomes must be identified in order for the Government of Sindh decision-makers to make the necessary amendments to the implementation process in order to attain the goals pursued.

Figure 9.3: The Project Control Cycle



Alarming Project Implementation Statistics

According to the Standish Group:

- 70% of projects are over budget and/or behind schedule
- 52% of all projects finish at 189% of their initial budget and some -after huge investments of time and money- are simply never completed.

For the Supervision of implementing agencies through private sector organizations for effective implementation of livelihood activities, the Master/Regional Plan Consultants recommend monitoring the partner organizations' input using a simplified approach of the Earned Value Management Method. The adoption of a proper method was also recommended among the lessons learned in the Cash Transfers Programs: *"…the absence of robust mechanisms for monitoring and evaluation."*

The Earned Value Management Method (EVM)

The Earned Value Management method was originally developed for construction projects, but is becoming increasingly popular for social and health projects. Flemming[30] indicates the following in this regard: "*Earned value is a project management technique that is emerging as a valuable tool in the management of all projects, including and in particular software projects.*"

The Specific Interest Group[31]outlines the Earned Value Management (EVM) as follows:

- *"Earned value management (EVM) is a project control process based on a structured approach to planning, cost collection and performance measurement.*
- *It facilitates the integration of project scope, time and cost objectives and the establishment of a baseline plan for performance measurement.*
- *Earned value management is a disciplined approach to project management which insists that accurate status information is produced to aid better management decisions.*
- *It is acknowledged as the best way to integrate time cost and scope.*
- *The key point of focus is on how much of the project has been produced and at what cost.*
- *This is compared with how much was originally envisaged.*
- *It is the combination of the great attention to detail in setting up the project and the interplay of the variances produced and their interpretation that makes earned value such a powerful managerial instrument."*

The Earned Value Management is recommended for the supervision of implementing agencies, through partner organizations, for effective implementation of livelihood activities due that the EVM is a valuable tool for the:

- Control – process and activities needed to correct deviations from plan and,
- Control the triple constraints
  - *i.* time (schedule)
  - *ii.* cost (budget, expenses, etc)
  - *iii.* performance (specifications, % of progress, etc.)

The EVM is based on three types of costs: Budgeted Cost (or Planned Cost, PC); Actual Cost, AC and; Earned Value Cost, EV.

Further, with the costs explained above, the EVM analyzes three types of variances:

i. ***Cost (spending)* variance (CV)** – difference between budgeted cost of work performed (earned value) and actual cost of that work.

ii. ***Schedule* variance (SV)** – difference between earned value and cost of work we scheduled to perform to date

iii. ***Time* variance (TV)** –difference between time scheduled for work performed and actual time to perform it

These can be better visualized in a graphical form:

[30]Flemming, Q.W. &Koppelman, J.M.Earned Value Project Management. Project Management Institute. Newton Square. Pennsylvania, USA

[31]Looney, J.H.The Importance of Earned Value for Project Control.PSMJ Resources UK. Gloucestershire, England

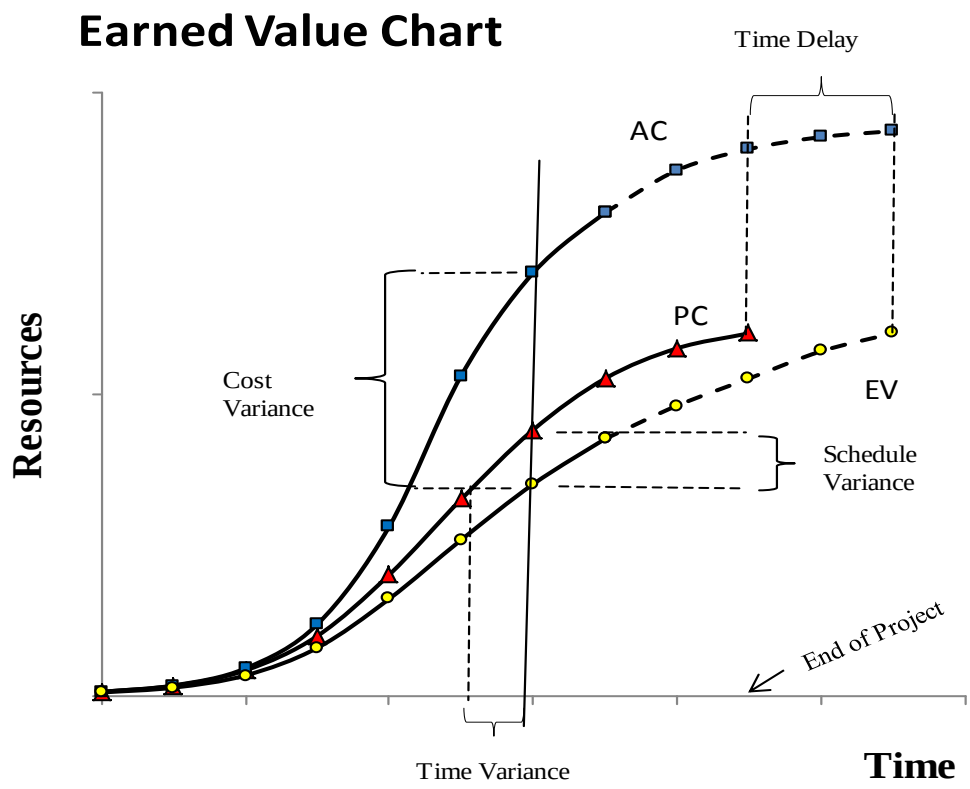


Figure 9.4: Earned Value Chart

The Earned Value, EV can be calculated by multiplying the Budgeted Cost (or Planned Cost) incurred times the percentage of completion of the activities under consideration. The EV should eventually be equal to the PC.

9.8 Legal and Policy Safeguards framework

General

1. According to the project design, privately owned land will be acquired for the project and the Land Acquisition Act 1894 of Pakistan will be applied. The project is being funded by the WB. The World Bank (WB) social safeguards that seek to avoid, minimize or mitigate adverse social impacts; and social costs to the affected people, or vulnerable groups as a result of implementation of the project have been applied and are discussed in this Chapter.

9.8.1 The World Bank Policy on Involuntary Resettlement OP–4.12

2. OP–4.12 deal the issues and concerns relating to involuntary resettlement due to the development project and provide guidelines to mitigate the adverse impacts on the local community, particularly their relocation. The Bank's experience indicates that involuntary resettlement under development projects, if unmitigated, often gives rise to severe economic, social, and environmental risks: production systems are dismantled; people face impoverishment when their productive assets or income sources are lost; people are relocated to environments where their productive skills may be less applicable and the competition for resources greater; community institutions and social networks are weakened; kin groups are dispersed; and cultural identity, traditional authority, and the potential for mutual help are diminished or lost. This policy includes safeguards to address and mitigate these impoverishment risks.[32] As such this policy provides basis for the development / preparation of Resettlement Policy Framework and Resettlement Plan (in case of 200 + project affected

[32]. Excerpts from WB OP 4.12. WB Operational Manual. December 2001.

persons). Since the number of identified PAPs exceeds 200, this policy is applicable and the project qualifies for the preparation of a resettlement plan.

3. The main objectives of Bank's safeguard policies can be described as under:

   i. Reduce and manage adverse risks of the development projects
   ii. Identify opportunities for promoting social benefits
   iii. Provide a process for full disclosure and meaningful stake holder consultation
   iv. Ensure that social risks are systematically addressed, evaluated, and incorporated at various stages of the project, such as decision–making, design, construction, and operation.

4. The triggers of Bank's policies in case of WB financed project are described as follows:

   1. **Loss of Income Sources or Livelihood:** Implementation of the proposed project interventions will likely to affect the livelihood of private land owners.

   2. **Loss of Immoveable Assets and Infrastructure:** The project will affect immovable assets of various types such as houses and shops. Besides private structures, the project will disrupt public assets like electric poles, telephone poles, mosques, trees, etc. Small rural settlements are situated at various distances from the proposed intervention areas. The construction activities will cause complete or partial disruption of access to roads in the construction stage, causing a social and economic disturbance for the people of the area.

BP–17.50 Public Disclosure

5. The BP–17.5 requires that the project related information / documents should be made public. The policy has laid down procedures for disclosing the documents relating to SA / RP studies of the project to the various tiers of the stakeholders and general public. The project information has already been disclosed / shared with the people at the time of conduct of socioeconomic and census surveys of the project area during June, 2012. The SIA / RP document will also be disclosed to the public / PAPs as per WB policy, after its approval from the Bank.

Environmental and Social Screening and Assessment Framework (ESSAF)

To provide a mechanism to carry out appropriate assessment of environment and social impacts and implement necessary safeguard measures under the emergency operations such as this project, the World Bank (WB) has prepared the Environmental and Social Screening and Assessment Framework (ESSAF). Recognizing the urgent need for assistance and emergency nature of potential operations to be financed under the MDTF, the ESSAF provides an approach, tailored to this emergency situation in line with OP 8.00 for the emergency operations, to manage the potential environmental and social impacts of the projects and activities. It provides guidelines to the implementation agencies in: (i) carrying out appropriate assessment of environmental and social impacts; (ii) planning and implementing necessary environmental and social mitigation measures for these projects during the implementation phase, in compliance with relevant World Bank safeguard policies and the national regulatory requirements in Pakistan. Since the ERRP is being proposed under MDTF, the ESSAF is applicable to this project also. The key aspects of the Framework are Impact screening, assessment and mitigation planning, consultations, planning, review and approval, disclosure, capacity building and monitoring implementation of safeguard instruments.

Resettlement Policy Framework and Entitlement Matrix

This Resettlement Plan (RP) has been prepared to compensate the affected people as a result of implementation of proposed interventions.

Basic Principles for Resettlement Plan Preparation

6. Taking into account the requirements of the ESSAF Guidelines and the OP–4.12, the following basic principles are devised for the preparation of RP.
   a) The negative impact on PAPs would be avoided or minimized as much as possible;

b) Where the negative impacts are unavoidable, the project–affected persons will be assisted in improving or regaining their standard of living. Vulnerable groups will be identified and assisted to improve their standard of living;

c) The SIDA will make cash compensation to the PAPs for their affected structures and assets falling within the COI

d) The SIDA will ensure that as far as possible the vulnerable affectees will receive some financial relief from the project. This will include one–time lump sum assistance equal to one month's inflation adjusted OPL, in addition to other admissible compensation / allowances.

e) The owners of affected structures, in addition to cash compensation for the structure on replacement cost basis will be allowed to salvage their building material. This applies to the owners including absentee owners of all categories of immovable structures.

f) Rehabilitation assistance i.e., compensation for lost business and workdays (including employees) due to relocation and disruption of business enterprise will be paid.

g) Before taking possession of the acquired land and properties, compensation assistance will be made in accordance with the Bank policy.

h) Appropriate grievance redress mechanism will be established at the project level to ensure speedy resolution of disputes.

Compensation Eligibility

7. PAPs are identified as persons whose livelihood is directly affected by the project due to project works. The eligible PAPs for compensation or at least rehabilitation provisions under the Project would be:

a) All PAPs identified along the project corridor losing small business structures, houses, boundary walls, trees and encroached cropped area. The all identified PAPs are encroaches on the government owned COI.

b) Tenants whether registered or not;

c) PAPs losing business, income and sources of livelihood; and

d) Employees (PAPs) losing income and salaries.

8. Compensation eligibility is attached with the cut–off date that will be announced one month after the completion of the 100% Census Survey.

Compensation Entitlements

9. Entitlement provisions for PAPs losing structures, assets, income; and entitled for rehabilitation subsidies, will include residential and commercial structures losses, crops and trees losses, a relocation subsidy, and a business losses allowance; based on tax declarations and / or lump sums, in case of non–availability of such documentation, in accordance with the inflation adjusted official Poverty Line (OPL). The impacts are defined as mild and severe. The mild impacts are those where a structure will not lose its present use and remains useful after rehabilitating the affected part. The severe impacts are those where after demolishing the affected part, the remaining structure becomes redundant for its present use.

Owners of Small Business Structures

10. The owners of the business structures with severe impacts are entitled for the following compensation.

a) Full compensation for the total covered area of the affected shop at replacement cost basis.

b) Self Relocation Allowance equal to the prevailing advance amount for having a shop in the market: A person wishing to have a shop in a busy business area/ place; generally have to pay an advance amount to the owner or previous occupier of the commercial structure. For the determination of such amount, discussions were made with the affected people.

c) Severe Impact Allowance equal to 6 months of inflation adjusted OPL will be given.

d) Livelihood Allowance equal to 6 months of inflation adjusted OPL.

e) One time paid Shifting Allowance on lump sum basis will be determined on the basis of discussions with the mini trucks/tractor/trolley operators in the area.

11. The owners of the business structures with mild impacts are entitled for the following compensation.

a) Full compensation for the affected area of the shop at replacement cost basis.

b) Structure Rehabilitation Allowance equal to the 50% of the affected area of shop at current market rates.

c) One time paid Shifting Allowance on lump sum basis will be determined on the basis of discussions with the mini trucks/tractor/trolley operators in the area.

d) Livelihood Allowance equal to 3 months of inflation adjusted OPL.

e) Additional allowance in case of vulnerable.

Owners of Houses

12. The owners of the houses with severe impacts are entitled for the following compensation.

a) In case the structure can be built on the remaining space of the affected house, full compensation for the total covered area of the house at replacement cost basis.

b) One time paid house rent for 03 months @ Rs. 4,000/= (4000*3= Rs. 12,000.00) for acquiring a residence during the construction period.

c) Livelihood Allowance equal to 03 months of inflation adjusted OPL.

d) One time paid Shifting Allowance @ Rs. 4000/- on lump sum basis.

e) One time paid additional allowance equal to one month inflation adjusted OPL (Rs. 11,951) in case of vulnerable.

13. The owners of the houses with mild impacts are entitled for the following compensation.

a) Full compensation for the affected area of the house at replacement cost basis.

b) Structure Rehabilitation Allowance equal to the affected area of the house at current market rates.

c) Livelihood Allowance equal to 03 months of inflation adjusted OPL.

d) One time paid additional allowance equal to one month inflation adjusted OPL (Rs. 11,951) in case of vulnerable.

Squatters

14. The squatters are eligible for the following compensation package.

a) Livelihood Allowance for 03 months equal to inflation adjusted OPL.

b) One time paid additional allowance equal to one month inflation adjusted OPL (Rs. 11,951) in case of vulnerable.

c) Tenants

d) The tenants are eligible for the following compensation package.

e) Livelihood Allowance for 6 months equal to inflation adjusted OPL.

f) Self Relocation Allowance @ Rs. 50,000/- (The amount generally paid as advance to the owner or previous occupier of a shop by the new occupier).

g) Shifting Allowance @ Rs. 4000/-

h) One time paid additional allowance equal to one month inflation adjusted OPL (Rs. 11,951) in case of vulnerable.

Crop Losses to Encroachers of Agricultural Land within the COI

14. No crop loss will occur as the encroachers have harvested the wheat crop and they have been warned at the time of Census Survey not to cultivate any crop in the SIDA owned land in the next season. The encroachers farmers will be provided with one time paid cash compensation at current market rates equal to annual gross harvest, for lost of source of income. Crop compensation will be paid both to landowners and tenants based on their specific sharecropping agreements, if any.

Trees:

15. No fruit trees will be affected. Only timber / fuel wood trees will need removal from the COI. The owners will be paid cash compensation at market rate, based on type and age of the affected trees.

Business Workers and Employees:

16. Indemnity for lost wages for the period of business interruption up to a maximum of three (03) months, equal to inflation adjusted OPL.

Assistance for Vulnerable People:

17. Vulnerable people (PAPs below the poverty line, disabled and women headed households) will be given a one–time paid allowance equal to one month's inflation adjusted OPL in cash, in addition to other admissible allowances and priority in employment in project–related jobs.

Entitlement Matrix

18. Based on the above discussed eligibility criteria and compensation entitlements, and keeping in view the nature of losses and implementation issues of the proposed project, the following Entitlement Matrix (EM) has been prepared.

Table 9.2: Entitlement Matrix

Type of Loss	Application	Definition of PAPs	Compensation Entitlements
Loss of Agricultural Land			
	Partial loss of land holding and the remaining holding economically viable and at	a) Legal Owner with valid title or customary or usufruct right	PAPs will be entitled to: - Cash compensation for acquired land at replacement value,
		b) Tenant, leaseholder, and sharecropper	PAPs will be entitled to: - Cash compensation for lost income for the remaining period of lease,

Type of Loss	Application	Definition of PAPs	Compensation Entitlements
	least equal to or more than 0.5 acre (marginal impact on household income and living standards)	c) PAPs without valid title (encroachers, squatters)	PAPs will be entitled to: - Vulnerable squatters will be entitled to assistance for loss of income, - Encroachers will not be entitled to any compensation or assistance,
	Loss of entire land holding lost, or where partial loss but the remaining land is less than 0.5 acre or is rendered economically unviable (severe impact on household income and living standards)	a) Legal Owner with valid title or customary or usufruct right	PAPs will be entitled to: - Equivalent area of land with equivalent productive potential at location acceptable to PAP, or, - Cash compensation for acquired land at replacement value at informed request of the PAP, - Transition allowance for a period of three months,
		b) Tenant, leaseholder, and sharecropper	PAPs will be entitled to: - Cash compensation equivalent to market value of gross harvest for one year production or for the remaining period of tenancy/lease, whichever is greater, - Affected labor will be compensation for loss of income equivalent to three months of wages,
		c) PAPs without valid title (encroachers, squatters)	PAPs will be entitled to: - Vulnerable squatters will be entitled to assistance for loss of income, - Encroachers will not be entitled to any compensation or assistance,
Loss of Structures and Trees			
Houses and Structures	Private owners	All relevant PAPs regardless of legal ownership / registration status (including absentee encroachers)	♦ Encroachers are eligible for compensation for the loss of or damage to the structures / assets, and resettlement assistance for loss of income / livelihood, but are not eligible for compensation for loss of land within the COI. ♦ In case of partial impacts full cash assistance to restore remaining structure. ♦ For house owners, one time paid house rent for 03 months for acquiring a residence during the construction period.
Trees	Private owners	All PAPs regardless of legal status (including encroachers)	Cash compensation per tree, at market rate on the basis of discussions with the Forest Department officials and the owners of private forests All the affected trees are mostly at the pole stage with average age ranging between 6–9 years.
Loss of Common Property Resources / Public Utilities			

Type of Loss	Application	Definition of PAPs	Compensation Entitlements
Public Utilities: Affected Electric and Telephone Poles	Costs as determined by relevant departments	Relevant Departments	♦ For Electric Poles, per unit shifting / relocation cost will be taken after consultation with the concerned Government Department. ♦ For Telephone Poles, per unit shifting / relocation cost will be taken after consultation with the concerned Government Department.
Loss of Income and Livelihood			
Crops	Lost Crops on the encroached land	All PAPs regardless of legal status (including encroachers)	One time paid rehabilitation allowance in cash at current market rates equal to annual gross harvest, for lost of source of income.
Business Employment	Temporary or permanent loss of business employment	All Employees (PAPs)	Worker / employees: Indemnity for lost wages for the period of business interruption up to a maximum of 3 months.
Allowances			
Livelihood Allowance	Transitional livelihood costs	All PAPs including Owner Business Operators, Tenant Business Operators and Squatters	Livelihood allowance equal to the inflation adjusted OPL to meet with the living expenses for maximum 3 months.
Severe Impact Allowance	Business Interruption Compensation	Owners and tenants of affected shops on permanent basis	The PAPs will be compensated in cash for six (06) months, based on inflation adjusted OPL, to provide them sufficient time for setting their business at new location.
Self Relocation Allowance	Amount for having a new shop in a busy business area/ place	Owners of Affected Shops	For permanent business losses, the PAPs will be paid cash compensation as Self Relocation Allowance to have a new shop at another business location in lieu of his affected shop. Generally, such amount has to be paid to the owner or previous occupier of the commercial structure by the new occupier.
		Tenants of affected shops	The tenants will be paid Self Relocation Allowance. (The amount generally paid as advance to the owner or previous occupier of a shop by the new occupier).
Shifting Allowance	Transport costs	All PAPs affected by relocation	The PAPs with permanent structures loss will receive shifting allowance (one time paid) for transporting belongings / salvageable material or shifting moveable structures. The amount has been determined on the basis of discussions with the mini trucks/ tractor trolley operators in the area.
Additional Assistance to Vulnerable	All Vulnerable PAPs	PAPs below poverty line	One–time paid allowance equal to one month of the inflation adjusted OPL in cash, in addition to other admissible allowances and priority in employment in project–related jobs.

Interaction with Different Departments / Agencies

19. The SIDA is responsible for ensuring the project compliance with the laws and regulations relating to the social concerns of bypass construction and operation, and that all pre–construction requisites, such as implementation of RP are met. This will require interaction with the line departments. The nature of the relationship between the SIDA and the line departments is given as follows.

- **Provincial Revenue Department**

Under the national law, matters relating to land use and ownership are controlled by the Revenue Departments of provincial governments. In case of these proposal interventions, the entire COI is owned by the local inhabitants, and there will be acquisition of privately owned land. At the time of COI clearance from the encroachments, after payment of compensation to the encroachers, the SIDA will maintain a close liaison with the local revenue offices to avoid any misunderstanding / issue between the SIDA and the PAPs.

- **Local Government & Local Administration**

The SIDA and its contractor must ensure that the project meets the criteria of the Government of Sindh for the establishment of construction camps and plants, use of water resources and the safe disposal of wastewater. These matters lie in the jurisdiction of Local Governments. Therefore, the contractor should liaise closely with the concerned body. The SIDA will coordinate and monitor the social–related issues.

The SIDA will also liaise with local government / administration on matters related to the recruitment of local labor, their wage rates, resettlement of squatters, removal of encroachments or sources of congestion, traffic controls, etc. In specific cases, the SIDA will make an agreement with the municipality, local government, or other service provider concerned on the resettlement of displaced encroachers.

Management of socioeconomic Impacts / Social risks

20. The socioeconomic impacts / social risks of the Project have been determined and mitigation / enhancement measures provided. A management plan to this effect is provided as given in Table-9.3.

Table 9.3: Management of socioeconomic Impacts / Social risks

Social Risk	Mitigation	Responsibility	Construction Stage
Land to be Acquired on permanent Basis			
The proposed interventions will be owned by SIDA after construction. Consequently, there will be acquisition of private proprietary land on permanent basis.	As compulsory land acquisition is involved, conflicts between the EA, the contractors, and landowners are likely.	Contractor, PE, PD SIDA	Construction

Social Risk	Mitigation	Responsibility	Construction Stage
Temporary Land Acquisition			
Land required for establishing contractor's facilities including camp, workshop, plants, earth material and dumping excess spoil will be acquired directly from private landowners by the contractor. The provisions of the Land Acquisition Act, 1894 will not be invoked, as the acquisition of the land will be temporary and will be covered by short–term lease agreements between the landowners and contractors under the approval of the Project Engineer. Rental terms will have to be negotiated to the satisfaction of the landowners concerned.	♦ The staff of the SIDA and supervisory Consultants will monitor the process of restoration and ensure, through the terms of the construction contracts, that landowners are compensated according to the terms of the lease agreements, and the restoration actions agreed upon by the contractors are duly carried out. The photo–documentation of the existing land prior to temporarily acquisition should be available, which will be beneficial to resolve the restoration conflicts between the landowner and contractor.	Contractor, PE, PD SIDA	Construction
	♦ Similarly, prior to the commencement of construction activities, the Contractor will carry out base line survey for selecting the camp sites, dumping sites, public and community / private owned utilities, in conformity with the requirements of SIA study. The contractor will submit a development plan to the Engineer–in–charge and local government for its scrutiny and approval.	Contractor / PE	Pre–Construction
	♦ Project facilities, viz., construction camp and workshop will be located at a minimum distance of 500 m from existing plantation, and settlements, etc. This limit will be 1000 m in case of batching plant.	Contractor / PE	Pre–Construction
	♦ As far as possible, waste / barren land i.e. areas not under agricultural, residential or forestation use, and natural areas will be used for material (if required) and setting up project facilities.	Contractor / PE	Construction

Social Risk	Mitigation	Responsibility	Construction Stage
	♦ Where the use of agricultural land is unavoidable for of earth material, the top 30 cm of the plough layer will be stripped and stockpiled for redressing the land after the required material has been removed. In case deep ditching is carried out, the top 1 m layer of the ditching will stripped and stockpiled. The ditch will initial filled with scrap material from construction then leveled with the stockpiled topsoil to make it even with the rest of the area. It shall be ensured that the scrap does not contain any material that may produce obnoxious material that would contaminate soil or water resources.	Contractor / PE	Construction
	♦ Barren lands or valley side slopes will be used for dumping the excavated spoil material. Appropriate sites have to be located along the road for this activity.	Contractor / PE	Construction
	♦ These facilities will be regularly monitored and cleaning activities implemented during operation phase to improve the cross drainage facilities of area.	PD,SIDA	Operation
Increased risk of accidents caused by partial closure of road during construction			
♦ During construction activities, traffic flow will be disturbed. At sections passing through populated areas, there will be limited scope for providing diversion tracks for the mobility of local and thorough traffic that will increase the risk of accidents.	♦ Proper site specific measures will be carried out in consultation with supervisory consultants to ensure the safety of population residing along and around the project corridor. Site specific Traffic Management Plans (TMPs) will be prepared and implemented by the Contractor with the approval of the Project Engineer.	Contractor / PE	Construction

Social Risk	Mitigation	Responsibility	Construction Stage
	♦ During operation stage SIDA will make arrangements with some organization / contractor for proper maintenance and operation of the proposed bypass. Periodic inspections will be made by the contracted firm to identify the problem areas and their remedial measures. For this purpose the firm should be fully equipped and there should be contingency plan in case of any emergency / natural disaster.	SIDA	Operation
Problems to Health and Safety of Labor and Employees on Construction Work and Provision of Safety Equipment to Workers on Site.			
♦ Occurrence of accidents / incidents during the construction activities, particularly from excavation activities is common. The workers and general public residing along the project corridor or near the work sites will particularly be at risk.	♦ Complying with the safety precautions for construction workers as per International Labor Organization (ILO) Convention No. 62, as far as applicable to the project contract.	Contractor / PE	Construction
	♦ Training of workers in construction safety procedures, social awareness, equipping all construction workers with safety boots, helmets, gloves, and protective masks, and monitoring their proper and sustained usage.	Contractor / PE	Construction
♦ Contractor staff while on work may get injuries.	♦ Contractor will ensure the provision of medicines, first aid kits, vehicle, etc. at the camp site.	Contractor / PE	Construction
Gender Issues			
♦ According to the findings of the socioeconomic survey, the rural women normally use the open field latrines and their privacy may suffer due to the project activities. Moreover, they actively participate in other	♦ The Contractor will select the specific timings for the construction activities particularly near the settlements, so as to cause least disturbance to the local population particularly women.	Contractor / PE	Construction

Social Risk	Mitigation	Responsibility	Construction Stage
outdoor socioeconomic activities such as livestock rearing, bringing of potable water, etc which may also be affected by the project activities.	♦ The Contractor will carry out the construction activities in such a way that the open field latrine usage timings by the local community particularly women, should not be affected. The normal timings to use the toilet facilities by the rural women are early in the morning and at late in the evening. So, the Contractor will have to take care of these timings.	Contractor / PE	Construction
♦ The induction of outside labor may create social and gender issues due to the unawareness of local customs and norms. It may also cause hindrance to the mobility of local women for working in the field, herding livestock, picking fuel wood, etc.	♦ Contractor will take due care of the local community and observe sanctity of local customs and traditions by his staff. Contractor will warn the staff strictly not to involve in any un–ethical activities and to obey the local norms and cultural restrictions particularly with reference to women.	Contractor / PE	Construction
	♦ During construction activities, if privacy of the nearby households is affected, the Contractor will inform the house owner to make some arrangements. Similarly, Contractor will take care as much as possible that the construction activities should not affect the privacy particularly with reference to women.	Contractor / PE	Construction

Social Risk	Mitigation	Responsibility	Construction Stage
Social Conflicts and Employment of Locals on the Project			
The presence of outside construction workers may cause some degree of social disruption and even active disputes with the local community as a result of social / cultural differences. This particularly relates to the disruption of the privacy of women working in the fields or even in the yards of their houses, should the house lying at lower elevation than the working sites. Likewise the risk of theft of the community assets by the Contractor workers and vice versa may occur.	♦ Good relations with the local communities will be promoted by encouraging Contractors to provide opportunities for skilled and unskilled employment to the locals, as well as on–the–job training in construction for young people. Contractor will restrict his permanent staff to mix with the locals to avoid any social problems. ♦ The Contractor will warn the workers not to involve in any theft activities and if anyone would involve in such type of activities, he will have to pay heavy penalty and would be handed over to police. Similarly, at the time of employing, Contractor has to take care that the workers should be of good repute. The Contractor camp will be properly fenced and main gate will be locked at night with a security guard to check the theft issues from community side.	Contractor / PE	Construction
Rise in the Prices of Essential Commodities			
Due to induction of outside labour for project works, the demand for basic items will increase thereby causing an increase in the prices of essential commodities	The project will exert no negative impacts on the prices of essential commodities. It is estimated that project will employ about 120 skilled and un–skilled staff. Most of the un–skilled labour will be recruited from the local areas. As such there will be no extraordinary increase in the demand for essential or other commodities. The Contractor, will, however, be required to maintain the field camps supplies from the main Mangora market.	Contractor	Construction
Use of Local Water Supplies and Other Common Resources			
♦ Local water supplies will be required to meet campsite and construction requirements, bringing its use into competition with the use by the local communities.	♦ The contractor will explore the alternative water resource so that the existing community water resources are not impacted. No existing water source under the use of community will be exploited by the Contractor for campsite facilities as well as construction purposes.	Contractor	Construction

Social Risk	Mitigation	Responsibility	Construction Stage
♦ Local water may be affected due to implementation of project both in quantity as well as quality.	♦ Availability of water for campsite facilities and construction purposes will be ensured by the Contractor prior to start of construction activities. As per Local Government Act, the contractor will seek approval from the local government for exploitation of the water resources.	Contractor / PE / Local Govt.	
	♦ The Contractor will be required to maintain close liaison with local communities to ensure that any potential conflicts related to common resource utilization for project purposes are resolved quickly.	Contractor	
	♦ The contractor will prepare guidelines for the workers for minimizing the wastage of water during construction activities and at campsites.	Contractor	
Possibility of Spread of HIV / AIDS Amongst the Project labor and Adjoining Population	♦ Contractor to arrange HIV / AIDS awareness programs in the field camps on regular basis by a qualified expert / doctor. ♦ Contractor will provide recreational facilities such as playing volleyball of football after the work hours. ♦ Similarly, he will provide indoor recreation in terms of radio and TV at the eating place. ♦ The Contractor will ensure regular medical check–up of the camp staff from a qualified doctor on fortnightly basis. If any person found affected with any of the transmittal diseases will be immediately shifted from the camp to the hospital for detailed check–up and treatment. The cost will be borne by the Contractor. ♦ Contractor will restrict his permanent staff to mix with the locals to avoid any social and health problems.		
Recreational Facilities for Public	♦ The Contractor will ensure the restoration and rehabilitation of construction and camp sites on completion of the project.	Contractor	Post Construction

Social Risk	Mitigation	Responsibility	Construction Stage
	♦ SIDA will develop parks particularly for children and ladies at appropriate sites along the road to provide them better recreational opportunities. This will also attract the outside tourists as well, thus increasing the incomes of the local people through increased socio–economic activities. ♦ SIDA should carry out tree plantation along the road.	SIDA	Post Construction
Restricted Mobility			
♦ During the construction phase the general mobility of the local residents and their livestock in and around the project area is likely to be hindered. Likewise access to the natural resource may be affected. This particularly implies to the women and children.	♦ The contractor will ensure that the mobility of the local communities and their livestock is not hindered by the construction activities. The contractor will provide crossing points at the road at appropriate places to facilitate the people for going across the road for their daily works and having free access to the natural resources.	Contractor / PE	Construction
♦ Construction activities, particularly excavation and movement of haul truck and machinery may disrupt the existing tracks leading from the main road to settlements. This will limit the accessibility of the local population to the main road.	♦ Generally the contractor will avoid using the village tracks for hauling the construction material. However, if it is unavoidable, the existing ones will be widened, overlaid with shingle or surface treated to accommodate local as well as contractors traffic under the approval of the Project Engineer.	Contractor / PE	Construction

Grievance redressal mechanism

21. The social and resettlement issues relating to the implementation of project works and their mitigation have been identified in the SIA/RP Study. However, in spite of best efforts, there is every chance that the individuals / communities affected by the project are dissatisfied with the measures adopted to address the adverse social impacts of the project. In this situation an effective Grievance Redressal Mechanism (GRM) will ensure the timely and successful implementation of the project. It will also provide a public forum to the aggrieved to raise their objections and through conflict resolution, address these issues adequately.

The main objective of the GRM is to investigate charges of irregularities and complaints received from the affectees and provide an early, transparent and fair resolution. Keeping in view the findings of the SA baseline study, it is anticipated that the nature of such complaints will relate to compensation matters by the project functionaries. Some of the grievances that may arise are listed as follows:

- Name of the AP is missing from the list,
- Losses (such as damage to crops) not identified correctly,
- Inadequate or inappropriate assessment of compensation

- Improper distribution of compensation in case of joint ownership
- Problems in the relocation of infrastructure
- Delays in the payment of the compensation,
- Any other issue arising during the project implementation.

Grievance Redress Committee (GRC)

Under the GRM, a Grievance Redress Committee (GRC) will be created and established at contract site, which will look into all the grievance cases. The GRC will include:

- Project Director, SIDA, (Chairman of the Committee)
- Assistant Director (Resettlement), SIDA (Member of the Committee)
- Resident Engineer (Member of the Committee)
- A representative of the Supervision Consultants (Member of the Committee)
- Two representatives of the Project Affected Persons (PAPs) (Members of the Committee)

AD (Resettlement) will act as Secretary of the Committee. The Committee will meet at least twice a month and provide decision to resolve the issues at the end of the meeting. The non–official members will be provided logistics for the committee meetings. The committee may request the complainant to attend and present his case. However, the aggrieved person will have the right to register his cases for resolution by the court, in case he is not satisfied with the decisions of the GRC.

- **Complaints Management Register (CMR)**

The Assistant Director (Resettlement) will maintain a CMR to record grievances brought forward by affected communities, and ensure that these are appropriately addressed. The complaint register will provide for: the date and particulars of the complaint; description of the grievance; follow–up action required; name of person responsible for implementing the action; and a target date for redressal. The AD will be supported by the Resettlement Expert of the Construction Supervision Consultant for this purpose. The actual measures taken to mitigate the concerns will also be recorded in the register. The complainant's views on the remedial action taken will also be documented in the Register. All complaints received in writing or received verbally will be (written), properly recorded and documented.

- **Conflict Resolution Procedure**

The AD (Resettlement) will be the initiating authority to address the issues. He will be bound to forward the compliant to the PD within 3 days. The PD will take a decision on the compliant within 3 days on receipt of compliant to him and will inform the complainant through AD (Resettlement). If complainant is not satisfied with his decision / action, the PD will refer the case to GRC. The Committee will review the matter keeping in view its nature and suggest a remedial action within 4 days. If considered necessary, the Committee will consult the complainant as well. Once the Committee decides the remedial action, the Project Engineer will implement it within a week.

In case some response on the complaint is not received within 15 days of the lodging of the complaint, the complainant may also send a reminder to the GRC with 07 days notice to take legal remedial measures.

In case of complainant’s disagreement with the decision of the GRC, the PD, as Chairman of the Committee, will send the case to the PD (ERRP), SIDA. The PD will respond within 07 days. If the complainant is not satisfied, the complaint will have the option to go to the court of law. In case of such eventualities, all affected persons will be exempted from legal and administrative fees made / paid / incurred pursuant to the grievance redressal procedures. The conflict resolution process at project level is provided in Table 9.4.

Table 9.4: Conflict resolution process at project level

Stage	Action	Location	Responsible Body	Complaint Resolution Period
1.	Complaint is received and registered	PD Office / Project Site Office	AD (Resettlement)	03 days from the date of registration (if not settled then Stage–2)
2.	Passed on to Grievance Redressal Committee	At project site	GRC	Within 4 days (if not settled then Stage–3)
3.	Referred to PD (ERRP), SIDA by the DD	PD Office	PD through PD	07 days from the date of receipt of complaint in PD's office

Monitoring and evaluation

The Monitoring and Evaluation (M&E) is a way to check, asses and evaluate the status of project activities on a regular basis. It helps in timely identification, analysis and removal of the bottlenecks at various stages of project implementation and expediting actions. The M&E of the RP implementation is a tool to serve the interests of the project planners, executors and operation managers, as they share the common concern for timely corrective measures. Specifically, the objectives of the monitoring and evaluation of RP implementation are: (1) to ensure that the standard of living of APs is restored or improved, (2) to monitor whether the time lines are being met, (3) to assess whether compensation, rehabilitation measures are sufficient, (4) to identify problems or potential problems, and (5) to identify methods of responding immediately to mitigate hardships. The M&E activities to ensure the effective implementation of RP are described as follows.

Internal Monitoring

The internal monitoring of RP implementation will be the responsibility of SIDA. It will be a continuous activity and will be managed by the Project Director, SIDA. The PD will ensure that the Project functionaries carry out the following activities efficiently and transparently.

- Verification of project-affected persons, specifically squatters, on the basis of their national identity card numbers/ photographs, to ensure that only those PAPs recorded before cut-off date are allowed to claim entitlement benefits.
- Identification of the public facilities and utilities needing relocation.
- Signing leases and recording compensation payments in case of delays.
- Providing shifting assistance to displaced PAPs.
- Verifying that the amount to be paid as compensation and the schedule of compensation is in conformity with the provisions of the Entitlement Matrix.
- Recording and addressing the concerns of PAPs during and after resettlement.

The Project Director will provide the findings of monitoring activities in the Monthly Progress Report regularly, under a separate head namely "Implementation of RP" with details of the issues aroused and the mitigation measures adopted under Grievance Redressal Mechanism (GRM).

Monitoring Role and Responsibilities

The role and responsibilities under the M & E plan are described as under:

- The Project Director will be responsible for monitoring the progress of resettlement activities under the RP and status of the project's consultation strategy, based on progress reports submitted by the PD, SIDA.
- The SIDA will review the efficacy of the M&E arrangements quarterly, relating to social and resettlement issues, and refine the arrangements accordingly. In this respect, SIDA will also take into consideration the findings / suggestions made by the independent external consultants engaged for social monitoring.

M & E Arrangements

A **Social and Resettlement Committee (SRC)** consisting of PD, DD (Environment), AD (Resettlement), and representatives from the Supervision Consultants will be formed at the project level. This committee will be responsible for coordinating the social and RP implementation and monitoring issues and reporting to the PD. The committee will be required to convene quarterly, although may need to meet on a monthly basis in the initial stages of the project. The committee will ensure that the following activities are carried out transparently and according to the provisions of the RP by the responsible persons.

- Verifying PAPs on the basis of specified documents
- Verifying public facilities and utilities identified for relocation
- Carrying out a consultation and dissemination campaign with regard to compensation procedures and entitlement packages
- Establishing a grievance redressal committee to ensure fairness and transparency during the resettlement process
- Preparing a joint on–site inventory and valuation of the affected assets and incomes of individual PAPs
- Preparing individual entitlement files
- Preparing and approving compensation budgets
- Ensuring an adequate notice period is given to APs before shifting
- Ensuring and recording compensation payments in case of delays
- Providing shifting assistance to displaced squatters
- Identifying major issues of conflict between PAPs and the Contractors during implementation of resettlement activities.

In addition, to further strengthen the RP implementation and monitoring arrangements, the Contract Administration and Construction Supervision Consultants will provide a Senior Social Safeguards Specialist to review the status of the RP implementation in the light of the targets, budget and duration that has been laid down in the RP.

The Project Director will provide the findings of monitoring activities in the Monthly Progress Report regularly under a separate sub–head "Internal Monitoring", with details of the issues aroused and the mitigation measures adopted under Grievance Redress Mechanism (GRM).

External (Independent) Monitoring

The external monitoring will be carried out on quarterly basis. The objectives of this process is to ensure that the provisions of the RP are being implemented, grievance redress mechanism is adopted, public consultations are carried out, the Contractor and the Supervision Consultant are maintaining the up–to–date records of their activities, etc. For external monitoring, SIDA will hire the services of independent Consultants / individual experts, with advice and concurrence of Bank on the Consultants selected. The Consultants will review the status of the RP implementation in the light of the targets, budget and duration that had been laid down in the RP. The key tasks during external monitoring include:

- Develop specific monitoring indicators for undertaking monitoring and evaluation for Resettlement Plans implementation and the Community Participation;
- Review results of internal monitoring and verify claims through random checking at the field level to assess whether resettlement objectives have been generally met. Involve the affected people and community groups in assessing the impact of resettlement for monitoring and evaluation purposes.
- Review and verify the progress in resettlement implementation of the project and prepare quarterly reports for the PMU and World Bank.
- Evaluate and assess the adequacy of compensation given to the PAPs and the livelihood opportunities and incomes as well as the quality of life of PAPs of project-induced changes.
- Evaluate and assess the adequacy and effectiveness of the consultative process with PAPs, particularly those vulnerable, including the adequacy and effectiveness of grievance procedures and legal redress available to the affected parties, and dissemination of information about these.
- socioeconomic conditions of the PAPs in the post–resettlement / rehabilitation period;
- communications and reactions from PAPs on entitlements, compensation;
- changes in housing / business restoration and income levels;
- grievance procedures; its recording, reporting and processing time and its redressal;

Third Party Validation

The SIDA will engage a firm/individual for 3rd Party Validation of the Internal and External Monitoring of RP implementation. The firm/ individual for 3rd Party Validation will develop monitoring and evaluation indicators for the study on the basis of following parameters.

- Efficacy of mechanisms and indicators for internal and external monitoring;
- Mechanism used for disclosure of information, consultation and participation of Project Affected Persons;
- Effectiveness and efficiency of PMU, FIU and Supervision Consultants in RP Implementation;
- Assessment of the resettlement efficiency, effectiveness, impact and sustainability for drawing lessons for future resettlement policy formulation and planning.
- Evaluation and assessment of the adequacy of compensation given to the PAPs and the livelihood opportunities and incomes as well as the quality of life of PAPs of project-induced changes.
- Evaluation and assessment of the adequacy and effectiveness of the consultative process with PAPs, particularly those vulnerable, including the adequacy and effectiveness of grievance procedures and legal redress available to the affected parties, and dissemination of information about these.
- Institutional arrangements; and
- Level of satisfaction of PAPs in the post resettlement period.
- The firm/ individual engaged for 3rd Party Validation will present the findings of the study in the form of bi-annual and annual reports (final) to the Bank and Client. A financial provision on lump sum basis will be kept for this activity in the social / resettlement budget.

9.9 Social Acceptability

The proposed interventions and solutions suggested by the stakeholders during the two phases of consultations were presented to the stakeholders in details during the consultative workshops. The stakeholders were given opportunity of supporting or rejecting those interventions with alternative solutions. In case, the stakeholders agreed with the interventions, they were asked to prioritize it. However, some stakeholders found difficult to prioritize solutions as they think that all solutions are almost of equal importance. Majority of the stakeholders during the phase-II consultations supported the proposed interventions. Nevertheless, the main stakeholders' message to the decision makers and project execution organizations is as follows:

Whatever intervention or a solution you propos for the community, you have to consult relevant community and obtain people's opinions and approvals before any work starts.

The summary of the stakeholders' endorsement/rejection of the suggested solutions is given below.

9.9.1 Community Perceptions for Proposed Interventions

9.9.1.1 Privatization of FGW Tubewells of SCARPS

The main issues identified during the Phase I of the Project were the following:

- a significant proportion of the SCARP tubewells are non operational
- the overall performance of the drainage project staff is not satisfactory
- irrigation shortage is causing low productivity

The stakeholders proposed the transition of fresh water tubewells of SCARPS (FTWs), rehabilitation of the tubewells of less than 1.5 cusec capacities and provision of incentives for construction of private tubewell. In addition, the stakeholders suggested upgrading of the workshops and other infrastructure before transition as well as a revision of the operating rules of private development of groundwater with consideration of socioeconomic and environmental issues.

The consulted stakeholders at all district and area water board levels have endorsed the solutions. Badin and Umerkot stakeholders have not endorsed nor rejected as the solutions are not applicable to these two districts. The consulted stakeholders of Sukkur, Khaipur, Naushero Feroze and Nawabshah districts suggested transfer to the landowners, FOs or watercourse association with intensive involvement of local communities. The stakeholders underlined that a proper transition must be followed by correct operation and maintenance preferably by the involvement of the local communities.

9.9.1.2 Rehabilitation of SCARP Drainage Tubewells of LBOD

The issues and problems identified during the phase I are the same as for the SCARP fresh water tubewells. The stakeholders suggested rehabilitation and replacement of worn out tubewells with more efficient means of capturing agricultural drainage and mixing it for reusing in the canals. In addition to this, a revision of situation that requires tile and open drains and pumping stations for disposal of drainage in some areas was suggested. In the stakeholders' opinions, the quality of water discharges to Rohri Canal should be reviewed.

Stakeholders from Mirpurkhas, Tando Allahyar, and Ghotki districts gave a very high priority to the intervention on the SCARP tubewells. They claim that in some places around 95% of the tubewells are not functional at all. In addition, the stakeholders think that landowners who gave the land for installation of the tubewells should be allowed to appoint a chokidar to look after the tubewells. The stakeholders from districts where there are no tubewells endorsed the solution but could not give it the highest priority.

9.9.1.3 Bio-saline Agriculture/ Conjunctive/ cyclic use of drainage water for forestation in LBOD and Kotri command area

The stakeholders identified the following issues: Water scarcity below Kotri barrage has adversely affected the agro-ecosystems. The persistent drought conditions since last decade have degraded lands. Leaving the lands without crop for prolong periods induce desertification and reduce productivity. Reduced production resulted in decline in livelihood opportunities.

The following solutions suggested by the stakeholders:

i. Introduce bio-saline agriculture which could can be practiced on marginally saline lands using brackish water for growing salt tolerant food and fodder crops, bushes and trees
ii. Use surface drains (which mostly carry *pancho* water from rice fields) for growing salt tolerant species of crops, grasses and halophytes.

The stakeholders highly valued this scheme. They suggested extensive plantation campaigns with full participation of people from all walks of life. Plantation campaign should be initiated on the embankments of canals, streets and roads and local NGOs should be given the opportunity to take on the campaign. People call for a complete ban on indiscriminate cutting of trees. In order to enable a successful implementation and operation and maintenance of the proposed project, a full community ownership must be ensured. Stakeholders want to see an integrated approach where all government departments will support and be involved in the tree plantation.

In addition, the consulted stakeholders call for tough enforcement of the environmental law, improvement of the awareness system, pilot intervention, use of local wisdom, inclusion and training of women to participate in the implementation of the scheme and introduction of environmental issues in the school syllables. Use of fertilizers and pesticides may be minimized and crop rotation be adopted to maintain the fertility of soil. Use of organic farming may be supported.

Stakeholders in all districts and area water boards endorsed the solution. However, some stakeholders expressed a certain reservation to the solution. For example, the stakeholders from Nawabshah think that the scheme may disturb soil fertility and suggested rose-plant water resistant varieties to be planted. Tando Mohammed Khan stakeholders suggest plantation of bio-diesel tree which would support local economy and reverse environmental degradation while Naushehro Feroze stakeholdrers promote plantations of rice, jantar, bih, Baid Mushk and Date trees in the Kotri Drainage Basin. Thatta stakeholders think that forestation should be done in fresh water rather than in drainage water. In case of forestation in drainage water, the water must be treated for pollutants and the stakeholders require that the Standard European Rules on Agriculture be applied.

9.9.1.4 Disaster Crisis Management Unit in SIDA

The burning issue stated by the communities along the flood protection bunds is their vulnerability to flood havoc. Communities are very apprehensive of unexpected breaches during floods. The main problem stakeholders pointed out are:

i. Inadequate and poor O&M of the drainage system, including sub drains and on-farm drains
ii. IPD and SIDA and associated AWBs and FOs need strengthening and staffing to carry out their routine operations and maintenance functions.
iii. Equipment should be purchased, personnel retrained and dispatch of maintenance crews scheduled.
iv. Train well-equipped emergency crews province wide for emergency and disaster response.

The main solution to the identified problems suggested and discussed by stakeholders at workshops was the establishment of the Disaster Crises Management unit in SIDA. The SIDA disaster/crisis management unit should train the necessary staff, prepare and coordinate plans for emergency situations and disasters within SIDA's ordinance. Out of fifteen districts, twelve endorsed the suggested solution. Area water board Nara stakeholders think that '*a disaster unit should be established in coordination with PDMA'*. Moreover, they proposed a full partnership with local farmers.

The stakeholder from Thatta, Mirpurkhas and Tando Allahyar, opposed the solution. They stated that the existing field units should be strengthened. In addition, the Government has already announced disaster management authority in Sindh by allocating all resources and facilities and establishing a new crisis unit will be duplication of work. They also underlined the presence of mismanagement in SIDA and IPD.

Generally, majority of the stakeholders endorsed the solutions; however, the solution has not been given the highest priority. The main reason is stakeholders' disbelief that the establishment of this unit would dramatically improve the situation during the crisis.

9.9.1.5 Brackish Water Fish in LBOD system (Nawabshah, Sanghar, Mirpurkhas and Badin Districts)

During the Phase I consultations, the stakeholders identified the following issues:

i. Livelihood for fishermen community of the area has declined
ii. Decline fish production and species
iii. Degradation of fisheries resources due to deterioration of the dhands water quality

The main solutions to the identified problems suggested and discussed by stakeholders at workshops was the introduction of brackish water fish in LBOD area, were the:

i. Construction of earthen fish ponds on private lands located in the command area of LBOD.
ii. Establishment of brackish water fish hatcheries
iii. Involvement of fish farmers in identification of areas for fishponds
iv. Preparation and implementation of 'on-the-job' trainings to fish farmers for capacity building

The main objectives are to utilize saline water, make the areas productive and improve livelihood of people.

The consulted stakeholders in all district and area water board levels have endorsed the solutions. However, the stakeholders from the Nara CAW emphasized that '*prior to implementation of this scheme, water quality should be tested at least three times as it is likely that water contains some heavy metals'.* In addition, the stakeholder from Tharparkar endorsed the solution and suggested that fisheries should be environmentally friendly and farm holder should be trained on technical aspects for modern/scientific management.

The stakeholder from Thatta suggested that *'small fish farming may be introduced in Thatta Delta and Coastal area, not just around the LBOD System'.* **The stakeholders from the Badin endorsed the solution but stressed that, fish farming near LBOD is impossible until the flow of hazardous and poisonous water from sugar mills stops.** Although majority of the stakeholders endorsed this solution, only the stakeholders from Ghotki gave this solution a first priority while the stakeholders from Nawabshah ranked it as a second priority and stakeholders from NCAW and LBCAW gave it 3rd priority, remaining all other stakeholder did not give it higher priority.

9.9.1.6 Second Line of Defense for Indus Bunds from Hyderabad to Thatta - Sujawal Bridge

The main issues identified during the Phase I of the Project by the stakeholder were the following:

i. Communities along the flood protection bunds feel vulnerable to flood havoc
ii. Lack of proper disaster Management and Preparedness
iii. Communities, particularly along the flood protection bunds and beyond, are apprehensive of unexpected breaches during floods.

The main solutions to the identified problems suggested and discussed by stakeholders at workshops was the Second Line of Defense for Indus River Bunds downstream of Kotri Barrage on Left Bank in Two Stages, Thatta-Sujawal Bridge to Hyderabad. The consulted stakeholders from three districts, Badin, Mirpurkhas and Tando Allahyar and all three AWB have endorsed the solutions. The stakeholders of remaining twelve districts opposed the solution. Stakeholders of those districts suggested that the original bunds be repaired, rehabilitated and strengthened (from Guddu to Thatta)

instead of building a second line of defense. According to the stakeholders of Naushahro Feroze, the original bund should be repaired through an internationally trusted company.

Generally, majority of the stakeholders did not endorse the solutions and the solution has not been given the highest priority.

9.9.1.7 Water Logging and Salinity, Ghotki Saline Project

The main issues identified during the Phase I of the Project by the stakeholder were the following:

i. Farmers in areas without any drainage infrastructure/network desire that drainage projects are constructed in their respective areas to control water logging and salinity menace, to reclaim arable land and to increase their farm productivity.
ii. Because of lack of alternate livelihood opportunities, poverty and food insecurity is increasing

During consultations with the stakeholders, they suggested the reduction of those major problems by controlling the water table and by identifying the best alternative for the effluents.

The consulted stakeholders at all district and area water board levels have endorsed the solutions.

Badin and Thatta stakeholders have not endorsed nor rejected as the solutions are not applicable to these two districts. The consulted stakeholders gave some additional suggestion. The stakeholder from Sukkur and Khaipur suggested South Khairpur saline/sweet water project should be reopened. The stakeholder from Ghotki pointed out that this area has already at some places the drainage system which is not in working properly. They especially talked about the Karo Naro drainage channel established during the British regime.

The stakeholder from Naushahro Feroz pointed out that if tube wells start working properly, water logging & salinity would automatically be controlled and reduced. The stakeholder from Nawabshah highlighted that high Delta crops like sugar, banana and rice should be restricted in the district. Plantation of Eucalyptus and conic ropes may be promoted. Bio saline agriculture and fish ponds should be introduced.

Stakeholders from LBCAWB suggested that Mangrove plantation should also be encouraged to control water logging and salinity. Stakeholders from GFAWB re highly concerned about the issue suggested to that Government should take more action as in Punjab the land production is much higher than in Sindh. They also think that the Government ban on some crops such as rice should strictly be implemented to control water logging problem.

The majority of consulted stakeholders has endorsed the solutions but out of fifteen districts only the stakeholders from Nawabshah has given this solution a first priority. The stakeholders from T.M.Khan, Sukkur, Khairpur and GFCAWB put this solution on the second priority while the stakeholders from Noushero Feroz gave it a 3rd priority. All other consulted stakeholders gave a lesser ranking to this solution.

9.9.1.8 Revival of Dhand System

Following are the key issues and problems identified in the consultative workshops with stakeholders in support of the mentioned proposed intervention:

Failure of the Cholri weir and breaches in the bunds

i. The brackish water dhands have turned into marine
ii. The entire ecosystem has changed affecting the fauna and flora of the dhand complex
iii. The livelihood opportunities have dwindled
iv. The dhands adjoining fertile lands have turned saline and degraded

The stakeholders suggested the following actions:

i. The dhands shall be provided with a bund about 1 km from the Tidal Link to allow breathing space for the tidal water
ii. This 1 km distance should be occupied by mangrove plantation to minimize the erosion due to rains and tidal effects

iii. The bund shall extend from the northern end of the dhands moving southwards and westward cordoning the entire dhand complex with a protection bund
iv. From the KPOD side at a suitable firm ground, diversion canal should be provided with a gated structure to allow the storm water from KPOD to enter in dhands to a manageable capacity.
v. From southern side, a spillway channel should be provided to evacuate the dhands when the water level in dhands reach to a risky level

The proposed intervention was shared with the stakeholders at the consultative workshops in order to take their concurrence for solving above mentioned issues and problems. The stakeholders in the environment and natural resources groups discussed and endorsed the proposed intervention collectively. **In general, a high priority was given to the scheme.** The stakeholders of Nara canal area water board strongly recommended the intervention by putting this at number one in terms of ranking and suggested that methods of wetlands revival should also be addressed. Similarly, the stakeholders of Mirpurkhas and Tando Allahayar area strongly recommended the proposed intervention. While endorsing, the people of Nawabshah area shared the significance of the intervention that the water from river reaching at dhands may be preserved in dhands too. The people of Sanghar suggested that the bunds should not be above the land surface. The sweet water may be allowed in depressions and dhoras. Vegetation may be grown on both side of bund like trees of Babur, Sheesham, Neem, and Eucalyptus.

The stakeholders think that the depressions along with the canals water or courses should be used as fish hatcheries. When there is more water, these depressions may be filled with fresh water that can be used at times when needed. The stakeholders of Tando Mohammad Khan area want to see a dhand named Kolab fully rehabilitated. This dhand covers around three hundred acres of area and is famous for fish production such as Dhangri. The dhand is covered with grass and beautiful birds mostly visit the dhand.

The stakeholders of Hyderabad and Matyari suggested that the rehabilitation process must be ensured with the participation of local communities.

9.9.1.9 Protective Plantation of Mangroves in the Coastal Areas of Badin and Thatta Districts

During the phase I consultations, the stakeholders identified the following issues:

i. Sea intrusion
ii. Degradation of dhandhs
iii. Natural disasters
iv. Coastal erosion
v. Deforestation of mangroves
vi. Decline of fish resource
vii. Limited livelihood opportunities
viii. Fragile coastal environment

The main solutions to the identified problems suggested and discussed by stakeholders at workshops was the protective plantation of mangroves in the coastal area. The stakeholders suggested:

Survey for identification of potential areas for mangrove plantations

i. Raising of mangrove and salt resistant plant nurseries
ii. Plantation of mangroves to protect wetlands and tidal link
iii. Plant mangroves in blank mudflats in coastal areas (in backwater and frontage of sea)
iv. Raising of salt-tolerant tree species in supra tidal zone

The stakeholders in all districts and area water boards have endorsed the proposed solutions.

There was no any single objection to this solution. The stakeholders also suggested that a variety of mangroves must be selected according to the environmental condition. The stakeholders from Tharparkar suggested plantation of fodder trees including the Thar belt near Rehmki Bazar and

Ropamari and Dhands. Prior to plantation or introduction of any variety, a proper environmental assessment should be conducted.

The stakeholders from LBCAW suggested a pilot project which should be implemented as role model for others. NCAW stakeholders suggested that in the area of Tidal Link where there is no mud other species like *khabar, kirar* should be planted.

Although the consulted stakeholders in all district and area water board levels have endorsed the solutions, only the stakeholders from four districts, Mirpurkhas, Tando Allahyar, Umerkot, and Tharparkar have given a first priority to this solution.

9.9.1.10 Aquaculture (Shrimp Farming and Mud Crab Culture) Development in Coastal Areas of Badin and Thatta Districts

The main issues identified during the Phase I of the Project were the following:

i. Depleting fish resources
ii. Reduced livelihood opportunities
iii. Poverty spreading
iv. Limited fishermen capacity

The main solutions to the identified problems suggested and discussed by stakeholders at workshops was the shrimp farming. The Coastal area became more suitable for shrimp and fin fish culture including crabs and lobster. Immense potentials exist to start commercial scale fish / shrimp farming. Fattening of mud crabs, green crab or mangrove crab has good potential in the area.

All consulted stakeholders in all district and area water board levels, have endorsed the solutions. The stakeholders from Thatta recommended that shrimps and crabs be introduced through farming and by providing training to local fish farmers. The stakeholders from Sanghar recommended that shrimps and mud crab be developed in coastal areas while stakeholders from LBCAWB suggested nurseries for shrimp and mud crab followed by a large level of local marketing.

Although the consulted stakeholders at all district and area water board levels have endorsed the solutions, only the stakeholders from Nawabshah gave it a first priority.

9.9.1.11 Revival of main Dhoras (natural water flows)

The community consultations on the proposed revival of main dhoras and potential construction of drains in the left-over-areas have been conducted in the area which is traversed by the major dhoras on the Left Bank of Indus. The consultations included the following dhoras and drains: Dhoro Puran, Sonhi Dhoro, Dhoro Naro, Hakro Dhoro, Dhoro Pithoro, Bhaikhan Dhoro and D4 Drain.

Generally, local communities endorsed the proposal. They expect to be saved from flooding, damages and constant relocation during rainy seasons. People expect only rain water to flow in dhoras as they would use it for livestock and domestic purposes. The most cited benefits were that dhoro will enable fast draining of water and that land, houses and livestock will be saved from floods.

'Puran is our mother; our descendants were always looking at Puran as mother; they saw it running. And that was the time when nearby lands were all green. Now, since many years we see it as our mother has passed away because all nearby lands are facing drought condition day by day.' Ghulam Mohammad Khoso village, Dhoro Puran, Tharparkar

Almost without exception, respondents expressed their support for the proposed dhoras revival as well as the readiness to participate. **95.6%** stated that they are ready to cooperate with Government in every way they could. Most of ordinary people are poor and cannot contribute money, but they suggested paid daily labour, collecting donations, giving information to the working team, looking after construction material etc. Consulted communities expect the Government to involve them in operation and maintenance activities.

Nevertheless, certain reservations towards the Project have been recorded in Mirpurkhas area. Some landlords were reluctant to allow consultations with people and especially with women. Also, in

some cases villagers at first were unwilling to discuss the revival of dhoro as their villages are almost entirely built in the dhoro. For example, people of Shagan Bhagat village, Sonhi dhoro, Mirpurkhas, claim that dhoro did not flow for years and due to that, they built structures in its bed. Rano Ramdan, Bahram Khan Gorchani and Shagan Bhagat villages along Dhoro Puran in Mirpurkhas as well as Mir Jo Goth and Haji Jaffar Hakro villages along proposed Drain 4 in Tandu Allahyar, were not as pleased with the proposed interventions as it would affect their structures built and crops planted in the bed of the dhoro.

9.9.2 Resettlement Considerations

The involuntary resettlement, according to the World Bank Policy, may cause severe long–term socioeconomic hardships, impoverishment, and environmental damages unless appropriate measures are carefully planned and carried out. The Policy requires that involuntary resettlement should be avoided where feasible, or minimized exploring all viable alternative project designs. In case it becomes unavoidable the affected persons should be meaningfully consulted; providing them an opportunity to participate in planning and implementing the resettlement program. They should be assisted in their efforts to improve their livelihoods and standard of living or at least to restore these, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher. This Policy endorses the eligibility of all the categories of persons, whether with formal legal rights or without these rights, in a project, but occupying project area prior to the cut–off date acceptable to the Bank.

The Resettlement Action Plan (RAP) shall be developed in accordance with the requirements of the World Bank (OP-412 on Involuntary Resettlement which requires the preparation of a Resettlement Plan, should the number of affected persons exceed 200. As the number of affected persons in case of this project has been identified as more than 200, hence the project qualifies for the preparation of a full RAP.

Purpose of the RAP

The purpose of preparation of the RAP is to ensure that the identified affected persons (APs) and the total extent of their losses based on the census survey and subsequent assessment are compensated in a fair, timely and transparent manner in accordance with existing laws of Pakistan and the requirements of the donor. The major aims of the RAP are described as follows:

- To avoid or minimize involuntary resettlement wherever feasible, exploring all viable alternative project designs.
- To ensure that Affected Persons (APs) should have their former living standards and income earning capacity improved, or at least restored; and should be provided adequate support during the transition period.
- Encourage the community participation in the planning and implementation of the RAP.
- Ensure proper compensation for the affected land, structures and other assets.
- Ensure a transparent compensation process for the affected people.
- In view of the COI requirements and complexity of resettlement issues, suggest measures for the concerned government agencies and departments to upgrade their institutional capacity to implement RAP
- The preparation of a RAP acceptable to World Bank is a condition to project interventions.
- The implementation of the RAP, including the project information disclosure to APs and full completion of the compensation program detailed in the document, will be condition for the provision of no–objection to the initiation of project works.

The scope of the study for the present project includes the preparation of a RAP for the APs of the proposed interventions under the legal and policy framework of Land Acquisition Act, 1894 and World Bank Guidelines on involuntary resettlement.

Identification of Project Affected Persons

According to 100% Census Survey in the corridor of impact (COI, 152 meters), the number of Affected Households (AAHS) has been identified 993. Among these, 587 AHHs fall under multiple categories of land, structures, and trees. There is one absentee AHH. The total number of PAPs works out to be 4257.

Land Acquisition

The prelimrenary estimates of survey of the project area shows that and area of 644.72 ha of agricultural land (163.30 ha, barani and 481.42 ha, irrigated land) owned by 200 households. The compensation and rehabilitation cost relative to this impact is Rs. 394.02 million. However, there will be temporary acquisition of land during construction phase for various construction related activities such as access roads, residential quarters for construction teams, storage places for equipment, operational space, borrow areas and spoils deposit areas. The provisions of the Land Acquisition Act, 1894 will not be invoked in this case since the acquisition of the land is temporary, and will be covered by short–term lease agreements between the landowners and contractors. The construction contractor will be responsible for making arrangement for hiring of the land for temporary use and / or payment of the compensation of this land or land based infrastructure as applicable under intimation and approval of the PD. The contractor will restore the land to its original condition before handing over to the owner.

Loss of standing crops

The survey has revealed that about 824 farmers will be losing their source of livelihood as a result of project intervention. The survey has revealed that 638.06 Ha. of cropped area, comprising of 221.01 Ha for wheat, 232.03 ha for cotton , 27.0 Ha for Chilies and 31.51 haof sugarcane crop crops will be affected. The prelimrenary estimates of compensation for loss of standing crops have been estimated as Rs. 73.18 million.

Removal of Trees

Total number of privately owned trees falling within the proposed COI comes to about 6,391. These include Shesham, Kandi, Neem, Babul, etc. All the affected trees are mostly at the pole stage with average age ranging between 6–9 years. These will be used as firewood. 9%, i.e. 564, of the total trees were Fruit trees. The total prelimrenary estimates of compensation for privately owned affected trees works out to be Rs. 8.56 million.

Loss of Structures

It has been observed that 322 structures will be affected including 14 shops. The total prelimrenary estimates of compensation cost for affected structures have been calculated as Rs. 274.41 million.

Indigenous & Vulnerable Persons and Female Headed Households

No indigenous persons were identified in the project corridor. However, 165 vulnerable were identified. They will be compensated as per provisions of EM.

Archeological, Historical, and Religious Sites

No archaeological and historical sites were observed in the vicinity of proposed project corridor.

Public Utilities within COI

No public infrastructure including schools, hospitals, offices, etc. fall within COI. However, 15electric poles and 12 telephone poles falling within the COI will be relocated through their respective departments. The total prelimrenary estimates of relocating the utilities works out to be **Rs. 0.705 million –** (Rs. 0.525 million / – for electric poles and Rs. 0.18 million – for telephone poles)

Additional Assistance for Vulnerable Households

The income analysis of PAPs has been revealed that the number of vulnerable households comes to 165 laborers. These people will be deprived of their daily livelihood earnings due to project works. They belong to poor segment of the society and cannot bear the disruption in their daily earnings.

Such people are considered as vulnerable. For such households and individuals, in addition to the compensation for their affected assets, an additional assistance of Rs. 11,951 / – (equal to one month amount of inflation adjusted OPL according to average household size), will be paid. The amount of prelimrenary compensation to be paid on this account comes to be **Rs. 1.98 million.**

Resettlement budget

The cost of RP implementation is included in the overall socioeconomic management budget of the project. The total preliminary estimated budget amount of this RAP works out to be about Rs. **756.46 million**. These estimates may be revised while finalizing the resettlement action plan.

9.9.3 Monitoring Framework to be adopted by the Client

The monitoring and evaluation (M&E) of project implementation performance, mechanisms for feedback to the implementing agencies, mechanisms for ensuring that the lessons learned are accounted for, and for development of management information systems to monitor project performance effectively, will be better implemented by a unit or cell inside the Sindh Irrigation and Drainage Authority rather than contracting fragments of it to consultants, because the M&E practices need to be institutionalized and SIDA needs to grow along with the unit proposed. However, sub-contracting work for specific tasks would be part of the routine M&E activities of the M&E Unit.

Definition of Monitoring and Evaluation

The United States Agency for International Development (USAID) is one of the leading institutions in the world in the monitoring and evaluation (M&E) arena. Therefore, it was borrowed from them the definition[33] of M&E:

> *"Evaluation is defined as a systematic and objective assessment of an ongoing or completed project, program, strategy or policy. It is designed to determine the relevance, effectiveness, efficiency, sustainability and/or impacts of an intervention, strategy or policy. The purpose of an evaluation is to generate credible and useful information that contributes to improved performance, accountability and/or learning from the experience and to assess their effects/impacts and inform decisions about future programming.*
>
> *In common parlance, monitoring and evaluation are often mentioned together as signified by the acronym M&E. While the two complement each other, they are conceptually and operationally different. Monitoring is a continual process designed to provide information to decision-makers about the progress (or lack of it) of a project, program or policy. It involves checking the progress against pre-determined objectives and targets, and tells us what is happening or has happened. Evaluation, on the other hand, is much more comprehensive. It goes beyond tracking of progress and seeks to identify the underlying factors and forces that affect the implementation process, efficiency, sustainability and effectiveness of the intervention and its outcomes. "*

Monitoring	***Evaluation***
Clarifies program objectives	*Analyzes why and how intended results were and were not achieved*
Links project activities to their resources and objectives	*Assesses specific contributions of activities to the results (for example, addresses the cause-effect linkage or attribution issues)*
Translates objectives into measurable (usually quantitative) performance indicators and sets	*Examines other desired results not easily measured or quantified*

[33]USAID, Evaluation Guidelines for Foreign Assistance.Planning and Performance Management Unit. March, 2009

targets (intended results)	
Routinely collects data on these indicators and compares actual results with targets	*Explores unintended results as well as intended ones*
Reports on progress to Directors and alerts them to problems requiring attention and action	*Provides lessons and recommendations for adjustments in programs and policies to improve results."*

WSIP-I Objectives and M&E Rationality

The overall goal of the WSIP-I Project is to "*improve the efficiency and effectiveness of irrigation water distribution in three Area Water Boards (AWBs) (Ghotlu, Nara and Left Bank), particularly with respect to measures of reliability, equity and user satisfaction*."

The World Bank Three Pillars of the Country Assistance Strategy are:

(i) Sustaining growth and improving competitiveness;
(ii) Improving government effectiveness and service deliverable and;
(iii) Improving lives and protecting the vulnerable.

WSIP-I objectives would be achieved by: (a) deepening and broadening the institutional reforms that are already underway in Sindh; (b) improving the irrigation system in a systematic way covering key hydraulic infrastructure, main and branch canals, and distributaries and minors; and (c) enhancing long-term sustainability of irrigation system through participatory irrigation management and developing institutions for improving operation and maintenance of the system and cost recovery.

Activities deemed eligible for M&E were selected based on the Consultants Phase-II Report recommendations. The recommendations were centered on significant stakeholder consultations, detailing rationale, output, impact, along with technical and economic viability, sustainability, socially acceptability and a ranking process. A ranking procedure with the evaluation criteria for possible solutions, considering, costs, economic returns, technical, social, and environmental feasibility was employed. The method applied contemplates five major criteria and a number of sub-attributes. These are: i) social accessibility; ii) financial soundness; iii) environmental benefits; iv) Socio-economic impact; and; v) sustainability. Each of the sub-attributes identified by stakeholders for each of the interventions was evaluated according to the expected impact.

The recommendations for the consideration of SIDA, PID, and the GoS are the following:

A. Core Projects be Selected as First Priority

i. Rehabilitation and improvement of LBOD drainage infrastructure;

ii. Revival of natural water ways (dhoras) to drain out the storm water;

iii. Protective plantation of mangroves in the coastal areas of left bank;

iv. Establishment of Disaster Management Cell in SIDA; and

v. Gender mainstreaming in irrigation and drainage.

B. Preparation of PC-1s for the Second Priority Projects

i. Privatization of FGW SCARP tubewells; and

ii. Rehabilitation of the LBOD and SCARP tubewells,

Among these, SIDA instructed the Consultants not to pursue further the establishment of Disaster Management Cell in SIDA and, on 10 May 2012 the Panel of Experts in a meeting expressed hesitation about including the study Gender Mainstreaming in Irrigation and Drainage. Thus, these two studies will not be considered for the M&E write up.

The SIDA Monitoring and Evaluation (M&E) Unit

Objective of the M&E Unit

The objectives of the Monitoring and Evaluation (M&E) Unit are to ensure the systematic assessment of project implementation performance; mechanisms for feedback to SIDA management; mechanisms for ensuring that the lessons learned are accounted for and; for the development of management information systems to monitor project performance effectively, by collecting information on regular basis using performance indicators, identifying corrective actions and evaluating the impact of SIDA's interventions.

The M&E Unit's Tasks and Activities

The M&E Unit will be responsible for the following:

i. Establish a Management Information System (MIS). The M&E Unit will supervise the development of an integrated M&E system.

ii. Develop M&E policies and procedures. The M&E policies and procedures will be documented in M&E guidelines, to be used by all SIDA Staff, AWBs, contractors and consultants.

iii. Socialize the M&E Unit's objectives. The M&E Unit will be responsible for socializing the M&E objectives, policies and procedures to all key stakeholders (at District and Provincial levels) involved in the WSIP-I project, to ensure there is a common understanding of the objectives and the overall process.

iv. Socialize Information and Findings. The M&E Unit will develop and implement a systematic information approach to ensure participation of all stakeholders in the consultations of lessons learned regarding the SIDA implementation activities. Information shall be socialized following the completion and adoption of findings from surveys, studies and additional reports. Besides consultation workshops; SIDA Website, periodic TV appearances and newspaper articles shall be means for socializing information and findings.

v. Project Monitoring. The M&E Unit will conduct project monitoring through site visits, review of reports and analysis of performance monitoring indicators and other data.

The Management Information System (MIS)

The M&E Unit shall develop or sub-contract the development of a Management Information System (MIS) for M&E to handle performance data, analysis and reports for onward transmission to the SIDA MD and SIDA Board of management.

The MIS has to be based on outputs, processes and performance indicators to be identified for every particular intervention. These shall be used by SIDA MD and Directors to make decisions and manage their activities. Microsoft SQL SERVER 2012 software (a relational database management system) is suggested to develop the MIS.

The following attributes should be considered when designing the system:

i. Capacity to store and handle project outputs and outcomes data and generate reports for management

ii. Capacity to link project outputs and outcomes to budget allocations/spending

iii. Capacity to document important M&E actions, processes and performance indicators

iv. Capacity to store and track updates to an M&E Work plan

Human Resources Required

The SIDA M&E Unit will be headed by the M&E Director whose primary responsibility will be to manage all M&E activities. The M&E Director will be assisted by staff from each of the Area Water Boards, an Economist, a Statistician and an IT specialist. The M&E AWB staffs are required to carry out the basic monitoring activities of all SIDA interventions in their respective zones in addition to being answerable for data quality assurance. The AWB Directors will ensure that all such activities are carried out timely and efficiently and, will alert management regarding issues that can adversely affect the intervention results. The Economist will plan, identify requirements, prepare terms of reference, staffing requirements, and costs estimates and will liaise with engaged sub-consultants to conduct various research and impact studies of the WSIP-I project to enable SIDA and Stakeholders determine the extent to which WSIP-I project objectives are being achieved. The Statistician will lead in the collection, analysis and presentation of numerical data on the implementation of SIDA's programs and activities (for example, soils, water quality, groundwater, surface water, flood levels, and downstream effects, agricultural, fisheries, and other socio-economic data). The existing SIDA IT specialist will also provide services to the M&E Unit making sure that the network and Internet systems run smoothly.

Table 9.5: Detailed costs

S. No	Designation	Market Rate per month	Per annum
1.	Director	125,000	1,500,000
2.	Economist	90,000	1,080,000
3.	Statistician	90,000	1,080,000
4.	Data Collector AWB (3)	50,000	600,000
5.	Data Entry/Programmer (2)	50,000	600,000
6.	Computer Operator/Secretary	30,000	360,000
7.	Driver (2)	40,000	480,000
8.	Naib Qasid (Tea Boy)	12,000	144,000
	Total	**487,000**	**5,844,000**

Infrastructure Required

Two offices within the SIDA building

i. Equipment Required

Item	Cost Rs.
Computers, printers, etc.	1,200,000.-
Software	500,000.-
Furniture	300,000.-
Vehicle (2)	8,000,000.-
Total	10,000,000.-

ii. Budget

a. Initial Costs Rs. 10,000,000/-

b. Sub-contracts Rs. 20,000,000/-

c. Annual Operation Costs

Salaries	Rs. 5,844,000.-
Per diem	Rs. 6,676,000.-
O&M Vehicle	Rs. 3,000,000.-
Stationary	Rs. 300,000.-
Miscellaneous (maintenance eq. & office)	Rs. 400,000.-
Total	Rs. 16,220,000.-

Performance monitoring Plan: Table 9.6 describes the intervention – wise indicators and related parameters for each proposed projects. The typical format has to be adopted during the execution.

Table 9.6: Performance Monitoring Plan

Program Component	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
WSIP-I Strategy	*This massive infrastructure is deteriorating and in need of rehabilitation along with reforms to improve allocation of water as well as the efficiency of its use*						
Rehabilitation and improvement of LBOD drainage infrastructure	LBOD Canal network rehabilitated. Earthworks	Earth works LBOD System consisting on: Desilting; cut; formation of berms; inspection paths; maintenance roads; etc.	**Name of Drain** / **Length RDs** Spinal Drain 656 KPOD 180 DPOD 127 Nawabshah West Main Drain 206 Nawabshah East Main Drain 313 Singhoro Branch Drain 143 Sanghar Main Drain 77 Patoyun Branch Drain 95 Mirpurkhas Main Drain 386 LBOD Branch Drain 144 Fuleli Guni Outfall Drain 126 Karo Ghunghro Outfall Drain 371 Total 2,824	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Weekly
	VR Bridges	Reconstruction of fully damaged Village Road Bridges capable of taking AA loading	**Name of Drain** / **VR** Spinal Drain 6 KPOD 1 DPOD - Nawabshah West Main Drain 2 Nawabshah East Main Drain - Singhoro Branch Drain 4 Sanghar Main Drain 2 Patoyun Branch Drain 1 Mirpurkhas Main Drain - LBOD Branch Drain 6 Fuleli Guni Outfall Drain - Karo Ghunghro Outfall Drain 2 Total 24	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Quarterly
	Foot Bridge cum Aqueducts	Combination of foot bridges and watercourse aqueducts into one reinforced concrete	**Name of Drain** / **WC/FB** Spinal Drain 5 Nawabshah West Main Drain 2 Nawabshah East Main Drain 3 Singhoro Branch Drain 7 Sanghar Main Drain 6 Patoyun Branch Drain 5 Mirpurkhas Main Drain 8	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Monthly

Program Component	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
		structure and; watercourse aqueducts	LBOD Branch Drain 13 Karo Ghunghro Outfall Drain 3 Total 52				
	Escapes	Reinforced concrete side weir structures to offload 1,000 cfs to dhoras	**Name of Drain** **Escapes** Spinal Drain 2 DPOD 1 Total 3	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Quarterly
	Tide Gated Control Structure	A structure capable of checking the tide constructed with reinforced concrete, gates and sheet piles.	**Name of Drain** **Tide Control Structure 1(At RD 20 of KPOD)** KPOD	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Semesterly

Program Component	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
WSIP-I Strategy	*Recommend measures for retention and / or Safe disposal of drainage, Storm and flood Water*						
Revival of natural water ways (*dhoras*) to drain out the storm water	Dhoros Earthworks	Earth works on Dhoros consisting on: Desilting; cut; formation of banks; inspection paths; maintenance roads; etc.	**Dhoro** / **Length (RDs)** 1) Puran 715.500 2) Hakro 273.383 3) Sohni 672.605 4) Bhai Khan 482.307 5) Digri 66.932 6) Pithoro 90.427 7) Naro/Nabisar 111.554 8) South Khairpuir-1 (HM) 416.687 9) South Khairpuir-2 (NTW) 142.724 10) Ghotki Dhoras 2,016.000 Total 4,988.119	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Weekly
	DR. Bridges	Construction and reconstruction of District Road Bridges capable of taking AA loading	**Dhoro** / **DRB** 1) Puran 7 2) Hakro 5 3) Sohni 14 4) Bhai Khan 7 5) Digri 1 6) Pithoro 2 7) Naro/Nabisar 4 8) South Khairpuir-1 (HM) 8 9) South Khairpuir-2 (NTW) 8 10) Ghotki Dhoras 5 Total 61	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Quarterly
	VR Bridges	Construction and reconstruction of District Road Bridges capable of taking AA loading	**Dhoro** / **VRB** 1) Puran 31 2) Hakro 24 3) Sohni 49 4) Bhai Khan 80 5) Digri 7 6) Pithoro 17 7) Naro/Nabisar 32 8) South Khairpuir-1 (HM) 64 9) South Khairpuir-2 40	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Quarterly

Program Component	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
			(NTW) 10) Ghotki Dhoras 44 Total 388				
	Aqueducts	Watercourse aqueducts crossing dhoras	**Dhoro** Aqueduct 1) Puran 12 2) Hakro 7 3) Sohni 20 4) Bhai Khan 216 5) Digri 4 6) Pithoro 5 7) Naro/Nabisar 15 8) South Khairpuir-1 (HM) 51 9) South Khairpuir-2 (NTW) 23 10) Ghotki Dhoras 58 Total 411	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Monthly
	Foot bridges	Reinforced concrete foot bridges	**Dhoro** FB 1) Puran 21 2) Hakro 15 3) Sohni 20 4) Bhai Khan 73 5) Digri 2 6) Pithoro 16 7) Naro/Nabisar 29 8) South Khairpuir-1 (HM) 68 9) South Khairpuir-2 (NTW) 18 10) Ghotki Dhoras 41 Total 303	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Monthly
	Foot Bridge cum Aqueducts	Combination of foot bridges and watercourse aqueducts into one reinforced concrete structure	**Dhoro** AQ/FB 1) Puran 2 2) Hakro 7 3) Sohni 0 4) Bhai Khan 21 5) Digri 0 6) Pithoro 8 7) Naro/Nabisar 3 8) South Khairpuir-1 (HM) 60 9) South Khairpuir-2 (NTW) 12 10) Ghotki Dhoras 5	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Monthly

Program Component	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
			Total 118				
	Siphons	Reinforced concrete siphons to pass the storm water under the drains	**Dhoro** Siphon 1) Puran 1 2) Hakro 0 3) Sohni 1 4) Bhai Khan 1 5) Digri 1 6) Pithoro 0 7) Naro/Nabisar 0 8) South Khairpuir-1 (HM) 0 9) South Khairpuir-2 (NTW) 0 10) Ghotki Dhoras 0 Total 4	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Semesterly
	Outfall Structures	A dhora outfalling into another dhora. The structure will be reinforced concrete with proper stone pitching	**Dhoro** OF. S 1) Puran 0 2) Hakro 1 3) Sohni 0 4) Bhai Khan 0 5) Digri 0 6) Pithoro 1 7) Naro/Nabisar 1 8) South Khairpuir-1 (HM) 1 9) South Khairpuir-2 (NTW) 1 10) Ghotki Dhoras 4 Total 9	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Quarterly
	Railway Bridge	Railway bridges crossing dhoras need to be modified or new constructed. The Railway Authorities need to be approached.	**Dhoro** RB 1) Puran 1 2) Hakro 1 3) Sohni 0 4) Bhai Khan 0 5) Digri 0 6) Pithoro 0 7) Naro/Nabisar 0 8) South Khairpuir-1 (HM) 0 9) South Khairpuir-2 (NTW) 0 10) Ghotki Dhoras 0 Total 2	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Semesterly

Program Component	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
	Village road Bridge cum Aqueduct	Village road bridges combined with aqueducts into one single reinforced concrete structure	**Dhoro** VRB/Aq 1) Puran 0 2) Hakro 0 3) Sohni 0 4) Bhai Khan 15 5) Digri 0 6) Pithoro 4 7) Naro/Nabisar 3 8) South Khairpuir-1 (HM) 8 9) South Khairpuir-2 (NTW) 2 10) Ghotki Dhoras 13 Total 45	Surveys and reports from contractors and LBOD PD	PD reports and contractors payment receipts	LBOD PD	Quarterly

Program Component	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
WSIP-I Strategy	**Sustaining growth and improving competitiveness.**						
Protective plantation of mangroves in the coastal areas of left bank	Area Planed	Hectares Planted	Ha.	Area Mapping	GIS / Physical Survey	Executing Agency	Annual
	Plants Raised in Nursery	No. of Plants raised	No.	Actual Counting	Field Staff	Executing Agency	Quarterly

Program component	Indicator	Indicator definition	Measurement unit	Data collection method	Data source	Responsible entity	Frequency & periods of data collection
WSIP-I Strategies	*"The key challenge for Pakistan is to sustain its recent growth performance in order to generate significant poverty reduction"*						
Social. the World Bank (2007) identifies three inter-linked and mutually reinforcing pillars of the Country Assistance Strategy: i) sustaining growth and improving competitiveness; ii) improving government effectiveness and service delivery; and iii) improving lives and protecting the vulnerable.	Population change and migration	Monitoring the population of the area on the flooding areas, Delta and Coastal Zone should provide indication if the socio-economic conditions are such that the residents are forced to migrate to get jobs or not.	Number				Bi-annually
	Income distribution	Living standard measurement surveys as defined by the World Bank	World Bank questionnaires (about 200 questions)				Bi-annually
	Poverty	Determining the poverty level by finding the total cost of all the essential resources that an average human adult consumes in one year.	Number				Bi-annually
	Gender	Equality in gender and gender discrimination					
	Participation	Consultations and meetings arranged by the implementation agency.	Number of people				

Overall Project	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
All Components/ Interventions	Yield per ha	Increase in farm productivity due to reduction in waterlogging and salinity	kg/ha	Impact assessment surveys	Project Impact Assessment Consultants Reports	SIDA	Yearly
	Cropped Area	Increase in cropped area due to reduction in waterlogging and salinity	Area in ha	Impact assessment surveys	Project Impact Assessment Consultants Reports	SIDA	Yearly
	Farm Income	Increase in Per ha value of crops	Rupees per ha	Impact assessment surveys	Project Impact Assessment Consultants Reports	SIDA	Yearly
	Fish Production	Value of increase in fish production	Rupees per ha	Impact assessment surveys	Project Impact Assessment Consultants Reports	SIDA	Yearly
	Forestry Based Production	Value of increase in forest based production	Rupees per ha	Impact assessment surveys	Project Impact Assessment Consultants Reports	SIDA	Yearly

Overall Project	Indicator	Indicator Definition	Measurement Unit	Data Collection Method	Data Source	Responsible Entity	Frequency & Periods of Data Collection
	Reduction in Flood Damages	Area saved from inundation and crop submergence	Rupees per ha	Flood inundation observations	Project Performance Monitoring Consultants Reports	SIDA	Yearly
	Dislocation of Rural Household	Number of population saved from dislocation and reduction in number of marooned days	General observation	General observation	Project Performance Monitoring Consultants Reports	PDMA reports	Extreme flood years
	Disease incidence	Reduction in disease incidence	General observation	General observation	Project Performance Monitoring Consultants Reports	PDMA reports	Extreme flood years
	Quality of water in the drains	Reduction in pollutants in the drainage system	Level of physical and hazardous chemical contamination in the drains	Quality monitoring	Project Performance Monitoring Consultants Reports	Special surveys	Quarterly

9.10 Capacity Building and Training

Capacity building is an ongoing process through which SIDA enhances its ability to identify and meet development challenges. It is a process to increase the skills, infrastructure, and resources of SIDA for the promotion, delivery and sustainability of the Institution. Among the institutional strengthening activities of SIDA are the facilitation and delivery of learning exercises by providing resources and training.

SIDA's Training Centre

According to SIDA's Web Site[34], the Institution recognizes that with the reforms in the Irrigation Sector in Sindh the organizational capacity of the Farmer Organizations (FO) becomes crucial to the performance of the irrigation system. SIDA points out that the number and responsibilities of the FO's requires a large, dedicated and long-term training effort of their members. The aim of the training is to familiarize the FO key staff with the primary management processes at minor and distributary level. SIDA further identifies the fields where the training should be provided: *"To improve water management at distributary and minor level and also at canal level it is crucial to build the capacity of Farmer Organizations in improved water management, revenue collection, FO administration, water saving and crop and livestock production and others".*

SIDA's Training Package

SIDA has identified the following subjects for training at FO Level and AWB Field Staff

FO Level

i. Institutional reforms in Irrigation and Drainage
ii. Introductory Water Management Reforms
iii. Basic HRM procedures and conflict management
iv. Effective communication and conflict management
v. O&M and Community Contract Management
vi. Business planning and project preparation
vii. Project planning and implementation
viii. Financial audit and FO transparency
ix. Irrigation campaign planning
x. Basic computer skills
xi. On farm water management
xii. Improving crop and livestock productivity
xiii. Gender integration and poverty alleviation
xiv. Environmental management and mitigation
xv. Income generation and resource mobilization
xvi. Organizational linkage and Income Generation
xvii. Group dynamics and leadership development

AWB field staff

i. Orientation on Irrigation Reforms
ii. Upstream control on Cross Regulators
iii. Revenue assessment and administration
iv. SWMO 2002
v. Controlling Direct Outlets
vi. Environmental management and mitigation

[34]SIDA Web Site. Training Center. http://www.sida.org.pk/transition/Training%20cell/default.asp

vii. Retraining distributary/ minor level staff

Benazir Bhutto Shaheed Youth Development Program (BBSYDP)

The BBSYDP contemplates a very comprehensive training program to benefit farmers and also personnel from the Government of Sindh Irrigation and Power Department; the Sindh Irrigation and Drainage Authority, SIDA and Area water Boards.

9.10.1 Master/Regional Plan Consultants Training Proposal

The Master/Regional Plan Consultants conducted a training course on *Tools for Flood and Drainage Monitoring and Management, GIS, Current Metering, HEC-RAS* in September 2012. The course aimed at introducing the participants to the numerical/computer model-based approach to the integrated planning and management of large irrigation canals and drains. The overall goal of the course was to persuade irrigation and drainage engineers that by using canal hydraulics simulation model the economic and social welfare of the irrigation system users can be maximized and to motivate them to apply and continue their studies in canals modeling. The course was designed for irrigation and drainage engineers and managers of the Sindh AWB, SIDA and the Irrigation Department. The results of the course were encouraging. Twelve professional staff attended the course and their participation and interest expressed in the course contents were positive.

In view of the existence of the SIDA Training Centre and the BBSYDP, with the training course experience described above and in order to avoid duplication of efforts, the training is envisaged to aim at the project objectives to address flooding and drainage issues not covered by the SIDA Training Centre and the BBSYDP. Accordingly, the training is proposed to be dived into three types:

i. Training of beneficiaries

ii. Training of beneficiaries' leaders

iii. Training of SIDA/AWB staff

i. ***Training of beneficiaries***

The farmers need practical training mainly in the maintenance of the field drains. The training should start with an explanation of the different types of maintenance; routine (or normal maintenance), deferred maintenance, preventive maintenance and emergency maintenance. They should also be aware that if maintenance is neglected, then rehabilitation is required and in the worst case scenario, reconstruction.

The training then should concentrate on the "Walk-Through" Survey, originally developed by the late Prof. Skogerboe at Utah State University.

"Walk-Through" Survey

According to IIMI,"…in a government managed irrigation system, Irrigation Department receives funds annually for O&M of irrigation system. These maintenance funds are used to undertake routine or deferred maintenance works. Unfortunately, majority of the canals, distributaries, minors and water control structures are deteriorating under a combination of unavailability of sufficient funds for maintenance, increased political interference, lack of interest and motivation of government officials, and poor reward system for good work performance. Aside from this, with the passage of time, agency officials have left the habit of patrolling the irrigation system network, which they did."

Because of travelling by car along the canals/drains, the field personnel do not have the opportunity to see the problems developing in the system and minor problems go unnoticed. A number of minor problems –when neglected for a period of time- develop into major problems, leading ultimately into rehabilitation works. The most important and foremost step is to conduct a detailed "Walk-Through" Survey that lists all type of maintenance needs on the field drains and sub-drains including outlet structures which impede efficient management of the system. The survey should be conducted jointly by a team of technical staff from SIDA/AWB and a group of farmers and their leaders from the area.

Involving the farmers in the "Walk-Through" Survey is highly important because they are very familiar with the system; spend more time along the drains than the SIDA/AWB field staff and it is not unusual to find out that they know the operations and maintenance problems better than the field personnel. During the "Walk-Through" Survey some problems, which may not be noticed by the technical group can sometimes be identified through the users of the system.

According to IIMI, the maintenance should be focused on 1) strengthening of banks, 2) desiltation, 3) removal of shrub and trees, 4) repair of gate structures, 5) repair of outlets, 6) repair of bridges and crossovers, etc. The "walk-thru" surveys should be carried out twice in a year; once when the channel is dry and once when the channel is running at full supply level.

ii. ***Training of Leaders***

Leaders need special training beyond the technical training they should receive. Leaders need training in leadership, financial management and system drainage. Skogerboe describes the objectives of the latter two; adopted below.

Leadership

With the understanding that leadership is a relationship between the leader and those who are being led, training needs to develop the leaders' understanding the fundamental objectives of the users association and the importance of adequately communicating these goals to the farmers in their associations. Leaders must learn how to identify and know their own strengths and weaknesses before they can inspire trust in people. A key leadership training objective is to develop the skills of helping people do their best

Financial Management

The leaders need special financial management training to build up their capability for managing their financial resources and to maintain a proper record of all financial matters, including record keeping for contributed labor during maintenance activities. Farmers should be allowed to select their trainees from among themselves.

System management

The farmers should be able to manage not just their irrigation watercourses systems, but also the field drains. The primary focus of the training should be the management of the system, the scheduling of the maintenance activities, estimates of labor force and equipment requirements, scheduling of the participations of the members of the drainage users and the M&E (monitoring and evaluation) of the systems operation and maintenance.

iii. ***Training of SIDA/AWB Staff***

According to Skogerboe, two types of training are required by the field staff:

i) Operations training and ii) Maintenance training

Operations training

The main concept taught in the Operations and Maintenance of Irrigation Systems Course at the International Irrigation Center at Utah State University is: "Measurement is Synonym of Management**".** If you can measure it you can manage it. However, if you don't measure it, you don't know what you have and if you don't know what you have, you cannot manage it. The course should concentrate mainly in discharge measurement.

Maintenance training

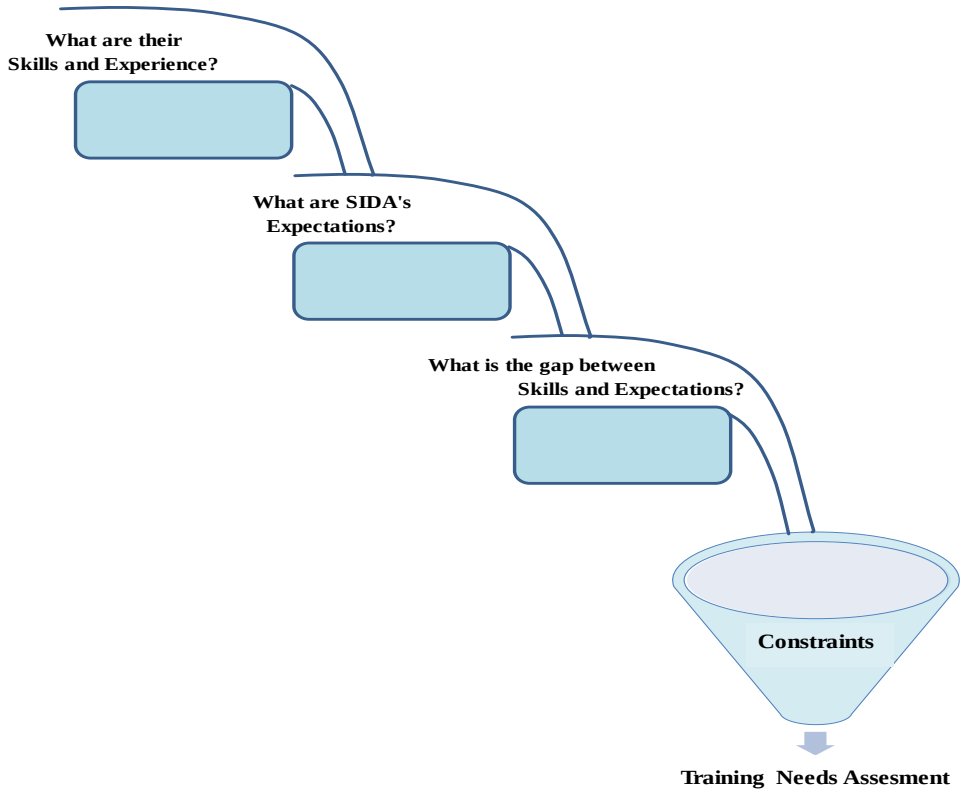
The training should be conducted around the different concepts of maintenance: routine (or normal maintenance), deferred maintenance, preventive maintenance, emergency maintenance the worst case scenario, reconstruction. As with the farmers, the training then should concentrate on the "Walk-Through" Survey complemented with 1) strengthening of banks, 2) desiltation, 3) removal of shrub and trees, 4) repair of gate structures, 5) repair of outlets, 6) repair of bridges and crossovers, etc.

Guidelines to Prepare Planning Process

The recommendations given below for the planning training courses were borrowed from Marketing and HR specialist, Mr. Bruhad Buch[35] and FAO[36] combined with the extensive training experience of the Regional Master Plan Consultants.

Training Needs Assessment

The first step in the training planning is to conduct a training needs assessment to objectively determine the specific training required. The following chart presents the variables to be taken in consideration when assessing the training needs keeping in view the objectives of SIDA, the AWBs or the Irrigation Department if required.



Training Components

Once the training needs, including the restrictions faced either by the trainees or SIDA, the training course and contents need to be properly planned. The following are some of the elements to be considered.

- Course objectives
- Target learning outcomes and trainees
- Description of the course
- Course length and session duration
- Trainees pre-requisite skills and equipment
- Teaching material & training aids needed and equipment requirements

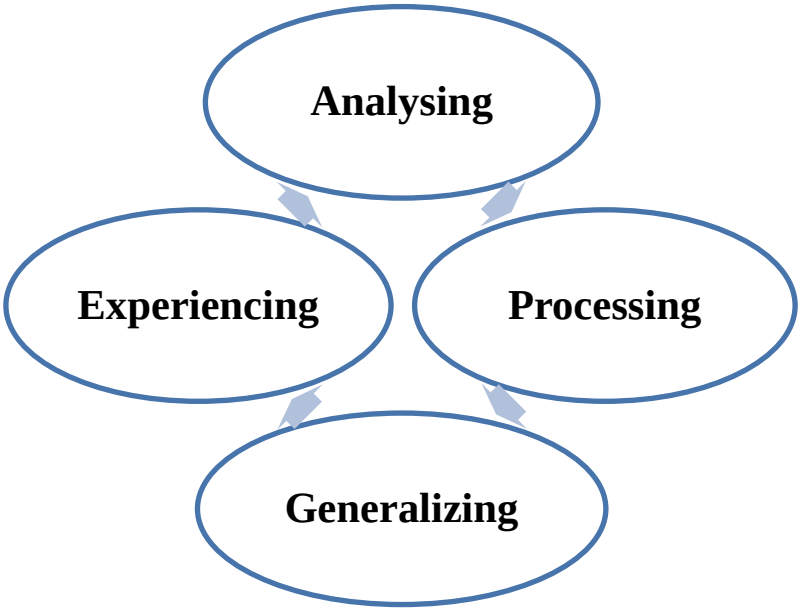
[35] Buch, Bruhad. How to Prepare a Basic Training Module. Training on the go. Slideshare.net

[36] FAO. Farmers Training Manual (PT&E-FMW). Rome April 2001

- Logistical issues and support
- Course content summary:
  - Major topics to be addressed
  - Brief description for each topic
  - Outcomes and new skills expectations
  - Hands-on-learning training approach should be used or another suitable method.

Teaching Approach

According to FAO (2001), adult learners –as is the case of SIDA's personnel– normally go through some phases of a learning cycle. SIDA and AWB's staff have wide experience in the tasks they routinely perform and have already gained substantial knowledge and skills through their lives. It is recommended that SIDA training focuses on using their staff knowledge and skills as the basis of their learning process. These phases are experiencing, analyzing, processing and generalizing. FAO (2001) explain these phases with the following chart:



9.11 Criteria for the Selection of Poor Beneficiaries

Human Development Index (HID)

According to a report prepared by the United Nations Development Program (UNDP) Human Development Report[37], in November 2011 Pakistan's **Human Development Index (HID) was 0.504** ranking 145 out of 187 countries and territories stated.

The HID has been defined[38] as: "*A summary composite index that measures a country's average achievements in three basic aspects of human development: longevity, knowledge, and a decent standard of living. Longevity is measured by life expectancy at birth; knowledge is measured by a combination*

Lowest HDIs in Asia & Oceania

1	Afghanistan	0.398
2	Nepal	0.458
3	Yemen	0.462
4	Papua New Guinea	0.466
5	Myanmar	0.483
6	Timor-Leste	0.495
7	Bangladesh	0.500
8	Pakistan	0.504
9	Solomon Islands	0.510

Source: Wikipedia (1)

[37] Wikipedia. List of countries by Human Development Index. http://en.wikipedia.org/wiki/List_of_countries_by_Human_Development_Index
[38] Economic Glossary. http://glossary.econguru.com/economic-term/Human+Development+Index

of the adult literacy rate and the combined primary, secondary, and tertiary gross enrollment ratio; and standard of living is measured by GDP per capita."

Countries fall into four broad human development categories, each of which comprises 47 countries: (i) Very High Human Development, (ii) High Human Development, (iii) Medium Human Development and (iv) Low Human Development, where Pakistan is ranked (46 countries in this category).

Inequality-Adjusted Human Development Index (IHDI)

The UNDP further adjusts the Human Development Index (HDI) with what are called the Inequality Factors (IF) to come up with the Inequality-Adjusted Human Development Index(IHDI)[39]. The UNDP published a list of countries by inequality-adjusted human development index in its 2011Human Development Report. According to the UNDP, the IHDI is a *"measure of the average level of human development of people in a society once inequality is taken into account. It captures the HDI of the average person in society, which is less than the aggregate HDI when there is inequality in the distribution of health, education and income. Under perfect equality, the HDI and IHDI are equal; the greater the difference between the two, the greater the inequality." In that sense, "the IHDI is the actual level of human development (taking into account inequality), while the HDI can be viewed as an index of the potential human development that could be achieved if there is no inequality."*

IHDIs in Asia & Oceania

1	Nepal	0.301
2	Yemen	0.312
3	Timor-Leste	0.332
4	Bangladesh	0.363
5	Pakistan	0.346

Source: Wikipedia (3)

Inequality Factors (IF)

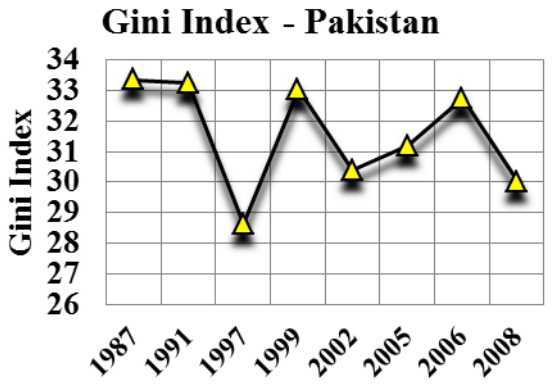
The inequality factors are related to the three parameters that define the HDI, (i) inequality of life expectancy at birth; (ii) inequality in education and; (iii) inequality in income.

Life Expectancy Index

Wikipedia defines life expectancy index as follows: *"Life expectancy is the expected (in the statistical sense) number of years of life remaining at a given age. It is denoted by e_x, which means the average number of subsequent years of life for someone now aged x, according to a particular mortality experience"*

Education Index

Wikipedia defines education index as follows: "The Education Index is measured by the adult literacy rate (with two-thirds weighting) and the combined primary, secondary, and tertiary gross enrollment ratio (with one-third weighting). The adult literacy rate gives an indication of the ability to read and write… Education is a major component of well-being and is used in the measure of economic development and quality of life, which is a key factor determining whether a country is a developed, developing, or underdeveloped country."



Source: www.indexmundi.com

[39]Wikipedia. list of countries by inequality-adjusted human development index (IHDI).http://en.wikipedia.org/wiki/List_of_countries_by_inequality-adjusted_HDI

Income Distribution Index (Gini Coefficient)

Income distribution inequality(also known as the economic inequality or the gap between rich and poor) comprises disproportions in the distribution of wealth and income within or between populations or individuals. The term usually refers to inequality among individuals and groups within a society, but can also refer to inequality between countries. The issue of economic inequality is also related to equality of opportunity.

There a number of methods to estimate the Income distribution index. One of the more commonly used methods is the Gini Coefficient, which is a measure of statistical dispersion developed by the Italian statistician and sociologist Corrado Gini[40].

Wikipedia defines it as: "*The Gini coefficient measures the inequality among values of a frequency distribution (for example levels of income). A Gini coefficient of zero expresses perfect equality where all values are the same (for example, where everyone has an exactly equal income). A Gini coefficient of one (100 on the percentile scale) expresses maximal inequality among values (for example where only one person has all the income)*"

The UNDP Pakistan[41]presented the following inequality factors for Pakistan for 2011

- Loss due to inequality of life expectancy at birth: 32.3%
- Loss due to inequality of education:46.4%
- Loss due to inequality in income:11.0%
- Overall loss: 31.4%
- Inequality-Adjusted Human Development Index(IHDI): 0.346

In order to enhance Pakistan's fight against poverty and to improve its position in relation to the Human Development Index (HID), Pakistan has launched a number of programs and projects aiming at increasing the three basic elements of human development. Among these, particular emphasis has been given on the possibility of combining cash transfers and basic skills development.

Annual Plan 2007-08 Planning Commission[42]

The Annual Plan 2007-08 Planning Commission identified the main causes of poverty in Pakistan as:

i. Lack of asset ownership
ii. Inaccessibility to services
iii. Lack of employment opportunities
iv. Dominance of unskilled and semi-skilled labor force
v. Voicelessness and powerlessness of the poor
vi. Vulnerability to shocks

According to the Planning Commission, the core instruments of the strategy include:

- Expanding the coverage cash transfers using conditional cash transfers (CCTs) supplemented with unconditional transfers, through the Food Support Program (FSP) and Zakat;
- A new public works based on low-wage employment;
- Child labor programs, and various new pilots such as (i) combination of cash transfers and basic skills development aimed at enabling the poor to quality for microfinance and (ii) programs for bonded labor;
- Scaling up school feeding and social care services

Social Protection Strategy for Pakistan[43]

[40]Gini coefficient. http://en.wikipedia.org/wiki/Gini_coefficient

[41]Tanaka, Toshihiro. Sustainability and Equity: A better future for all. Nov 2011. UNDP Pakistan

[42]Planning Commission .http://www.pc.gov.pk/National_Plans.html

The Strategy's long and short term objectives are the following:

> *"Thelongtermobjectiveistodevelopanintegratedandcomprehensivesocial protectionsystem,coveringallthepopulation,butespeciallythevulnerablepoorand thevulnerablenon-poor.Anintegratedsocialprotectionsystemwouldalsoextendto protectcitizensfromthemajorhazardslikelytoaffecttheirwellbeing,includinglife cycle,health,employment,livelihoods,policychange,andnaturalandenvironmental hazards."*

> *"In the short and medium term, the main priorities of a social protection strategy are to address the needs of the poorest and most vulnerable. The most urgent task is to address the needs of the 10 percent poorest households in Pakistan. These are people who do not earn enough to sustain a basic life of dignity, do not have any assets or investments in human capital, are not able to access most state provided or privately available opportunities in the economy, do not have any opportunities for breaking their poverty trap…"*

The Social Protection Strategy for Pakistan document mentions that two large programs providing regular cash transfers have been launched: (i) The Guzara under Zakat and (ii) the Food Support Programme under the Bait-ul-Maal.

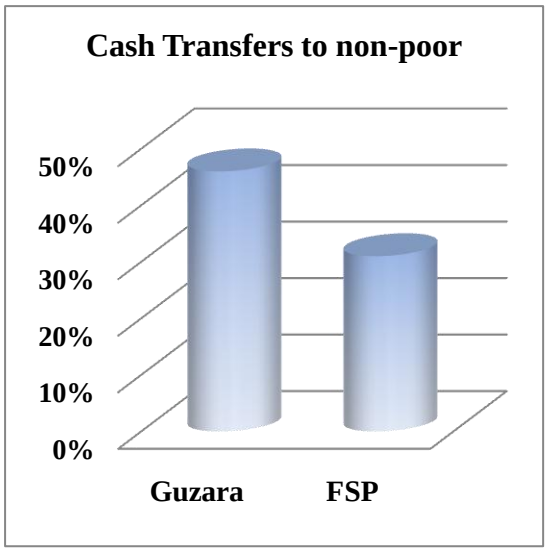
Options for the Cash Transfer Programme

According to the Protection Strategy, attention needs to ensure the transfers facilitate household investment in education and health and the selection of beneficiaries. The Protection Strategy reviewed the three following available options:

i. *"One option is to attach conditions to cash transfers in order to ensure poor households invest in education and health care; but significant deficits in education and health infrastructure may militate against them.*
ii. *Urgent steps must be taken to improve the selection of beneficiaries, with an especial focus on the ten percent poorest households.*
iii. *Monitoring and evaluation could ensure programme meet their objectives and adapt to changing circumstances."*

Cash Transfers Programs' Lessons

The Protection Strategy reports the lessons learned as duplicated below. The main parts are cited due to the importance of the statements:



"The poverty and vulnerability reduction efficiency of these two programmes is constrained by the absence of effective selection and review procedures. Coverage of the poor is a major issue. The combined number of beneficiaries of the two regular cash transfer programmes is 2 million, while the total number of poor households is estimated at approximately 6 million. Even if the programmes were accurately targeted on the poor they would reach at best one third of poor households, but ***there are significant leakages to the non-poor in both these programmes. A conservative estimate of the incidence of Guzara allowances suggests that, as a minimum, 40 percent of beneficiaries are non- poor, compared to 26 percent of FSP benefits leaking to the non-poor.*** *Further analysis of the incidence of the*

[43]GOP: Planning Commission. Social Protection Strategy for Pakistan. Islamabad May 2006

programmes within the poor concludes that the FSP has a better reach among the ultra poor than the Guzara allowance. Estimates suggest that 46 percent of FSP beneficiaries can be classified as ultra poor. The programmes are not sufficiently well targeted on the poorest.
Poor targeting is a consequence of deficiencies in several areas. Neither the Zakat nor the PBM have nationwide coverage. A recent Gallup Poll of beneficiaries finds that one third (one quarter) of localities in Pakistan lacks a Zakat committee (PBM point). The selection of beneficiaries under Zakat is done at the locality level, and in practice involves a large measure of discretion by committee members. PBM selects according to priority ordering of applicants, but on a first-come-first–served basis. ***Entry into the programmes is open to the influence of local elites,*** *and may reinforce existing patterns of exclusion. There are no procedures for the review of entitlements and the exit of beneficiaries from the programmes.*

A glaring omission in terms of programme design is the absence of robust mechanisms for monitoring and evaluation. As a consequence, there are important gaps in knowledge as to whether the programmes are meeting their objectives, whether they are effective compared to alternative uses of the funds and how they can be adapted and reformed to improve their effectiveness…"

Criteria for the selection of poor beneficiaries

The Louis Berger Group Inc. and Indus Associated Consultants (Pvt) recommend using the method developed by Sabina Alkire and James Foster[44], known as the Alkire Foster Method and sometimes as AF Method. This method was first introduced by the authors through the University of Oxford in 2009.

The Alkire Foster Method

The AF Method allows unidimensional analysis but mainly provides a technique to conduct multidimensional analysis. The Multidimensional Poverty Index (MPI) is the combination of the Headcount (H) of people who are poor and the Average Intensity of Deprivation (A). For this, the AF method provides with an intuitive methodology easy to be implemented and interpreted.

The AF Method starts with a multidimensional data in a shape of a matrix, where on the *x* axis the domains (d) are listed and on the *y* axis the population (p) are enumerated. Each of the domains is given a cutoff (*c*) or maximum value below of which a person is poor. Then the deprivation matrix g^0 is estimated by replacing the values for each individual above the cutoff with a zero (or no deprivation) or one (deprivation). This way we construct a matrix formed by ones and zeros (known as the *(0,1)-Matrix*), so the domains can be added if required regardless of their units, because the common unit now becomes "number of domains".

Alkire and Foster added a second cutoff concept, called the Dual Cutoff Approach, denoted with the letter *k*. This second cutoff sets the number of domains in which an individual must fall under the deprivation concept. The headcount ratio, H and the Average Intensity of Deprivation, A are calculated using this modified *(0,1)-Matrix*$g^0(k)$.

Drain in Sindh blocked by an aqueduct, where the neighboring voiceless and powerless people are severely affected during the floods

[44] Alkire S. & Foster, J. Counting and Multidimensional Poverty Measurement. Journal of Public Economics. 2011

Dimensions

The three dimensions used to estimate the Human Development Index (HID), health (life expectancy), education and, standard of living should be included in the criteria for the selection of poor beneficiaries with the addition of a fourth dimension, the Voicelessness and Powerlessness Factor.

Alkire and Santos[45]had already indicated that because data are a binding constraint, a key priority for future work on multidimensional poverty must be data around core areas such as informal work, empowerment, safety from violence, and human relationships (social capital and respect versus humiliation).

The Consultants working on the Master/Regional Plan mainly related to flooding and drainage issues, have conducted hundreds of interviews among the poor and have observed that the poorest of the poor are voiceless and powerless. This is confirmed by the cash transfer experiences reported by the Social Protection Strategy for Pakistan mentioned above, where "*entry into the programmes is open to the influence of localelites"*. The degree of their lack of political power and lack of influence should be assessed and included among the dimensions to be considered when selecting the cash transfers and basic skills development beneficiaries.

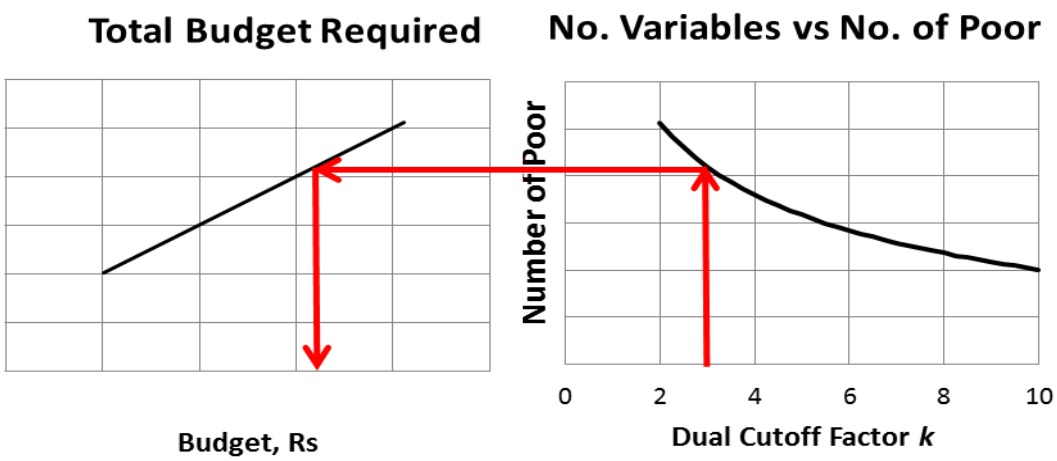
Domains

The domains suggested are:

Health	Nutrition Child mortality Life expectancy
Education	Years of schooling School attendance Basic skills
Living Standard	Cooking fuel Water supply Sanitation Electricity House condition (floor & roof) Assets
Voicelessness and Powerlessness Factor	

The analysis

A sensitivity analysis should be conducted following the Alkire Foster Method, where the Dual Cutoff



[45]Alkire, S. and Santos, M.E. Acute Multidimensional Poverty: A New Index for Developing Countries. OPHI WP-38 July 2010

factor k should vary, starting with $k = 2$ to $k = 10$. The number of poor identified for the various values of k can be multiplied times the cash budget per person and estimate a range of budgets needed to benefit the poor. The total budget available for transfers can then be matched with the budget required for each value of k and this way the number of poor can be estimated. The chart below explains the approach suggested in a graphical form.

10 Water Balance and Drainage Assessment

10.1 Introduction

The hydrology of the Lower Indus Left-Bank is characterized by three distinct processes. The upper sub-basin is the tail-end of a drainage basin, which transform into a meandering flood plain before forming a typical fan shaped delta. The land built up with alluvial deposit has scattered depressions, sand bars and a decreasing slope towards the coastal region. Large scale artificial irrigation over a large belt between the river Indus and the Thar Desert induces typical characteristics of the irrigation hydrology. The average annual rainfall is about 150 mm in the upper region against an annual evapotranspiration of 2,200 mm. The coastal region is relatively humid with an average rainfall of 240 mm. Recent climatic trends indicate high probability of having climate change impacts in the whole region.

In the post 2000 period, the Lower Indus Basin has faced two years of severe drought (2001-02), three years of rain-based floods (2003, 2006, and 2011) and one mega river flood (2010). In addition to flood-protection and drainage issues, agriculture sector faces water and land management challenges, to be managed under higher uncertainty. Four cropping zones cultivate sugarcane, rice, cotton and orchids as the major crops of summer. This water-intensive agriculture requires an effective drainage and aquifer management. High ground water salinity over 80% of the region limits reuse of the aquifer. Leaching of the root-zone becomes more water intensive with the rising of groundwater aquifer. Hence, the drainage is critical for the agriculture sector and an essential component of water resources management.

The water use efficiency in agriculture is strongly linked with the groundwater management and drainage efficiency. A water balance of the Left Bank estimates water demands of different sectors, actual water availability and the efficiency of water use. The water balance model computes water demands and supply, aquifer recharge and the required drainage at the annual, seasonal and monthly bases. These estimates under non-flood conditions provide the base-line drainage requirements of the region.

The physical network of the Left Bank Outfall Drain (LBOD) has the capacity and outfall limitations. Because of topographic, hydrological and social constraints, capacity of the drainage facilities cannot be increased to an unlimited level and not without tradeoffs. It makes understanding and management of rain-based floods essential. A detail hydrological analysis has been carried out to re-estimate rainfall probability and recurrence intervals. This analysis is followed by runoff estimation for different soil moisture conditions. The drainage capacity curves are computed for a range of rainfall storms. For the ten and twenty years return periods, runoff is simulated for the routing and evacuation patterns under different catchment performance scenarios.

The water balance, rainfall frequency, rain-runoff-flood routing analysis is carried out using three models. A spreadsheet model is developed for the water-balance analysis. The models HEC-SSP and HEC-HMS, developed by the *US Army Corps of Engineers* are used for the rainfall frequency analysis and the runoff-flood routing studies. These studies were conducted in detail[46]. This chapter summarizes some of the simulation results.

10.2 Water Balance of the Indus Left-Bank

The water-balance methodology is used to assess water needs for irrigation and other water-related issues (Ritter, 2006). Based on water demand and supply accounting with various details, water-balance analysis can be used to assess the drainage needs, water use efficiency, water stress, urban water-supply and development impacts. *The water balance accounting methods are widely used with a fairly good knowledge of data limitations and possible uncertainties in assessment of different parameters* (Kirby *et al.* 2008, Van Dijk *et al.* 2008). These studies discussed external sources of

[46] Detail studies includes description of the models and results from the four models used by the project; HEC-SSP, HEC-HMS, HEC-RAS and WaterBalance Model. The data limitations and sensitivity analysis is a part of the report.

uncertainty like human influences on measurements and unexpected climatic variability. In most of cases, external uncertainties could be higher than the internal methodological uncertainties or the limitations of a specific model.

A straight forward water balance approach focussing agriculture water accounting is used in the Indus Basin (RAP 1978, WISP 1991). The water supply and demand components are estimated individually, based on monitored canal diversion, tube-well density and cropping patterns. The key input components are river diversions and crop-evapotranspiration. The groundwater table measurements (DTW) by WAPDA in the post Tarbela period (1978 onwards) provide closing-term of the seasonal water balance, i.e. changes in groundwater aquifer levels twice a year. Principally, estimation of the input, output, and storage changes of water at key locations provided the basic components of a gross water-balance.

The water-balance of the left-bank can have the following limitations:

- Accuracy of the secondary data for canal-diversions, cropping intensities and groundwater table monitoring,
- Representativeness of the measurements on the scale
- Limited information about non-agricultural water use and the waste water reuse

10.3 Water Balance Approach

The water-balance analysis is carried out for the whole Left-Bank region at the annual, seasonal and monthly scales. The main objective of this analysis is to analyse the water demand supply relations and water use efficiencies. A secondary objective is to quantify different water uses, groundwater recharge and drainage components. The water balance of the left-bank is split into different spatial units (GCA, CCA, Gross Irrigated Area). The seasonal WB is carried out for three consecutive years having no extremities. It is further split into monthly level. The water demands of all sectors are estimated. The sub-basin of the Left bank has well defined hydrological boundaries and most of the required data is available from the secondary sources.

Relatively simple water accounts are carried out for the nine canal commands of the left-bank, focusing on the irrigated agriculture. The physical and hydrological boundaries of the gross canal command areas are difficult to define, and water uses by different sectors within these boundaries are not available.

The water use efficiencies, drainage and groundwater components estimated through the gross water balance are used to improve the drainage estimates from LBOD sub-catchments.

10.3.1 Data used for the Analysis

Water Data: The daily rainfall and climate data from meteorological stations. The data is considered reliable.

- Surface inflow data includes 10-daily and monthly data of river flows and canal diversions from the barrages.
- Groundwater data include *Water Table data*: pre and post monsoon water table monitored by SMO (Scarp Monitoring Organization) at the canal command level.
- *Ground-water Pumpage*: estimated based on well density (reported by the *Agriculture Statistics Sindh* 2006,) and monthly water demands.

Crop Data: The last ten years data from two sources, i) district wise seasonal land use and cultivated areas by different water sources, compiled by the Agriculture Department, ii) the canal wise cropping patterns and cropping intensities at the seasonal bases, by Provincial Irrigation Departments.

Data for population and other water use sectors: the main source of information is the Sindh Development Statistics.

Other Data: different water use coefficients from various studies (all references are given).

10.3.2 Water Balance Equations

The basic water balance equation can be written as:

$$V_{in} + P = \Delta S + V_{out} + E$$

V_{in} : Volume of surface and sub-surface inflow;

P : Precipitation in the selected boundary of the water-balance region

V_{out} : Surface plus sub-surface outflow volumes

E : Net evaporation and transpiration

ΔS : Change in groundwater storage, positive sign indicates an addition.

All water-balance terms are split to represent the processes considered in the water balance, some more complicated than others, like evaporation and transpiration term, which has to encompass all water uses, planned and unplanned. The water inflow into the region is considered only from the Indus River, diverted through channels and limited river losses. The outflow consists of all evapotranspiration components, surface drains outflow and sub-surface outflow. The infiltration rate and flat slope of the Indus delta suggests that the sub-surface outflow could be ignored.

The change in groundwater storage, ΔS, is a sum of groundwater recharge and extractions through pumpage, direct uses and groundwater outflow. The groundwater used by crops through capillary rise is an important source of water for wheat in high water table areas. The evaporation from waterlogged areas and water bodies is taken into account:

$$\Delta S = V_{gwr} - V_{gw\text{-}p} - ET_{gw\text{-}cap} - ET_F$$

$$V_{gwr} = V_{gwr\text{-}rain} + V_{gwr\text{-}canal} + V_{gwr\text{-}rivers+link} + V_{gwr\text{-}pum} + V_{gwr\text{-}other\text{-}uses}$$

V_{gwr} : Total groundwater recharge from rainfall ($V_{gwr\text{-}rain}$), Canals ($V_{gwr\text{-}canal}$), $V_{gwr\text{-}rivers,}$ Pumpage ($V_{gwr\text{-}pump}$) and other uses $V_{gwr\text{-}other\text{-}uses}$

$V_{gw\text{-}p}$:Groundwater extraction through pumpage.

$ET_{gw\text{-}cap}$: Groundwater used through capillary rise

ET_F : Free surface evaporation from areas with high water table.

The gross evapotranspiration, E, includes;

$$E = ET_{crop} + ET_{nb} + ET_{di} + ET_F$$

ET_{crop} : Evapotranspiration in the reported cropped area

ET_{nb} : Non-beneficial evaporation from different uses

ET_{di} : Evapotranspiration from domestic and industrial uses.

ET_F : Free surface evaporation

Evapotranspiration from the cropped area is estimated with reference to the sources of irrigation

$$Et_{avail\text{-}crop} = ET_{canal} + ET_{rain} + ET_{gw\text{-}pump} + ET_{gw\text{-}cap}$$

10.3.3 Sector-wise Water Requirements

The water requirements are computed for all water use sectors. The model CROPWAT is used to calculate the potential crop evapotranspiration for all major crops on 10-daily bases. The seasonal average crop Et is given in Table-10.1. The domestic water requirements for the left-bank are computed at 65 gallons per person per day rate. All water use outside agriculture, industry and

commercial sectors are included in these requirements. For 18 million people, about 2 bcm diversions are estimated. The net water use efficiency in domestic sector is taken 25%. The industrial water demand is computed for high water use systems, because efficient cooling systems and water-recycling is rarely introduced. The commercial water uses include the uses of public facilities (schools, hospital, parks, etc.), business and infrastructure.

Table 10. 1: Left-Bank Water Demands at the Use-level – Year 2007-08

Sector	Size	Average Water Use Rate	Annual Water Demand/ Use
Gross Area	8.40 Mha	Gross Demand	25.13 bcm
Irrigated Agriculture GCA	3.95 Mha	Kharif 885mm, Rabi 435 mm	19.8 bcm
Other/ Barrani cultivation	0.3 Mha	Water used 75% of the irrigated area	2.0 bcm
Forests	0.6 Mha		1.35 bcm
Population (urban 23%, rural 77%)	18.28 million	65 litre per day	1.95 bcm
Industrial: sugar industry uses	32 factories	21 cubic meters per ton of sugar produced	300 mcm
Commercial water needs		15% of the domestic diversions	0.3 bcm

10.3.4 Water Supply

The total water available in the system, including rainfall and groundwater pumped is summarized in table 10.2. The rainfall quantities are computed at the seasonal and monthly bases. The weighted average rainfall 165 mm during the year was higher than the annual normal's. The groundwater supply in the well-irrigated areas considers that 70% of the water demand at the watercourse head is satisfied. Only 35% potential of the reported wells is used. For the domestic and industrial supply, a direct diversion from the canals is considered 20%.

Table 10. 2: Water Availability and Diversion (bcm) 2007-08

Water Source	Unit values	Water Volume (bcm)
Rain – Gross Area	165 mm	10.9
Rain – GCA		4.88
Canal Diversions at three barrages		33.1
No of wells and pumpage potential	100,000	18
Groundwater pumped within CCA		3.0
Pumped in well irrigated (non-perennial GCA & *sailaba*)		2.44
Pumped for other uses		2.40

10.3.5 Salient Water-Balance Results

Various water-balance estimates are given in table 10.3. About 30% evapotranspiration from the crops and forest land occurs outside the CCA. This estimation is based on the land use data reported at the district level. The non-beneficial evapotranspiration is more from outside of the CCA, as the non-agricultural uses generate higher Non-Beneficial Evapotranspiration. A major part of the rainfall outside the CCA also goes into NBET. The computed value of NBET 7.86 bcm comes from the formal water use processes. More than 11 bcm (9 maf) is the excess water available in the system, which can recharge groundwater aquifer, water bodies and the drainage system. The major part of it will finally evaporate. A part of it will contribute to the "unaccounted beneficial uses", however, these uses could not be quantified without measuring all unaccounted water use processes.

Table 10. 3: Water-Balance Outputs from the Canal Command Area and the Left Bank

	Kharif	Rabi	Annual	Kharif	Rabi	Annual
	CCA			Left-Bank Region		
Gross Crop Evapotranspiration	13.3	5.7	19.0	18.7	8.7	27.4
Non-Beneficial Evapotranspiration (NBET)	3.67	1.32	4.99	6.20	1.66	7.86
Available for GW Recharge	7.92	3.69	11.61	11.27	4.09	15.36
Excess for Groundwater change	7.74	2.08	9.82	6.73	-0.26	6.47
Required Drainage	2.40	0.54	2.94	4.26	0.95	5.20

The existing canal escapes and surface drains can carry 1.5 to 2 bcm water during five months of summer. The actual change in groundwater aquifer and the potential drainage outflow during summer is computed from the depth to water table data of SMO and observed operations of drains during a non-flood year. The net groundwater change over the year (ΔS in WB equation) was slightly negative as shown in Figure 10.1. Which, means about 6bcm is additionally utilized by the system or goes to NBET, in the end not contributing for the groundwater recharge.

Some recent water-balances carried out at smaller scales were compared with the gross regional results and carry out a sensitivity analysis to identify the data-gap and uncertainties linked with some of the variables.

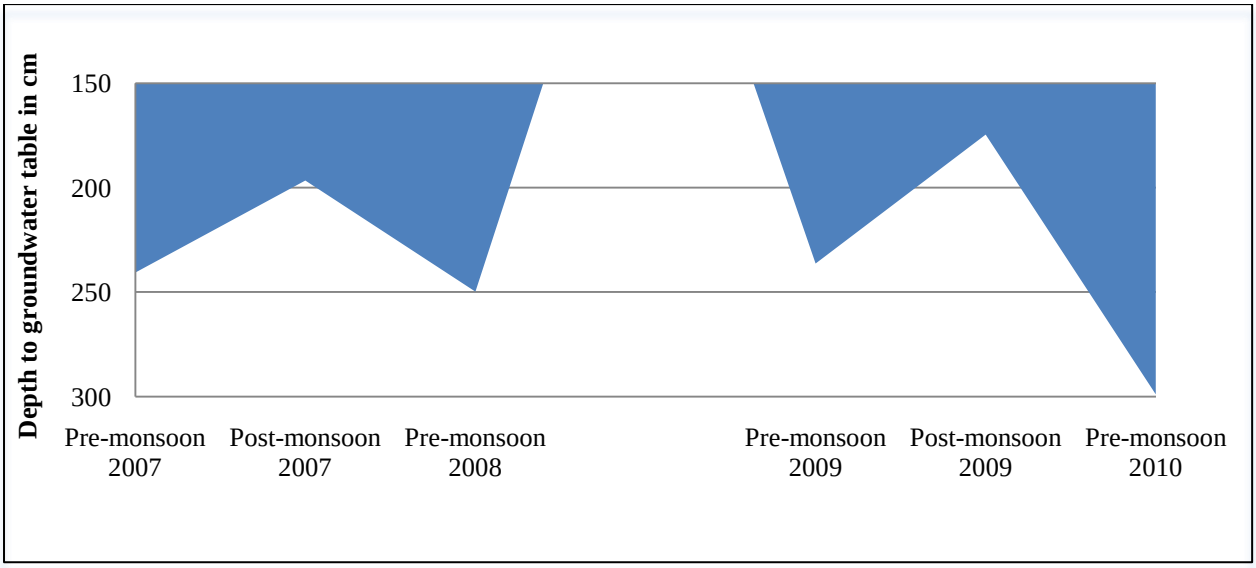


Figure 10. 1: Average Groundwater Aquifer Level Left-bank from 2007 to 2010, based on twice a year monitoring

10.4 Water Use Efficiency in the Agriculture

The agriculture water uses are computed for total cropped area divided into the canal and tube-well irrigated and Barani sub-units. The whole analysis is repeated at the monthly scale. The efficiency of the irrigated- agriculture is more revealing at the monthly scale. The Figure-10.2 shows the water demand versus supply situation at the regional and the field levels. The figure also shows the total canal supply as a ratio of water demand at the root-zone.

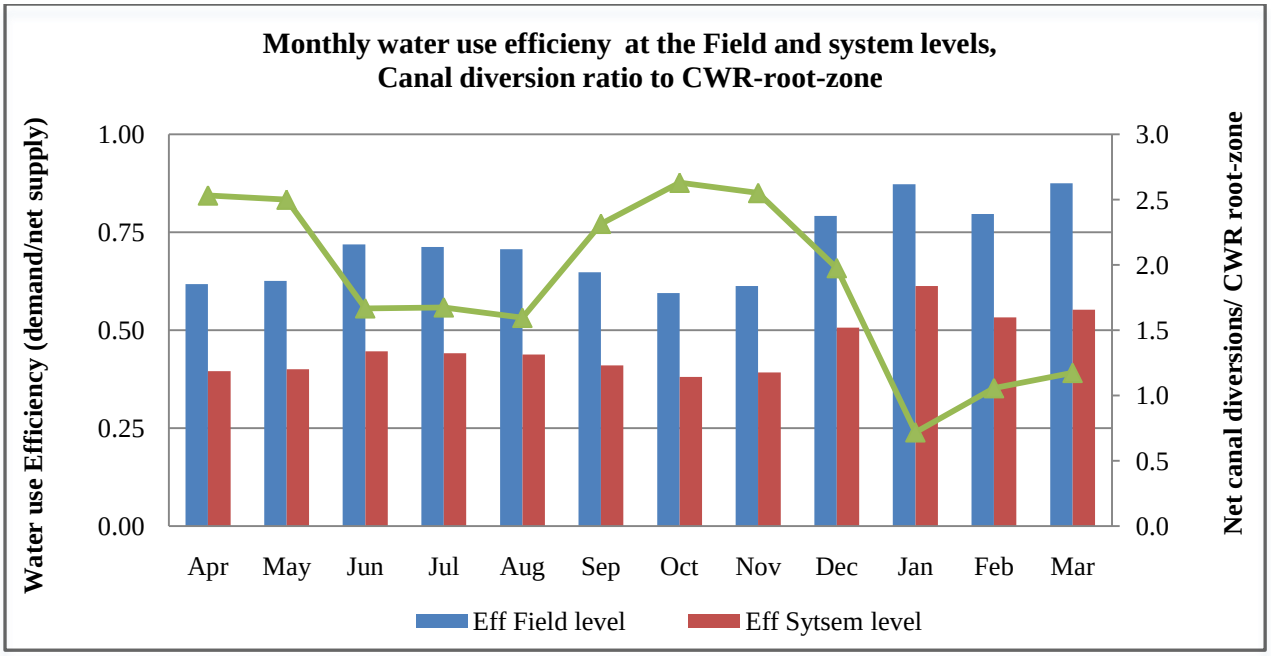


Figure 10. 2: Water use Efficiencies

- The field level water use efficiency is between 60% to 80% during different months. It is higher when the canal supplies are relatively low. The groundwater is used during these months with a higher efficiency. The computed efficiencies during the best performing months are higher than the reported in 1991 (WISP 1991) and 1978 (RAP 79).

- The system level monthly water demand/ supply ratio varies from 40% to 60% over the year. The same efficiency range is reported by various studies. However, the efficiencies here could be under-estimated; i) under-reporting of the cropped area is an accepted fact, ii) diversions from the irrigation canals for other uses is not explicitly reported.

- The canal diversions from the barrage head-works are clearly influenced by the river water availability, surface storages and the network capacity. During the second half of the Kharif season, canal diversions are about 2.5 times of the water requirements at the root-zone. While, during early Rabi, canal diversions were 80% to 100% of the root-zone requirements. The high soil moisture left at the end of Kharif season help early growth of crops. However, this demand-supply pattern is not favourable for the water use efficiency and crop production.

10.5 The Rainfall Frequency and Runoff Estimations

The storm runoff and additional drainable flow generated in LBOD are estimated using an integrated modeling approach. These estimates provide a continuity to two previous detail studies carried out in 1965-67 (LIP 1967) and 1980 (LBOD Design studies Annex 4 Hydrology). Salient features of the methodology and key results are summarized in this section.

10.5.1 Estimating Rainfall Probability

The probability of rainfall extremes and recurrence interval (return period) analysis is carried out for three MET stations, Nawabshah, Chorr and Badin. Daily data of 35 years have been used for the complete analysis, while a larger data-set is used for the daily maximum analysis, 72 years data for Badin and 44 years for two other stations. The General Frequency and Bulletin 17B procedures provided in the model HEC-SSP are applied for the probability calculations. The confidence limits (5% & 95%) and expected probability curves allow to check the uncertainty and reliability of the results.

An example of general-frequency probability curve for one-day rainfall in Nawabshah is shown in Figure 10.3. The *Low-Outliers* and the extreme *historical-events* can disturb the systematic pattern of rainfall in a watershed. The "low outliers" bias will be higher for a shorter data-set and will need to be managed by excluding the extreme values. For Nawabshah 2.5 mm is set as a low-threshold rainfall, it excludes three data points from the analysis.

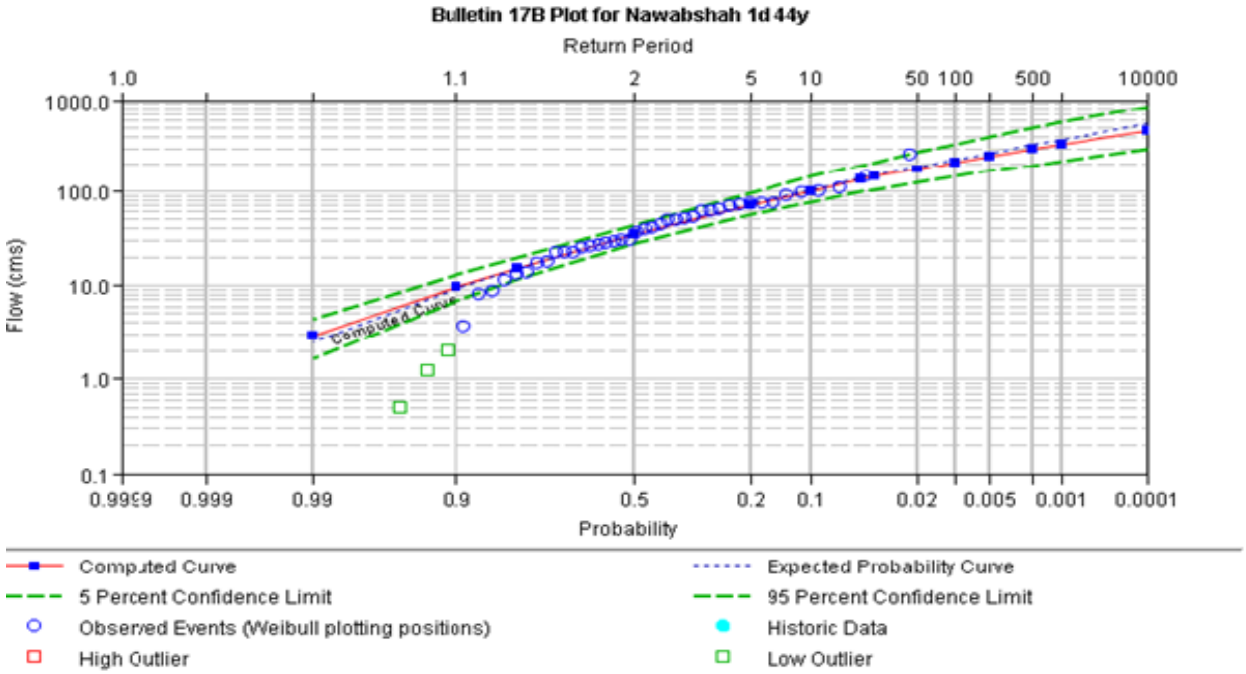


Figure 10.3: Log Pearson III curves showing the probability of one day maximum rainfall in Nawabshah

The confidence limits show all data points on the higher side are within the range. However, gaps between computed and expected probability curves determine the reliability of probability estimates. It can be seen from the curve that the estimated rainfall beyond 200 year return period will not be reliable. This deviation is caused by the single highest data-point. The longer period data- sets are recommended to estimate the probability for 500 or 1000 years. The Chorr data has the maximum influence of the low and the high values on the probability curve. The threshold levels are computed for all data series of three stations. In case of Nawabshah, maximum rainfall event is highly sensitive, as shown in Figure 10.4. The consistency of data is checked using the normal statistical tests (T-tests).

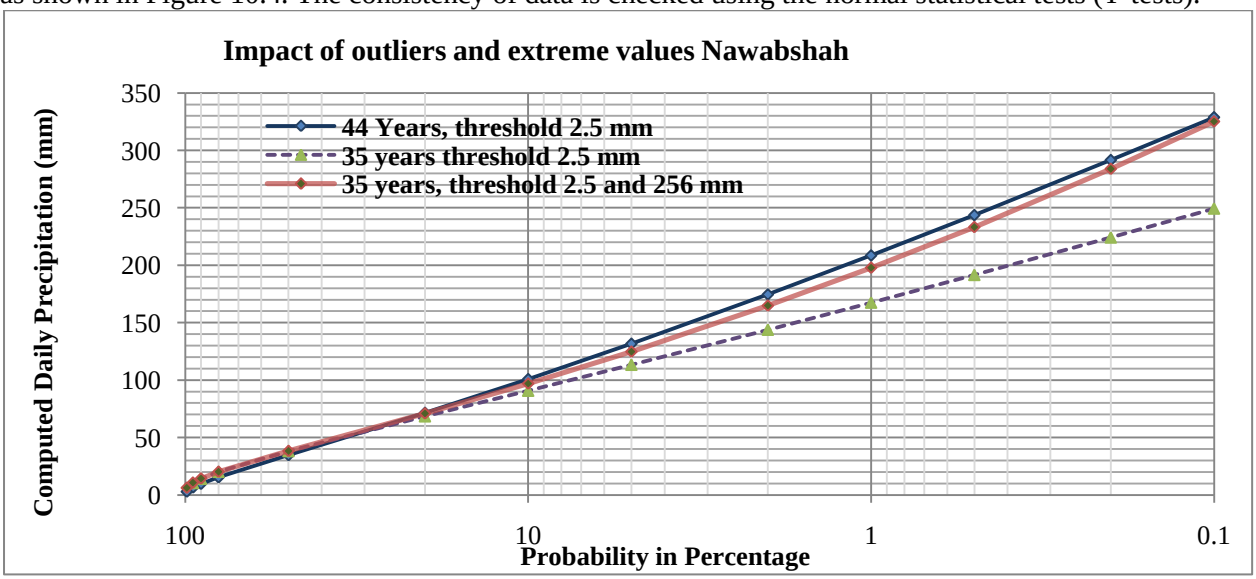


Figure 10.4: Sensitivity of the Return Period (probability) estimates with reference to extreme values

The computed recurrence intervals of 24 hour data for three stations are given in Figure 10.5. The probability patterns of the Chhorr data are further explored and discussed in the detail report on hydrology.

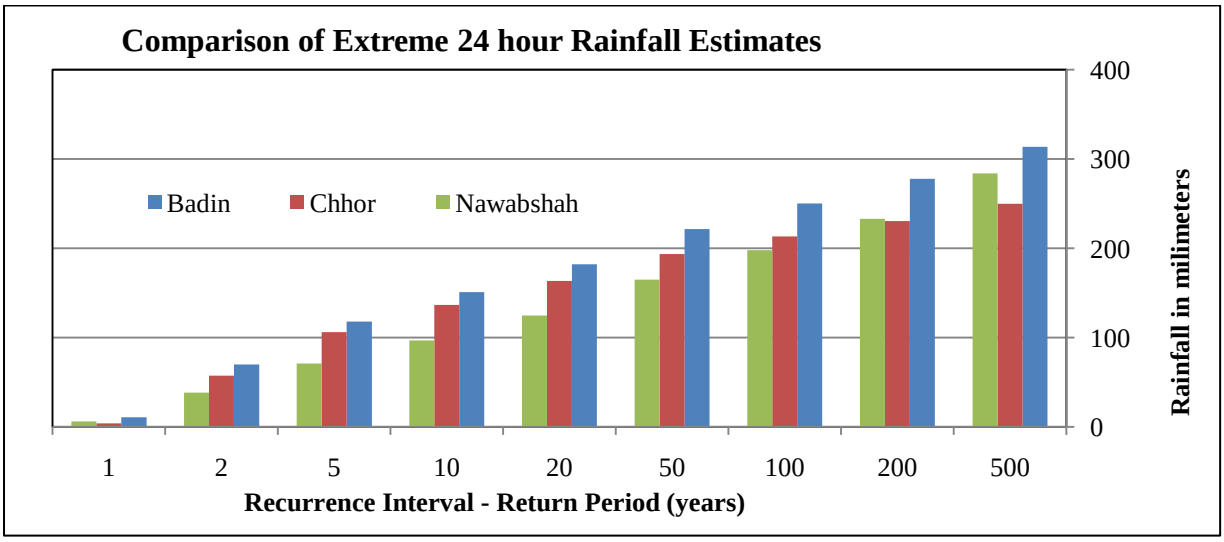


Figure 10. 5: Recurrence Intervals (Return Periods) for 24 hour maximum rainfall

10.5.2 Frequency Estimates for Longer Periods

The maximum annual rainfall occurring during 2, 5, 10, 20 and 30 days is analysed using 35 years data from three stations. The frequency patterns vary from station to station. The total rain quantities, number of wet days and the behaviour of monsoon showers influence shapes of the probability curves. The middle part of the rainfall curves (representing 2 to 100 year return period) for one, two and five days is important for the runoff estimates and evacuation analysis.

The resultant frequency curves for Badin are shown in Figure 10.6. The Badin curves indicate that maximum rains over two days have about 30% probability of repeating the first day rains. Within 20-days, probable rainfall is three times more than the one-day rainfall. The high peak for thirty days is caused by a couple of years with multiple occurrences of heavy rains. While the one day storm is used for capacity estimates, rain-patterns of the longer periods are simulated for the flood-routing analysis.

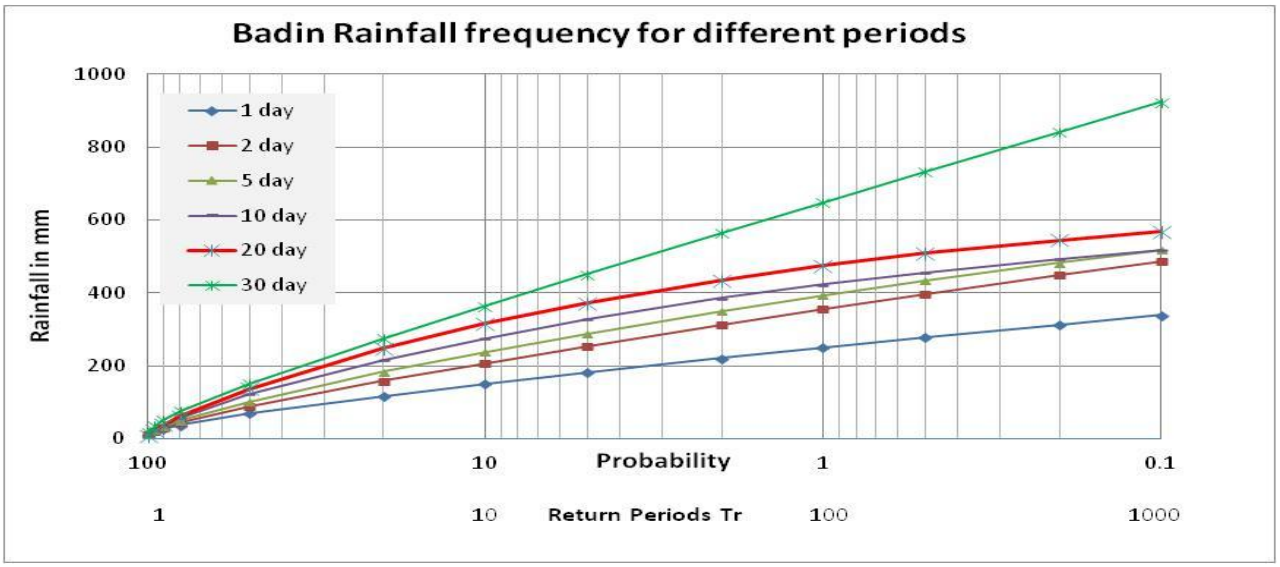


Figure 10. 6: Rainfall frequency for one to thirty day maximum rainfall

10.5.3 The Design Storms for LBOD

As a standard practice, the design storm for a new drainage system is selected to minimize the damages and ensure safety of the drainage network. The estimates against the design storm provide guidelines for capacity and safety margins. The criteria for the urban systems are much more rigorous than the large rural systems. The type of facilities to be provided with drainage network also influences the capacities and initial investments like the type of urban area or the load and utility level of a communication system. An option to enhance a drainage network in the future allows selection of conservative parameters for the large surface drains. The normal design procedures estimates runoff based on short-period storm intensity to determine the capacities of field drainage inlets. The larger periods like 24 hours are used only if the data are not available or the flood routing is not considered on the real-time basis. Many rural drainage systems are designed for ten and twenty years return periods. For the large surface drainage systems, natural or constructed detention basins/systems are provided to reduce the actual release rates below ten-year frequency design storm flows. Performance analysis of the proposed or existing drainage systems normally considers one hundred year recurrence interval.

A conservative approach was adopted in 1980 for the selection of all design coefficients of LBOD. The land use patterns and infiltration rates measured in 1967 were used as a reference, though higher values were proposed in some cases. The proposed final capacities of the LBOD drainage- network considered:

- Proposed- system will effectively drain 1 in 5 year storm,
- Rainfall up to 50 mm will generate no runoff; this threshold value was reduced from 100 mm recommended in 1967,
- In 1965 infiltration values of 500 mm to 80 mm per day were reported. The hydrology studies of 1980 proposed an average infiltration rate of 45mm/day and evaporation 7 mm/day.
- About 27% of the precipitation converts into runoff and 22% reaches to the drains.
- Designed field outlets could take much less water than the calculated runoff of a sub-catchment, because a substantial number of uncontrolled inlets were expected to discharge into the branch and main drains.
- During floods, no direct diversions from the irrigation network were expected.

10.5.4 Rain-Runoff Estimates

The rain-runoff estimates are used for:

i) capacity determination of the drainage channels, and
ii) to provide guidelines for integrated management of the drainage from different sources

As shown by the water-balance analysis, manageable effluent during summer may increase non-uniformly, depending upon the total availability of water in the system. The drainable surplus from irrigation and other uses is in the range of two billion cubic meters (2 bcm) in summer. The drainage system can gradually take higher shares of this affluent, as the farmers and local users (like urban municipalities) can discharge their utilities into the drainage network. To address these issues a hydrological simulation model is used, which can compare runoff assessment methods and carry out flood routing scenarios.

The HEC-HMS model is selected to simulate the short duration storms using the curve number (CN) method of the Soil-Conservation Services and the Soil Moisture Accounting Method (SMA). The Curve Number Model can simulate flood flows for 13 days and rainfall for more than 5 days. The SMA method is additionally used for long-term rainfall-runoff-routing simulations.

The comparison of both methods shows higher sensitivity of the Soil Moisture Accounting method to the initial conditions, like the soil saturation level at the beginning of a storm. The impact of antecedent soil moisture conditions could be substantial for one-day storms. The soil moisture saturation can vary from 20% in April to 80% in August (Hunting 1967). The pre and post-monsoon data shows 50cm to 100cm rise in groundwater level. The hydrology study of 1980 considered a maximum loss rate of 45 mm per day, which in-fact could be only a few millimetres per day on a large percentage of the cropped land. The original interception of rain by the soils is directly influenced by the soil wetness. The long spans of rainfall will have a much lower infiltration rate and interception by the soils and water bodies.

The evacuation of the agriculture lands within three to five days is considered critical for vegetables and cotton crop. Different sub-catchments of LBOD can have 30% to 50% more rain in five-days compared to a one-day storm.

10.6 Components of the Drainable Flows in LBOD

The gross drainable surplus includes three smaller components contributing to the base-flow, i) saline groundwater pumped through the public wells, ii) the irrigation-surplus and, iii) the urban and industrial waste water generated in the catchment. The storm flows are calculated for 10 years and 20 year return period. The Table-10.4 below summarizes gross drainage quantities, estimated in the previous sections.

Table 10. 4: Gross Drainable Discharges in cubic feet per second

Source	Drainage Flows Normal Year Cusecs	Drainage Flows 10 years Storm Cusecs	Drainage Flows 20 years Storm Cusecs
Pumped sub-surface saline	600	-	-
Urban/industrial flows	400	800	1000
Irrigation Surplus	1200	-	-
Rainfall Runoff	2500	9000	12000
Off Loaded from LBOD	***0***	***2000***	***3000***
Flow at LBOD RD 159	4700	8000	9000 - 10000
Expected Response of the Basin	Each rain event will be evacuated in three days. There could be local flooding	There could be flooding in one or more sub-catchments. About 60% of flood water will be evacuated in five days	Medium floods in Mirpurkhas and Badin catchments. If the irrigation contribution is reduced to nil and 3000 cfs offloading is supported, 70% of the flood will be evacuated in 10-days.

10.7 Characteristics of the Flood Routing through LBOD

10.7.1 The Drainage Capacity and Evacuation Period

During the floods of 2011, more than 10,000 cusecs discharge was reported in the spinal drain and more than 13,000 cusecs in KPOD and DPOD out-falling drains of LBOD (WAPDA, SIDA, Army Report 2012, ACE 2011). However, the hydraulic simulations show that the system could not take more than 7000 cusecs discharge at RD159 of the Spinal Drain, after fully consuming the free-board. The maximum discharge in the system could be 9000 cusecs, including the additional flows in KPOD from the Kotri area. However, at this flow, the Spinal and Branch drains were breached at multiple locations and two planned relief cuts were operated for many weeks.

The field observations show that the capacity of the secondary and tertiary drainage system has increased responding to the local drainage needs. The post flood interventions by the users, NGOs and the line-agencies have contributed to the extension of the network. The controlled inlets have been added to the system at all levels including the spinal drain. Some of the sugar-mills have added sub-drains to the system. These additions have increased the average summer and the pre-monsoon flows in the LBOD network. The post flood rehabilitation in 2012 has further increased the capacity of various components of the LBOD.

The evacuation of storm flows from LBOD catchments will be directly influenced by the pre-flood status of the system and the canal diversions to the drainage network during floods. It is obvious from the history of LBOD and the opinion of the stakeholders that the existing system cannot be treated as a new system. There is a need to enhance the safety margins and operational management of the system.

The relations between drainage capacity and evacuation periods are developed by simulating different intensity storms from a square-mile catchment. The Soil Moisture Accounting method is used to explicitly consider the soil moisture and evapotranspiration parameters shown in the figure 10.7. The daily maximum rainfall of 50 mm to 250 mm is simulated in eight incremental steps for the field inlet capacity of two, three, four, six and eight cusecs. It is assumed that in each case total generated runoff will be accumulated within the catchment and will be evacuated only through the drain inlets. This figure can be used to have a rough estimate of required drainage capacity at the tertiary and secondary levels. At each upward level, 10% capacity margins should be added.

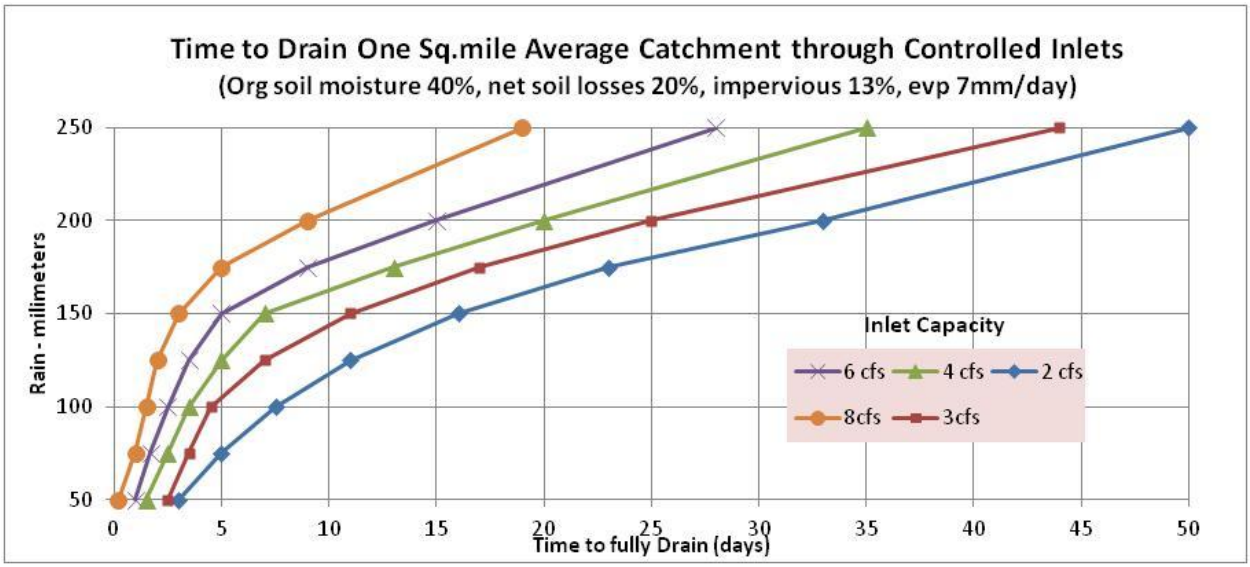


Figure 10. 7: Inlet Capacity and Evacuation Period for 50 mm to 250 mm rainfall

It can be seen from the figure, that the rainfall-evacuation period relations are not linear.

To evacuate 100 mm rainfall from the watershed within 5 days, the minimum inlet capacity should be three cusecs. For 150mm storm evacuation 6 cusecs capacity inlet will evacuate within 5 days, while the same inlet will evacuate 200mm rain-runoff in 15 days.

10.7.2 The Catchment Evacuation Patterns

The flood routing from a large catchment is not just the sum of inlet capacities multiplied by the time. The routing process will include accumulation of the flood water in low lying areas and at the head of tertiary outlets, a variable flow velocity and a gradual decrease in contributing inlets. Accumulation of water just after the storm will increase the available working head and the velocity. As the drainage continues, the number of functional inlets will decrease. The evapotranspiration will take place from the stored water, wetland and high groundwater table. The rest of the water will go through the drainage network.

The 10 years return period rain will create a flood peak of 8000 cusecs in Badin catchment (Figure 10.8). The base-flow of 2000 cusecs will be generated from the next day and will reduce to 100 cusecs in seven days. The drainage outflow rate from the Badin catchment is computed as 2000 cusecs for five to six days evacuation. The rate of evacuation will decrease as the accumulated water in the system decreases. Within six days, 80% of the water will be drained out, while 9 days will be required to fully drain the sub-catchment. These simulations are carried out for all sub-catchments for two to twenty years return periods.

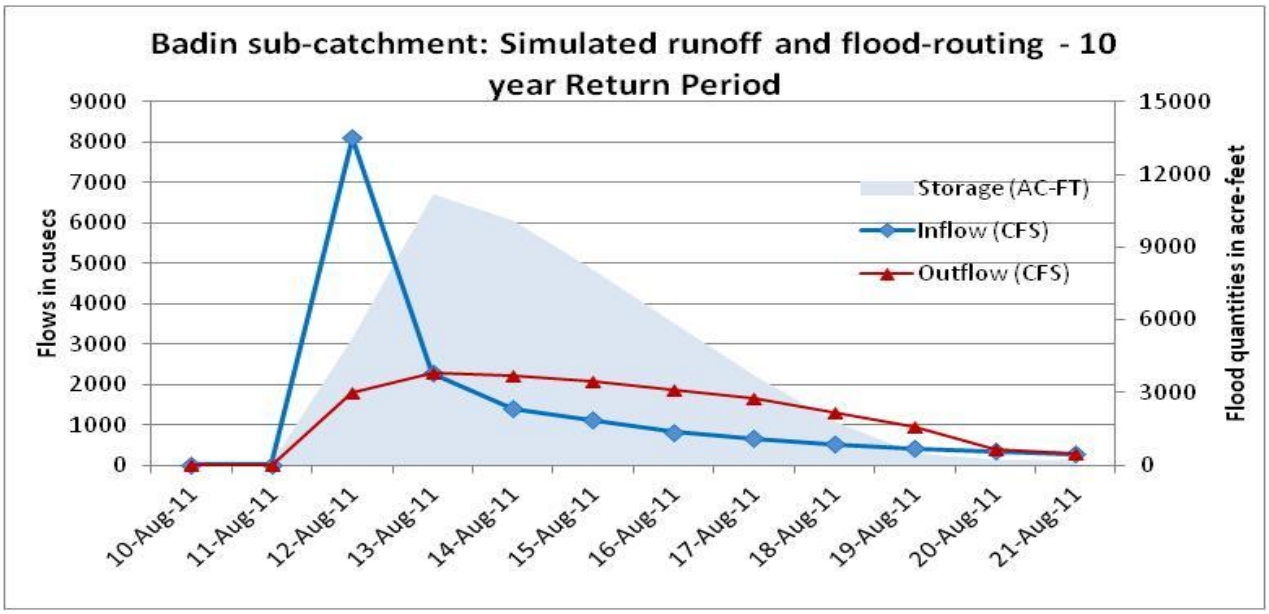


Figure 10. 8: Direct Runoff and routed-flows from the Badin catchment area are drained into the LBOD Spinal. Net evacuation potential of 2100 cfs has been estimated for 10 year return period Storm.

The actual rainfalls of two recent flood years, 2006, 2011, are simulated using these sub-catchment models. The results are compared with the actual evacuation pattern. By adjusting the flooded areas, the models provide a fairly good estimate of the flood evacuation behaviour. These scenarios cannot provide required calibration inputs, because a consistent data set of measured flood levels is not available. These simulations can be much improved by using a digital elevation model in combination with a hydrological model.

10.8 Recommendations

1. Current assessments and modelling studies are helpful in quantifying the individual processes; rainfall frequency curves, runoff quantities, effluents from irrigation, flood routing, evacuation patterns and physical boundary constraints. The integrated behaviour of the catchment and drainage system helps in identifying available flexibilities and operational constraints. However, this work is carried out over a short period of time, using the secondary data. Specific studies of the identified gaps will not only substantiate this analysis, will provide confidence in real time flood and drainage management.

2. LBOD is not a robust self-operating drainage channel. The Standard Operational Procedures for LBOD drainage network should be developed and implemented, including regular Operations and Maintenance (O&M) and Monitoring and Evaluation (M&E) procedures. These procedures should consider three operational ranges, base-flow in winter, regular drainage flow during Kharif and flood flow during above-average rainfall years.

    a. Changes in hydrological trends are evident; i) more rains of higher intensity and longer duration in the central part of the left-bank region, ii) increased irrigation effluent in summer, iii) increasing discharge of domestic and industrial effluent to the drainage system, and iv) decreased saline effluent from the SCARP wells.

    b. Physical changes and local interventions have provided a higher utility to the users. However, uncontrolled and scattered interventions could be damaging to the system.

    c. Integrated operations of irrigation and drainage network during floods can minimize the risk to population, infrastructure and agriculture.

3. The natural retention capacity of the left-bank region plays a critical role in a gradual evacuation of runoff. Severe flooding (2011, 2003) may occur when the retention capacity of a catchment is over topped. A sudden evacuation is not possible. Hence, the retention capacity of sub-catchments should be maintained and enhanced wherever possible.

4. Current water use and effluent management may lead to higher water-logging and surface salinity. That will put at risk some achieved benefits of the existing drainage system like high value crops and good crop yields. The water use efficiency in agriculture can be improved by targeting better demand-supply match, increased share of low water use crops, shifting of water use from summer to winter and re-use of irrigation effluent.

5. Some capacity enhancements of the existing network are possible. However, the topography and outfall limitation cannot provide a complete capacity-solution. Hence, the hydraulic efficiency needs to be improved and maintained during floods. The remodeling of the system must ensure, i) modularity of the structures, ii) controlling backwater flows at all levels, iii) establishing emergency breach locations for the spinal and main drains.

11 Feasibilities

11.1 Rehabilitation and Improvement of LBOD Drainage Infrastructure

Introduction

The LBOD network, serving Shaheed Benazirabad, Sanghar and Mirpurkhas districts, and the Badin area drainage system was built during 1985 to 2003 to dispose-off the drainage effluent aka the base flow generating from the tile drains and saline ground water (SGW) tube wells, and the storm water flows (SWF) generated by runoff in the catchment area of 04 districts.

The above mentioned drainage network provides a relief to the cultural command area of about 1.734 million acres irrigated by Rohri, Nara and left bank area of Kotri Barrage canal systems encompassing Shaheed Benazirabad, Sanghar, Mirpurkhas and Badin districts.

During the last three decades, particularly in 1994, 2003, 2006, and 2011, the left bank of Indus experienced repeated extreme rainfall events that caused colossal damage to human lives, agriculture, particularly standing crops, livestock, stored grains, private and public properties, highly productive and physical infrastructures and worst affected was Road network in all districts. A large segment of population was marooned and or displaced constraining their access to social services, and livelihoods, till the return of normality. It is anticipated that due to climatic changes of coming decades, area will witness occurrence of such extreme weather conditions more frequently. The situation is further exasperated by damage to tidal link and collapse of Cholri Weir, causing sea encroachments during high tides, degrading large tracts of productive land and depressing its productivity potential, and salinizing the fresh water bodies diminishing their fish production potential. This has led to loss of livelihood of considerable populace.

The drainage system is in dilapidated state, and the existing capacity of the LBOD and Badin area drains is insufficient to drain out the storm water within a period of 03 to 05 days. In the past years whenever the rainfall exceeded the designed capacity, causes inundation of the low lying areas, and the stagnation of storm water for longer periods. This is may be due to the deferred maintenance, and unauthorized breaches by the farmers along the drains and irrigation canals to dewater their stagnant water from their fields. The weak banks with lack of adequate free board (FB) are prone to breaches and flooding of the area. The situation is further exasperated due to the submergence of drains at point of outfall, blocking the flows in the network and resulting in overtopping and breaches and relief cuts. The irrigation water of canal escapes and breaches of irrigation channels adds to the pressure.

Box 1: Profile of Spinal Drain

Length (RD)	657
Discharge (cfs)	1240 – 4600
Bed width (ft)	85 -162
Depth (ft)	8.75 -13.33
Side Slope (-)	1:3
Berm width (ft)	20
Longitudinal Slope (ft/ft)	0.000118 - 0.00005

In August and September of 2011, most parts of left bank of Indus received ever maximum rainfall of 500 to 1,200 mm, inundated most areas with an average depth of 03 to 04 feet. The average rainfall of was about 300 mm within 24 to 48 hours and was two to three times exceeding the existing capacity of drainage network. The heavy rainfall in the Shaheed Benazirabad, Sanghar, and Mirpurkhas districts generated a runoff of about 15,000 cfs, while LBOD system was designed for a discharge of 4,600 cfs.

During the 2011 floods, despite less capacity of the drains, obstructions in the system, encroachments in the water ways causing overtopping and breaches at a number of places, the system performed better than anticipated. The high level of water in the spinal drain caused submergence of the MMD and the LBOD branch drains resulting in the inundation of adjoining villages and towns, severely damaging the life and property. Many adjoining farmers gave relief cuts to the banks of the spinal and branch drains to evacuate the storm water. The damage to the drainage infrastructure was enormous and quite a few watercourse aqueducts collapsed and bridges were damaged.

To ensure the safe disposal of the storm water and to avoid the sea intrusion it is suggested that the proposed interventions of Redesign of LBOD are carried out in two phases. Consultants recommend that to SIDA that the emergency works be completed by June 2012, including desilting of the drain beds, restoration of the freeboard, repair of damaged inlets, and stone pitching at vulnerable points.

It is expected that the proposed interventions would decrease the inundation period and depth of submergence in a manner that would reduce the vulnerability to damage to the water hazards damaging the life and property of the communities along the drainage system, and does not disrupt their normal life and livelihoods. The provision of adequate FB would also serve as an insurance to carry bank full discharges like the one witnessed during 2011 rainy season. In addition this intervention aims reducing the negative impact of seawater intrusion.

Context and Justification (Issues and Options)

The project area lacks natural drainage and the few existing natural drainage lines, were severed by the network of irrigation canals built in 1932 or subsequently and also by construction of road infrastructure in the left bank area. The poor drainage conditions coupled with perennial irrigation supplies have resulted in the rise of water table in irrigation command areas.

A small scheme comprising network of open shallow drains was excavated by the Irrigation Department in the Makhi Dhand area which lies between Jamrao, Mithrao and Nara canals to check the rising water table. In absence of any proper outfall, the effluent from this system is being pumped into Mithrao canal but due to shallow depth of drains, control of water table could not be achieved.

In the extreme southern catchment, namely Badin area, open surface drains were constructed by Irrigation Department within Kotri Barrage Command during 1960 to cater for storm water drainage and excess effluent from rice fields. The system has been provided with the outfall through Kadhan Pateji Outfall Drain (KPOD) on to the mud flats and Pateji Dhand in Rann of Kutch.

To check the rising water table and to provide relief from surface runoff generated by rainfall in Nawabshah, Sanghar and Mirpurkhas areas, extensive networks of surface drains, drainage tubewells, tile drains and interceptor drains along the major canals were constructed by WAPDA during the implementation of LBOD Stage-1 Project.

The overall objective was to raise agriculture production through higher yields by alleviating water logging, salinity and reclamation of saline lands. The system covered Nawabshah, Sanghar and Mirpurkhas areas. Among the components of the project are:

- A network of surface drains discharging to the sea via a spinal drain and tidal link.
- Deep tube-wells to intercept seepage water and control the groundwater table by groundwater into the surface drainage network.
- Interceptor drains beside canals to recover fresh water seepage for use in irrigation.
- Buried tile drains to control groundwater tables where drainage tube-wells are not feasible.
- Additional power capacity at seven (2x Nawabshah, 2x Sanghar & 3x Mirpurkhas) existing grid stations (required for the operation of 1700 x tube-wells with 1.0 to 1.5cusecs discharge).
- A network of power supplies to tube wells and drainage pumping stations.
- Remodeling canals (Nara Canal) to increase capacity (in order to provide irrigation water for the reclaimed land from water logging and salinity).
- Construction of Chotiari Reservoir to provide system storage allowing secure supplies to the Lower Nara Canal System. The purpose of linking LBOD project with Chotiari Reservoir was to utilize the stored water for Rabi season crops (November to May) in LBOD benefited area.
- On Farm Water Management to improve watercourses and water use practices.

Hierarchy of the surface drainage system of LBOD Stage-1 Project comprise; Sub-drains, Branch drains, Main drains, Spinal drain, Outfall drains and Tidal link out falling into the Arabian sea. Geographical units, where this surface drainage system is located, are:

- Nawabshah (Shaheed Benazirabad) Component;
- Sanghar Component: and
- Mirpurkhas Component

In addition to the above three components, there are several drainage systems of Badin area out falling into Spinal Drain and KPOD. Surface drainage systems of LBOD Stage-1 Project and Kotri Surface Drainage comprise of:

- Surface Drainage Network of Nawabshah Component Project
- Surface Drainage Network of Sanghar Component Project
- Surface Drainage Network of Mirpurkhas Component Project
- Surface Drainage Network of Badin Area
- Spinal Drain
- Dhoro Puran Link Drain
- Dhoro Puran Outfall Drain (DPOD)
- Kadhan Pateji Outfall Drain (KPOD)
- Fulleli Guni Outfall Drain
- Karo Gunghro Outfall Drain
- Tidal Link

The major issues for slow delivery of drainage system are:

- In-efficient performance of natural drainage due to encroachments and obstructions.
- Overtopping at number of places due to in adequate capacity.
- Submergence of drains at out falls points feeding KPOD.
- Backflow in Mirpurkhas Main Drain and Drains feeding KPOD.
- Limited capacity of the entire drainage network to cope with heavy storms.
- Roads, canals, built up areas and drains have caused compartmentalization of the area blocking the natural drainage system.
- Inadequate capacity of Culverts/Bridges at crossing points of drains with road network.
- Additional storm water entered into LBOD system from overflowing of Dhoras.

Obstruction of Natural Flow of Storm Water by Road Network

The natural flow of storm water was blocked by roads; therefore, storm relief cuts were given to metalled roads in MirpurKhas - Naukot, Badin – Jhudo, Naukot - Jhudo, Tando Adam - Hyderabad, Chamber – Tando Allahyar, Badin – Nindo and at various locations where water was trapped along the road without culverts and causeways.

Submergence of Drains at Outfall Points

Storm rainfall on the upper catchments of Nawabshah, Sanghar and MirpurKhas components produce maximum flow resulting in high water levels in the KPOD submerging some of the outfall drains:

i. Drains Out Falling into Spinal

- MMD at RD 297 of Spinal.
- LBOD Branch Drain at RD 204 of spinal.
- Shadi Bahadur Branch at RD 182 of spinal.

i. Drains Out Falling into KPOD.

Submergence of the drains out falling into KPOD along with level difference is as under:

- Tando Bago Branch Drain – 4.54 ft.
- 1R to Tando Bago Branch Drain – 4.54 ft.
- 5R Sub-drain of KPOD – 0.45 ft.
- Behdmi Link Sub-drain – 1.23 ft
- 2R Sub-drain of KPOD 0.3 ft.
- Serani Branch Drain – 0.92 ft.

Water Management

Following are the major draw backs of water management which have added to the storm water damages during 2011.

- Entire area is crossed by irrigation channels/canals. The water in some canals was not stopped well before rains and it added to storm water flows and caused wide spread inundation in the area.
- Breaches and illegal cuts made by farmers to the canal distribution network for immediate evacuation of storm water from cotton and sugar fields also increased the flow in the drainage network.
- The irrigation escapes continued to flow during the rainfall storms and played havoc.

Damage to Infra Structure

i. Damage to Main Drains

The following main drains were over topped their banks breached at number of places and also relief cuts were given to save the cropped area and local abadies. The detail of damages is as under.

- Damages to Spinal Drain during the storm water floods of 2011 and the Spinal Drain System was running in full upto banks level with the discharge ranging from 9000 to 10000 cfs.
- Damages were reported when Dhoro Puran was running full and parallel to DPOD and also very high water level were observed resulting overflows.
- Damages to KPOD while carrying discharge in excess of design flows approximately in the range of 7000-8000 cfs.
- DPOD prism was damaged when it was flowing with discharge of 4000-5000 cfs.
- Mirpur Khas Main Drain was breached at number of places due to submergence at outfall of the Spinal Drain at RD 297 and also inadequate capacity.
- Damages to LBOD Branch Drain and other drains in the Badin area due to in adequate capacity and submergence at RD 203 of spinal drain.
- Damages were reported to cash crops, orchards ,houses and road network due to flooding of the towns of Jhudo, Digri, Pangrio and Badin area from breaches of drains and canals network.

ii. Damage to Bridges and Water Course Crossing Aqueducts

On the spinal drain and branch drains a number of bridges have been affected due to submergence and overtopping. A number of water course crossing aqueducts were completely washed away. Damage to hydraulic structures on spinal drain and main and branch drain network is enormous.

iii. Major Problems of LBOD

Following are the major drawbacks and constraints of the LBOD drainage network to perform during heavy rain storm of 2003, 2006 and 2011.

- The existing drainage network is unable to drain the catchment areas of all three sub components of LBOD Project within a period of 3 to 5 days to minimize damage to standing crops, mostly cotton.
- The inadequate Free Board resulted in breaches at weak sections of Spinal Drain and over flowing at bridges and other structures.
- Inundation of low lying areas and towns due to breaches in irrigation and drainage network.
- There was submergence of main drains due to less working head like Mirpur Khas Main Drain, LBOD Branch drain and other direct drains out falling at their point of confluence with the Spinal drain.
- The rain-fall pattern in lower Sindh has been modified due to climate change phenomena with the result that the extreme events of rain fall have been recorded and those causing wide spread flooding in the areas and these would continue to do so in future also.
- Due to weak sections and breaches the number of structures like Water course- Crossings, Inlets and Bridges were completely washed away.
- Increased Sea intrusions and entry of salt water at control points.
- Absence of control structure to check Tidal effect.

The irrigation water of escapes and breaches of the network when added with the storm water played havoc with the neighboring Towns and Villages and abadies and damaged infra structure in the area i.e. road network and protections bunds.

The most feasible option is to enhance the capacity of existing LBOD drainage network to safely allow passage of flood events like 2011 and to control the high tide impacts.

Location

LBOD stage-I project area is located in Sindh, in the Lower Indus Basin. It lies between latitudes 24º 10' and 26º 40' N and longitudes 68º 09' and 69º 26' E in the districts of Nawabshah, Sanghar and MirpurKhas. The project is located on the left bank of river Indus in the command of Sukkur Barrage. Major towns of the project area are Nawabshah, Sanghar and MirpurKhas and Badin. All the Major towns of the area are either connected by metal roads or by railway line.

The project area serves a cultivable commanded area (CCA) of 1,734,523 million acres, divided into three component projects is shown in Table 1.

Table 1: Gross and Cultivable Commanded Areas of Project Components

Project	Gross Area (acres)	CCA (acres)
Nawabshah	626,000	554,500
Sanghar	424,000	362,500
MirpurKhas	376,000	358,800
Badin	593,496	458,723
Total of LBOD	**2,019,496**	**1,734,523**

Output

Redesign of LBOD

The capacity of spinal drain would be increased to cater floods of 2011 level and existing structures on LBOD drainage network would be rehabilitated with the following features:

- Metal Road proposed on IP of Spinal Drain from RD 159+000 (terminal point) to RD 815+822 (start point).
- All watercourse crossing aqueducts are to be replaced with pipe crossing in reach RD 159 to RD 297 of Spinal Drain.
- All submerged bridges are to be raised minimum 2 ft FB from the existing deck level in reach RD 159 to RD 297 of spinal drain.
- All bridge crossings of District Roads with LBOD Drainage network to be reconstructed with full water way and zero fluming and minimum 2 ft free board is to be provided.
- Inlets to be provided on all drains at an interval of 5 RDs on either side.
- All structure of LBOD Branch Drain (Badin area) to be reconstructed.
- All outfall structure of main drains out falling in to spinal drain to be newly constructed with full water way and with 10ft raising of both banks to allow for surcharge storage in length of 05 miles upstream.
- On Spinal Drain all structures shall be provided with stone pitching of 200 ft upstream and 300 ft downstream and adequate water way upstream of structure will be ensured.
- A discharge of 3000 cusecs will be offloaded at RD 211, RD 335 and RD 578 of Spinal Drain.
- All natural depressions/vacant lands/barren lands would be connected to drainage network through appropriate structures and artificial lakes/storages would be created for temporary detention of storm water at on farm level and to cause delay in contribution to main drainage network (community work).
- A Gated Tidal Control Structure to be manually operated would be constructed at RD 26 of KPOD and connected with the Tidal Link through properly stone pitched outfall drain with bank width of 50 ft on either site.
- Provide mobile pumping stations in four units of LBOD drainage network and at selected reaches of spinal drain.
- Construct discharge measuring sites on LBOD drainage network.

Project Impacts

The overall impacts would be improved drainage network with sustainable irrigated agriculture and improvements in hygienic conditions in the health sector and in the productivity of human being. By growing high value food crops in well the health nutrition and economic status of rural populations can be improved and there would be increased opportunities for employment as new industries may develop in prosperous areas. Some of the positive impacts are:

- Removal of excessive standing water and salinization of the land resulting in reduction of cultivated area in Kharif.
- Favorable conditions for Rabi crops due to lack of timely disposal of surface water from rice fields into the Sea.
- Improve environmental conditions in the area.
- Increased agricultural production by way of improving crop yields and cropping intensities.
- Increased area under Rabi cultivation by providing favourable conditions by timely removal of surface water from rice fields.

- Controlled salinity and removal of excess salts from the soil profile with increased production.
- Draining of stagnant pools of water and saving of the infrastructure in the project area.
- Provide a base for monitoring of water quality of both canal and drainage water.

Financial Outlay

The total costs of long term solution of the LBOD project under feasibility study are going to be in the range of Rs. 15 Billion to 20 Billion including the emergency repairs and essential restoration work those have already been completed by SIDA in June 2012; the further rehabilitation works to be done at estimated cost Rs. 3.5 Billion proposed for completion by December 2012.

After the completion of suggested interventions a recurring expenditure of Rs. 800 – 1000 millions would be required for O&M of LBOD. The detail Financial and Economic analysis is included in the Feasibility Report of the project.

Implementation Period and Arrangement

It is planned to implement the suggested long term measures starting from July 2014 and to complete it by June 2020.The entire project for the purpose of biding has been divided into06 packages for implementation and is to be executed through International and National bidding in a competitive manner ensuring full transparency. The construction works are to be supervised for both quality and quantity through renowned international and national Consultants of repute. The size of package varies from Rs. 500 million to 2000 million.

Monitoring Framework

It is essential that the monitoring of the performance of drainage system is carried out on continuous basis with the help of staff gages installed at control points and the rating tables formulated by the Consultants, to be updated after every flood season. Permanent gauges will be installed at outfall point of Shakoor Dhand and Shah Samando Creek and observed regularly. The water table depth throughout the left bank area is to be monitored for the period of pre monsoon and post monsoon with help of the SMO WAPDA as they have installed an extensive network of piezo-meters and tubewells. A number of Sugar Mills are operating in the command area of drainage network and are to be monitored for the pollution. These are adding highly toxic effluent into drains and need to ensure that no untreated effluent is discharged into the drainage network. In addition to this environmental monitoring will be done during construction and after completion of the project on regular bases through and environmental monitoring cell to be established in the SIDA office. The maintenance of the infra structure be monitored for its discharge capacity and safety of structures. The changes in the ground water level and its water quality parameters be observed and a data base developed for monitoring the quality of the ground water and reuse of drainage water.

The full benefits of drainage cannot be achieved if other developments such as irrigation management are not implemented at site. There is risk involved that at field level farmers may e encouraged by the drainage system to be wasteful with water. At SIDA level there are important factors such as adequate design, quality construction, and very good maintenance. The drainage benefits may decrease gradually due to poor maintenance.

Due Diligence

All the storm water drainage systems of the Left Bank are unregulated, and so are not subject to good water management during the passage of floods. The operating agency to ensure the following roles during events of very high storm:

- Ensuring canal supplies to the region are stopped as early as possible but atleast 07 days earlier to extreme rainfall event
- Making sure that the sub-surface drainage effluent pumping ceases – to allow the full drain capacity to be used for storm water drainage

- Checking on water levels at major control points in the drainage network, especially in the main and spinal drains, to allow banks to be strengthened and raised if water levels are threatening to inundate valuable land areas, such as towns and major villages
- Patrolling the drains to try and by force stop cutting of embankments by farmers so that no extra storm water is not added to drainage network
- Inspecting drains after the passage of the flood, to ensure all urgent remedial works are completed before the resumption of sub-surface drainage pumping.

The degree to which such tasks are carried out will obviously depend upon the resources to be made available to the operating agency, but the budgets to be allocated for operating the drainage network must take the requirements of storm water drainage management into account. It is especially important that the reliable information is made available to the Irrigation Department to allow for reduction of canal supplies at times of forecasts for heavy rains (once the reliability of these forecasts is established), and that information systems within the Irrigation Department are improved for much advanced early warnings.

Flooding induced by extreme storm events in lower Sindh is a major concern in lower Sindh with inundation of low lying area and because of very flat slope there is frequent poundage in the fields. It is essential that the detention ponds/recharge percolation tanks and storm water retention basins are constructed at On Farm Level for field drainage and without provision of the same the collector system of LBOD cannot evacuate the storm water of 2011 level with a reasonable period (community work).

Technical Feasibility

In the Lower Indus Report, drainage was considered at two levels. The first was within individual projects where only local drainage problems were considered and the second concerned the disposal of drainage water outside the projects by means of a system of main drains discharging in to an outfall drain. Branch and sub-drains dispose-off the effluents of tube wells, tile drains and/or storm water run-off within individual project areas. These are constructed as part of these projects. The construction of the main fund outfall drains were built as a separate project stages to match the overall development programme of the region.

Provision was also made for storm drainage in the southern part of the catchment, in addition to providing drain capacity to cope with the drainable surplus. The capacity was designed to accommodate the flow, from once in five year five day storm. The quantum of run-off was calculated by analysis of losses on a typical unit catchment. Direct ingress of run-off to the drain is impractical because it would require an excessively large drain. For this reason pipe inlets are planned to control the unrestricted flow into the drainage network. The flexibility of tubewell pumpage together with the use of pipe inlets for storm water drainage should, allows a better control of inflows into the drains. The "Left Bank Master Plan" (LBMP) is an interpreted development of irrigated agriculture along Light Bank of River Indus in Northern Sindh and southern lower Sindh. The plan envisages for overall development of 9.71million acres irrigated of Left Bank Canals of Guddu, Sukkur and Kotri Barrages. The LBMP comprises of agricultural sector programs i.e. livestock, forestry (mangroves) and fisheries (wet lands) and water sector development i.e. Drainage and flood control. The entire project area is divided into 04 drainage components. This feasibility study of LBOD is a part of Master plan to provide adequate storm water capacity to drainage network for 20 years return period as compared to 05 years return period of original design and adequate disposal system into the Sea. The proposed solution is integration of natural drainage and man-made drainage systems.

The basic purpose of the project is to increase cropping intensity, yield of crops and to decrease agricultural risks through integrated development of irrigation and drainage system.

Economic Justification

Flood irrigation was practiced to raise the agriculture along left bank area during early settlements along the Rivers of Indus Basin. Later on till the middle of nineteenth century many inundation canals were used to irrigate the agriculture fields. The existing weir controlled system of irrigation network started after the middle of nineteenth century. The present irrigation system of the country consists of 03 major storage reservoirs, 16 barrages, 12 link canals, 2 major siphons and 47 main canals. Originally such an extensive irrigation network was developed without providing the proper drainage facilities due to the essential reason that water tables were fairly deep in most parts of the Indus planes. However, with the passage of time due to lack of proper drainage water table rose to a level close to surface resulting in water logging and salinity problems. By the time of independence a considerable productive agricultural areas were affected by water logging and salinity. Estimated loss of irrigated lands due to water logging and salinity was about 99,000 acres/year at that time. It was necessary to provide the drainage system to sustain irrigated agriculture.

The most recent scientific assessment by the Intergovernmental Panel on Climate Change (IPCC) estimates that due to global warming extreme events of rainfall would be recorded in Lower Sindh and right now the interval of extreme events of rainfall varies from 4 to 5 years. So provision of adequate drainage is must in the area to sustain economic life.

Social Safeguards

Environmental social impact have been study by the LBMP Consultants in detail by conducting interviews with the farming community and other people living in the vicinity of the project specially in the command areas of Nara and Rohri Canals. The irrigation and drainage system existing in the area is fairly sustainable and with the anticipated improvements at outfall conditions and with increased capacity of drainage network will have major positive impacts and no major adverse environmental impact are anticipated in respect of habitat, cultural heritage. The proper drainage effluent disposal would increase cropped area and minimize damages to standing crops and also will provide sufficient employment opportunities to locals.

No social and environmental adverse impact are visualized if recommended project is implemented but project viability will depends upon government strictly enforcing existing laws and regulations to control canal water coming to drainage system and also no fishing actives to be allowed in sub drains, branch drains, main drains, spinal drain and outfall drains of KPOD and DPOD under any circumstances. The water rate recovered should also include O&M drainage maintenance costswith100% recovery and made available to SIDA for adequate maintenance. The sugar mill owners are to ensure pre treatment of their effluent and also contribute major share to improvement of LBOD drainage network. In case the above recoveries are not enforced the project would be nonviable.

The World Bank Project Appraisal Document (2007) refers to the WB Safeguard Policies to be followed. Among the 10, five were originally selected by the Bank and are commented below.

World Bank Safeguard Policies

Safeguard Policies Triggered by the Project	Yes	No
Environmental Assessment (OP/BP 4.01) Environmental assessment of civil works of the LBOD System will be conducted according to the procedures described under the Environment Impact Assessment & Environmental Management.	✓	
Natural Habitats (OP/BP 4.04) Natural habitats will not be disturbed in LBOD because the system already exists.	✓	
Pest Management (OP 4.09) LBOD by itself will have no effect on the pest management safeguard.	✓	

Safeguard Policies Triggered by the Project	Yes	No
Cultural Property (draft OP 4.11 – OPN 11.03) No cultural property will be disturbed in LBOD because the system already exists.		✓
Involuntary Resettlement (OP/BP 4.12) No resettlement will take place in LBOD because the system already exists. The drains downstream of the side weirs will be contained within the natural waterways (dhoras) study.	✓	
Indigenous Peoples (OD 4.20)		✓
Forests (OP/BP 4.36)		✓
Safety of Dams (OP/BP 4.37)		✓
Projects in Disputed Areas (OP/BP/GP 7.60)		✓
Projects on International Waterways (OP/BP/GP7.50) The storm waters drained by Dhoro Puran and the storm waters conveyed by DPOD will eventually discharge in Shakoor Dhand, which is a natural lake shared between Pakistan and India. The existing drain, DPOD already discharges storm water into Shakoor Dhand. The polluted waters are being controlled by a 9 feet weir at the head end of DOPD. Dhoro Puran should also convey only storm water, which contains no pollution.	✓	

General Description of the Environmental Impact

The **rehabilitation works** consist of reshaping the canal prisms and in some reaches widening/reducing the berms and/or inspection paths; strengthening/rehabilitating the bridges; reconstruction of aqueducts; construction of side weirs; construction of the tide control structure and; rehabilitation/reconstruction of inlets. The **likely direct negative impacts** on the environment are:

1. *Construction camp*. Construction camps include workers' living and eating areas; mechanical workshop; equipment parking and; construction materials storage/stockpiling.
2. *Workshop and fuel servicing.* Transport, handling, and storage of petroleum products.
3. *Site preparation and clearing.* Site preparation, clearing of vegetation, temporary rerouting of traffic, topsoil stripping, and diversion, or re-channeling of waterways.
4. *Earthworks*. Removal and placement of earth. Construction machinery moving around the ROW and work sites compact the lands changing the soils structure.
5. *Quarries and borrow sites.* Borrow for earth fill on IPs and aggregates for the fabrication of concrete will demand quarries and borrow sites.
6. *Air quality and noise impacts*. Impacts during construction will be observed.
7. *Waste materials*. Waste materials from drain clearing, concrete reconstruction/rehabilitation, and other activities will demand disposal sites.

Distribution of Benefits

The agriculture benefits to drainage project are complimentary to irrigation development and improvements to agriculture. For Left Bank area the agriculture benefits can generally be classified as under:

- Increase in area and yield due to timely removal of storm water
- Increase in yield due to removal of irrigation surplus
- Increase in cultivated area due to never cultivated land and by reducing in area of seasonally yellow lands
- Reuse of drainage water to augment crop water requirement at the time of stress
- Protection of move able and immoveable property in the project area
- Benefits due to reduction in damages of road network and other important of infrastructure

The storm water damages of 2011 flood amounting to Rs. 200 billion rupees (price level 2011) must be an eye opener for the policy makers and the operators. It is also anticipated that the average increase yield of the cash crops for the project life of 25 years can be 20 to 30 for the present. The expected increase in irrigated area can best estimated at the rate of 5 to 7 % over the life the project.

11.2 Revival of Natural Waterways to Drain out Storm Water

Introduction

In the study area on left bank of Indus SCARP projects like Ghotki FGW Project, SCARP Khairpur, North Rohri FGW Project, South Rohri FGW Project and LBOD Project were constructed. Basically these projects were introduced to check the rising water table and reclaim water logged and salinity affected agricultural lands in the relevant areas. Except LBOD other projects had not been designed for storm water drainage. Fresh water tube wells were pumping ground water directly into field water courses, whereas the saline water from tube wells in SCARP Khairpur was being pumped out through surface drains into Rohri Canal to mix and dilute it with river water in order to make it usable for crops. This was done due to absence of any drainage outlet in project area.

During the unprecedented rains in 2011 ranging from 600 to 1100 mm, following seven districts of Sindh on left bank of Indus suffered tremendous losses due to inadequate storm water drainage systems of LBOD and Badin area and non availability of any drainage outlet in Khipro-Umerkot, Digri, Tando Allahyar and Tando Ghulam Ali areas.

Table-1: Summary of Losses/Damages Due to Rain In Sindh - 2011, Upto 28 November 2011

S. No.	District	Persons Died	Persons Injured	Persons Affected	Houses Damaged	Cattle Head Perished	Area Affected (Acres)	Crop Area Damaged (Acres)
		Total	Total	Total	Total			
1	Badin *	73	10	1,021,301	382,562	10,060	984,805	375,718
2	Mirpurkhas *	60	230	705,151	118,110	12,280	819,833	171,522
3	Sanghar*	39	93	1,237,432	213,928	19,040	927,201	356,473
4	Sh.Benazirabad*	39	82	900,000	200,000	22,646	U.S	290,000
5	T. Allahyar*	3	5	569,829	70,163	197	369,685	81,645
6	T. M. Khan *	17	24	585,411	72,935	187	390,997	78,038
7	Thatta *	18	15	177,758	11,257	131	198,111	164,889
	Grand Total	249	459	5,196,882	1,068,955	64,541	3,690,632	1,518,285

Source: NDMA, November, 2011

Similarly in 2012, unprecedented rainfall to the extent of 150 to 300 mm in a single day occurred in Ghotki, Sukkur and Khairpur districts on left bank of Indus. Losses and damages as reported by Provincial Disaster Management Authority (PDMA) are presented as follows:

Table-2: Summary of Losses/Damages Due To Rain in Sindh, Up to 02 November 2012

District	Deaths	Injured	Persons Affected	Houses Damaged		Villages Affected	Crops Affected (Hectares)	Cattle Head Perished
				Partially	Fully			
Ghotki	34	143	342,300	38,955	11245	3,268	70,582	445
Khairpur	9	8	499,000	15,130	4,070	1,448	43,478	183
Sukkur	NR	NR	NR	11,908 325	325	NR	17,313	27
Total	43	151	841300	54085	15640	4716	131373	655

Source: (PDMA) Sindh

The extreme rainfall events in the year 2003, 2006 and 2011 in lower Sindh and 2012 in upper northern Sindh caused unparalleled loss to the human lives, marooning of settlements, standing crops, livestock, damage to the physical and productive infrastructure, means of communications, displacement of flood affected population and their livelihoods. According to a report of PDMA the

estimated value of damages from the 2011 flood was about Rs.454 billion and the losses of 2012 flood are being evaluated.

Context and Justification (Issues and Options)

These calamities challenged the ability to cope with such catastrophe, and warranted corrective and mitigation measures to avert similar miseries, in the event of reoccurrence of rains of alike magnitude in future. This experience also provided an opportunity to evaluate the performance of the drainage network, need for its strengthening, and to explore ways to offload pressure on the drainage system. This also flagged the need for exploring ways to evacuate storm water from Left over Areas (LOA) like Khipro-Umerkot, Digri, Tando Allahyar, Tando Ghulam Ali, Khairpur South, and Ghotki saline areas presently not served by and connected to any drainage network. Moreover, the existing fresh ground water tube wells installed in Ghoki, Khairpur, North Rohri and South Rohri areas are not suitable to drain out storm water.

The natural flow of storm water was blocked by inadequate sized culverts and bridges on roads; therefore, relief cuts were given to roads like MirpurKhas–Naukot road, Badin-Naukot road, Tando Adam – Hyderabad road, Chamber –TandoAllahyar road, Badin – Sujawal road, Shahdadpur-Tando Adam road, Hala- Shahdadpur road and Badin-Sirani road at several places where flow of water was blocked.

Breaches and illegal cuts made by farmers to the canal distribution network and drainage network for quick evacuation of storm water from cotton, chilies, tomatoes, and sugarcane fields also increased the flow in the drainage network. The irrigation escapes continued to flow during the monsoon rains and played havoc.

Damages were reported to cash crops, orchards, houses and road network due to flooding caused by the encroachments on the alignment of dhoras and blockage of storm water in the towns of Jhudo, Digri, Naukot, Tando Ghulam Ali, Mirpur Khas, Pangrio, Khoski and Badin. The irrigation water of escapes and breaches of the canal network combined with the storm water played havoc with the neighboring Towns and Villages and damaged infra structure in the area.

The existing drainage networks of LBOD and Badin designed for lower runoff according to the rainfall conditions at the time of their construction are unable to drain out the catchment areas under present climatic conditions. The rain-fall pattern in Sindh has been modified due to climate change with the result that extreme events of rain fall have been recorded causing wide spread flooding in the areas and it is expected to continue in future also.

Submergence of main drains like Mirpurkhas Main Drain, LBOD Branch drain and other direct drains out falling at their point of confluence with the Spinal drain occurred due to less working head.

To address these issues, the Consultants evaluated the possibility of employing the dormant *dhora*s to ensure safe disposal of flood waters. To mitigate the situation, revival of the natural water ways is critical. The reactivation of these *dhora*s would not only dispose-off the storm water but will also serve as interceptor drains to check the rising water table. Moreover, the storm water in the *dhora*s can be utilized by the farmers at the tails of deficit irrigation channels after lifting through pumps.

Location

The project is based on the command areas of Ghotki, Sukkur, and Kotri Barrages on left side of Indus River, particularly the areas that are presently not connected to any drainage network. The project area will also include the coastal belt and parts of the Thar Desert where most potential depressions are located. It covers about 9.757 M. Acres of cultivable commanded area (CCA) in the districts of Ghotki, Khairpur, Naushehro Feroze, Shaheed Benazirabad, Sanghar, Matiari, Hyderabad, Tando Muhammad Khan, Tando Allahyar, Badin and parts of Thatta, Sukhar, Umarkot and Tharparkar districts.

The Gross Commanded Area (GCA) and the Cultivable Commanded Area (CCA) of the Barrages and Canals in the study area on left bank of Indus are presented in the following Table 11.2.3. The total

GCA of the three barrages on left bank of Indus is 8.589 M. Acres which includes 1.017 M.Acres of Guddu Barrage, 6.163 M. Acres of Sukhar Barrage and 2.577 M. Acres of Kotri Barrage. Out of the eight main canals on left bank of Indus, Ghotki Feeder, Nara Canal, Akram Wah and Phuleli Canal fall under the administrative control of Sindh Irrgation and Drainage Authority (SIDA) and the remaining four canals are under the administrative control of Irrigation Department, Government of Sindh.

Table-3: CCA/ GCA of Barrages & Main Canals in the Study Area

Barrage	Canal	Canal Classification	Maximum Authorized Discharge (Cusecs)	CCA (M. Acres)	GCA (M. Acres)
Guddu	**Ghotki Feeder**	**Non-Perennial**	**11670**	**0.855**	**1.017**
Sukkur	Khairpur East	Perennial	2550	0.369	0.57
	Khairpur West	Perennial	2150	0.322	0.424
	Rohri	Perennial	16936	2.601	2.667
	Nara	Perennial	13861	2.24	2.502
		Total	**35497**	**5.532**	**6.163**
Kotri	Akram Wah (Line Channel)	Perennial	3770	0.487	0.518
	Fuleli	Non- Perennial	14330	0.929	1.111
	Pinyari	Non- Perennial	10490	0.786	0.948
Total			**28590**	**2.202**	**2.577**
G.Total			**75757**	**8.589**	**9.757**

Output

The main outputs that would be accomplished include:

Revival of Dhoras

- Activation of Dhoro Puran from Mirpur Khas up to Shakoor dhand.
- Activation of Sohni dhoro from Shahdadpur to Mirwah Gorchani.
- Activation of Bhai Khan dhoro from Tando Allahyar to Pangrio
- Construction of dhora bypasses for Dighri, Jhuddo, Tando Ghulam Ali and Naukot towns.
- Activation Hiral escape/ Pithoro Dhoro, Hakro Dhoro & Naro (Nabisar) Dhoro.
- Activation of Sarfaraz (Digri) Dhoro, Pangrio, Khairpur Gumbo & Roshanabad dhoras
- Activation of Khairpur South dhoras
- Activation of Ghotki dhoras
- Activation of Miranpur-Bachal Rahu Dhoro, Kandiaro-Moro Dhoro

Leftover Areas (LOA)

- Construction of surface drains in T.Adam, T.Allahyar, T.M Khan and T.G. Ali area
- Construction of surface drains in Dighri area
- Construction of surface drains in Umerkot, Farash and Khipro area
- Construction of surface drains in Khairpur South area

- Construction of surface drains in Ghotki area.

LBOD Escapes

- Construction of 3X Escapes on LBOD i/c Side Weirs and Link Channels to offload 1000 cusecs through each escape to dhoras.

Project Impacts

The overall impacts would be improved drainage network with sustainable irrigated agriculture and improvements in hygienic conditions in the health sector and productivity. By growing high value food crops economic status of rural populations can be improved and there would be increased opportunities for employment as new industries may develop in prosperous areas. Some of the positive impacts are:

- Facilitate early evacuation of storm water flows from crops and settlements;
- Reduce the flood pressure on the existing drainage networks of LBOD and Badin by offloading storm water from LBOD Spinal at three locations before reaching in Badin area;
- Increase agricultural production by way of improving crop yields and cropping intensities.
- Reduce losses to infrastructure like roads, canals and drains by diverting major quantity of storm water to natural routes i.e. dhoras.
- Improve environmental conditions in the area.
- Minimize loss to properties, human lives, crops, livestock, poultry and fish farms;
- Avoid submergence of structures and back flow in sub drains and branch drains;
- Intercept the rising water table by round the year flow in dhoras;
- Provide drainage to five leftover areas on the left bank of Indus;
- Protect the settlements with bypasses where critical;
- and Harvest flood water by storage in the natural depressions where ever possible.

Financial Outlay

The indicative cost for activation of the natural waterways and proposed drainage networks in leftover areas is estimated at Rs. 44 billion. The outputs mentioned above include the emergency works, such as: channelization of the dhoras, provision of bypasses where urgently needed, clearance of encroachments and land acquisition, and increasing the capacity of existing structures where ever possible. The emergent works have already been commissioned and are to be completed by end of the year 2012.

Implementation Period and Arrangement

In view of urgency due to unexpected heavy rainfall during last two monsoons of 2011 and 2012 in southern and northern Sindh respectively, the overall time period for this intervention has been restricted to eight years from 2011 through 2020. The detail of financial year (FY) wise expenditure on major activities, including emergency works is presented in Table 4 below.

Table-4: Indicative Cost Estimates for the Revival of Dhoras including bypasses (Rs. Millions)

S.No	Main Outputs	2011/12	2012/13	2013/14	2014/20	Total
	Revival of Dhoras					
1	Activation of dhoras, Puran upto Shakoor dhand, Sohni dhoro & Bhai Khan dhoro and bypasses of Mirpurkhas, Jhuddo,	65	615	1,320	16,409	18,409

S.No	Main Outputs	2011/12	2012/13	2013/14	2014/20	Total
	Tando Ghulam Ali					
2	Activation & Restoration of pocket drains along Hiral escape/ Pithoro Dhoro, Hakro Dhoro & Naro (Nabisar) Dhoro i/c Naukot bypass	30	180	200	4,303	4,713
3	Activation of Sarfaraz (Digri) Dhoro, including Digri bypasses	7	27	271	286	591
4	Excavation and revival of Pangrio, Kh' Gumbo & Roshanabad dhoras	-	-	-	703	703
5	Excavation and revival of Ghotki dhoras	-	-	-	2,160	2,160
6	Excavation and revival of Khairpur South dhoras	-	-	-	3,057	3,057
	Leftover Areas					
7	Construction of surface drains in T.Adam, T.Allahyar, T.M Khan and T.G. Ali area	-	-	-	4,668	4,668
8	Construction of surface drains in Digri area	-	-	-	1,149	1,149
9	Construction of surface drains in Umerkot, Farash and Khipro area	-	-	-	5,080	5,080
10	Construction of surface drains in Ghotki area	-	-	-	2,111	2,111
11	Construction of surface drains in Khairpur South area	-	-	-	434	434
	LBOD Escapes					
12	Construction of 3X Escapes on LBOD i/c Weirs and Link Channels	-	-	-	490	490
	Grand Total	**102**	**822**	**1,791**	**40,850**	**43,565**

The project works are to be executed through competitive bidding by inviting International and National civil construction firms ensuring full transparency. The construction works are to be supervised for both quality and quantity through renowned international and national Consultants.

Monitoring Framework

It is imperative to monitor the performance of drainage system in leftover *areas* on continuous basis by installing staff gages at control points. The rating tables shall be formulated and updated after every flood season by the O&M staff. Permanent gauges shall be installed and observed regularly at outfall point of each dhoro and at Shakoor Dhand in addition to the outfall points of drains into dhoras. The depth to water table throughout the left bank area shall be observed before and after each crop season for which SMO WAPDA has already developed an extensive network of observation points like piezometers and tube wells. As the storm water coming into the dhoras is to be utilized for agriculture purpose by the farmers of deficit tail reaches of irrigation channels, it should be pollution free. A number of Sugar Mills and other industries are operating in the command area of drainage networks and are adding highly toxic effluent into drains. They should ensure at source treatment of industrial effluent before it is discharged into the drainage network. In addition to this environmental monitoring will be required during construction and maintenance phases of the project on regular basis through an environmental monitoring cell to be established in the SIDA. The maintenance works of the drainage infra structure and dhoras shall also be monitored for discharge capacity and structural safety. The changes in the ground water level and quality of storm water in drains and dhoras shall be determined to develop a data base for monitoring the level of the ground water and reuse of storm water.

The full benefits of drainage networks can only be achieved if proper management of irrigation system is implemented. There is a potential risk that at field level, the farmers may be encouraged by the drainage system to be wasteful with water. The drainage benefits may decrease gradually due to poor management and maintenance.

Due Diligence

The operating agencies responsible for O&M of drainage networks shall ensure the following actions after the forecast of very high storm:

All the storm water drainage systems of the Left Bank are unregulated, and so are not subject to good water management during the passage of floods.

Canal supplies shall be stopped as early as possible keeping in view the distance of Head Regulator from the region to be affected by extreme rainfall event.

Base flow from tube wells and irrigation water from canal escapes shall be completely stopped to allow the full drain / dhoro capacity to be used for storm water drainage.

Gauge readings at major control points in the drainage networks of leftover areas and on dhoras including Spinal drain shall be monitored on hourly basis, to adopt precautionary measures in time.

Vigilant patrolling of the drains and dhoras shall be carried out to stop unauthorized relief cuts by farmers and to identify the vulnerable points if any. Relief cuts given by farmers create hindrance in the movement of machinery and staff in the event of an emergency.

All the required machinery shall be repaired and mobilized to vulnerable points of the system to meet an emergency.

Before releasing the base flow into the system after passing the storm water, the banks and allied structures on drains/ dhoras shall be inspected for rain damages and rain cuts and all urgent remedial / repair works shall be completed.

Sufficient funds and resources including manpower and machines shall be made available to Operating Agency for efficient handling of emergent situation.

Reliable and timely information about extreme rainfall events shall be provided to relevant Operating Agency to avoid loss to standing crops due to longer periods of canal closure.

Budget provision for storm emergency shall always be made in the yearly plans and re appropriated in development works if no extreme rainfall event occurs by 30th September every year.

Flood / storm information system in Operating Agency shall be improved for quick communication from Head of Agency to the lowest rank.

Technical Feasibility

Originally the LBOD surface drainage system was designed for a runoff based on five years return period and five days evacuation period keeping in view the frequency of rainfall at that time. Since the year 2003 the climate cycle has changed and extreme events of rainfall have occurred in lower Sindh during the years 2003, 2006, and 2011. This phenomenon has now extended to the northern part of Sindh where unprecedented rainfall to the extent of 300 mm occurred in a single day in the year 2012. The losses and damages caused by the storm of 2011 and 2012 have been mentioned earlier in this Report.

The changed climatic conditions have necessitated to review the storm drainage capacity of existing surface drainage systems and to provide drainage to leftover areas where no surface drainage has been provided so for. Earlier the WAPDA consultants in their report had proposed to raise the banks of Spinal Drain by 2.0 ft. above the last designed water level. Although this option will avert the overtopping of Spinal drain and will thus reduce the flood damages to some extent. However there is potential risk of submergence of structures and back flow in few drains including Mirpur Khas Main drain and LBOD Branch drain. The deck slabs of bridges can be lifted to the new level but water course and canal aqueducts feeding the lands on either side of drain cannot be raised due to technical grounds. To overcome this problem the possible solution appears to be the offloading of excess storm water coming from upper reaches, to natural waterways / dhoras. As such, three side weirs are proposed at RD 578, RD 336 and RD 212 of Spinal drain to offload storm water coming from S.Benazirabad Sanghar and Mirpur Khas areas. About 1000 cusecs will be offloaded at each escape weir and will be sent through link channels to nearby dhoras.

Similarly, the storm water coming from the proposed surface drainage systems of Left Over Areas shall be drained out through natural waterways / dhoras passing through respective areas.

Moreover, it is proposed that MMD presently out falling into Puran Dhoro at RD 29 should be separated from Puran Dhoro to outfall into Spinal Drain at RD 295 to send its polluted effluent into the sea. The Puran Dhoro which was cut off from its natural route shall be allowed to underpass

Spinal Drain through a siphon and follow its original path to Shakoor Lake. By this arrangement about 2000 to 3000 cusecs of storm water will be offloaded from Spinal Drain. After offloading 5000 to 6000 cusecs of storm water from Spinal drain it is expected that submergence of structures and back flow in drains would be reduced to a great extent.

Economic Justification

With the passage of time and execution of development works the natural waterways which used to provide storm water drainage in Sindh, have been completely blocked by inadequate or none crossing structures, roads, railways, irrigation canals and even surface drains. Generally, shorter reaches on all dhoras have been filled up and are being utilized for crop cultivation. Also fish ponds have been established in few non operational reaches of dhoras. However, the Government of Sindh has recently enacted legislation in this regard, and it needs to be enforced and complied with. It appears that after the unprecedented rainfall events of 2011 & 2012 there is strong political will to activate the natural waterways /dhoras to drain out storm water.

Table-3 indicates that a maximum of 75,757 cusecs of water are drawn from Indus River through eight major canals off taking from three barrages, which irrigate 8.589 M.Acres of land on left bank of Indus. Roughly one third of irrigation supplies to crops percolates through soil and is added to underground water. Consequently the ground water level (water table) has gone up and created water logging and salinity problems on the left bank of Indus. This problem has been further aggravated by heavy rainfall events due to global climate changes combined with inadequate or no drainage network in most of the areas.

In view of foregoing, it is imperative to provide drainage network to Leftover Areas by activation of dhoras and improve the efficiency of the existing drainage systems to sustain irrigated agriculture and economic activity in the study area.

Social Safeguards

Environmental social impact have been study by the Consultants in detail by conducting interviews with the farming community and other people living in the vicinity of the project especially in the natural water way areas of the Left Bank. The drainage system existing in the area is fairly sustainable and with the anticipated improvements at outfall conditions and with increased capacity of drainage network will have major positive impacts and no major adverse environmental impact are anticipated in respect of habitat, cultural heritage. The proper storm water disposal would protect the cropped area and minimize damages to standing crops.

The World Bank Project Appraisal Document (2007) refers to the WB Safeguard Policies to be followed. Among the ten policies, five were originally selected by the Bank and are commented below.

World Bank Safeguard Policies

Safeguard Policies Triggered by the Project	Yes	No
Environmental Assessment (OP/BP 4.01) Environmental assessment of civil works of the natural water ways will be conducted according to the procedures described under Environment Impact Assessment & Environmental Management.	✓	
Natural Habitats (OP/BP 4.04) Natural habitats will be restored to the natural state.	✓	
Pest Management (OP 4.09) Natural water ways by itself will have no effect on the pest management	✓	

Safeguard Policies Triggered by the Project	Yes	No
safeguard.		
Cultural Property (draft OP 4.11 – OPN 11.03) No cultural property will be disturbed in natural water ways.		✓
Involuntary Resettlement (OP/BP 4.12) Resettlement will take place in the activation of the natural water ways. The details of resettlement action plan are given in the appendices.	✓	
Indigenous Peoples (OD 4.20)		✓
Forests (OP/BP 4.36)		✓
Safety of Dams (OP/BP 4.37)		✓
Projects in Disputed Areas (OP/BP/GP 7.60)		✓
Projects on International Waterways (OP/BP/GP7.50) The storm waters drained by Dhoro Puran and the storm waters conveyed by DPOD will eventually discharge in Shakoor Dhand, which is a natural lake shared between Pakistan and India. The existing drain, DPOD already discharges storm water into Shakoor Dhand. The polluted waters are being controlled by a 9 feet weir at the head end of DOPD. Dhoro Puran should also convey only storm water, which contains no pollution.	✓	

General Description of the environmental impact

The **rehabilitation works** consist of reshaping the natural water ways and in some reaches widening/reducing the embankments; strengthening/rehabilitating the bridges; reconstruction of aqueducts; rehabilitation/reconstruction of inlets. The **likely direct negative impacts** on the environment are:

1. *Construction camp*. Construction camps include workers' living and eating areas; mechanical workshop; equipment parking and; construction materials storage/stockpiling.
2. *Workshop and fuel servicing.* Transport, handling and storage of petroleum products.
3. *Site preparation and clearing*. Site preparation, clearing of vegetation, temporary rerouting of traffic, topsoil stripping, and diversion or re-channeling of waterways.
4. *Earthworks*. Removal and placement of earth. Construction machinery moving around the ROW and work sites compact the lands changing the soils structure.
5. *Quarries and borrow sites.* Borrow for earth fill on IPs and aggregates for the fabrication of concrete will demand quarries and borrow sites.
6. *Air quality and noise impacts*. Impacts during construction will be observed.
7. *Waste materials*, Waste materials from drain clearing, concrete reconstruction/rehabilitation, and other activities will demand disposal sites.

Distribution of Benefits

The agriculture benefits to drainage project are complimentary to irrigation development and improvements to agriculture. For Left Bank area the agriculture benefits can generally be classified as under:

- Increase in area and yield due to timely removal of storm water

- Increase in yield due to removal of irrigation surplus
- Increase in cultivated area due to never cultivated land and by reducing in area of seasonally yellow lands
- Reuse of drainage water to augment crop water requirement at the time of stress
- Protection of move able and immoveable property in the project area
- Benefits due to reduction in damages of road network and other important of infrastructure

The storm water damages of 2011 flood amounting to Rs. 200 billion rupees (price level 2011) must be an eye opener for the policy makers and the operators. It is also anticipated that the average increase yield of the cash crops for the project life of 25 years can be 20 to 30 for the present. The expected increase in irrigated area can best estimated at the rate of 5 to 7 % over the life the project.

11.3 Protective Plantation of Mangroves in the Coastal Areas of Left Bank

Background and Rationale

This feasibility has taken its cue from the issues and problems and respective interventions identified, proposed, and prioritized by the stakeholders in consultative workshops held during phase 1 of the study at community, district, regional, and national levels and pre-feasibilities prepared and discussed with the stakeholders during phase II.

Thatta and Badin are the two major hazard-prone districts of Sindh. Cyclones, heavy rainfall, droughts and floods follow each other often in quick succession. The intervening respite is normally short. Major disasters in the recent years include the cyclones in 1964/65, heavy rainfall in 1973, floods during in 1988, torrential rainfall in 1994, the cyclone in 1999, an earthquake in 2001, severe floods in 2003 and recent floods in 2010 and heavy rainfall in 2011.

Above events have resulted in several multidimensional issues and the problems in the delta and coastal area. It has been established that the resources of coastal areas such as mangroves, fisheries, and agriculture on which the people of the area are dependent for their livelihood have been adversely affected and become scarce. This has resulted in variety of social and economic problems in the area and its population. Mangroves are no longer there as they were vanished during 1999 cyclone, freshwater fisheries have declined due to sea intrusion in the existing dhands thereby converting freshwater areas to brackish water areas and, agricultural area have been adversely affected by water logging and salinity due to poor drainage and sea intrusion.

Project Objectives

The proposed project/intervention titled, **"Protective Plantation of Mangroves in the Coastal Areas of Left Bank"** is non-structural. The main objective of the project is to provide protection to the coastline and the delta ecosystems ensuring sustainable livelihoods to the local communities. The project has been so designed that it would create a biological screen, protect the lower reaches of the drainage system, engineering structures, farmlands, wetlands/water bodies and arrest coastline erosion and sea water intrusion. In addition, the proposed intervention will support fish production, provide fuel wood and fodder to local communities, and improve their livelihoods. The establishment of mangrove plantation is also in line with the CDM initiatives, and will act as carbon sink.

Project Location

The project will be located in coastal area of district Badin and Thatta district (left bank of Indus), comprising of coastal Talukas (sub-districts) namely Badin and S.F Rahu of Badin district and Jati and Shah Bander Talukas of Thatta district where potential areas/mudflats will be identified.

Issues and Problems

The main issues are:

i) Unchecked sea intrusion
ii) Degradation of dhands.
iii) Inadequate public sector support for mitigating natural disasters
iv) Increasing coastal erosion
v) Deforestation of mangroves.
vi) Decline in fish resource
vii) Inadequate livelihood opportunities.

Project Outputs

The main outputs/targets of the proposed intervention are:

- Establishment of container plant nurseries **(11.0 million mangrove plants)**
- Mangrove plantation on blank mudflats in the frontage of sea and backwater **(28,000 ha)**
- Plantation of mangrove belts along the wetlands and tidal link and salt tolerant species in supra tidal zone and around the perimeters of wetlands and bunds **(5000 ha)**

Avicennia marina, *Rhizophora mucronata* and other species of mangroves will be planted.

Mangroves habitat and environment functions are critically important to the delta ecosystem. Mangroves play a key role in combating natural and man-induced hazards in coastal areas. They act as first defense line against the waves in tsunami and cyclones. Mangroves help impede the unwanted flow of saltwater and with their extensive root systems also supports in reducing the disaster risk of sea intrusion in the coastal belt. Absorb excessive amounts of nutrients and contaminants. Under such circumstances the mangroves are capable of mitigating potential impacts of coastal hazards such as storms surges, tsunami and other types of flooding.

This feasibility offers a proposal to revitalize the mangrove plantation along the coast which is one of the most critical and complex coastal ecosystem severely threatened due to over exploitation, constrained fresh water flows, and disposal of industrial pollutants and drainage effluent.

Project impacts

The main impact of the proposed project will be:

i) Reduction in the coastal erosion and seawater intrusion and backwash, and further degradation of fertile land
ii) Enhanced fish production in the wetlands and dhands
iii) reduction in damages from cyclones/tsunami
iv) Reclamation of productive lands in the coastal area
v) Secured livelihood for the local communities
vi) Improved environment through carbon development mechanism.

Project Cost

The total estimated cost of the project is Rs.749.085 million. The estimates of costs are based on existing rates being used in the development projects on mangroves plantation in coastal areas of Sindh. The implementation period for the proposed project is five years.

Implementation Arrangements

The proposed project will be implemented through participatory approach by involving all stakeholders from project preparation, execution, and benefit sharing. Due to participatory approach the local communities will be involved from initial stages of project development, survey, selection of sites, planting, maintenance, protection, and distribution of benefits.

Efforts will be made to solicit bilateral and multilateral funding support from the development partners. Mangrove development initiatives are Clean Development Mechanism (CDM) projects which are usually funded from allocations made to member countries of international protocols such as Kyoto Protocol, MFF, CBD, WSSD, UNFCC, REDD etc. Pakistan is signatory on all above listed UN Protocols. The Government and International Donors and NGO and development organizations will also join to fund and execute this project. Mangroves are the carbon sinks and improve adverse environmental impacts due to climate change.

Financial and Economic Evaluation

The preliminary financial internal rate of return (FIRR) of the proposed project is 16.8%. The net present worth of benefits at 12% is Rs.833.9 million, and for cost is Rs. 1,219.4 million. The cash flow NPV at 12 % is Rs. 385.5 The benefit cost ratio is 1.5.

The preliminary economic internal rate of return (EIRR) of the proposed project is 18.2 %. The net present worth of benefits at 12% is Rs.750.5 million, and for cost is Rs. 1,219.4 million. The cash flow NPV at 12 % is Rs. 468.8 The benefit cost ratio is 1.6.

Environmental Benefits

Mangrove Forests provide environmental services through many ways. Protect shoreline from storm surges, cyclones and other extreme weather events, trap pollutants and reduce the effects of flooding, check sea intrusion and reduce its adverse impacts, protect structures (tidal link, bunds etc.), improve

fish habitat in wetlands and mangrove areas, prevent soil erosion, serve as carbon sinks and store of biodiversity, improve landscape beauty and, provide several ecosystem services. The project being developed under CDM will generate carbon credits which will be owned by the Government and will be used for other CDM projects. Hence, the project has several environmental benefits and is environment friendly project.

Social Benefits

The proposed project will have positive impacts on the social aspects of the society such as poverty, income distribution, employment generation, livelihood opportunities and gender mainstreaming. With the development of this project and its execution through integrated and participatory approaches the coastal people will be mobilized, organized and act as executing team will get direct and indirect employment and sources of livelihood which will ultimately alleviate poverty and distribute benefits equitably. Furthermore, the communities will own the project. Women will also be involved in all the processes of the project.

Resettlement Issues

No resettlement will take place as the project will be implemented on the government forest land.

11.4 Use of Drainage Water for Forestation in LBOD Area

Background/Rationale

Analysis of the forests during the process of consultation in phase – I and literature review revealed that these forests and farmland plantations have been degraded/depleted due to variety of social, economic and environmental problems. The degradation is pronounced in the form of their area, species composition, productivity, ecosystem functions and environmental services. The crux of degradation of tree resource in the area is pronounced

i) Deforestation/overcutting /depletion of trees from forest and farmlands.

ii) Degradation of forest and agro ecosystems iii) Decline in productivity & composition of forest and farmlands.

iii) Shortage of tree resource and associated services.

iv) Lack of participatory approach and coordination

v) Decline in per ha vegetation cover

A common issue/problem for establishing new forests, maintenance of existing ones and farm plantations is the scarcity of irrigation water from river, canals, distributaries and water courses due to overall shortage of water in the systems. The drainage water of drainage systems outfalls into Arabian Sea either directly or through LBOD and Kotri drainage systems. The quality of this water is such that it could be used for tree plantations by diverting from nearby drains to nearby forests and farmlands. Researches carried out indicate that drainage water is useful for tree species.

The option for improving the above scenario is to explore the sources of irrigation water to supplement the shortages of canal irrigation. One of the options is to use the drainage water of drainage systems in conjunctive or cyclic forms. Accordingly, a pre-feasibility titled, "Conjunctive/Cyclic use of drainage water for forestation on government forest lands and private farmlands in LBOD and Kotri surface drainage command area" was prepared. The drainage water will either be mixed with available irrigation water for the particular area or used in cyclic form i.e. supply canal water for certain number of irrigations and then supply drainage water of acceptable quality for other irrigations.

After technical evaluation and stakeholders' inputs during phase II this project has been considered feasible thus, a feasibilit**y/project** titled, "Use of Drainage Water for Forestation in LBOD Area" has been proposed and discussed with the stakeholders in workshops, meetings, and field visits.

The proposed intervention is Non-structural. No any structure is proposed in this intervention. Option pertains to tree plantation on forest lands and private farmlands by supplementing fresh water with drainage water for combating deforestation, improve environment, provide alternate use of drainage/storm water, enhance green infrastructure, proper land use, and improve tree/forest resource.

Project location and boundaries

The proposed project is located in two geographic areas namely i) LBOD command area located in Shaheed Benazirabad, Sanghar and Mirpurkhas districts and ii) Kotri Surface Drainage System located in Thatta and Badin districts.

Project Scope and objectives

The scope of the proposed project is to address the issues and problems responsible for degradation of forests through potential options and solutions so as to improve the vegetative cover in the inland forests owned by the government and on the private farmlands by supplementing drainage water of LBOD and Kotri drainage areas with canal irrigation water. The objectives of the project are: To combat deforestation through tree plantation, To explore alternate use of drainage/storm water for growing forests and reduce water shortage, To improve productivity of degraded lands, To improve tree resource on government forest lands and private farmlands, To supplement irrigation water shortage, To enhance green infrastructure to promote biological drainage and To improve environment through carbon sequestration

Specific outputs of project

The expected outcome, outputs and deliverables of the proposed intervention will be in the form of

i) Best alternate use of drainage water.

ii) Utilize drainage water for improving natural resources.

iii) Reduce pressure from LBOD drainage system at the tail end by reducing downward flow of drainage water.

iv) Reduce water logging and salinity in degraded lands.

v) Help improve the irrigation water shortages.

vi) Improve livelihood of farming community.

vii) Arrest desertification process.

The physical targets of the proposed project are as under

Raising of nurseries for forestation	15.0 million seedlings
Forest Plantations	5,000 ha
Forestry on farmlands through Social Forestry	3,000 ha

Implementation Arrangements

The project will be executed by the Sindh Forest Department over a period of 5 years. The total cost of the project is estimated as Rs. 270.0 million.

The approach for implementation of proposed project will primarily be participatory. The government land owners (Forest Department), Sindh Irrigation Department, Sindh Irrigation and Drainage Authority, private farming community and local civil society organizations/ communities are the major stakeholders for this intervention. All of them will be taken on board from planning, execution, monitoring and evaluation and operation and maintenance.

The project will use the social forestry/farm forestry tools in its approach and methodology for implementation.

Implementation Approach

1) Site identification and Selection

Prior to implement the proposed implementation the sites will be selected in consultation with the stakeholders i.e. Forest Department for forest lands and concerned farmers/landowners for private farmlands. Following broad criteria will be followed:

- The area to be planted should be located closer to drainage system.
- The area to be planted should be located closer to irrigation channel and should have a water share from that water channel.
- In order to utilize the water from both the sources in conjunctive or cyclic form the concerned stakeholders should show his willingness to afforest that area.
- The proposed area should be degraded but not completely waterlogged.
- It will be better to afforest the areas clusters of farmlands will be identified and the farmers jointly show their willingness to use drainage water and irrigation water allocated for that land.
- The farmers shall formulate a CO to execute the proposed intervention, decide roles and responsibilities and other aspects of intervention.
- The CO should be willing to spend some money for excavation of water courses separately for drainage and irrigation waters and their O & M.

- The project will only pay for supply of drainage water at source through construction of an outlet and if required lift machines to release drainage water from drains.
- Land development, planting, restocking, irrigation within farm, protection and aftercare will be the responsibility of individual farmers.
- Technical assistance and extension services will be provided by the concerned departments namely Forests, Irrigation, and SIDA.
- For forestation on forest lands almost same criteria for site selection will be observed except that the department is the sole owner of the area to be afforested through proposed techniques. The area closer to drainage systems will be identified.

2) Method of irrigation

a) **Conjunctive Use**

Conjunctive refers to mixing of irrigation and drainage waters to the areas for tree plantations. The irrigation water will be sweet water and the drainage water will be saline quality. In order to utilize drainage water for forestation both the waters will be mixed in required quantities to reduce salinity level of brackish water to sustain tree growth.

b) Cyclic Use

Cyclic use refers to use of irrigation and drainage waters to the areas for tree plantations in separate irrigations i.e. applications of one or two irrigations of sweet water from irrigation channels and another one or two irrigations of saline water from drains. The irrigation water and the drainage water will be applied in alternative form for forestation. In order to utilize drainage water for forestation both the waters will be used in required quantities to sustain tree growth and mitigate environmental problems.

c) Choice of Species

The tree species proposed for forestation in the project are: *Acacia nilotica, Albizzia lebbek, Casuarina equisitifolia, Eucalyptus camaldulensis, Leucaena leucocephala, Parkinsonia aculeate, Prosopis cineraria, Prosopis juliflora, Sesbania bispinosa, Sesbinia sesban, and Tamarix aphyll.a.*

Project Benefits

The proposed methods of irrigation will best utilize the drainage effluent for forestation and also meet the shortage of irrigation water from canals. Above all, the environment of the area will improve and the degraded and unproductive lands will be brought back to productive lands which will ultimately increase tree resource, combat deforestation, improve livelihood and alleviate poverty.

Environmental Benefits

The proposed project is environment friendly on the grounds that it will not have any adverse impacts on any green infrastructure of the areas, will utilize the drainage water for growing trees and crops, will improve degraded lands and increase their productivity and will improve the physical and chemical structures of the degraded soils.

Financial and Economic Evaluation

The financial analysis was undertaken for all the production parameters i.e. grasses, fuel wood, small construction wood and industrial wood, at an aggregated output level. The project viability was assessed for the project as whole. The overall FIRR for the project is 16.8%, while the NPV for the cost at 12% is Rs. 306 Million and NPV for the incremental benefits is estimated Rs.399 million. The cash flow benefits NPV @12% is Rs.94 Millions. The cost benefit ratio of the project is 1:1.31 on overall basis.

The economic analysis was undertaken for all the production parameters i.e. grasses, fuel wood, small construction wood and industrial wood, at an aggregated output level. The project viability was

assessed for the project as whole. The overall EIRR for the project is 18.6%, while the NPV for the cost at 12% is Rs. 306 Million and NPV for the incremental benefits is estimated Rs. 399 million. The cash flow benefits NPV @12% is Rs.122 Millions. The cost benefit ratio of the project is 1:1.31 on overall basis.

Social Benefits

The proposed project will have several socio-economic benefits for the society as under:

- Enhance productivity of lands in the form of food, wood, fodder and fuel.
- Provide livelihood opportunities to farm holders and associated workers through employment opportunities.
- Increase overall economy of the area by improving the productive capacity of degraded and unproductive lands.
- Livestock and wildlife will get improved grazing areas and habitats, respectively.
- Agricultural and livestock outputs will improve socio-economic status of farming community and associated stakeholders.
- The knowledge of use of drainage and sweet water in conjunctive/cyclic form will transfer the technology from scientific community to rural agrarian society.

Resettlement Issue

The project will be implemented on the private farm lands with the consent of the farm owners, thus will not require any resettlement.

11.5 Rehabilitation of Deh Akro II and Chotiari Wetland Complexes

Background and Rationale

Wetlands are the storehouses of globally endangered biodiversity of flora and fauna because of their extensive and rich food webs and biodiversity. There is great reliance on the wetlands as they are the main source of livelihood to the poor communities. Wetlands are ecosystems that provide numerous goods and services that have an economic value, not only to the local population living in its periphery but also to communities living outside the wetland area. Furthermore, wetlands also provide recreational opportunities and amenities, and flood control and storm buffering. Wetlands also provide a range of ecosystem services, including ground water recharge, flood control and water purification and also eco-tourism.

There are nineteen (19) wetlands declared as Ramsar Sites in Pakistan, nine are located in Sindh province of which six are situated on the left bank of Indus namely, Deh Akro, Nurruri lagoon, Jubbo lagoon, Runn of Kutch, Indus delta, and The Indus Dolphin Reserve. They have gained importance due to their unique biodiversity and habitat which shelters large number of species.

There are three important wetland complexes located on the left bank Indus in Sindh, the study area, namely Deh Akro II, Coastal wetlands and Chotiari reservoir and wetlands located in Shaheed Benazirabad, Badin and Sanghar districts, respectively. Deh Akro II and some wetlands of coastal wetlands are declared as Ramsat Sites under UN Wetland Convention at Ramsar, Iran.

Chotiari wetland complex extends over 20,243 ha and includes about 36 lakes, of which five are freshwater and 31 brackish water, fed by seepage from the Nara Canal and its Jamrao offshoot. Located in a typical stable sand desert habitat, the lakes occupy flat bottomed valleys surrounded by 5 to 10 m high sand dunes.

Deh Akro II is wildlife protected area and declared as Ramsar site under UN Convention on Wetlands. It consists of four major habitats; desert, wetland, marsh and agricultural. It is a natural inland wetland ecosystem, which supports a variety of rare and endangered wildlife species. This area hosts a considerable number of rare fauna. Many indigenous fish species are also found. Water scarcity during a persistent dry spell is adversely affecting the area. There are 36 wetlands forming a complex and having pre-dominant wildlife species of Crocodiles. This area is managed by Wildlife Department, Government of Sindh.

Issues and Problems to Wetlands

Wetlands are threatened by variety of factors both in the coastal zone and inland. Lack of proper management and ignorance of the importance of healthy wetlands are the primary causes. The stakeholders during the consultative workshops have identified the following issues and problems:

In Deh Akro II the major issue in this area is the shortage of water required for the survival and growth of wildlife species. At some times of year, especially during drought periods some wetlands get dried causing serious threat to the wildlife species available in these wetlands. Another issue in this wetland complex is the inadequate protection of wildlife from people for hunting and predators.

In Chotiari Wetland Complex there are two components of this complex viz. Chotiari Reservoir and Chotiari Wetlands. The entire area is managed by Irrigation Department, Government of Sindh for irrigation purposes. With the construction of Reservoir there is a serious problem of seepage through its earthen banks creating waterlogged conditions in the adjoining agricultural fields mostly privately owned. Stakeholders during consultations identified serious issue of waterlogging done by the reservoir and emphasized on its control through appropriate structural or non-structural measures.

Project Location

Deh Akro II is located in the desert area of district Benazirabad and about 30km east of Nawabshah City. The Chotiari Reservoir is located in District Sanghar and about 20km East of Sanghar City.

Scope and objectives of proposed Project

The principal objectives of the proposed project are as under:

1. To address the issues identified by the stakeholders for both the Wetland complexes such as provision of water to make the wetlands alive and productive, check seepage from reservoir to halt waterlogging, and provide assured protection to biodiversity available in these wetland complexes.
2. To formulate a Regional Wetland Management Strategy in the province of Sindh to ensure development of plans and manage the wetlands on scientific lines.

Proposed Activities / Solutions

1) Preparation of Regional Management Strategy/Restoration Strategy

The plan has two components: a Regional Management Strategy (Management Plan Restoration Strategy, including an outline of the studies to be undertaken in order to design a proper restoration and management plan for each wetland in Sindh) and three Action Plans (restoration options for three wetlands: Deh Akro, Chiotari Reservoir, Dhands and Tidal Link).

Within the Regional Strategy, each section will have two parts: one part describing the section's topic at the level of the Sindh province, one part describing this topic locally for each of the wetland complexes.

2) Regional Management Strategy

Management Plans aim to establish and maintain the sustainable use and development of the resources of wetland areas so as to improve quality of life, maintain biological diversity, productivity and quality of the concerned wetlands, through efficient and integrated management. For achieving this, long term vision and planning is necessary, and this is why the planning cycle is organized around "time loops".

3) Site-Specific Action Plans

The second component of the Regional Management Plan includes three Action Plans for three of the main wetland complexes found on the Indus River left bank in Sindh (Deh Akro, Chiotari, Dhands). The Action Plans (corresponding to the "Restoration and management strategy" subcomponent in the Regional Strategy tree) include:

- Structural measures
- Non-structural measures
- Socio-economic aspects
- Knowledge gaps – validation studies to be undertaken

Proposed Solutions for Deh Akro II

Ideally, the original water supply should be restored in order to avoid the environmental and economic negative effects of lakes drying out. In reality, this will probably be impossible. What could be possible however would be to provide the complex with just enough extra water to prevent the lakes from completely drying out and allow them to sustain life on a year-round basis.

Both structural and non-structural measures are hereinafter suggested. Structural measures concern the construction of an underground pipe linking the Nara Canal to the head lake(s) as illustrated by Fig. 9. This pipe would be only a few kilometers long (depending on local topography and natural slope), and its diameter should be wide enough to allow a strong flow to pass through. The idea indeed would be to open the connection between the canal and the pipe only during peak flow time in the Nara Canal.

This would allow avoiding two potential problems linked with diverting water from the Nara Canal through a pipe. The first is general water availability for irrigation downstream. Diverting some water during peak flow only should avoid creating water shortages downstream. The second is the danger

that the pipe gets clogged by siltation. Having only high speed flows in the pipe should allow it to keep itself free of deposits.

Non-structural measures concern dredging of the shallowest lakes in order to restore their storage capacity and resilience to droughts. This will depend on local orology and of dune stability in the immediate surroundings of the concerned lakes.

Proposed Solution for Chotiari Reservoir

Two options are suggested with two different structural measures, depending on the depth reached by underground seepage water. A complementary non-structural measure is also presented to improve the efficiency of the structural measures.

The first structural measure would consist in digging moats along the western and southern embankments of the reservoir. These moats would intercept seepage water before these can reach farmland areas. The alternative structural measure would be to create a grid of surface drains that would prevent the topsoil from becoming waterlogged or even flooded.

Implementation Arrangements

Deh Akro II is presently being managed by the Sindh Wildlife Department. The proposed project will also be implemented through this department and the local communities residing around the Deh Akro II Wildlife Complex. Chotiari Reservoir Complex is presently being managed by the SIDA. The activities proposed are of technical nature, thus will be implemented by the Government of Sindh through SIDA.

Proposed Monitoring Plan

Ideally, overall monitoring of the Regional Wetland Management Strategy should be done by the Regional Wetland Committee, if recommendations made under "Institutional context", are implemented. It should include people with expertise in:

- Institutional strengthening
- Legislative consolidation (environmental law)
- Wetland ecology
- Hydrogeology
- Sociology
- Rural Economy

And it should be able to rely on inputs by field teams (an ecologist and a social specialist) regarding site-specific management plans.

The proposed solutions will not have any negative environmental and re-settlement issues.

Project Justification

The total investment of the proposed is Rs. 637.0 million. The objective of this investment is to improve the existing management system through a strategy or action plan and enhance capacity of stakeholders involved. Deh Akro II is an internationally recognized site and declared as Ramsar Site for protection of wildlife. Thus, as requirement of its international significance no any activity detrimental for the wildlife and flora or harvesting of its products is allowed. Only limited rehabilitation activities required for management, protection and governance of natural resource are allowed. In Dek Akro II only shelter, food, water and maintenance of ecological significance have been provided. Likewise, for Chotiari Complex the adverse impact of reservoir due to seepage from bunds and underground i.e. waterlogging has been checked through biological and limited structural activities which will address the above stated problem for improving ecology and productivity within and outside the project area.

Thus this project cannot be evaluated in financial or economic terms but only environmental assessment is required.

Environmental Assessment

The proposed intervention is environment friendly as it will not create any environmental problems but will improve the existing environmental problem of waterlogging in the area and provide water for wildlife.

The activities in the Deh Akro II are provision of fresh water from Nara Canal system to address the problem of water scarcity and reduce the impact of drought in a complex of 32 wetlands. This site has rare species of crocodiles and fish and other wildlife which will benefit from the project interventions.

The main problem needing immediate redressal in Chotiari Reservoir is the creation of water logging in the adjoining field through seepage from the chotiari reservoir. Due to seepage from bunds the adjoining fertile and productive agricultural lands have become waterlogged and no cultivation is possible. The activities proposed in this site are construction of moat to check seepage and construct the interceptor drains to collect seepage water and dispose of in the Nara Canal for reuse as the quality of seepage water is good for use for irrigation to the agricultural crops. In this way not only the adverse problem of water logging will be addresses but also the affected agricultural lands will be productive.

It is thus concluded that the proposed project of rehabilitation of Deh Akro II and Chotiari Reservoir is environment friendly and also socially acceptable as there are no any negative impacts

ICID Environmental Checklist for the proposed project

The environmental checklist formulated by International Commission for Irrigation and Drainage has also been used to assess the impacts of proposed activities on the physical and other components of the environment such as hydrology, pollution, soils, sediments and ecology of the areas.

Resettlement Issues

Deh Akro II is a Ramsar Site and is being managed by the Sindh Wildlife Department, thus no any resettlement will take place. Likewise the Chotiari Reservoir Complex is also being managed by the Government of Sindh, through SIDA. Thus for both the sites no resettlement will take place.

11.6 Promotion of Brackish Water Fish in LBOD drainage Area

Background/Rationale

The province of Sindh is blessed with all kind of water resources i-e marine, brackish and fresh water. The environmental conditions are favourable for culture of all kinds of fish, which can survive and thrive and specific water quality and scope of intensive farming but lack of supply of seed and technical assistance has prevented the development. Thousands of acres of waste and water logged land is available in the LBOD project area and surroundings which can be converted into productive fish ponds. The majority of this land though already owned by residents of the area is not being exploited for any purpose. Water logged areas usually don't have owner ship problem as their original users are still around.

Problem Statement

There is ample area and depressions in the command area of LBOD system which is un-utilized due to salinity problem of the water available in the depressions. In such areas it is not possible to grow fresh water fish. In addition, the LBOD drainage water is available in ample quantity in the spinal, lateral and tertiary drains where brackish water fish could be introduced and propagated.

Project Location and Boundaries

The proposed project is located in left bank of Indus in the command area of LBOD system. The districts in which the proposed project will be initiated are; Shahaeed Benazirabad, Sanghar, Mirpurkhas and Badin. The proposed area is located in the cultivated areas of above districts and along the LBOD system i.e. spinal drain, lateral and tertiary drains and natural depressions where drainage water is naturally or artificially collected within the farmlands.

Project Scope and Objectives

The scope of the proposed project is to introduce the brackish water fish in the LBOD system areas where the quality of water is saline/brackish. The proposed intervention will utilize this water for constructed fish ponds which ultimately be a productive resource both the drainage water and the saline/waterlogged area. With this the alternative opportunities for improved livelihood will enhance in the farming community and ultimately the poverty will be alleviated. The specific objectives of the proposed project are as under:

- To develop and utilize brackish water resources / area lying un used.
- To convert unproductive area into productive area.
- To utilize the drainage water of LBOD system for fish production.
- To increase production of brackish water fishes.
- To strengthen the fisheries resources of brackish water.
- To introduce species of brackish water fishes for culturing practices.
- To train people of area in culturing of brackish /saline water fishes on modern scientific lines.
- To provide alternate sources of livelihood.
- To increase income of fisher farmer.
- To alleviate poverty through production of fish

Description of the Project

Primarily the nature of proposed project is non-structural as it pertains to promotion of fisheries resource and no engineering structure will be constructed but some earthen structures i.e. ponds will be constructed for fish culture hence the project is designated as structural-cum-non-structural.

Keeping in view the problem of induction of high influx in the population /country as well as province every year the food resources are declining day by day and the prices are touching to sky and the

purchasing power of the people is shrinking and allowing them to buy high protein products for protein requirement or consumption. To provide affordable animal protein to people the culture of the fish is the need of time. The LBOD project area does not have brackish water fish culture practices especially in Shaheed Benazirabad, Sanghar and Mirpuirkhas districts. It is proposed to introduce following brackish and marine water fishes can be cultured to increase fish production from water not being used for any purpose and to elevate poverty and uplift socio economic life of the people of the area. *Tilapia noliticus* and *Lates calcarifer* (Dangri) will be introduced.

Tilapia has become the third most important fish in aquaculture after carps and salmonides because of their good size, rapid growth and palatability. Like other fish they are good resource of protein and a popular target for artisnal and commercial fisheries.

In Tilapia farming only male population is raised to avoid wild spawning and avoid small size of female. Most growers use hormones to convert female fries to male fries. Tilapia are also easiest and most profitable fish to farm this is due to their omnivores diet mod of reproduction (the fries do not pass through planktonic phase) Tolerance of high stocking density and rapid growth.

Lates calcarifer (Dangri) popularly known as the seas -bass is excellent table fish growing about 1500 mm lengths it is marine fish which is tolerant to brackish water and even fresh water environment lower salinity (10-20 ppt) promotes better growth. It is carnivores highly predacious feeding on fishes, crustaceans, molluscs and worms its growth rate is very fast. The only disadvantage with this fish in cultural operation is that it requires a lot of forage fish in environment it is cultured more in fresh water impoundments such as ponds, tanks, lakes etc then in marine farms.

Description of Technical aspects of intervention

Pre-requisites for the selection of project and technical aspects are as under:

Site Selection: Selection of suitable site plays important role in fish farming one has to keep following in mind for profitable fish farming

- Pond should be constructed on the soils which have water retaining capacity i-e land should not be sandy
- Pond should be at place where water should be available in sufficient quantity.
- Land should not be under agriculture
- Land should not be in the flood area
- Land should be near some road

Soil: The proposed land should have clay loam, silty loam and sandy clay type of soil.

Water Quality: For better Tilapia farming water quality parameters required are: Temperature (20-30 C), turbidity (01-105 feet), pH (7.5-12), dissolved Oxygen (5-12 mg/liter, Calcium Carbonate (75-300 mg/l), Salinity (15-20 ppt)

Shape: There s no binding of shape/area of fish farm. However it is observed that rectangular fish farms are easy to maintain and operate.

Depth: 5-6 feet

Inlet: Inlet (Water supply source) is made on the top of pond it should be simple made of pipe.

Outlet: It should be in the bottom of pond and simple monk.

Food: Being omnivorous fish they eat both phytoplanktons and zooplanktons, small insects and larvae.

Approach and Methodology

Suitable sites will be selected after conducting survey as per technical parameters. The project will use barren and water logged lands for construction of new farms and utilize available ponds if any near branch or main drains and use their water as such no extra water will be required. The fish seed

will be obtained for already existing fish hatcheries and will be stocked and grown in the fish ponds constructed under the project.

Outcome/targets and scope

It is proposed to construct 80 brackish water fish ponds under the proposed project area on the private lands of Benazirabad, Sanghar, Mirpurkhas and Badin Districts. In each district 10 Tilapia farms and 10 Dangri farms will be constructed under this project. Thus the total number of Tilapia and Dangri Farms will be 40 each.

Implementation Arrangements

The farms / ponds will be managed by land owners. Sindh Fisheries Department will provide extension and advisory services.

Monitoring and Evaluation Mechanism

Monitoring and Evaluation is an important activity in project cycle. Since the proposed project is based on collaboration and participation of stakeholders, the monitoring will also be the same. A monitoring committee will be established constituting of members from each stakeholder with a clear mandate and monitoring mechanism. During the project execution and afterwards this committee will frequently monitor and evaluate the project outcomes, identify bottlenecks and address such bottlenecks through an interactive way. During the process of monitoring indicators and sub-indicators will be established and monitored.

Project cost

The project cost during the construction phase is estimated to be Rs. 545.200 million for Talapia component and Dangri component with following break up:

Construction Phase

Talapia Component	Rs. 42.000 million
Dangri Component	Rs. 42.000 million

Operation Phase

Talapia Component	Rs. 225.60 million
Dangri Component	Rs. 235.60 milion
Total	**Rs. 545.200 million**

Project Benefits

1) Social Benefits

Employment generation and livelihood

The project will generate employment opportunities for rural people especially fishing and farming communities during construction and execution phases and onwards. It will create direct and indirect jobs for both men and women.

Poverty, Distribution of Benefits

There are several social issues such as health and hygiene of farming community, income generation options, poverty and gender related issues in the project area. This project will address above issues through social benefits from success of the species for production at commercial or subsistence aquaculture levels, the project will generate income for poor inhabitants of project area and additional income for those fish farmers already active but not culturing species such as *Tilapia noliticus*. For those whose lands are not productive the project gives hope of the land being able to produce and use full output again.

2) Environmental Benefits

The proposed project will address existing environmental issues such as water logging and salinity, water quality aspects, degradation of agricultural lands, decline in fish resources, biodiversity loss and decline in natural resources habitats. Thus the project is environment friendly as it will not raise any environmental issue during construction and implementation phases.

The proposed project will not create any environmental issue during its construction and implementation phases but rather address the existing environmental issues such as water logging and salinity, water quality aspects, degradation of agricultural lands, decline in fish resources, and loss of biodiversity, and decline in natural resources habitats.

This is an environment friendly project as it will not create any adverse impacts on flora and fauna, soil, water, land use, climate etc. The proposed project will be executed in the command areas of LBOD system the care shall be taken to protect the existing wild vegetation of un-economic value. In fact such un-economic and un-utilized lands will be made productive due to introduction of brackish water fish.

It is concluded from the analysis of environmental, social and economic aspects that the proposed project is undoubtedly environment friendly, socially acceptable and economically beneficial as it will address the environmental and social issues and will generate income of farmers/fishermen, enhance the value of the degraded land and convert the un-economic and un-productive lands to productive as the proposed project areas are presently un-productive and the drainage water is creating other environmental problems.

Financial and Economic Analysis

The financial analysis of the proposed project has been worked out. For *Talapia* species the FIRR works out to 12.3% and EIRR works out to 16.1%. For Dangri fish FIRR and EIRR works out to 14.01% and 16.6%, respectively. The combined FIRR of the project worked out 13.2% and EIRR 16.4%.

Resettlement Issues

Resettlement is no issue as evacuation does not take place.

11.7 Shrimp and Mud Crab Farming in coastal areas of Badin and Thatta districts

Background and Rationale

With the passage of time the terrestrial resources are depleting due to several socio-economic and environmental problems. The focus is on aquatic resources which are cheapest source of nutrients and fish is one of the main resources. In Sindh fisheries is categorized as coastal fisheries and inland fisheries. Coastal fisheries are the backbone of economy of the country/province and coastal communities. This provides livelihood and a major food item to the local fishermen community. Due to sea intrusion, release of contaminated drainage effluents in the wetlands and sea, overfishing and use of illegal nets the fish resource is declining resulting in poverty, livelihood sources and change in fish diversity. The coastal districts of Badin and Thatta are worst affected due to above described problems since last two decades.

Description of the Project

The proposed project type is non –structural, to be implemented in the coastal areas of Thatta and Badin districts. Under this project mud crab fattening and shrimp farms will be established in four talukas, namely Shah bander, Jati, Kharo Chan and SF Raho (Golarchi).

Project location and boundaries:

The project will be located in the coastal areas of Badin and left side of Thatta districts comprising of Shaheed Fazil Rahu Taluka of Badin district and Jati, Shahbander and Kharochan Talukas of Thatta district.

Project scope and objective:

The overall scope of the proposed project is to strengthen the fish resource in the coastal area of Badin and Thatta through shrimp farming and fattening of crabs which have an extensive market potential within and outside the country. This will also improve the economy of the country/province and provide substantial livelihood opportunities to the local communities.

Specific objectives of the project are as under:

- To popularize shrimp farming and crab fattening interventions.
- To establish and demonstrate the shrimp farming and crab fattening technologies.
- To create awareness and build capacity of local coastal communities.
- To help provide and improve livelihood opportunities to the fishermen communities and local land-owners.
- To utilize the brackish sea and drainage water for aquaculture development in the coastal districts.
- 10 number of mud crab farms and 10 of shrimp farms will be established in Badin and Thatta districts as under:

Each farm will be of 10 acres; hence 200 acres of shrimp and mud crab farms will be established.

Approach and Methodology

Following approach and methodology will be adopted for the proposed project;

- The ponds will be built in inter tidal low lying areas.
- The tidal water into pond by gravity will flow during high tide and shutdown the inlet at receding tide to retain water into pond
- Flush water in low tide
- Cyclic change of water
- Low stocking (4 pls per square meter)

- No artificial aeration shall be needed.
- The post larvae will be kept on natural/low cost feed.
- The seed will be obtained from Sindh Government Shrimp hatchery Hawks bay Karachi.

Outcome/targets and scope

The outcome of the proposed project will be as follows;

- Survey of target areas
- Establishment of Crab Farms 10
- Establishment of Shrimp Farms 10
- Community trainings 60 man months

Description of Technical aspects of Project

The project will have two components, viz. Shrimp Farming and fattening of mud crabs.

Shrimp Farming: Due to recent floods and damage to LBOD (Tidal link) the intrusion of sea has change the topography of area near Zero point Badin as a result the side has become more suitable for shrimp and fin fish culture including crabs and lobster. Immense potentials exist to start commercial scale fish / shrimp farming.

Fattening of Mud Crabs: Mud crab (*Scylla serrata*) named Koko is very famous in taste in south East Asian countries. At present so many parties are exporting crabs to European and Fareast Asian countries which are on rise. The following species of crabs are exported in shape of crab meat, canned and alive.

1. *Scylla serrata* commonly known as mud crab, green crab or mangrove crab.
2. *Portunus pelagicus* commonly known as blue crab.
3. *Portunus sanguinolentus* commonly known as red spot swimming crab.
4. *Charybdis cruciata* commonly known as coral crab.

Mud crab likes to live in mud therefore named as Mud crab can be culture in following ways:

1. Fattening
2. Grow out

Water Quality: Water quality required for its growth is 0-50 ppt TDS. Temperature 12-35 degree C however if less than 20 degree C it stops taking food.

Food: Mud crab is a carnivore. Likes and eats fresh fish and other animal like mollusk barbells and small fries. Looking at export market and its depleting trade in the nature Scylla serrata can be reared easily but it is economically not viable as the production of natural resources is adequate to meet the existing demand.

Fattening: Crab fattening is practiced as under

- Small size crabs can be collected from sea mostly purchased from fishermen engaged in this trade.
- Reared in earthen ponds for 3 - 4 weeks (till skeleton become hard).
- The small mud crabs are fed trash fish.
- 15 small crabs can be reared in 1 square meter.
- Due to short fattening period no diseases therefore survival rate is 90%.

Grow Out: Small crab 10-100 grams are kept in earthen ponds for 3 to 8 months to get market able size 200-500 grams. One crab is kept in 1 square meter area. Survival rate is 40%.

Project Cost

Total estimated cost of the proposed project is Rs. 105.574 million**.**

Implementation Arrangements

The farms / ponds will be managed by land owners. Sindh Fisheries Department will provide extension and advisory services.

Monitoring and Evaluation Mechanism

Monitoring and Evaluation is an important activity in project cycle. Since the proposed project is based on collaboration and participation of stakeholders, the monitoring will also be the same. A monitoring committee will be established constituting of members from each stakeholder with a clear mandate and monitoring mechanism. During the project execution and afterwards this committee will frequently monitor and evaluate the project outcomes, identify bottlenecks and address such bottlenecks through an interactive way. During the process of monitoring indicators and sub-indicators will be established and monitored.

Project Benefits

Social benefits

Employment generation and livelihood

The proposed project will create ample direct and indirect employment. The shrimp farming and fattening interventions are directly related to the livelihood of the local population. The poor people will be engaged for employment, increase their earnings, benefit from the sale proceeds of shrimp and mud crabs and will also get nutrient food. All above benefits will improve the livelihood sources for the local poor people of the coastal area.

Poverty, Distribution of Benefits

The project area is a poverty ridden area where the poverty line is above 70% and the income distribution is not equitable. Due to execution of the proposed project the poverty level of the poor people, mostly fishermen, will improve significantly because they get employment and also the crabs and shrimps will be sold in enhanced price than the previous condition.

Environmental Benefits

This is an environmental friendly project as it will not create any adverse impacts on flora and fauna, soil, water, land use, climate etc. The proposed project will be executed in the mangrove areas the care shall be taken to protect the mangroves as due to increase in human activity there is apprehension that mangrove resource will be deteriorated on the cost of shrimp farming.

Financial and Economic Benefits

The financial analysis of the proposed project has been worked out for Shrimp farming the FIRR is 14.0% and EIRR is 23.5%. For Mud Crab fattening farming the FIRR and EIRR is 13.1% and 23.6%, respectively. The combined FIRR of the project is 13.7% and EIRR is 23.5%.

ICID evaluation

The project has also been evaluated as per requirements of International Commission for Irrigation and Drainage (ICID). The evaluation reveals that there is no negative impact of this project on the components of the environment.

The above evaluations reveal that the proposed project is environment friendly and also feasible both economically and financially.

Resettlement Issues

Resettlement is no issue as evacuation does not take place.

11.8 Bio-saline Agriculture in Badin and Thatta Districts

Background and Rationale

In Sindh, fresh water resources both for domestic and agricultural use are constantly depleting and crop yields suffer from a steady increase in soil salinity, especially in the arid and semi-arid areas. Equally or even more affected in some cases, are other resources like fodder for animals and fuel wood for the rural poor. Efforts are hence needed to find an alternate source of water and utilization of saline lands for economic benefits. Increasing need for food, fuel and forage for the growing human and animal population, has exerted a lot of pressure on these resources.

Under the bio-saline approach, useful production can be achieved from salt-affected wasteland without reclamation. The main focus is on the economic utilization of the land while still in the saline or sodic condition. There may be improvements in soil condition but this is a spin-off benefit. The latest promising bio-saline approach involves re-vegetation of salt-affected lands using salt-tolerant crops, trees, grasses and salt bushes. Growing salt-tolerant crops increases food and fiber, salt-tolerant grasses can help improve the grazing for animals. Similarly, growing trees and saltbushes has the added bonus that helps fill local needs for forage and fuel wood. The most common fuel is dried animal dung but provision of alternative fuels would enable this to be returned to the fields to improve the fertility of the land.

Research on reclamation of salt-affected soils, utilization of wastelands for cropping of suitable species, and fish culture, use of saline water for irrigation purpose etc. has been underway for quite some time by various institutions throughout the country. In Sindh, various public and private organizations are actively involved in education, research and development biosaline agriculture interventions. A number of technology options have been determined and tested from time to time for different situations. It is high time that integrated approach is made to implement the available technology to the benefit of farming community, to alleviate poverty in the rural masses, and to improve the environment. Farmer participation in these programs is key factor in the success of these interventions.

The drainage of effluent Kotri command area is carried through 18 major drainage systems. These drainage systems are carrying drainage effluent into sea except for three drains which are out falling into river Indus. One of these drainage systems Kadhan Pateji Outfall Drain (KPOD) is connected to LBOD and Tidal Link for outfall into Sea. The total design discharge capacity of the whole system on left bank is about 8,050 cusecs. The salinity level of the drainage effluent is about 2 dS/m which is suitable to grow most crops on marginal lands.

The drainage effluent if used for bio saline agriculture, would supplement farm incomes, and would release pressure on the main drainage system. Evidence from Pakistan and elsewhere show that the salt tolerant crops (glycophytes) irrigated with the brackish water grown on marginal lands has shown promise. These crops include salt tolerant varieties of wheat, barley, oilseeds, cotton, and different vegetables.

The communities in the coastal area, particularly in the Badin district proposed that since their natural resource base has degraded, hence technical support is needed to increase their farm productivity. It was suggested that if they are given access to the drainage water through public lift pumps, they would be able to grow salt tolerant crops. In response to this, the Consultants a Pre-feasibility was prepared to support and introduce bio-saline agriculture along the drainage network and the same was discussed with the stakeholders during the Phase-II of the study.

Issues and Problems

There are several strategies involved in the management of the saline soils like engineering approach, reclamation approach and Bio-saline agriculture approach. Engineering approach required draining the brackish water from soil and underground. Various drainage projects like SCARPs, Tile drainage

projects and tube wells were used to reclaim the land affected by water logging and salinity but the efforts could not yield anticipated results. It is estimated that over 100 hectares of land is becoming saline every day. This situation is very alarming and particularly in Sindh province, because lands are becoming saline more in Sindh than the other provinces. The climate of Sindh is arid and hot. On an average, the region receives the maximum rainfall of 170-200 mm. Because of shortage of irrigation water, the biological approach for reclaiming the saline and water logged soils through leaching is handicapped. The only option left to use such lands for crop production is through bio-saline agriculture.

Scientists are conducting experiments utilizing seawater for agriculture particularly in sandy soils. Sand is inherently low in the nutrients required for plant growth, has a high rate of water infiltration, and has low water-holding capacity. Therefore, agriculture on sand requires both irrigation and fertilizer. Surprisingly, 11 of the 13 mineral nutrients needed by plants are present in seawater in adequate concentrations for growing crops. In addition, the rapid infiltration of water through sand reduces salt buildup in the root zone when seawater or brackish water is used for irrigation. The high aeration quality of sand is also valuable. This characteristic allows oxygen to reach the plant roots and facilitates growth. Thus the combination of sand, saltwater, sun, and salt-tolerant plants present a valuable opportunity for many developing countries. Brackish water with comparatively less salinity than seawater is best to be use in sandy soils with success.

Water scarcity coupled with marginal soil and water resources warrant the use of bio-saline agriculture to get appreciable production from presently unproductive lands lying barren for want of fresh water. At present the drains of some areas are polluted with sugar mill effluent. Efforts shall however, be focused to stop the sugar mills effluent entering in the drainage system, because the users will hesitate using the sugar mill effluent laden waters in their lands for agriculture.

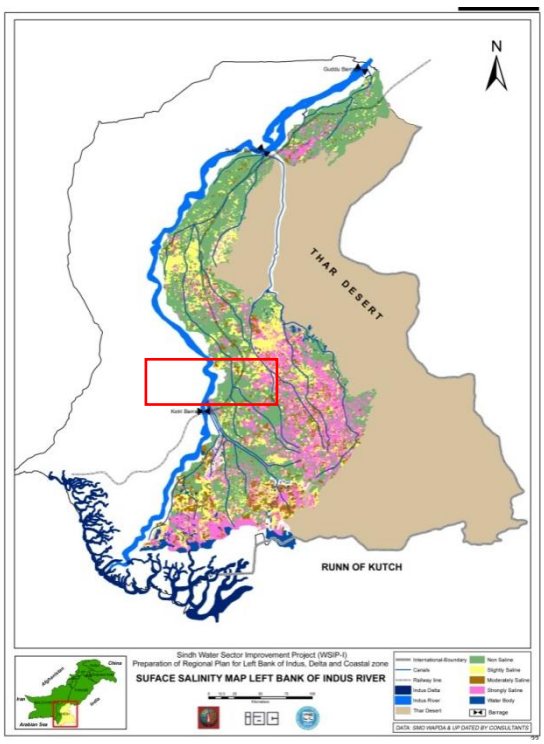


Figure 1: Highly Saline area of Thatta and Badin

Location

The area under marginal lands in Badin and Thatta districts are marked on the map in Figure-1. These areas are either moderately or highly saline spread on thousands of acres. Under water scarcity conditions these areas are left barren without any vegetation. In Pinyari command, 65% of the soils are saline, while in Lined channel and Phuleli command, about 50% soils are either moderately or highly saline Table- 1. The drainage water of surface drains of Kotri surface drainage system is marginal water with TDS in the range of 1000 to 1500 ppm and could beneficially be utilized for biosaline agriculture for growing salt tolerant crops, shrubs, trees and grasses.

Table-1- Left Bank Command Wise Salinity Status of the Area

S. No	Main Canals	Area in Acres	Salinity Class- ECe dS/m at 25° C (% of area)				Miscellaneous area	Total
			Non Saline 0-4	Slightly saline 4-8	Moderately saline 8-15	Strongly Saline >15		
	Ghotki Feeder	984795	73	6.0	3.0	9.0	9.0	100
	Nara Canal	2431394	29	23	10	33	5.0	100
	Rohri Canal	998588	57	22	6.0	9.5	5.5	100
	Khairpur Feeder West	300000	72	13	4.0	4.0	7.0	100
	Khairpur Feeder East	506000	61	17	7.0	6.0	9.0	100
	Pinyari	981207	22	**19**	**5.0**	**40**	14	100
	Fuleli	1045651	44	**21**	**10**	**20**	5.0	100
	Lined Channel Akram Wah	531965	27	**23**	**15**	**22**	13	100
	Total area of Left Bank Command	9708725	48	18	7.5	18	8.5	100

Objectives

The objectives of the proposed project are to;

i) Reduce the area of culturable waste,
ii) Minimize the degradation and desertification of lands
iii) Offload the pressure on the main drainage system
iv) Improve environment of the area
v) Improve socio-economic conditions of the communities

Due Diligence

Due to scarcity of fresh water resources all over the world and especially in the developing countries, efforts are underway to utilize brackish water and saline lands for growing salt tolerant crops, grasses, trees and shrubs. Having a very limited knowledge of utilization of brackish water for crop growing, people leave their marginal lands barren without any crop or vegetation. This renders the lands totally un-useable for farming. Scientists are working on utilizing even sea water for growing crops that suit to the marine environments and have successfully grown a number of crops, oil seeds, grasses and fruit trees (list given in Table-2, 3 and 4). There is plenty of brackish water with permissible salinity levels suitable for growing a number of crops, fruit trees, grasses and fuel wood trees. This is the best opportunity to bring the marginal lands under cultivation to support the poor people to earn their livelihood and rear livestock on the grasses grown on marginal lands. Some of the crops, grasses and fruit trees are given below which can grow profitability under brackish water and marginal lands:

Table-2: Crops grown under saline conditions with yield reduction with increasing salinity

Crop Species	100%		90%		75%		50%		0%		Salt Tolerance
	ECe	ECw	ECp	ECw	ECe	ECw	ECe	ECw	ECe	ECw	
Barley	8.0	5.3	10	6.7	13	8.7	18	12	28	19	Tolerant
Cotton	7.7	5.1	9.6	6.4	13	8.4	17	12	27	18	Tolerant
Sorghum	6.8	4.5	7.4	5.0	8.4	5.6	9.9	6.7	13	8.7	Moderately Tolerant
Durum Wheat	5.7	3.8	7.6	5.0	10	6.9	13	8.7	20	13	Moderately Tolerant
Soybean	5.0	3.3	5.5	3.7	6.3	4.2	7.5	5.0	10	6.7	Moderately Tolerant
Groundnut	3.2	2.1	3.5	2.4	4.1	2.7	4.9	3.3	6.6	4.4	Moderately Sensitive
Rice	3.0	2.0	3.8	2.6	5.1	3.4	7.2	4.8	11	7.6	Moderately Sensitive
Sugarcane	1.7	1.1	3.4	2.3	5.9	4.0	10	6.8	19	12	Moderately Sensitive
Maize	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9	10	6.7	Moderately Sensitive

Table-3 Salt Tolerance of Different Fodders
ECe of Soil (dS m^{-1}) Associated with 50% yield Reduction

Italian Rye-grass	11.20
Fodder Beet	19.00
Fodder Radish	11.00
Hawasi Radish	12.50
Lucerne Hijazi	12.20
Kallar-grass	22.00
Jhancha (Elephant grass)	13.00
Japani Millet	15.00

Source: Proceedings of Workshop/Seminar on Salt Tolerance in Plants, University of Agriculture, Faisalabad, 1978

Table- 4: Fruit Trees tolerant to Salinity and Water logging

Eugenia Jambolana (Jaman)	High tolerance to salinity.
Zizphus jujube (Ber)	High tolerance to salinity.
Psidium guajava (Guava)	Moderately tolerant to salinity and water logging.
Grevia asiatica (Falsa)	High tolerant to salinity.

Outputs

The main outputs will include:

i) An area of 125,000 acres will be planted / grown with saline resistant crops

ii) 625 community based lift pumps will be installed, each supporting 200 acres

iii) distribution channels will be laid out to deliver water to participating farmers

iv) salt tolerant crops, trees, shrubs and grasses will be grown in these areas to supplement the income of the farmers and to improve the local environment by vegetative cover that will support the livestock

Outcome and Impact

It is estimated that selected salt tolerant crops, grasses, and trees will be grown on about 125,000 acres, generating an annual net farm income of Rs.5,000 per acre per year. This will not only increase the farming intensity, will also enhance the household income of participating farmers, and will also provide additional employment to landless labor. The proposed project will also have several indirect benefits, such as increased availability of better nutrition to household members, will also help in the availability of fodder and forage for the livestock, and would arrest further degradation of soils.

It will reduce pressure on overall drainage system thereby eliminating the risk of breaches, overtopping and back flow in the branch and sub-drains, The intervention will increase overall agriculture produce, sustain the livestock and better utilize the wastewater which otherwise will flow into the sea through drainage.

Implementation arrangements

Since the drains are flowing below the ground level the water at suitable points will be pumped into purpose built channels along the drains. All the operations of the project will be executed through participatory approach. The SIDA/IPD will procure and install the lift pumps, and the community groups will operate and maintain the lift pumps. An NGO will be engaged for community mobilization. The agriculture department will provide support for soil testing and identification of appropriate crops and varieties.

Monitoring Framework

Project manager with supporting staff will monitor the activities of the project in accordance with the designed work plan. *Warabandi* of the turn of water will be based on the land holdings and the availability of the water. Selection of the crops, trees, grasses will be on the bases of type of the soil, extent of salinity of the holding and on scientific grounds on recommendations of the project management. Code of conduct shall be farmed out in consultation with stakeholders with mutual agreement of all the partners. Conflict resolution committee comprising of the project management and notables shall resolve the conflicts amicably.

Project Cost

The total cost of intervention is estimated as Rs.2.4 billion. This includes cost of procurement and installation of lift pumps at Rs.50,000 each, cost of laying out distribution system, land clearance at Rs.10,000 per acre, and cost of Management and Community Mobilization through NGO at Rs. 43.75 million

Economic Viability

The preliminary analysis suggests an indicative IRR of 13.3 percent. Nonetheless, the project has been designed based on the assumption that the hazardous effluent originating from sugar mills and other sources discharged into selected drains needs to be completely terminated, else the drainage effluent is not usable for bio-saline agriculture, and farmers will be reluctant to use this water. Hence if the drains are not kept free of the sugar mills effluent, the project has a high risk of failure. In this context, the EPA Sindh has to mobilize efforts and enforce the environmental act 1997 in letter and spirit else penalties need to be imposed on defaulters as already mentioned in the regulation in force.

Safeguards

Environmental

The proposed project is environment friendly as it will not have any adverse impacts on any green infrastructure of the areas. Any salinity build up in the marginal soils due to application of the saline drainage water would be washed off with the rain water flows in monsoons. Moreover, only those crops, grasses, and trees will be selected that will help reduce the soil salinity. This intervention will

improve the ecosystem and local environment; reduce desertification, encourage livestock production as well as agriculture produce and thus make the life of the communities a bit comfortable.

Social

The proposed project will increase the productivity of the degraded lands thereby improving the economic status of the farming community, province and the country. In addition it will provide livelihood opportunities through employment generation and alleviate poverty.

11.9 Rehabilitation of Coastal Wetlands

Introduction

Wetlands are among the world's most productive environments and are essential part of our landscape. They are the cradle of biodiversity and a vital component of the freshwater cycle. Wetlands provide numerous benefits that include rich floral and faunal habitat, improved water quality, flood abatement, water storage and groundwater recharge, support for fisheries, and opportunities for education and recreation. They are also key natural resources providing livelihood opportunities for the local communities. Wetlands are dynamic ecosystems with complex interrelationships of hydrology, soils and vegetation. Like other green areas the wetlands are also under tremendous environmental degradation. As a result, this important environmental source is depleting at an alarming rate. Therefore, an internationally acceptable up to date scientific technology is required to monitor wetlands effectively.

In Sindh there are more than 100 wetlands of which about 90% fall on the left bank of Indus and the rest are located on right bank (Fig-1). They range from coast, river, lake, marsh, pond and channels to lagoons. There are three wetland complexes namely Deh Akro II (32 dhands) located in district Benazirabad, Chotiari (22 dhands located in Sanghar district and Indus delta/coastal wetlands (15 wetlands) located in Badin and Thatta districts.

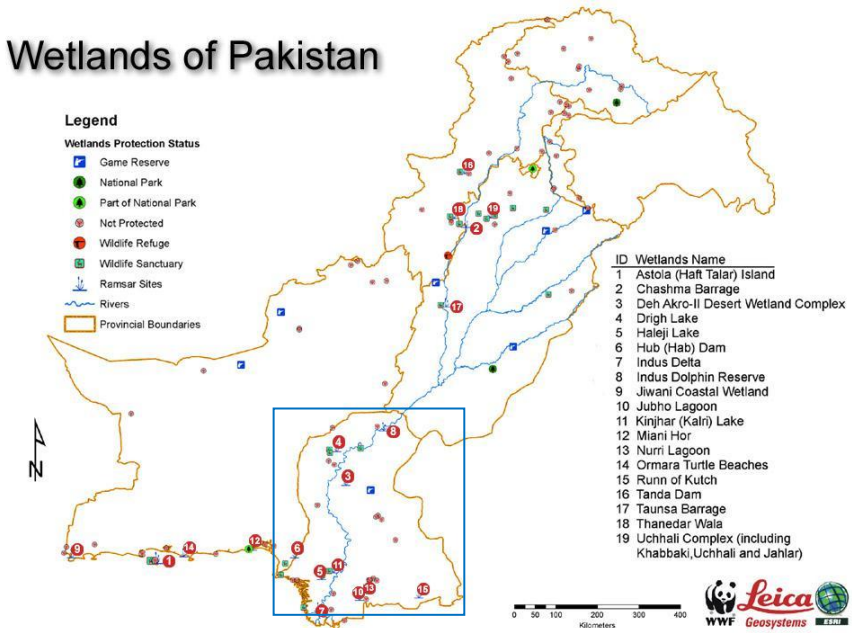


Figure-1: Wetlands of Pakistan and Sindh

The wetlands are important natural resource base of economic importance. They provide livelihood opportunities, mainly fishing, for the local communities. The coastal wet lands, particularly Sanhro and Mehro dahnds - the Ramsar sites, were recharged by flows from storm water runoff and surface drainage system in the southern districts (Badin and Thatta). To avoid KPOD drainage effluent discharges into the above mentioned two dhand complexes, a 42 km long tidal link canal was built to detour the outfall into Shah Samando creek. In addition to this at Chotiari dhand, a weir was constructed to protect the *dhands* from excessive drainage flows and back flows into the tidal link during high tide.

Issues and Problems

Since the 1960s, when the Kotri Basin drains were built to discharge into the coastal dhands they have become an important local fishery, and a waterfowl habitat of international importance. Portions of two of the Sindh dhands (Sanhro and Mehro) have been declared Ramsar sites, and the Rann of Kutch is included on the WWF list of the 200 globally most important biodiversity hot-spots. The natural pattern of surface drainage and overland flow, especially of storm runoff, from this coastal and near-coastal zone in Badin District is south and southeastward towards the Rann of Kutch. To avoid discharging LBOD through KPOD directly into this environmentally sensitive international wetland, a Tidal Link drain was built 42 km southwestward across the dhands and the Rann of Kutch from KPOD to the nearest active tidal creek, Shah Samando Creek. The Tidal Link drain was isolated from the Rann of Kutch and the dhands by high embankments. An 1800 ft weir, called the Cholri Weir, was built where the Tidal Link Canal passes through Cholri Dhand in order to attenuate high water levels

in the Tidal Link drain during high tide by allowing water to flow into the dhands during this period, and to protect the dhands from excessive drainage during low tide when the water would flow back into the Tidal Link Canal.

1) With the collapse of Cholri weir and breaches in the tidal link due to cyclone 2 A in 1999, the salinity level of the *dhands* has been compromised due to back flows from the sea.
2) With the salinization of these *dhands*, the fish productivity capacity has been severely impaired. Also during the low tides, the *dhands* drain out into the tidal link, causing sedimentation and lowering the storage levels in the *dhands*.
3) Unsustainable methods of exploitation of these resources coupled with lack of sustainable and participatory policies and planning to conserve such resources have resulted degradation of such resources and threatened the very survival of the communities dependent on these resources.
4) Both tidal fluctuations and sea water intrude into the dhands and KPOD, and there is now an open connection between the dhands and the Tidal Link, exposing the dhands to tidal fluctuations, sea water intrusion, sedimentation, and excessive drainage during low tide. The LBOD can now be described as a "new river" that is forming an estuary and is an integral part of creek formation into the coastal area.
5) Severe erosion of the Tidal Link, breaches in the flanking embankments, and the collapse of Cholri Weir are the main problems and cause of degradation of coastal wetlands.

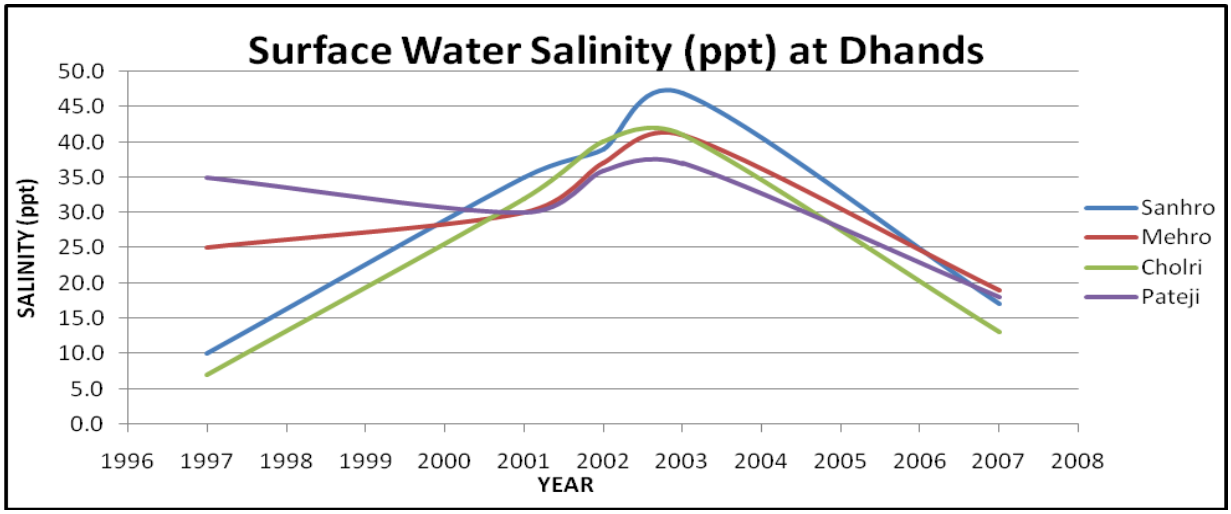
The Tidal Link has invited the sea to approach the land and now the tidal fluctuations are visible. This process will continue, and its progress is difficult to predict. Adapting to this new process requires continuous hydraulic and environmental monitoring in learning by doing approach. The IPOE suggested that LBOD Stage II & III in light of the present outfall conditions of LBOD Stage-I should be postponed until the existing problems at the outfall are adequately address and solved.

Present Status of Wetlands

The Tidal Link Canal bed and banks were constructed with the soil obtained from the canal excavation and consisted mainly of silty loam in which scour and erosion processes are highly sensitive to flow velocity. The analysis indicated that the sea water was not expected to penetrate more than 19 km upstream to an area about 5 km downstream of the Cholri Weir, the main connection between the Tidal Link and the dhands. Due to the sensitivity of the soil of the tidal link, the erosion of the bed and banks continued right from the inception of the tidal link canal and the process continues till today resulting in the breaches of the banks and erosion of the bed.

The salinity in the tidal link as well as the dhands after the collapse of Cholri weir started increasing gradually with the passage of time till 2003-04 then gradually decreased Figure-1 and Table-1.This occurred because seawater intrusion into the dhands took place right from the time the weir was damaged and tidal water got intruded into dhands through this opening (weir). The salinity recorded in dhands in 2012 was also in the range of 64 to 70 mS/cm almost same as of 2003-04. This showed that the salinity of dhands has become almost stable at this range due to continued back and forth movement of the tidal waters in dhand complex.

Figure-2 Surface Water salinity of Coastal Dhands



(**Source: NIO, NESPAK 2009)**

Table-1 Surface Water Salinity of Dhands

RD's	Year									
	1997 Before Cyclone 2A		2001		2002		2003		2007	
	Salinity (ppt)	Depth (m)	Salinity (ppt)	Depth (m)	Salinity (ppt)	Depth (m)	Salinity (ppt)	Depth (m)	Salinity (ppt)	Dept h (m)
Sanhro Dhand	10.00	0.80	35.00	0.70	39.00	0.50	47.00	0.40	17.00	0.40
Sanhro Mehro Dhand	25.00	0.60	30.00	0.60	37.00	0.30	41.00	0.30	19.00	0.30
Cholri Dhand	7.00	1.00	32.00	0.80	40.00	0.80	41.00	0.70	13.00	0.60
Pateji Dhand	35.00	0.50	30.00	0.60	36.00	0.60	37.00	0.60	18.00	0.50

(Source: NIO, NESPAK 2009)

Master Plan Consultants visited tidal link to observe its morphological behavior and to suggest the possible structural / non-structural measures to improve outfall conditions for LBOD. Main objective of the visit was to identify and analyze the existing conditions of the tidal link, the process of creek development and the flow of tidal water from sea through tidal link to Dhand complex and back to sea. Following observations were made during the visit of the tidal link and suggestions are also offered about proposed structural / non-structural measures. Table-2 shows the depth of water measured at four locations with coordinates and other parameters.

Table 2: Location wise parameters data of coastal areas

Location	Coordinates	Depth of water (ft)	Altitude (ft)	TDS (ppm)	pH	Salinity EC(mS/cm)
At Cholri Weir	24 15.5478 N 68 40.4230 E	37	3.25	41216	8.3	64.4
Creek in dhand	24 16.0502 N 68 37.1513 E	26	4.93	44352	8.4	69.3
Creek at zero point	24 15.3603 N 68 40.7705 E	18	10.22	44800	8.3	70.0
Tidal link RD (-53)	24 15.3640 N 68 40.7542 E	20.5	9.02	41336	8.3	65.0

1. The design top width of the tidal link at the beginning was 152 ft and that at the outfall 233 ft. This width has increased manifold and has reached 3600 ft or more at some places in the vicinity of the outfall and near dhand complex
2. Pronounced scouring of the tidal link banks was noticed with mixing of the eroded soil in the tidal link waters making it muddy and highly turbid. The creek developed at the location of damaged Cholri weir kept deepening and widening with the passage of time due to erosion by high velocity tidal waters at the time of tide recession.
3. Flow of tidal water to and from the dhand complex together with wave wash has tremendously eroded the tidal link banks and the process appears to continue that may result in width wise expansion of tidal link for quite some time.
4. Presently the tidal link has been converted to a sea creek due to non existence of protected bunds.
5. Due to erosion, the coastal lands of Badin and Thatta districts are progressively under severe threat of washing away into the sea by tidal waves.
6. Stopping seawater intrusion is therefore, the need of the day because the tidal influence is adding to the environmental degradation causing severe scouring of soil and adding to the salinity of soils in dhands area.
7. The coastal wetlands are an important ecosystem and a predominant source of livelihood for coastal communities. The revival of the coastal wetlands has therefore become a dream unless some viable solution to check sea water intrusion is made effective and is sustainable
8. Apparently the structural solution does not seem workable in this area, therefore, ecosystem approach for the revival of dhand ecosystem is proposed taking start from the northern end of dhand complex and moving gradually towards south and southeast.
9. The team has already proposed a biological solution i.e. plantation of mangroves in the area. This solution is to be extended and implemented on the potential sites so as to ensure their protective role.
10. The interventions of Zulfikarabad Project which is being actively executed in the coastal areas of Jati, Shahbander, Kharochan and Keti bunder are also of worth consideration.
11. If the option of any structural solution is considered, the cost of the intervention would surpass the benefits to accrue. Secondly, the prevailing conditions at tidal link do not warrant taking risk of possible failure of structure either at the tail end of the tidal link or the place where the cholri weir failed.

12. However, NIO is entrusted to recommend most suitable alternative to stop seawater intrusion suggesting tidal control structure on the tidal link at suitable place that can withstand the climatic conditions.

Objectives of the Project

The main objectives are to:

i) revive the *dhands* as a source of livelihood

ii) restore and improve the ecosystem; through protecting the *dhands* from seawater

iii) promote the local fish in fish ponds filled with drain water and storm water

iv) grow salt tolerant crops for supplementing the farmers income

v) grow salt tolerant trees and shrubs for fuel wood and income generation

vi) develop fodder for livestock and reeds for migratory birds

Due Diligence

The present conditions of the outfall area are quite different from the ones observed when LBOD outfall system was in the stage of preparation and before it started operations. There is now an open connection between the dhands and the Tidal Link, exposing the dhands to large tidal fluctuations, sea water intrusion, sedimentation, and excessive drainage during low tide. A small tidal creek type system of drainage channels has now developed in Cholri Dhand, which is closest to the Tidal Link. The Tidal Link drain bed and banks were constructed with the soil obtained from the canal excavation and consisted mainly of silty loam in which scour and erosion processes are highly sensitive to flow velocity. At present both tidal fluctuations and sea water intrude into the dhands and KPOD, and the drainage and environmental functions of the Tidal Link portion of the LBOD outlet are impaired. The entire ecosystem of the dhands has been vanished and sea has occupied the area. This requires a wise decision to revive the ecosystem to bring back the conditions that existed before the LBOD.

Proposal to revive the dhand ecosystem through "Ecosystem Approach"

Presently the dhands receive water from Karo Ghungro and Guni Phuleli drains. The water of these drains is slightly brackish with 1000 to 1500 ppm all the year round and is suitable for local fish, reed grass, salt tolerant crops and trees and migratory birds provided the sugar mill effluent is stopped in these drains. The area of dhands is around 67,000 acres. This area will be divided into suitable parcels after a detailed survey of the area using appropriate dykes and the following interventions shall be practiced depending upon the location, status of soil salinity and surface elevation:

1. Fish ponds in sanhro and Mahro dhands
2. Reed grass areas
3. Salt tolerant trees and bushes
4. Salt tolerant crops and grasses for livestock fodder
5. High value Oil seed crops like castor and linseed etc.

Project Outputs

The following are the main outputs of the proposed intervention:

i) Fish ponds will be established on 20,000 acres for local fish production under brackish water conditions

ii) Salt tolerant crops will be grown on 10,000 acres to utilize areas for supporting the communities

iii) Salt tolerant trees, shrubs and fruit trees will be established on 10,000 acres for fuel wood and to add to the income of the locals in addition to environmental improvement

iv) Grasses that can survive in saline environment shall be grown on 10,000 acres to provide fodder for livestock of the communities for providing milk to the families and add to the income of the people

v) With the improvement of the ecosystem and the environment, the migratory birds and water fowl together with other wildlife will thrive and flourish

vi) Mangroves will also be planted on mud flats and other potential areas to protect the coast from the cyclones and tsunamis and to minimize coastal erosion

Project Outcome and Impacts

This intervention is expected to improve and revive to a larger extent the ecosystem of the *dhands* and would enhance the household income of the communities that are dependent for their livelihoods from these wetlands. The main outcome of the project includes:

i. About one thousand ton of fish will be produced annually; as such an amount of Rs. 100 million will be earned

ii. Refuge to local water fowl, migratory birds;

iii. Production of 5,000 mt of fodder for livestock;

iv. About 2-3 million trees would be planted

v. Estimated 50,000 cattle heads will be reared on grasses cultivated on 10,000 acres taking average 5 cattle per acre

vi. An estimated amount of Rs.10,000 will be earned from one acre cropped area as such an amount of Rs. 10 million will be earned from crops

vii. Improved ecosystem and better environment for the wild life and biodiversity;

The project will also provide employment to local communities, and would reduce the poverty incidence to 50 percent from the current estimated level of 75 percent.

Project Cost estimates

Management cost and cost of survey work, dykes, land development, hatchery, and capacity building etc of the project is estimated to the tune of Rs. 459 million

Project Justification

There are enormous environmental benefits, and better livelihood opportunities will be created for the communities. The ecosystem approach however is time consuming intervention and will require 10 years or more to harvest the true benefits. The success however is linked with overall climatic conditions and the involvement of the stakeholders and their coordinated efforts making the project to reach sustainable progress.

Safeguards

This is an environment friendly option to revive the badly degraded ecology of *dhands*, will create employment opportunities for local communities, improve the salinity of *dhands* and will help conserve valuable water resource presently wasted to the sea through drainage. There are numerous social benefits including better livelihood opportunities, favorable environment for migratory birds and fodder for livestock thus raising the socio-economic wellbeing of the communities.

12 O & M Arrangements and Yardsticks for Drainage

12.1 Estimated O&M Requirements of the Project Facilities over the Project Life

Definition of operation and maintenance

There are three main activities:

- Maintenance and Repairs (M&R)
- Extensions and Improvement (E&I)
- Establishments (Estt)

O&M = (M&R) + (E&I) + (Estt.)

E&I include:

i. Reconditioning of Banks
ii. Maintenance of Banks, Earth Work
iii. Rehandling of spoils
iv. Re-selectioning of soil

Money needs to be invested in arresting the degradation of the drainage system.

12.2 Drainage Structures

Drainage facilities in Sindh have been provided over a gross command Area of 5.3 Mha. These facilities include installation of 5835 tube wells (3,697 FGW and 1,777 SGW) 365 Scavenger wells, Construction of 8200 Km surface drains, 565 Km interceptor drain and 0.1MA covered with tile drain.

Under the SCARPS the sub-surface drainage systems of tube wells on the Left Bank of River Indus has completed on Gross Command Area of 3.685 MA where various drainage technologies have been adopted for water table and salinity control. The drainage facilities comprises of 3170 fresh Ground Water tube wells, 2168 saline ground water tube wells, 365 scavenger wells, tile drains over an area of 0.1 MA and 4458Km surface drains under the following drainage projects.

- Ghotki Fresh Ground Water Project
- Khairpur SCARP Project
- SCARP North Rohri Fresh Ground Water Project
- SCARP South Rohri Fresh Ground Water Project
- LBOD Stage-1

12.2.1 Ghotki Fresh Ground Water Project

The project is located in Ghotki district, the GCA of project is 0.178 million hectares (0.44 MA) and CCA is 0.162 Mha (0.400 MA). A total of 1015 fresh ground water wells of total capacity of 2070 cusecs were installed. The capacity of individual tube wells vary from 1.5 cusecs to 2.5 cusecs depending upon the aquifer conditions. This project has been framed to increase its cropping intensities (Base year) from 95% to 150% at ultimate development. The tube well pumpage in addition to irrigation supply through Ghotki canal (Non perennial) will result continuous assured supply of water throughout year.

Additional tube wells were installed as such total number of tube wells in the project area is 1,092 out of which 875 are operational and 217 are non-operational due to various reasons. As such the pumping capacity has been reduced by 19.87%. Defects are due to 88 transformers burnt/theft, 31 -11 KVA transmission line defective, 18 borehole failures, 47. due to defective motors and 33 due to pump defects.

12.2.2 Khairpur SCARP Project

Project is located in District Khairpur the GCA of the project is 0.178 Mha (0.44 million acres) of which 0.15 Mha (0.38 million acres) is cultivableunder Khairpur Feeder East and Khairpur Feeder west both canals are perennial. The project is essentially a drainage project. A total of 540 tube wells of various capacities were installed to control the ground water table at 7 ft. below the natural surface level. Out of total number 540 tube wells, 175 pump ground water of acceptable (fresh water) quality which is directly utilized in the field channels for augmenting the existing irrigation supplies on full development. Base year cropping intensities were 91% in 1966-67, will ultimately attain a level of 165%. For disposal of saline effluent 550km of surface drains were constructed and five pumping stations with an installed capacity of 855 cusecs to dispose-off the saline effluent into the Rohri Canal. Additional 105 tube wells were installed under Khairpur SCARP has increased to 645.

The operational status of tube wells indicates that 289 tube wells are operational and 356 tube wells are non operational due to various reasons. Tube wells are non operational due to 182 transformers theft/burnt, 39 11 KVA line defect, 61 Bore failure, 41 Motor defects, 12 pump defect and 15 control panel defects.

12.2.3 SCARP North Rohri Fresh Ground Water Project

The project is located is located in Districts of Khairpur and Naushero Feroze. The GCA is 0.32 Mha (0.793 MA) and CCA is 0.278 Mha (0.69 MA). A total of 581 tube wells of various capacities between 1.5 cfs and 5.0 cfs have been installed. Annual pumpage of fresh ground water is about 1.08 MAF to supplement the irrigation supplies. The cropping intensity during base year was 98% and with target of 150 percent. The project was completed during 1969-1979.

Out of 581 tube wells of Naushero Feroze Division 259 are non-operational, due to transformer theft/burnt 1 11 KVA line fault, 110 bore failure, 27 motor defect, 5 pump defect and 2 control panel defect.

12.2.4 SCARP South Rohri Fresh Ground Water Project

The project is located in districts of Nawabshah and Hyderabad. GCA is 0.22 Mha (0.541 MA) and CCA is 0.152 Mha (0.375 MA). The project receives perennial irrigation supplies from Rohri Canal system supplemented by the addition of 1,214 fresh ground water tube wells with designed capacity of 1 to 2 cusecs. The cropping intensities during base year were 88 % which is planned to increase upto 110 % .

1214 tube wells were constructed in the priority area providing a discharge capacity of 1 to 2 cusecs of individual tube wells. Additional 8 tube wells were installed as such total number of tube wells is 1,222.

The operational status of the Tube wells indicate that 860 tube wells are operational and remaining 362 tube wells are non-operational as such the pumping capacity of Tube wells has been reduced from 2,660 to 1,873 cusecs

which have direct impact on the agricultural production due to reduction in pumpage from tubewells. Non-operational tube wells are 205 due to transformer theft/burnt, 44 motor burnt, 69 pump defect, 34 bore failure 7 control panel, and 3 11 KVA line defect.

12.2.5 LBOD Stage-1

LBOD Stage-1 project was prepared in November 1983, PC-1 was submitted to Government of Pakistan in Feb. 1984, approved by ECNEC in August 1984 and construction of LBOD Stage-1 project started in 1985-86 and completed in 1997 except Chotiari Reservoir, which was completed in 2002 and handed over to SIDA. Total area served by the three component projects Nawabshah, Sanghar and Mirpurkhas is over Gross Command Area (GCA) 1,426 MA and Cultural Command Area (CCA) 1,276 MA and other infrastructure as shown in Table 12.1.

The System comprising three components Nawabshah, Sanghar and Mirpurkhas LBOD Branch Drain and outfall System were handed over to Irrigation Department/Sindh Irrigation & Drainage Authority upto 2002. WAPDA Operated System for one year before management transfer to IPD/ SIDA.

Nawabshah Component

Nawabshah component provides drainage facility on gross area of 0.626 MA with a network of main branch and sub-drains totaling 323 Km. Subsurface drainage components comprise 274 tubewells and scavenger wells 191 and 225 Km of interceptor drains. The tubewells have been designed to operate at 60 % efficiency and maintain water table at 7 ft below ground surface. Storm Drainage disposal has been provided through network of surface drains and inlets for evacuation of 50 % component of rainfall and 50 % allowed for deep percolation. Surface drainage network will provide evacuation of storm runoff within 2 days to 3 days through network of inlets. Tubewells are non-operational due to various reasons, 100 due to transformers theft/burnt, 133 due to 11 KVA line defect, 26 due to motor defect and 33 due to defective pumps.

Sanghar Component

Sanghar Component provide drainage facility over a gross area of 0.424 MA with network of main, branch and Sub-drains. 93.8 % of this area has been provided with Sub-surface drainage by 642 tubewells and 175 scavenger wells, 122 Km of interceptor drains are provided for seepage control along main canals. The Tube wells have been designed to operate at 60 % efficiency and maintain water table at 7 ft below ground surface. The project has been designed to reduce flood damage by lowering high water table to provide more capacity for infiltration of excess irrigation applications and part of storm water. Surface drainage network will provide evacuation of surface runoff within 2 and 3 days. 572 tubewells are operational and 224 tubewells are non-operational due to various reasons. Tubewells are non-operational due to transformers burnt/theft, 70 11 KVA line fault, 5 bore failure, 48 motor burnt defect, 11 pump defects and 6 control panel defect.

Mirpurkhas Component

Mirpurkhas component provides drainage facility over a gross area 0.376 MA, with network of main branch and Sub-drains Main drain following the approximate course of existing Dhoro Puran. Most of the project area (77.1 %) has been provided with Sub-surface drainage by 752 tube wells, tile drains on 0.55 MA. The project has been designed to reduce flood damage by lowering water table to 7 ft. depths for enhancing infiltration of excess irrigation application and storm water. Surface drainage network will provide evacuation of storm runoff within 2 days to 3 days through network of inlets. There are 188 operational and 172 non-operational tube wells. The tubewells are non-operational due to various reasons i.e. 36 due to transformers theft/burnt, 100 11 KVA line fault, 27 motor defects, and 9 pump defect and16 control panel defect.

Table 12.1: Command area and drainage infrastructure in LBOD stage-1 component

Component	Gross area	Culturable command area (CCA)	Length of Surface drains	Length of disposal channel	No. of drainage T/W	No. of Scavenger wells	Int. Drains		Tile drains		No, of storm water inlets
							Length	Pumping stations	Area served	Pump station	
Unit	%0 acres	%0 acres	Km	Km	No.	No.	Km	No.	%0 acres	No.	No.
Nawabshah	626	555	323	602	274	191	225	53	-	-	435
Sanghar	424	632	554	913	642	175	122	122	-	-	566
Mirpurkhas	376	359	326	876	752	-	235	75	55	68	590
Total	1426	1276	1203	2391	1668	365	582	250	55	68	1581

Adequate recovery of drainage O&M costs from farmers is essential if the system is to be operated and maintained effectively.

The main characteristics of well-operated canal system can be enumerated in their order of importance:

- Reliability (arrival of water according to schedule).
- Timely supply (meets irrigation requirements).
- Equitable distribution (for all outlets along a distributary).
- Efficient supply (minimization of water losses and wastage in regulation).
- Accountability, discipline and enforcement.
- Maintain canal O&M standards
- Minimum involvement of system administration combined with maximum co- ordination with farmers.

A well-operated irrigation system should aim at the achievement of most, if not all, of these characteristics.

12.3 Operational Deficiencies

The short comings in the O&M activities of canal system which should be avoided are listed as under:

i. The primary problem in alluvial canal systems in Pakistan is that the sanctioned flow does not reach the tail end outlets of distributaries and minors. Some of the reasons why water does not reach the tail end water courses are:-

   a) Over drawl of outlets upstream.
   b) Inaccurate seepage loss estimates.
   c) Inaccurate inflow estimates.
   d) Sedimentation and resulting change in water surface levels.
   e) Improperly set outlets/ or faulty design of outlets.
   f) System changes since what was designed or constructed.
   g) Limited desilting.
   h) In-efficient management
   i) Socio-political pressures.

ii. Absence of sufficient standard water measurement devices to ensure accurate distribution of water as planned.

iii. Scheduling and delivering water in canals without considering crop demand, which tends to wastage, excessive losses, over-irrigation or under-irrigation. These result in low crop yields, salinization and water logging besides wastage of water.
iv. Inefficiency of management results in unreliable and inequitable distribution of water among outlets. Operation of canals either in excess of or below the designed discharge resulting in alterations in geometry of canal sections.
v. Poor communication and transportation systems which can totally fail during emergency (storms, rainfalls etc).
vi. Handling the system specially operation & regulation by illiterate or semi-skilled persons.
vii. Minimal participation of the farmers or their viewpoint in all operation activities of canal systems.
viii. Inadequate performance standards.
ix. Frequent breaches of canals and interruptions in water supply, particularly at distributaries and minors levels due to inadequate maintenance, or by farmers.
x. Insufficient or not well defined procedures of monitoring, evaluation and accountability at all levels of management.
xi. Administration is lacking in preparation of operational and maintenance plans and their implementation.

12.3.1 Good Operating Maintenance System

- Keep the system in top operating conditions at all times through proper maintenance.
- Obtain the longest life and greatest use of the systems facilities by providing good maintenance and timely replacements.
- Achieve the foregoing objectives at lowest possible cost.

12.4 Effective institutional arrangements, enhancement in rates/charges

Water rates, known as *abiana* are charged by the Provincial Government for canal water supplied to irrigators. This is not a tax, but a service charge recovered from the farmers in respect of matured crops only. The history of the modern rates structure dates back to 1873, when the Canal and Drainage Act was enacted. Section 36 of this Act prescribed that *"The rates to be charged for canal water supplied for the purposes of irrigation to the occupiers of land shall be determined by the rules to be made by the Provincial Government and such occupiers as accept the water shall pay for it accordingly".*

An important sector covenant is the requirement to achieve full recovery of the O&M cost of Irrigation and Drainage system. The actual level of cost recovery declined due to inflation. The transferring of secondary level irrigation and drainage O&M to FOs the aiming at phasing out subsidies for O&M within the shortest span of time, which is only possible with efforts of Sindh Government in imposing drainage cess at the earliest and enhancement of *abiana* rate together with strict implementation of transparent recovery system.

Proper operation and maintenance of any system demands participation of beneficiaries sharing the responsibilities. The establishment of Provincial Irrigation and Drainage Authority (SIDA) to look after operational system of Irrigation network. Water boards at divisional level established to supervise and guide the Water Users Association. The flat rate of abiana be perceived to help the farmer's community escape from the high-handedness of revenue staff.

12.4.1 Contract Water and Water Rates

The Association or federation of Associations at any level , may contract with the Irrigation Department for the supply of canal water on a contract basis at the outlet, or contract on a volumetric-rate basis at the minor or distributary canal, as provided in the canal rules, instead of the crop-rate basis commonly used. The Association will collect, and pay, the agreed rate to the government.

12.4.2 Financial obligations and sources of income

To meet its financial obligations, farmer organizations should levy charges for all types of water related services. The cost of operating irrigation and drainage systems is the basis commonly used for

determining service charges in the water sector throughout the world. Therefore, the cost of a service delivery can be determined easily when services are rendered by a single farmer organization thus, a realistic assessment should be made. In accordance with SIDA Act 1997, farmer organizations are liable to meet some financial obligations while managing parts of irrigation system.

12.4.3 Payments to Area Water Boards (AWB)

According to SIDA Act, FO shall remit to AWB, the amount required to meet the costs for the management and operation of the canal system supplying water to the area under the jurisdiction of FO. The act empowers FO to keep operating and reserve funds under interest bearing fixed deposits in a bank. FO is bound to spend interest accrued from the fixed deposit amount on operation and maintenance including allied activities of the irrigation system.

12.4.4 Water Rates Assessment and Collection

With the passage of time, revenues have declined as water rates could not keep pace with the rising inflation. The factors affecting the wide gap between O&M cost and recoveries are gradual build up cost of public tube wells, flood works and establishment, stagnation of water rates, and declining collections. Abiana collection against current demand in Sindh for the Year 1999-00 to 2009-10, the recovery range is 51% to 98% with an average of 90.4 % as depicted in the following Table 12.2.

Table 12.2: Abiana Assessment V/s Collection

Year	Assessment/Demand (Rs. Millions)	Collection (Rs. Millions)	Recovery
1999-2000	624.05	597.91	95.81
2000-2001	453.50	428.92	94.57
2001-2002	380.24	341.73	89.87
2002-2003	362.86	290.25	98.00
2003-2004	293.66	223.83	72.00
2004-2005	276.00	245.29	62.00
2005-2006	276.00	255.46	55.00
2006-2007	240.45	227.30	51.00
2007-2008	268.20	247.99	92.45
2008-2009	183.25	159.13	86.84
2009-2010	260.65	254.21	97.53
Average	329.06	297.46	90.40

Source : Board of Revenue, Sindh Hyderabad

SIDA was established as per SIDA Act passed in 1997 and Government of Sindh gave responsibility of abiana assessment and collection to SIDA/AWBs/FOs under institutional reforms program. The agreement between Board of Revenue and SIDA was signed on May 16th, 2001 for assessment & collection of abiana from Kharif 2000 onwards by AWBs beginning from Nara Canal AWB given in Table 12.3.

Table 12.3: Establishment of Area Water Board (AWB)

Area Water Board	Year of Establishment	Authorized for Recovery from Season	Administrative Districts	CCA (Million)
Nara Canal AWB	1999	Kharif 2001	Mirpur, Umerkot, Sanghar, Khairpur	2.273

Left Bank AWB	2002	Kharif 2003	Badin, Hyderabad, T.M.Khan	1.416
Ghotki Feeder AWB	2002	Kharif 2003	Ghotki & Sukkur	0.851

Source : SIDA

Area Wise *Abiana* Responsibility of FOs is given in table 12.4.

Table 12.4: Area Wise *Abiana* Responsibility of FOs

AWB	FOs Signed IDMT	Total FOs collecting *Abiana*	Area (CCA in million acre) with FOs	Area (CCA in million acre) with AWB	Total (in million acres)	Remarks
NCAWB	159	159	1.386 (60%)	0.906	2.292	
LBCAWB	93	55	0.791 (66%)	0.624	1.415	
GFCAWB	62	61	0.576 (69%)	0.253	0.829	
Total	314	275	2.753 (61%)	1.783 (39%)	4.537	

Source: SIDA

AWB wise number of abdar v/s area and their performance are shown table 12.5.

Table 12.5: Number of Abdar vs Area

AWB	Total CCA (Ma)	Total Abdars	Per Abdar Area (Acre)	Standard Area per Abdar (Acre)	Remarks
NCAWB	2.292	144	15917	5000	Out of 313 Abdars many do not perform their duties.
LBCAWB	1.415	93	15218		
GFCAWB	0.829	76	1092		
Total	4.537	313			

Source: SIDA

Area water board wise abiana target and achievement is shown in Table 12.6.

Table 12.6: Statement of Target & Achievement of Abiana in Nara, Left Bank and Ghotki Feeder AWBs

S. No.	Year	Target (Rs. Millions)	Achievement (Rs. Millions)	% age
Nara Canal AWB				
1	2001-02	66.82	59.60	89%
2	2002-03	64.20	45.28	71%
3	2003-04	53.98	36.09	67%
4	2004-05	59.74	22.65	38%
5	2005-06	66.11	19.47	29%

6	2006-07	39.69	14.21	36%
7	2007-08	40.93	5.38	13%
8	2008-09	74.15	34.85	47%
9	2009-10	69.38	38.15	51%
Sub Total (A)		535.00	275.56	52%
Left Bank AWB				
1	2003-04	18.74	6.32	34%
2	2004-05	22.39	8.16	36%
3	2005-06	25.22	8.57	34%
4	2006-07	21.21	7.35	35%
5	2007-08	20.64	7.44	36%
6	2008-09	36.21	12.31	34%
7	2009-10	29.08	13.28	35%
Sub Total (B)		173.49	63.47	37%
Ghotki Feeder Canal AWB				
1	2003-04	37.85	23.95	63%
2	2004-05	37.06	14.90	40%
3	2005-06	28.84	17.46	60%
4	2006-07	21.47	14.33	66%
5	2007-08	19.17	14.61	76%
6	2008-09	19.59	17.63	67%
7	2009-10	8.03	7.35	55%
Sub Total (C)		172.01	110.03	64%
Grand Total A+B+C		**880.50**	**449.06**	**51%**

Source: SIDA

Table 12.7: Summary of abiana collection in 3 AWBs in Sindh (as of June 2012)

AWB	**Target (Rs. in Millions)**	**Recovery upto June 2012**	**Percentage**
GFCAWB (2003-2010) Kharif	172.03	110.03	64 %
LBCAWB(2003-2010 Kharif	173.52	63.47	37 %
NCAWB (2001-2010) Kharif	535.03	275.56	52 %
G. Total	880.58	449.06	51 %

Source: SIDA

The data in above table shows that out of total target of Rs.880.58 millions the recovery is only Rs.449.06 million which works out to 51% in the three AWB (Table-12.7).

Agency wise outstanding

Table 12.8: Agency wise outstanding Dues

S.No.	Agency	Total Dues			Total
		NCAWB	GFCAWB	LBCAWB	
A	Agriculture				
1	FO/Farmer	192.07	3.45	3.4	198.92
2	AWB Agriculture Consumer (Non Farmer)				
B	Non Agriculture				
3	Muncipal & Town Commitees	7.70		-	7.70
4	Union Council/VDAs	8.00		-	8.00
5	Army/ Airforce	2.50		-	7.50
6	Forest & Fish Ponds	17.90		1.00	18.90
7	Sugar Mills	54.90		2.50	57.40
8	Oil Fields	8.50		5.40	13.90
9	Pakistan Railway	0.70		-	0.70
10	Industries	0.50		20.41	20.91
11	HDA/WASA	-	-	63.50	63.50
12	Others (Cattle Colony, Schools etc)	-	-	-	40.02
	Grand Total	292.77	8.45	92.81	437.45

Source : SIDA

12.4.5 Reasons of low recovery

Following are the main reasons for low recovery by different agencies in three AWBs;

- Lack of commitment of field staff
- Lack of transparency and improper receipt books
- Unauthorized recovery by the revenue staff
- Political interference
- No third party audit of assessment and collection
- Non-notification of Drainage Cess by the Government of Sindh

12.4.6 Steps for improvement and enhancement in recovery of *Abiana*

Following are the suggested steps for improvement and enhancement in abiana recovery.

- Water requests and water deliveries have to be recorded and matched with conveyance capacity, seasonal water allocations and total water
- Water deliveries have to be converted into financial transactions.
- Installation of “Check Valve with Water Meter” at the head of a watercourse.

- Water closure device at the head of water course be installed.
- Installation of Irrigation System Controllers for supplying water in the necessary quantity and at the right time, which may be mechanical or electromechanical irrigation timers.
- Issuing water charges bills half yearly instead of annually(after Kharif and Rabi)
- Levy of surcharge of minimum 10 percent on late/non-payment of dues in time.
- Improved collaboration between Irrigation and revenue departments
- Monitoring/ review by a three member team of Irrigation, revenue and accounts professionals to check the status of receipt and expenditures after each agriculture season (Kharif, Rabi)
- Enhancement of powers of FOs to curtail or cut-off water supplies to defaulters.
- Steps to curb theft of water, so that equitable water distribution is maintained and prevention of illegal use of more water than their designed share.

12.4.7 Way Forward

It is necessary to estimate the full cost of water used in a particular sub-sector of water use and this should include the Opportunity Cost of water as well as the Environmental Externalities. The Full Cost should present the context for setting water prices, effluent charges, and incentives for pollution control

For estimating the value of water, it is critical to reflect societal objectives of poverty alleviation and food security, and incorporate the net benefits from return flows and non-irrigation uses of water. The present level of water fee (Abiana) charged is a portion of the O&M cost, there is a need to develop methodology for estimation of full value of water.

There is a need to gradually develop strategy for costing and charging of water fee so that rapid increase in Abiana and other water fees may not affect the users adversely. Furthermore, inter-sectoral strategy is also needed for charging in different sub-sectors of water use i.e.agricultural and non-agricultural users. Raising water tariffs, levying effluent charges and encouraging water markets can play significant roles in improving economic efficiency and environmental sustainability of water use.

It is proposed that the FOs may enter into a Service Performance Agreement with a contractor for collection of water related charges after assessing the amount of Abiana. The Highest Bids be evaluated “Technically” and “Financially”, on the basis of which a binding contract between FO and a service contractor for collection of water charges (Abiana).

12.5 Development of O&M Yardstick for Irrigation and Drainage System 2012

12.5.1 Introduction

The yardstick is the standardized estimate for cost per unit quantity of work. Quantification of a reasonable level of expenditure to sustain an effective irrigation system was carried out in 1978/79. O&M costs were desegregated both into amounts per CCA and per length of canal, drain and bund and per tubewell. All establishment staff costs were excluded. An updating study was carried out in 1988 the purpose of which was to calculate the reasonable requirement for O&M expenditure on the irrigation and drainage network existing at the time of the study based on actual costs in 1986/87.

The use of yardstick for various components of maintenance works greatly simplifies and facilitates the preparation of the non-development budget. The yardstick were first introduced in the Irrigation Departments of all provinces in 1937, and used in all provinces for budgeting purposes by applying a multiplier to account for the inflation. The yardsticks are to be updated and got to be approved from the Finance Department.

Estimates of reasonable O&M costs (’’yardstick”) were made in 1978/79 by Sindh Irrigation Department and updated in 1988 based on 1986/87 activities and costs. The yardstick provided costs per unit of canal, drain, structure etc. (excluding establishment staff costs) and approximately translated to a 1988 rate of Rs 25/ acre and Rs 38/ acre for land without and with drainage respectively. It appears that IPD Divisions, in preparing their budget bids, no longer make much use of yardstick in view of non-acceptance by the GOS Department of Finance. Instead budgets are built

up from calculations of establishment costs and estimates of the maintenance work to be done using standard construction rates, the last revision of which was in 1989. well below the estimated real costs.

Maintenance of the system is carried out by three different methods:

- Using permanently or seasonally hired labour (Beldars) supervised by Daroghas
- Using plant and equipment hired from the Mechanical Divisions ; and
- Using contractors for both plant and labour.
- Routine minors maintenance of embankments and structures is carried out by the Beldars, each being allocated a specific length of canal. Greasing of gates etc. is carried out by the Tyndils. Cleaning and desilting of the distributary and minor canals is normally limited to the annual closure period (2-3 weeks in December/January) when both hand labour, bulldozers and sometimes tractors are used.

Hand labour by Beldars is sometimes augmented by farmers assisting on a 'self-help' basis. Major earthworks and structural works are mainly undertaken by contractors during the closure period although bank raising and strengthening is carried out by tractors and bulldozers working over longer periods.

The AWB's and FO's are required to have realistic staff for proper O&M of distributaries and minors under their command. he O&M works likely to be undertaken by AWB's and FO's include weed growth clearance, debris removal, bed clearance, maintain banks and inlets, repair and maintenance of cross drainage works,tubewells, and monitoring the drainage flows under their jurisdiction.Their project area covers command areas of Guddu, Sukkur, and Kotri Barrages.

The drainage network is clogged with silt and weeds. This restricts free flow of the drainage effluent and causes breaching. At present the routine maintenance are deferred due to limitations of maintenance funds, and even the available funds are not being judiciously utilized.The periodic operation and maintenance of the system is carried out through maintenance funds allocated for each component which is mainly based on general parameter for yearly maintenance and operational features. Therefore an approved yardstick is required for equitable distribution of funds for different components of system network.

The 'Maintenance Yardstick' approved by the competent authority are used against the existing inventory of irrigation facilities to act as a baseline for estimating proposed Operation and Maintenance budgets for works components.

12.5.2 Operation and maintenance yard-stick:

For the flow irrigation to be beneficial, a Drainage cover is a complimentary part. The percolation water from fields, the seepage from porous banks of earthen Channels, the rainfall and floods cause a slow rise of the Sub-Soil water level. The Drainable Surplus, unless it is disposed, may encroach on the root-zone soil to affect the health and yield of crops, due to water-logged conditions. Also the rising S.S.W.L brings up the injurious salts, with capillary transport, to affect root zone and land surface with salinity.

The SCARPS Projects were executed by WAPDA and handed over to the Irrigation and Power Department for Operation and Maintenance at the standard laid down by the aid giving agencies. However, the operational cost and maintenance of the SCARP tubewells manifold surpassed the abiana/drainage cess collection, a heavy burden on the exchequer.Due to deferred maintenance, most of the tubewells are dysfunctional or nonoperational. Even some tubewells infrastructure are non-existent and their remains are only available, as some tubewells have lost their basic infrastructure due to want of repairs and replacement, vandalizing of pumps, motors, electrical fittings, transformers, hookups, high or low tension wires and deferred maintenance with the result that many tube wells are out of commission.For the O & M of SCARP Tubewells and Pump Stations, Electricity happens to be the main constituent of expenditure. Its tarrif of Rs.10 per Kwh has increased to to fuel adjustment charges and other factors. Consequently the maintenance liability of these facilities has

increased to manifold than that in 1988. To partly meet with the increased O & M expenditures a drainage cess is levied on basis of area actually grouped. However like flow Irrigation & Low lift Irrigation (Pumping) Schemes, some subsidization is necessary in case of SCARPs.

The Yard-Stick for Tube wells and Pump Stations on the basis of unit rate per Horse Power and for Carrier/Surface Drains on the basis of per mile.

12.5.3 Methodology

The maintenance costs for the provincial-level have been obtained from the maintenance yardstick of the Government of Sindh and inflated to the 2011-2012 level using the inflation rates. The establishment (or operational) costs have been directly taken from the actual budgets of the Sindh Irrigation Department. The O&M costs for the branch and sub-drains and the FO level costs have been worked out separately.

The maintenance and repair (M&R) costs include construction, repair, silt removal, removal of weed growth. Maintenance and repair costs can be defined as the direct costs expended on the physical upkeep of the irrigation system. Another category of maintenance costs is referred to as ‘’ ***rehabilitation and improvement***’’ cost. These costs do not form part of the regular maintenance cost allocations but are prepared as development projects and are generally aimed at re-modeling drainage system

i. Background
ii. Introduction
iii. Objectives

The Province of Sindh has a vast irrigation and drainage network and is one of the primary beneficiaries of the Indus Basin Irrigation System of Pakistan which is considered as one of the largest contiguous irrigation systems in the world. Sindh has three major barrages on the Indus River that divert approximately 48 million acres feet MAF (59) billion cubic meters-BCM) of water annually to the 14 main canal commands in Sindh Province. These canal systems have an aggregate length of 13,325 miles (21,445 Km), which serve a gross command area (GCA) of 14.391 million acres (5.8 million ha). There are also about 42,000 watercourses (tertiary channels), which have an aggregate length of about 75,000 miles (120,000 Km). The water diversion in the study area is approximately 11.6 MAF for eight canal commands.

The project area covers command areas of Guddu, Sukkur, and Kotri Barrages, with respect to canal systems, the discharges, length and CCA are shown in Table 12.9.

Table 12.9: Left Bank Canals

S,No	Canal System	Discharge (cusecs)	Length (Km)	CCA (M. Acres)
1	Ghotki	8490	1448	.85
2	Nara Canal	13649	2679	2.24
3	Rohri Canal	16600	3779	2.60
4	Khairpur Feeder West	1940	578	0.32
5	Khairpur Feeder East	2094	734	0.37
6	Pinyari Canal	13636	1260	0.79
7	Fuleli Canal	14859	1162	0.93
8	Akram Wah	4100	758	0.49
	Total	75,368	12,398	8.59

The Drainage on the Left Bank of Indus comprises of the following:

i. Ghotki Drainage
ii. Khairpur Drainage System
iii. Scarp North Rohri (SNR) Drainage System
iv. Scarp South Rohri (SSR) Drainage System
v. Left Bank Outfall Drainage System (LBOD)

vi. Kotri Drainage System

The Sub-surface Drainage System on the Left Bank of Indus comprises of:

- Tubewell
- Tile drainage Project

The drainage network clogged with silt and weeds, restricts free flow of the drainage effluent and causes breaching. Weed growth in the drains is a serious problem. This causes obstruction in the flow of water and induces rapid siltation of drains.

At present the routine maintenance are deferred due to limitations of maintenance funds, and even the available funds are not being judiciously utilized.

The periodic operation and maintenance of the drainage system is carried out through maintenance funds allocated for each component based on demand which is mainly based on general parameter for yearly maintenance and operational features. Therefore an approved yardstick is required for equitable distribution of funds for different components of system network.

The 'Maintenance Yardstick' approved by the competent authority are used against the existing inventory of irrigation facilities to act as a baseline for estimating proposed Operation and Maintenance budgets for works components.

12.5.4 Maintenance Objectives and Activities

Objectives

i. Keep the system in top operating condition at all times through proper maintenance.

ii. Obtain the longest life and greatest use of the systems facilities by providing good maintenance and timely replacements.

iii. Achieve the foregoing objectives at lowest possible cost.

Activities

The drains carry large volumes of water over long distances which are generally made of earthen banks from the locally available fine to coarse soil particles. The earthen banks are prone to weathering action such as rainfall, wind etc. The rate of deterioration depends on the soil and climatic condition of each area. The major damage occurs due to rainfall and traffic trespass etc. Sedimentation reduces channel cross sectional area. Operating levels are raised to maintain design flow thus reducing free board. Any neglect with regard to maintenance may lead to failure of the bank causing huge damage to the adjoining crops, property and communication network.

All structures and facilities for storage of water are subject to deterioration in varying degrees. Constant vigilance is necessary to identify and correct potential unsafe or unsatisfactory conditions as they develop. General erosion, settlement of embankment or structure, scour, seepage washing away of embankments can result in major failures if not corrected or repaired without delay. Breaches are an expensive failure, not only due to the cost of repair but for the loss or damage to crops of the farmers directly affected as well as those living downstream. An effective program of maintenance would include the following activities:

i. Routine Maintenance
ii. Preventive Maintenance
iii. Seasonal Maintenance
iv. Annual Maintenance
v. Unscheduled Maintenance
vi. Emergent Repairs

This requires considerable planning and accurate Work Plans by the implementation agency.

12.5.5 Categories of Drains

For determining yardstick, the drains will be classified in following five categories.

Discharge (Q)	Bed width (Ft)	Classification
Upto 25 cusecs	Upto 10	Sub Drains
25-100 cusecs	10 to 15	Branch Drains
100-500 cusecs	15 to 25	Main Drains
500-1000 cusecs	25 to 50	Main Drains
Above 1000 cusecs	Above 50	Outfall Drains

(2) Drain Maintenance Standards

The jobs involved in maintenance drains are:

- Repair of outside slopes and inspection path.
- Maintenance of channel beds to design level by periodical removal of silt.
- Maintenance of structures such as bridges, culverts, siphons, aqueducts and inlets
- Painting of metal surface of gates and greasing of gears of regulators.

The maintenance standards adopted are:

Facility	Maintenance standard
Drain embankment	Replace 5 inches of material on IP &NIP along 20% by manual labour
Embankment outside slopes	Replace 2.5 inches of material along slopes of 20% channels annually
	Repair 10 rain cuts per 1000 ft annually for channels 100-500 cusecs, 15 raincuts for channels above 1000 cusecs
	Remove all trees and bushes on the outer slopes and control weed growth to facilitate inspection of any seepage.
	Turf 5% of slopes of all drains annually
Embankment inner slope and Berms	Maintain turf on inner slopes and Berms above water level
	Cut weed sand trees from inner slopes and berms to allow visual inspection of drain bank prism
Sediment Removal	Remove annually about 8100 cft of sediment from 25% or minor upto 25 cusecs 20% of drains (25 to 100 cusecs) capacity, and from 5% of drains (100-500 cusecs) capacity.
	Establish monitoring stations at suitable location to ensure that cross sections and sediment concentration remain within designed limits
	Sediment removed shall be placed along toes of outer slopes

Canal Structures	Inspect annually gates. Gears gate hoists and steel accessories and re-paint repair or replace them as needed during canal closure. The cost for these works is to be included as per mile cost of the canals

12.5.5.1 Annual maintenance problems

(a) Channel blockage by deposited sediment and weed growth.
(b) Embankment failures
(c) Revenues generated by the system had not kept pace with rising costs.

Poor maintenance can also produce negative environmental consequences, for example water logging and salinity caused by impeded drainage and adverse impacts on health from water-related diseases.

The Yard-Stick for Tube wells and Pump Stations on the basis of unit rate per Horse Power and for Carrier/Surface Drains on the basis of RDs/Mile.

The O&M cost of the drainage system is expected to rise in future on account of the positive relationship between the age and physical deterioration of the system. There should be cost recovery system to cope with the rising costs of operation and maintenance (O&M) for which reasonable YARD-Sticks are required for each component of the drainage system. SIDA to establish a service-client relationship between SIDA and AWBs, AWBs and FOs, and FOs and individual farmers regarding O&M proportionate amount

There is a need to improve the seriously deteriorated physical condition of the existing drainage system, which has been caused by the persistent accumulation of deferred maintenance. For physical improvement, the FOs will need to undertake optimal investments in O&M of their parts of the system. They also need to pay sufficient money to the AWBs for optimal O&M of the main drains of the system that evacuates water from their areas of concern.

12.5.5.2 Operation and maintenance of Irrigation and Drainage Infrastructure

- The authorities responsible for operation and maintenance are:
- Irrigation and Power Department Government of Sindh
- Sindh Irrigation and drainage Authority (SIDA)
- Area water Boards of Ghotki Feeder, Nara Canal and Left Bank Canals.
- Farmer Organization's (FOs)

From the above stakeholders it is now evident that the AWB's and FO's are also required to have realistic staff for proper O&M of Distributaries and Minors under their command.

The O&M works likely to be undertaken by AWB's and FO's include weed growth clearance, debris removal, bed clearance, maintain banks and inlets, repair and maintenance of cross drainage works, bridges, Tubewells, Tile drainage Sumps and monitoring the drainage flows under their jurisdiction.

The O&M expenditure partly can be financed through Abiana (water charges) and Drainage Cess. It has been learnt from the concerned agencies (SIDA & PID) that at present no drainage cess is being charged and collected as they require notification from the Provincial Department

12.5.6 Water Rates Assessment and Collection

With the passage of time, revenues have declined as water rates could not keep pace with the rising inflation. The factors affecting the wide gap between O&M cost and recoveries are gradual build up cost of public tube wells, flood works and establishment, stagnation of water rates, and declining collections. Abiana collection against current demand in Sindh for the Year 1999-00 to 2009-10, the recovery range is 51% to 98% with an average of 90.4 % as depicted in the following Table.

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Year	Assessment/Demand	Actual Collection	Recovery %
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2002-2003	362.86	355.60	98.00
2003-2004	293.66	211.43	72.00
2004-2005	276.00	171.12	62.00
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Average	329.06	297.46	90.40

Source : Board of Revenue, Sindh Hyderabad

SIDA was established as per SIDA Act passed in 1997 and Government of Sindh gave responsibility of abiana assessment and collection to SIDA/AWBs/FOs under institutional reforms program. The agreement between Board of Revenue and SIDA was signed on May 16th, 2001 for assessment & collection of abiana from Kharif 2000 onwards by AWBs beginning from Nara Canal AWB.

2010- 2011	Nil	Remission on account of failed crops due to very high flood
2011- 2012	Nil	Remission on account of failed crops due to heavy Rains

Flat rate assessment of Abiana will form the basis of assessment of water rates (Abiana) for Kharif and Rabi season. It is suggested that assessment of water rate (Abiana) is leviable per acre of C.C.A (culturable commanded Area).

The Yardstick Provision and Actual Budget 2011- 12

The reasonable requirement for O&M of Irrigation infra structure fire 2011 -12 (works only) is consolidated at page it is compared with actual allotment below, to find a gap between the two figures

Table 12.11: O&M Requirement and Budget (Million Rs.)

Head of Account	Consolidated O&M Requirement 2011-12	Budget Grant (Million Rs.) 2011-12
0422 Flow and Lift Irrigation and Embankments (works only)	2533.688	538.615
0423 Land Reclamation	2445.754	250.598
Total	4979.442	789.213

- Insufficient budgetary provisions by Government for operation maintenance of the Irrigation system and Drainage network.
- Gap between O & M Fund requirement and cost recovery.

12.6 Irrigation System of Left Bank of River Indus

The irrigation network of Guddu, Sukkur and Kotri Barrages comprises 14 feeders and main canals, 1462 branch canals, distributaries and minors. The area on the Left side of Indus includes the following canal systems

12.6.1 Summary of Yardstick

Table 12.12: Operation & Maintenance of Irrigation & Drainage Infra-Structure

Facility	Qty or No.	Unit Yard Stick Rate	Amount (Million) Rs.	Remarks
a. Irrigation works Flow Irrigation (including Irrigation colonies)	10257 Virtual miles	153407	1573.5	
Repair and Replacement of Barrages Gates & other E&I works	0.05x5618.12		280.9	
b. Lift irrigation (Small Irrigation Scheme)				
On canal	3705 H. Power	65329	242.044	
c. Flood Embankments				
(a) Main Bunds (River)	935.00 miles	368140	344.211	
(b) Loop Bunds (River)	339.00 miles	296026	100.353	
	Total Irrigation	**(0422)**	**2541.08 Millions**	
d. Land Reclamation (0423) Works				
(1) SCARP Tube wells (3837 Nos.)	77528.4 H.P	23286 Per H.P	1805.33	
(2) SCARP & other Pumps (31 No.)	1804.2 H.P	21302 Per H.P	38.433	
(3) SCARP & other surface Drains	5157.8 Virtual Miles	69760 Per Mile	359.808	
(4) SCARP Colonies	12 Nos.	Varies Colony	19.842	
		Sub Total:	2223.413	
II. Add 10% Provision for E & I and other works			222.341	
	Total Land Reclamation (0423)		**Rs. 2445.754 Million**	

Therefore Grand Total Irrigation & Land Reclamation 2541.08+2445.754=4986.762 Million

Now C.C.A of the three Barrages left side including Lift Irrigation Schemes = 8.59 Million Acres

Therefore rate per acres of CCA (with Drainage cover) = 4986.762/8.59 = Rs. 580.53 P/ Acre

Unit rate to be recovered for irrigation & Drainage = Rs. 580 Per Acre

CCA is located on left bank of Indus.

12.6.2 Yardstick per Cusec Utilization

To work out the economics of irrigation supplies, a Yardstick on the basis of one cusec utilization could be worked out as under:

i. One cusec irrigates 80 Acres Dry Crops in Kharif + 120 Acres Wheat/Pulses in Rabi = 200 acres in a year.

ii. Considering Average Net Production value of Rs 15000/- per acre (excluding cost of inputs such as seed, fertilizer etc. but including farmer's share) the net addition afforded by 1 cusec to G.N.P. would be Rs 200×15000 = Rs.3000000 per cusec of water.

iii. The Canals supply a total quantum of 49 MAF daily discharge of (49×1000000)/ (365×2) = 67123 cusecs. Therefore, net addition to G.N.P. afforded by 67,123 cusecs becomes Rs.30,00,000× 67, orRs.201,369 Millions.

iv. Finally considering only 2% as working expenses of above, the cost for O&M will be Rs 201,369×0.02=4027.38 million. Therefore Yardstick Rate per one cusec utilization of irrigation water = 4027380000/67123=Rs.60,000.

Yardstick Rate Per one cusec utilization is Rs.60,000.

12.6.3 Yardstick Rate per Acre Cropped

One cusec of irrigation supply cultivates 200 acres of land. As such yardstick per acre of cropped area will be 60,000/200 = Rs.300/-

Working expenses = Rs. 6.525 / 2.783 = Rs. 2.34 per cultivated acre, in year 1933-34[47]

Now considering Average 5% escalation from 1933-34 to year 2011-12 i.e 78 years, the working expenses per Acre cropped, will escalate to Rs. $(1.05)^{78}$ = 44.954 x 2.34 = 105.19

Considering the total cultivated area 9.707 million acres x 105.19 = 1021.08

Yardstick Rate per acre cropped is Rs.1021.08

12.6.4 Yardstick per Virtual Mile (Of flow Irrigation)

The actual mileage of Irrigation Channels of all categories is 11846 and VIRTUAL mileage is 14865 worked out as under:

Mileage	Actual Length (Miles)	Virtual Length	Miles
Main Canals & Feeders	2242	2242×2=4484	4484
Branches	1555	1555×1.5=2332	2332
Distributaries & Minors	8049	8049×1=8049	8049
Total	11846	Virtual Miles =	14865

Whereas the total length of irrigation channels on left bank of Indus is 8130 miles, which is 69% of Sindh Province as such virtual length will be 10257 virtual miles of left bank canals.

For convenience of calculations a representative section of a channel which carries a discharge of 251 cusecs, having a bed width of 30 feet, F.S.D of 4.0 feet and mean velocity of 2.1 ft/sec. is adopted. Its virtual mileage will be 1.5 times the actual. The top widths of Inspection Path & NIP will be 12 feet and 8 ft. respectively[48].

12.6.5 Unit Rate per Actual mile:

1. ***Regular W.C. Estt.*** @ ½ man per actual mile for both banks @ Rs.6000/- per month i.e. 1/2×6000×12=Rs.36000 per year. Considering that only 1/20% W.C. Estt; remains to be converted the fractional amount of this Sub-Head = 1/20×36000 = Rs 1800

2. ***Abkalani W.C. Estt:***

[47] *(Source; Sukkur Barrage Completion Report).*

[48] (Source: Yardstick 1988)

i.	Beldars	@ 1 man/actual mile for both banks @ Rs6000/- per month for four months i.e. Rs.1×6000×4= Rs.24000
ii.	Gang of Coolies.	@ ½ man/actual mile @ Rs.6000/- for 4 months i.e. 1/2×6000×4 = Rs12000
	Sub-Darogas,Gauge Readers,Cycle Messengers & Telephone Operators.	@ 1/20 of (a) & (b) above i.e. Rs. (24000+12000)/20 = Rs.1800 Sub Total : (1) + (2) = Rs.37,800

3. Abkalani Stores

There are 32 Divisions charged with up-keep and safety of canal systems each purchasing Abkalani materials worth Rs.500,000 for protection and cure against leaks developing into breaches.

Total purchase will be= Rs.500,000×32 = Rs.16,000,000

Thus Rate per actual Mile = 16,000,000/11846 = Rs.1350.67

4. Silt Clearance

Channels get silted due to sluggish velocity in hard-flow commands, fluctuations of discharge in non-perennial channels and disturbed flow conditions on account of un-authorized withdrawals, less carrying capacity of flumed and drowned structures etc. The normal silt charge of 4 gms/litre or 0.113kg/cft of water gets doubled during May-August. If only 1/2 percent of this quantity gets deposited in such conditions, the computations will show that the channel will silt in 0.44 ft. depth to give quantity in one mile as 0.44×30×5000 = 66000 cft. Again reckoning that 20% length of Perennial channels and 30% length of Non-Perennial channels will need silt clearance and considering Perennial to Non-Perennial Ratio of 5:3, average 23.75 percent of total length will need Silt Clearance.

Applicable Rates (SCSR-2012)

Break-up of Rates/1000cft:

i. Borrowpit excavation = 2117.50 (SCSR, item 3(a), p.)1.
ii. Laying earth in 6" layers, leveling, dressing and watering for compaction complete =Rs. 354.00 (SCSR, item 13(b), p3
iii. Earth work compaction by roller in ordinary soil =Rs.1445.58(SCSR Part VI, item 7(c) ,p2/16
Total rate = (a) + (b) + (c) = 2117.50+354.00+1445.58 = **Rs.3917.08 per %0cft.**
(a) The quantity per mile = 66000×23.75/100=15675 cft

. Therefore Cost per mile= Rs.(15675×3917.08)/1000 = Rs.61400.

(b) Construction of groynes, weed clearance, canal trimming and removal of

tudas and passis @ 5% of above i.e. Rs 61400×.05 = Rs.3070.

Yardstick Rate = (a) + (b) = 61400+3070=**Rs.64470/-.** per mile of flow irrigation.

5. Bank Works

(a) The earthen canal banks are subjected to wear and tear for number of reasons such as usage by Government and private vehicles, cyclonic winds, cutting of banks due to un-even flow e would be (12+8) × 0.5 ×5000 = 50,000 cft. and considering that 20% length of canal banks will need earth work the quantity per mile = 50000×20/100=10000 cft

Rate of 10000 @ Rs3917.08/1000= Rs.10000×3.917 = Rs.39,170.

(b) Earth work for closing of Rain Gharas and Leaks and Breaches @ 5% above i.e. 39170×.05 = Rs.1958.50.

Total (a) + (b) = 39170 + 1958.50 = Rs.41,128.50

Yardstick Rate for Banks is **Rs.41128.50** per mile

6. M&R to Structures

The structures need de-watering and inspection of their floors during closure, growing of bellies on D/S, filling up of scour holes near D/S curtain walls, repairs & restoration of gates and gearing, including scraping, painting, oiling and greasing of corrosive parts and change of rollers, repairs of stone or brick pitching's, and counter forts etc.

The Representative channel will have one Head and one Cross Regulator (combined with fall) one Road Bridge of Class-A loading and a Share of other structures such as Syphons, Aqueducts, direct Out-lets/Modules etc. to make a fair estimation of reasonable M&R requirements.

1. Capital cost of Head Regulator, 251 cusecs @ Rs. 13500 per cusec = Rs.3388500.
2. Capital cost of Cross Regulator,150 cusec @ Rs. 13500 per cusec = Rs.2025000.
3. Capital cost of Road Bridge (Class A Loading) @ 150 cusecs @ Rs11250 = 1687500.
4. Capital cost (share) of other structures, such as River Bridges, Syphons & Aqueducts. = Rs.99000.

Total Capital Cost =Rs.7200,000

The M&R at (1.5% ordinary + 0.5%Special) = 2% of above Cost. = Rs 144000..

Again reckoning length of representative channel as 20 miles (self alignment) and 12 miles of Off-taking minor(s) i.e. 32 miles of total length.

The O&M cost per mile = Rs.144000/32 = Rs.4500/mile.

7. M&R to colonies and Inspection Bungalows

The irrigation Department has to maintain colonies spread all over the province with respect to the maintenance of buildings, internal roads, water supply, sanitary, sewerage and street lighting besides the gardens & Lawns attached with them. Due to the expanding socio-economic standards these colonies require renovations, Extension and improvements to cater the housing needs of inmates. The liberal approach in this reasonable requirement for these colonies is as under:

List of Colonies (Canal Irrigation)

Large size		**Medium size**		**Small size**	
1	Sukkur (Very Large)	1	Ghotki	1	Daharki
1	Kotri Barrage Left Bank	1	T.M.Khan	1	Mirpur Mathelo
				1	Pano Akil
				1	Nawabshah
				1	Sanghar
				1	Mirpurkhas
				1	Badin
2 Nos		2 Nos		7 Nos	

A. Colonies

S.No	**Colonies**	**No**	**Basis**	**Amount**	**Remarks**
a	Very large colony at Sukkur	1	M&R @ 3 times of Medium Colony	1×3 ×3839036= 11517108	
b	Large size colonies	1	M&R @ 2 times of medium colonies 3×2×	1×2× 3839036 = Rs. 7678072	
c	Medium size colonies	2	2×3839036 = Rs 7678072	7678072	
d	Small size colonies	7	7 ×685694	4799858	
	Sub Total			**31673110**	

B. Inspection Bungalows

S,No	Category	Qty	Basis	Amount	Remarks
a	Inspection Bungalow of Circle House Standard	8	2% of capital cost	8× .02 ×18750000=3000000	
b	1st Class Insp. Bungalows	108	2% of capital cost9375000	108× .02 ×9375000= 20250000	
c	2nd Class Insp. Bungalows	136	2% of capital cost	136× .02 ×4500000 =12240000	
	Sub Total			35490000	

Grand Total of Colonies and Inspection Bungalows = 31673110+35490000 = 67163110

Yardstick rate per mile = 67163110/8130 = **Rs.8261/-**

8. M & R to Head Works

The M & R to the three Head Works will be 2 % (ordinary & special repairs) of their capital cost including closure works.

Table 12.13: Statement showing barrage wise costs of M&R

S, No	Name of Barrage	Original Cost (Rs Million)	Present Escalated cost (2012 @ 5% net Escalation (Rs Million)	M&R @ 1% (for every 7 alternate year)
1	Sukkur Barrage	51.13 (1933-34)	2298.29	22980000
2	Kotri Barrage	69.55 (1955-56)	1069.44	10690000
3	Guddu Barrage	216.40 (1963-64)	2250.56	22510000
	Total		5618.29	56180000

Therefore Rate per Actual Mile = 56180000/11846 = Rs.4742/.per mile.

9. Miscellaneous

Apart from the major items of silt clearance, bank works and repairs to structures there are some petty works to be done for proper upkeep of canal networks such as jungle clearance from banks and berms, weed clearance, surpassing of soft and sandy portions of Inspection Paths, dredging, repairs of RD & Mile Stones, canal gauges and linings pitching, hydraulic Data, Planning & Designs, printing dissemination, documentation discharge observations, taking of soundings, probing etc,. For these and scores of other petty jobs Rs.1500 per mile is the minimum and reasonable requirement.

Thus for Misc. Works as described above = **Rs.1500/-** per mile.

Table 12.14: Abstract of yardstick for requirement as per actual mile of flow irrigation

Regular (non-converted) W.C. Establishment		Rs.1800
Abkalani (Seasonal) W.C. Establishment		Rs.37800
Abkalani Stores		Rs.1351
Silt Clearance (including groynes, weed clearance etc.),		Rs.64470
Bank work (including E/work etc.)		Rs. 41128
M & R to Structures, Canals & Rivers		Rs. 4500
M & R to Colonies, Inspection Bungalows		Rs. 8261
M & R to Head Works		Rs.4742
Miscellaneous		Rs.1500
Sub Total I Works		**Rs.165552**
Other provisions		
Special & ordinary Tools & Plants	3% of I Works =	Rs.4939.
Workshop machinery & equipment	5% of I Works =	Rs 8233
T & T Charges	3% of I Works=	Rs 4939
E & I Works	5% of I Works=	Rs 8233
Unforeseen	1% of I Works =	Rs,1646
Sub Total		Rs.27990

Total Rate per actual mile = 165552+27990 = Rs.193542

Total reasonable requirement (for open canals) = 193542x 8130 = Rs.1573.50 Million.

Rate per virtual mile = 157349460 ÷ 10257 = 153407

Repairs and Replacement of Barrage Gates and other E & I Works = 5% of the up-valued cost of three Head Works i.e. 5618× .05 = Rs.280.9 Millions.

12.6.6 Lift Irrigation Maintenance Yardstick

Quite a few irrigation Canals in Sindh Flow in cutting in their Head reaches. Consequently the areas settled in their head reaches cannot receive the benefits of Flow- Irrigation. The old lifting devices - hurlas and Persian wheel - have practically yielded ground to electricity or diesel operated Pumping Sets & Pumping Engines - not to speak of Tube wells here. Consequently, the Irrigation & power Department have established 30 Pumping Stations on Nara Canal and other Canals. The details of Pumping Schemes along canals and River are given in Annexure-III.

The Yard-Stick Rate of Rs.65329 per Horse Power has been worked out in case of Canal

Lift Irrigation Schemes to place the reasonable requirement as under.

	HP	Rate (Rs)	Amount in Million
Canal Lift Irrigation Schemes.	3705	65329	242.044

12.6.7 Yardstick of Reasonable Requirement for O&M of Low-Lift (Pumping) Schemes along River and Main Canals

River water is a welcome source which could be advantageously tapped for cultivating relatively higher patches of land along River fringe. Similarly, some fertile chunks of areas in the head - reaches of canals could be developed by means of Low-Lift (Pumping) Schemes. There are in all 35 such schemes (except Shah Saddar Schemes) which pump 776.64 cusecs aggregate discharge to cultivate 135950 acres of lift lands along River Indus, Nara & Fuleli Canals etc. the details of these Schemes are portrayed in Annexure - III. Except for Shah Awais which is under process of electrification, most pumping schemes are electrically operated. The Yard-Stick of Reasonable requirements of Wadhu & Fasadi wah lift Schemes for Hyderabad Green belt, has been analyzed as a representative case of Small Lift Schemes has been undertaken to workout reasonable requirement of canal Pumping Schemes. ,

Data:	Design Discharge	=	28 cusecs.
Wadhu and	Actual Disch: pumped	=	9.87 cusecs
Fasadi Wah	No. Pumps	=	4 Nos
	Horse Power 1x40 + 3 x 45	=	175 H.P
	Length of channels	=	6.56 miles

A)	**Rate per horsepower**	**Rupees**
1)	W.C Abkalani Estt. For patrolling @ 1 man/2 miles i.e 3 men for 6.56 miles for July and august. Therefore Amount = 3x2x Rs. 6000	36000
2)	<u>Abkalani Stores.</u> Rs. 1350.67 per mile as for Flow Irrigation. . Therefore Amount = 6.56 x Rs. 1350.67	8860
3)	<u>O&M of Pumps: -</u> '	8755730

A)	**Rate per horsepower**	**Rupees**
	(Electricity Charges) Total Horse Power =175 Total connected Load = 175 x .746 = 130.55 load factor = 0.9 No. of working hours / day = 24 Total units consumed per year: 130.55 x 0.9 x 0.9 x 24 x 345 = 875573 units (excluding 20 ' days of closure). Therefore the cost of energy consumed with Rs. 10 per unit (KWH) = 875573x7.59 '	
4)	Due to fluctuation of discharge, the sections Of Wadhu & Fisadi Wah get silted. Also the Sections get choked due to wind-blown sand From nearby dunes along River. Considering average deposition of 0.5 ft. over 8 feet Average bed width, the total quantity of Silt clearance = 8 x 0.5 x 6.56 x 5000 = 131200 Cft @ Rs. 1134.38/=per%0 Cft (Manual work). 1134.38 (SCSR item 1(a)P1) Therefore Amount of Silt Clearance = 131200 x 1134.38÷1000	148831
	<u>Earth work for banks:</u> Considering average wear and Tear of 0.25 ft. Of 10 ft. wide 1/Path & 6 ft. wide non 1/Path, The Quantity of Earth Work per year = (10+6) x 5 x 6.56 x 5000 = 262400 Cft. @ Rs. 3917.08 Per % 0 Cft. x 262400x3917.08÷ 1000	1027842
5)	<u>M & R to Structures:</u> _ (Head Regulators, Bridges and Syphons.) - Cost of Pump House for Wadhu Wah & Fisadi Wah. Rs. 1350000 Cost of Two Road Bridges. Rs. 2250000 Cost of Two Syphons below , Metalled Road. <u>Rs.1800000</u> Rs.5400000	
6)	M & R @ (1 $^1/_2$ % ordinary & $^1/_2$ % Special) = 2% of capital cost Therefore Amount = Rs. 5400000 x 0.02 = '	108000
7)	<u>M & R to Building.</u> (operator's Quarters etc.) @ 2% of cost = Rs. = 300000 x .02 =.	6000
8)	<u>M & R to Machinery</u> (Pumps & Motors). 3 Pumps @ Rs. =. 540000 Each, . Therefore Total 540000 x3 = Rs. 1620000 1 Pump @ 360000 Each. = Rs.360000	297000

A)	**Rate per horsepower**		**Rupees**
	Total cost =	Rs. 1980000	
	Ordinary Repairs @ 5% of cost = Rs.1980000 x.05	Rs. 99000	
	Special Repairs @ 10% of cost = Rs. 1980000 x .10	Rs. 198000 **Rs.297000**	
	Miscellaneous	Lum Sum	5000

ABSTRACT

1.	**Work - charged Abkalani Establishment**	Rs. 36000
2.	Abkalani Stores.	Rs. 8860
3.	O & **M** of Pumps (Electricity charges)	Rs. 8755730
4.	**Silt Clearance**	Rs. 148831
5.	Earth work for Banks	Rs. 1027842
6.	M & R to Structures (Regulators, Bridges & Syphons)	Rs. 108000
7.	M & R to Buildings (Operator's Quarters, Pump House etc)	Rs. 6000
8.	M & **R** to Machinery (Pumps & Motors etc).	Rs. 297000
9.	Miscellaneous	Rs. 5000
	Total	Rs. 10393263
	Add 3% T & T Add 6% T & P (Spares) Add 1% Unforeseen Total: 10%	Rs. 1039326
	G. Total	**Rs. 11432589**

Total O & M Cost.	=	11432589
Total Horse Power. v	=	175 HP
Therefore Vard-Stick Rate of Reasonable Requirement		
Per Horse Power = Rs. 11432589/ 175	=	Rs. 65329/- Per HP
Total Reasonable Requirement for Canal Schemes.		
Total Horse Power (Annexure-III) of Small		
Schemes except River Schemes5455-1750	=	3705 HP
Yard-Stick Rate per Horse Power	=	Rs. 65329
Therefore Requirement 65329x3705	=	Rs. 242.044 Million

12.6.8 Yardstick for Flood Protective Bunds Maintenance and Flood Control

The mighty Indus called the 'lion' river travels some 600 tortuous miles from Gudu Rim station to Arabian Sea. Through - out its boisterous journey, it rides on a ridge and poses a potential threat to the entire infra-structure such as road and rail routes, canals and other public utilities During Abkalani season, it brings many anxious moment for irrigation Engineers and snatches their peace of mind as it erodes Bunds, attacks spurs, causes Wave Wash and tends to cut loose from its confining embankments (637 miles on left banks). The ordeal continues for several days as the battling crews dump stones in apron and spur noses to prevent its on-slaught and erosion. The establishment resorts to round-the- clock patrolling to detect any leaks through the earthen bunds. The surveillance for safety brings the ultimate success as the animated flows of Indus, finally attain eternal peace into Arabian Sea, after great turmoil and rumblings enroute.

The hill torrents (Kabula, Nari, Buri, salari, dillan, Gaj and Angai etc) emanating from Bugti hills and Khirthar Range, stage a two-pronged attack. During heavy down-pour over their catchments, they bring enormous flood flows with the bullet like velocities that are capable of disturbing earth particles of the F.P Bund. Their hammer-blow impact occasionally dis-locates the bund portions that have traversed and plugged old hill-torrent courses of Pre-Barrage period. To protect the right Bank command of Sukkur Barrage from their vagaries, many reaches of 172 miles long F.P. Bund and 20 mile long Manchar Containing Bund have been stone-pitched and few more have yet to be pitched under a phased program. In the vulnerable dhoro portions, where the breaches have repeatedly occurred in the past half-century, the Department might consider the feasibility of providing an R.C.C or C.C. breast wall (solid groyne) to blunt the impact of dashing currents. The Manchar Lake forms the final destination of hill-torrent floods. The flood flows of hill torrents is allowed to accumulate upto an optimum storage level of R.L. 114.0 when it is drained from Aral-Laki during early part of Rabi Season for Bosi-Wheat cultivations of some 45000 acres in-side Manchar Area. The Manchar Lake, being the largest fresh weather Lake of Sub-Continent, constitutes a bode for fish and fowl to capture/attract the fancy of tourists and game hunters.

The Maintenance Operations

The Maintenance and repairs of Flood Embankments comprises the following Operations:

i. In the pre-Abkalani period the E/Work to restore the loss of free-board and wave-wash deficiency of side-slopes is carried out and the stone-pitching, aprons and spur noses are thoroughly repaired.

ii. The regulating mechanism, the bond between E/Work and masonry, the pavement and pitching's are minutely checked and repaired for efficient and trouble-free role during floods. The Irrigation Sluices through Loop Bunds leading canal supplies inside floods. The loop compartments are also given similar treatment.

iii. The Bund Lahdhies, Bungalows - and Sluice Establishment Quarters are properly repaired to comfortably accommodate the patrolling personnel and other staff.

iv. The soft portions of Bund tops are surgrassed or stabilized with Pucca Earth, and Bund Gauges repaired and painted.

v. The Telephone and Wireless Sets are installed at vulnerable points for flood warning and regulation.

vi. The Abkalani materials including forest materials are procured and stocked along bunds at sensitive locations, where there is considerable Head across and Gauge-Height to pose the threat of a breach.

vii. During Abkalani Season the centrifugal pumps for filling up and soaking of wetting trenches are installed and operated by Mechanical Divisions.

viii. The Generating Sets are also provided by Mechanical Divisions to arrange night illumination at Wave-Wash and erosion sites

ix. The vehicles—Trucks, Jeeps and Tractor-Trolleys are deployed for transportation of labour and materials.

x. During the Abkalani season, starting from 16th May-to 15th September, Akbalani Establishment is engaged for round-the-clock patrolling and detection of leaks through the hidden cavities and holes caused by burrowing creatures such as rats, snakes and porcupines. This establishment also under-takes petty jobs, such as clearance of thin jungle from top and slopes, filling up of sand bags, lignting-up of hurricane lamps and Petromax, closing of rain gharas, leveling of top with basket work, sprinkling of water, and manual soaking of small trenches, construction and repairs of single groynes and 'Muharis' along ramps and Wave Wash location etc.

xi. The Bund gauges are reported and transmitted by Gauge-Readers and Telephone operators for flood-routing and computation of peak discharges. Keeping in view the above requirements and responsibilities, the maintenance Yard-Stick for Flood , Embankments is framed in the following pages.

Yardstick of Reasonable M & R to Flood Protective Bunds

PER ACTUAL MILE

DATA

(a)	River protective bund front line.	=	**935**	Miles
	River protective bund loops.	=	**339**	Miles
		Sub-Total(a) =	**1274**	Miles

Rate per Actual Mile (Normal Flood Year)

A. Front Bunds----935 Miles

1) Regular (Un-converted) W.C Establishment
@ $^1/_2$ man per mile @ Rs. 6000 per month i.e
Rs. $^1/_2$ x 6000x12 = Rs. 36000 per year
Considering that only 1/20th W.C
Establishment remains to be converted.
The fractional amount for this sub-head

= 1/20 x 36000 = Rs. 1800

2) Abkalani W.C Establishment
(for Patrolling and Petty Works)
16th May ---- 30th - & 1st Sep - 15th sept:
= I month @ 2 men/mile i.e Rs. 6000 x 2x1 = Rs. 12000
1st June – 30th June = month @ 4 men/mile
Amount = 6000x4x1 = Rs. 24000
1st july --31st August = 2 months
@ 8 men/mile (average for river bunds)
Normal floods i.e Rs. 6000 x8x2 = Rs. 96000
Gangs for 2 months July & August @

1 man per mile i.e Rs. 6000 x1x2 = Rs. 12000

Rs. 145,800

Supervisory Establishment sub – Daroghas,

Cycle Messengers, Telephone Operators etc.

@ one 1% of above = Rs. 1458

Sub Total Rs. 147,258

3) Abkalani material

(For treatment & Cure of Leaks, Wave Wash & Hutments for Breaches Labour). There are in all 18 Divisions to look after River Bunds. The rate per mile for Purchase of Abkalani materials works out to Rs. 52313 Per mile as per Standard list given at the end of this Chapter Rs. 52313

4) Earth work {to recoup wear and tear of top and side Slopes Wave - Wash deficiency etc.)

Considering average 14 ft. high and 20 ft.

Wide bund at top with 3:1 side slopes & 6.0

Ft. wide back berm etc. the perimeter of

Bund =132 feet. Now considering only

25 feet annual wear and tear along perimeter and

Wave - Wash damage, the earth work

Per mile works out to 132 x0.25x 5000 = 165000 Cft.

Finally reckoning that only 10 % length

Of Bunds will yearly require Earth Work for

Restoration of wear and tear and Wave - Wash

The quantity of Earth work per mile =

1/10 x 165000 = 16500 Cft @ 3917.08

Per 0/00 Cft Amount Rs. 64632

5) Repairs to Structures (Bund Sluices etc.),

For Civil and Mechanical repairs,2% of the

Capital cost of Bund Sluice

@ Every 30 miles = Rs. 7500000

Therefore M & R = 7500000 x 2 Rs. 5000

100x30

6) Repairs to stone Pitching and Apron.

(To recoup disturbed Portions of both)

Considering a minimum amount of Rs. 36000

Per mile for repairs and 1/6* length of Bunds

As stone — pitched, the reasonable requirements

= Rs. 36000 x 1/6 Rs. 6000

7) Repairs to Buildings.

(Bungalows and Pucca Bund Landhis)

Average cost of Bungalows Rs.5000000

Located at 50 miles a part.

M & R @ 2% = $\frac{5000000 \times 2}{100 \times 50}$ =Rs.2000

Average cost of Landhi 100x50 = Rs. 1000000

Located at 20 miles apart

M&R to Landhi @ 2%=

$\frac{1000000 \times 2}{100 \times 2}$ =Rs. 1000

Sub Total = Rs. 3000 Rs. 3000

8) Other Items

(a) Sur-Grassing Top of Bund
Considering only 5% length as soft and
Sandy and a rate of Rs. !2000 per mile, the
Reasonable amount = Rs. $\frac{12000 \times 5}{100}$ = Rs. 600

(b) Juck Work and groynes to prevent cutting of slopes.
Where stone pitching dose not exist @
Rs. 2500000 per mile for 2% of fun un-pitched Length.
Therefore Rate = Rs. $\frac{2500000 \times 2 \times 5}{100 \times 6}$ = Rs. 41667

(c) Repairs to Bund Gauges
Cement and Bricks will be purchased and
Work will be done by Department Mason
Mistries.
Normal or Minimum Amount = Rs. 660

Therefore Total Miscellaneous = Rs. 42927

Abstract (Front Bunds)

Regular (Un-converted) W.C Estt:	1800
Abkalani Work-Charged Establishment	147258
Abkalani Materials	52313

Earth work (To recoup Wave Damage, wear and tear)	64632
Repairs to Structures (Bund Sluices etc.)	5000
Repair to stone pitching and apron	6000
Repair to Building (Bungalows and Pucca landhis)	3000
Other items (Sur-grassing, Lai Pitching, Lai-Groynes & Repairs to Bund Gauges etc...)	42927
Sub Total of above:	322930

Other Provisions

i.	Deployment of Jeeps, Trucks and Tractor-Trolleys for transport of men and materials	1 %
ii.	Deployment of Centrifugal Pumps for soaking and testing and filling of Wetting Trenches.	$^{1}/_{2}$ %
iii.	Installation of Generating Sets for night illumination.	$^{1}/_{2}$ %
iv.	T & T charges -Installation of Telephones and Wireless Sets for Flood Warning and Regulation	$^{1}/_{2}$ %
v.	Experimentation Research and Design, River Surveys - and Design and Model Experiments	5 %
vi.	Deployment of Tractors, Bull-Dozer & other equipment of Irrigation and Agriculture Department (Hire charges) &- Other Mechanical works.	3 %
vii.	M & R to Soil Mechanical & Hydraulics Laboratories.	2 %
viii.	M & R to D..O.C Lahore	$^{1}/_{2}$ %
ix.	Unforseen Such as Erosion and Scour damages to spur etc.	1 %
	Total:	**14 %**

Therefore Yard-Stick Rate Per actual mile of Main
River Bunds = 322930 x 1.14 = Rs. 368140
Therefore total reasonable requirement for Main
River Bunds = Rs. 368140 x 935 = Rs. 344210900 (A)

RIVER LOOP BINDS - 339 Miles
Instead of 8 man/ mile during july and August as
on Main Bund, there will be only 4 men/mile
On Loop Bunds. Also there will be no extra gangs

And no Supervisory Establishment. Therefore the ,

W/Charged Abkalani Estt: 16-31 May &

1-15 Sept @ 2 men/mile will be @ Rs. 6000

=2X6000 = Rs. 12000

The W/Charged Abkalani Estt:

=4x6000 = Rs. 24000

During June @ 4 men/mile will be

The W/Charged Abkalani Estt:

During July & August @ 4 men/mile will be

=4x2x6000 = Rs. 48000

Rs. 84000

Abstract River Loop Bund

Regular (Un-Converted) W.C Estt:	Rs. 1800
Abkalani W.C Estt.	Rs. 84000
Abkalani Materials.	Rs. 52313
Earth Work	Rs. 64632
Repairs to Structures	Rs. 5000
Repairs to Stone Pitching & Apron	Rs. 6000
Repairs to Buildings	Rs. 3000
Other Items	Rs. 42927
Total	Rs. 259672

Therefore Yard-Stick Rate per mile at

Rs. 259672 x 1.14 = Rs. 296026

Reasonable Requirement for

Loop Bunds = 296026 x 339 = Rs. 100352814 (B)

Abstract Reasonable Requirements for Flood Embankments

(a)	River bunds front or main.	344210900
(b)	River Bunds Loops.	100352814
	Total	444563714

Standard List of Abkalani Materials & Other Stores Required Per Mile (Normal Floods 5.0 Lacs to 7.0 Lacs Cusecs)

Note: - For Low & Medium .Floods upto 5.0 lac cusecs, the quantity will be half of that given below.

Note: - For very High & Super Floods 7.0 - 12.0 lac cusecs of sustained duration. The quantity will be Two-fold, of that given below and the cost, with the prevailing rates thereof.

1. Hutments for Labour

(A) Forest Materials

		Qty or No.	Rate	Per	Amount	Remarks
1	Babul Munas (Verticals) 10- 14 ft. Incl. Cartage	20 Nos.	600	Each	12000	(i) Construction of 3 Intermediate landhies Size 10x7.5 ft. & one mile Landhi size 10x15 ft.
2	Babul Waras (Horizontals) 10- 12 ft Incl. Cartage	20 Nos.	360	-	7200	
3	Lai Punjars Incl. Cartage	80 Nos.	50	-	4000	
B) Other Materials						
4	Peesh (or Pun) Mats 6'x4.1'=25 sft. Incl. Cartage	300 ft	360	% Sft	1080	Mats on floor & East West Sides
5	Punkhas (Reed Patals) 8'x6.5' or 10x5 =50 sft.	1250 sft	720	% Sft	9000	Punkhas or Patals on sides
6	Tuwas 10x5=50sft	300 sft	360	% Sft	1080	Tuwas on roof & all sides with over lapping allowance
7	Munaj (Peesh) Wan	2 Kgs	48	Per Kg	96	
II Wave Wash Protection						
8	Coir rope $^1/_{2"}$	2 Kgs	144	Kg	288	
9	Gunny Bags large Size 2nd Bharti	50 Nos.	48	Each	2400	For wave wash protection
10	Gunny Bags Small Size. 2nd Bharti	50 Nos.	30	Each	1500	
11	Sutli (Jute) Superior	4 Kg	72	Kg	288	
12	Hurricane Lanterns (Germany) (Once in two years)	1 No.	420	Each	420	For night patrolling
13	Hurricane Lanterns (Pak Made) (Once in two years)	4 Nos.	2160	Dozen	720	
14	Hurricane accessories such as globes, oil extractors wicks, burners, caps, match	50% of 12 & 13			570	
15	Petromax Germany (Once in two years)	1/20 Nos.	7200	Each	360	For night patrolling
16	Petromax accessories such as globes, mantles,washers, pins, nozzles, spirit, and match boxes	50% of 15 above			180	
17	Torch 3- Cells	1 No.	360	Each	360	
18	Torches Accessories, Bulbs, cells	25% of item 17 above			90	
19	Kerosine Oil (Tin)	8 Tins	720	Tin	5760	For minor earth work for storage of P.O.Ls
20	Lai or Toot Baskets	12 Nos.	60	Each	720	
21	Spades / belches with Handle	2 No.	240	Each	480	
22	Empaty Drum (45 Gal. Capacity)	1/5 No.	1800	Each	360	
23	G.I Buckets 8" -10" dia	4 Nos.	3456	Dozen	1152	For Sprinkling of water
24	Earthen - Patoras	8 Nos.	108	Dozen	72	
25	Earthen - Jars	4 No.	108	Each	432	
26	Generator (Japan made) For every 20 miles and purchased once in 3 years @ Rs. 51300/- each		Share .	= 51300 / 20x3	855	

27 28 29 30 31 32	Electric Bulbs 200 watts Electric Bulbs 100 watts Holders & Cut – out etc. P.V.C Wire 3/029 Coils P.V.C Wire 3/036 Coils Bamboo Poles or Ballis	50% of Item 26		428	Illumination at wave wash, erosion side and vulnerable
			Total :-	51795	
33	Miscellaneous (Lime, Rations, Sand, Animal Dung, Mallets, Tarunger Wire etc.)	1% of above		518	
			Rs.	52313 per mile	

12.6.9 SCARP tubewells, surface & carrier drains & pumping station yardstick

For the flow irrigation to be beneficial, a Drainage cover is a complementary part. The percolating water from fields, the seepage from porous banks of earthen Channels, the rain-fall and floods cause a slow rise of the sub-soil water table. The Drainable Surplus, unless it is disposed, may percolate in the root-zone soil to affect the health and yield of crops, due to waterlogged conditions. Also the rising S.S.W.L brings up the injurious salts, with capillary action, to affect root zone and land surface with salinity.

: To avoid such a situation, a horizontal (Surface Drainage) a vertical (Tubewells Drainage) and the Sub-Surface Tile Drainage is provided, for effective control on the water table and maintenance of soil fertility. The pumpage from Fresh Water Tubewells, besides stabilizing the S.S.W.L at a safe level, also contribute supplement or bonus supply for irrigated Agriculture. Consequently the cropping intensity in all such SCARP areas has exceeded 115% to spell agrarian prosperity of the population. As for the saline Tube Wells, their effluent is carried through drainage channels for ultimate disposal in Rohri Canal. The pancho water in rice- growing tract is similarly disposed off into other canals.

The SCARP Projects listed in Annexure -VI are foreign - Aided ones which were executed by WAPDA and handed over to the Irrigation and Power Department since 1970 and onwards for Operation and Maintenance at the standard laid down by the aid-giving agencies.

For the O & M of SCARP Tube Wells and Pump Stations, Electricity happens to be the main constituent of expenditure. Its tariff of 16 paisa per unit (Kilo-Watt Hour) in 1978-79, has progressively increased to Rs.10/- per unit in 2008-09 due to fuel adjustment charges and other factors. Consequently the maintenance liability of these facilities has increased to manifold than that in 1978-79. To partly meet with the increased O & M expenditure Drainage Cess is levied on basis of area actually cropped. However flow Irrigation & low-lift Irrigation (Pumping)

Schemes, some **subsidization** is necessary in case of SCARP and Flood-Embankments of possessive Nature as they afford innumerable indirect benefits.

Sincel978-79, Irrigation & Power Department has added responsibility of maintaining 831 virtual miles of Kotri Barrage Surface Drainage Scheme, 410 Tube wells of Ghotki F.G.W Project, 180 Tube wells of SCARP South Rohri Project (Hala Unit), 877.9 virtual miles of Larkana - Shikarpur Surface Drainage Project, besides 340 virtual miles of L.B.O.D Project, 79.5 virtual miles of North Dadu (with its Wagan Pumping Station) and 250 more Tube wells of SCARP South Rohri through transfer payments. In 2002-03 at Ghotki 1602 tube wells installed.

The Yard-Stick for Tube wells & Pump Stations on the basis on unit rate per horse Power and for Carrier/Surface Drains on the basis of Actual and Virtual mile are calculated in the following pages.

12.6.10 Yardstick for O & M of One Tubewell SCARP North Rohri Naushehro Feroze

***Works*:**

1. **Electricity Charges**

Average H.P. = 25.5----------*Annexure VII*

Utilization factor = 90 %

Load Factor = 90 %

Working Hours/ day = 8 hours

Average Rate per Unit = Rs.10/Kwh (HESCO letter No.7535-62 dated 28-5-2012)

Electricity charges/ Tubewell per year = 25.5×0.746×0.9×365×8×10×0.9. Rs.449,932.

100 Nos. Tubewells each in SCARP Khairpur and North Rohri along Rohri Canal need 8 hours extra running for effective control of water table. Percentage Ratio of such Tubewells to the total Nos = 200/3101 = 0.0645

Therefore extra electricity charges for T/Wells along Rohri Canal = 449932× 0.0645 =29021 Therefore Total Electricity charges = Rs 449932+29021= Rs 478953.

2. **Transportation Charges**

Vehicles required for 1092 Tube-wells or 6 Sub Divisions, 6 Pickups for general duty such as repairs, monitoring, gravel shifting etc; 6 jeeps for AENs i.e. one Jeep per Sub-Division, 2 Jeeps for inspection of two XENs i.e.14 total vehicles required.

Average running of vehicles = 1600 KMs/month (or 1000 miles) @ Rate Rs20/ Km.

Cost/ T.W. = 14×1600×12×20 /1092 = RS.4923.

Motor Cycle for 12 Sub Engineers for supervision and inspection.

Average running 800 KM/month per Motor Cycle @ Rate Rs.5/-per km.

Transportation cost per T/Well per year = 12×800×12×5/1092 = Rs.527.

Total cost/T.W./Per year = 4923+527 = Rs.5450.

3. **Repairs to Buildings**

- Operators Quarter , Pump House / Electrician & Foreman Quarter, Distribution Structures**.**

Present depreciated capital cost of Buildings = 1250,000/-

Ordinary & Special repairs @ (1.5 +0.5) = 2 % of Capital Cost /T.W/ per year

= 1250000×2/100 = Rs.25000.

4. **Repairs to Link Water Courses (Distribution Links)**

Bank Work or Excavation

Taking average 2500 cft /T.W/Year @ Rs3781.25 per 1000 cft

Repair charges = 2500×3781.25/1000 = Rs.9453

5. Repair to Tubewells

(i) Ordinary repairs to motor, Pump Control Panel etc:

Present capital cost of one Set Rs1215480..

Ordinary repairs at 5% capital cost/year = 1215480×5/100 = Rs.60774.

(ii) Major repairs, such as pulling out Pump and major replacement of Pump parts and electrical parts about 10% tube wells of the Project i.e. 0.1× 1092=109.2 T.W. or approx. 100 Tube wells would annually require such major repairs. Taking total capital cost of Tube wells as Rs. 2000000/- Major repairs @ 5% = 2000000×100×0.05 = Rs 1000000/-.

Major repair charges / T.W. / Year = 1000000/1092 = Rs.9158.

Total of (a) + (b) = Rs.60774+Rs.9158 = Rs.69932.

6. Miscellaneous charges

(general store items) such as Gravel, Log Books, Forms, Kerosine Oil, Data Boards, Grease, Paints, Cotton Waste per Tube well per Year, L.S. = Rs.5000.

ABSTRACT OF ANNUAL M & R EXPENDITURE FOR ONE TUBEWELL

WORKS:

Electricity charges	Rs.478953
Transportation charges	Rs.5450
Repairs to Buildings	Rs.25000
Repairs to Link Water Courses	Rs.9453
Repairs to Tube wells	Rs.69932
Miscellaneous charges	Rs.5000

Total = Rs. 593788.

Annual M & R (Works) Expenditure
Per Horse Power = 593788/25.5 = Rs.23,286.

Therefore Reasonable Requirement of M&R Works

SCARP Naushero Feroze = 1092×25.5 × 23286 = Rs 648421956

SCARP SNR Hala Unit = 430 ×15×23286 = Rs 150194700

SCARP Khairpur = 640 ×24× 23286 = Rs 357672960

(A) Sub-Total = Rs 1,156,289,616.

Drainage Division Badin = 191 × 17.7 × 23286 = Rs78722980

Sanghar Drainage Division = 965 × 15 × 23286 = Rs 337064850

Nawabshah = 519×19.30×23286 = Rs 233248876

(B) Sub-Total =Rs.649036686

Total = Rs,1805326302 = Rs.1805.32 Million

Total Tubewells = 3837 Nos

Per Tubewell = 1805326302/3837 = Rs. 470505.

Yardstick for Operation and Maintenance of Pump Stations per Unit of SCARP for 2008-09 (29 Units) Khiarpur. No: & Horse Power of Pump (Scarp Khairpur)

Pump Station.	No. Of Pumps	Horse power of each Pump	Total Horse Power.
A.	3	25	75
B.	6	55	330
C.	4	55	220
D.	10	65.5	655
E.	8	65.5	524
Total No.	**31**	**Total H. Power**	**1804**

Therefore Average Horse Power of Each Pump Works out to be = 1804 = 58.2 H.P 31

1. Calculation of Electricity Charges
   (i) Average connected load = 58.2 x .746 = 43.4 K.W
   (ii) Working Hours = 8
   (iii) Utilization & Load factors = 0.9, 0.9
   (iv) Electricity tariff. = 10

   Therefore Amount = 43.3x0.9x0.9x8x365x10= Rs. 1026497

2. Transport Charges. (Per Set)
   4 vehicles in 4 sub Divisions for 31sets that Is 1/7.5 vehicles will be required per set for Supervisory and general duty and transportation Or shifting of Pump, Motors and taking 1600 K.M (or 1000 miles) of a vehicle at a Rs. 20 per K.M per month.
   Therefore Amount of Transportation per set
   = 1/7.5 x 1600 x 12 x 20 Rs. 51200

3. **Repairs to Building**
   Cost of Pump Chambers, Samps, Control Rs.
   Rooms, Operators and other staff quarter = 300,0000
   Total cost of 5 station (A,B,C,F & G)
   = 5 x 300,0000/- = Rs. 15000000/-
   Ordinary and special repairs
   @ (1 ½ + ½) = 2 % = $\frac{15000000x2}{100}$ = 300000/-
   Therefore Repair cost per unit = 300000x5/31 = Rs. 48387 per year

4. **Repairs to Machinery**
   a) Ordinary repair @ 5% of the cost of One se (Rs. 1800000/-) which is included of Pumps, motor & Motor control Pannels ets;
   Therefore ordinary repair Cost per Unit
   = $\frac{1800000 \times 5}{100}$ = Rs. 90000
   b) Major Repair @ 10% with 5% of Pumps

Needing Major Repairs every year.
Therefore Repair Cost per unit per year
$= \frac{10}{100} \times 1800000 \times \frac{5}{100} =$ Rs. 9000
Therefore Ordinary and major Repairs Cost per Set. Rs. 99000.00

5. **General Stores (Per Sets) Per month**

i)	1/2 K.G Bearing Grease @ Rs. 600/- Per K.G	=	Rs. 300.00
ii)	1 K.G Yellow Cup Grease @ Rs. 400/- Per K.G	=	Rs. 400.00
iii)	1/2 K.G Cotton Waste @ Rs. 100/- Per K.G	=	Rs. 50.00
iv)	1 Liter Kerosene Oil @ Rs. 100/- per liter	=	Rs. 100.00
v)	1 Ordinary / Mercury Bulb @ average rate of Rs. 200/-	=	Rs. 200.00
vi)	1 Duster @ Rs. 40- each.	=	Rs. 40.00
vii)	2 Nos. Dry Battery cells @ Rs. 25/- each	=	Rs. 50.00
		=	Rs. 1140.00
	Therefore General store per year per set = 1140 x 12	=	Rs. 13680.00

6. **Miscellaneous**

Log Register, data Boards,
Paints, Seeds, Plants, etc; L.S = Rs. 1000.00

Abstract per Unit per Year (Khairpur Pumping Station)

WORKS

(1)	Electricity	=	Rs. 1026497
(2)	Transport charges	=	Rs. 51200
(3)	Repairs to Buildings	=	Rs. 48687
(4)	Repairs to Machinery	=	Rs. 99000
(5)	General Stores	=	Rs. 13680
(6)	Miscellaneous	=	Rs. 1000
	Therefore Total Works per Unit	=	Rs. 1239764

Amount per Horse Power (Works)
$= \frac{1239764}{58.2}$ = Rs. 21302/ H.P

	Rate	H.P	No. of Motors	
Reasonable Requirement for Pumps	21302	58.2	x 31	Rs. 38,433,068

Works only in SCARP Khairpur

Total Expenditure on drainage pumps **Rs. 38,433,068**

Yardstick for Maintenance of Drainage Khairpur Drainage System

Category	Actual Miles	Virtual Miles
Main Drain	47.6	47.6×2 = 95.2
Branch Drain	58.2	58.2×1.5 = 87.3

Sub Drain	102.2	102.2×1 = 102.2
Disposal & Distribution channel	289.1	289.1 ×1 = 289.1
Total	**497.1 say 497.0 mile**	**573.8**

WORKS

1. **Surgrassing** (1" Thick)

   Considering 5% I/paths as soft and sandy

   of Main & Branch Drains.

   Qty. = .05(47.6+58.2)×5000×10 =264500 Sq. Ft.

   @ Rate of Rs.5 per 3" thick.

   Amount = 264500 × 5 / 3 = Rs.440833/-

2. **Excavation by Draglines** (Main & Branch Drains)

   Considering that Main and Branch Drain will require bed clearance after every fifth year.

   Qty. = 1/5 (47.6 + 58.2) × 5000× 15×1.5 = 2380500 cft

   Amount = 2380500× 1525/1000 = Rs.3630263.

3. **Excavation by Excavators** (Sub drain in alternate years)

   Considering that Sub Drain will require bed clearance in alternate year.

   Qty, = ½(102.2)× 5000 ×10 ×1.0= 2555000 cft

   @ Rate of Rs.874/- per%0cft

   Amount = 2555000 x 874/1000 = Rs. 2233070/-

4. **Excavation** by Manual Labour

   Considering that these channels will require bed clearance in the alternate year

   Qty : = ½ (289.1)×5000× 6× 1.0 = 4336500 cft

   Qty as wet earth rate

   @ Rate Rs. 847 + 121.6+167+ 438.65/2 = 1354.92 say Rs.1355

   Amount = 4336500 ×1355/1000 = Rs. 5875958/-

5. **Weed Clearance** (Main,Branch & Sub Drains) clearance every year as weed grows will flourish.

   Qty. = (47.6+ 58.2 + 102.2)×5000×10 = 10400000 Sq. ft.

   @ Rate of Rs 6/- per % Sft.

   Amount = 10400000×6 / 100 = .Rs.624000/-

6. **Bank Work.** (All Categories) manually or by Tractors.

   Considering wear & tear of 0.5 ft. every fifth year.

   Qty. =1/5×497.0× 5000×(10+6)×0.5 = 3976000 cft

   @ Rate of Rs 1453/- per %0 Cft.

   847+167+438.65= Rs. 1452.65 say Rs.1453

   Amount = 3976000× 1453/1000 = Rs.5777128/-

7. **Repairs to Structures** (at Rs.10000/- per structure)

   (a) (Bridges, syphons, Pipe crossings, culverts Aqueducts) = 1519 Nos

@ Rate of Rs.10000/- per structure = Amount = 1519×10000 = Rs. 15190000.

(b) Discharge Boxes/Sumps @ Rs.640× 6000 = Rs.3840000.

Total = 15190000 + 3840000 = Rs.19030000.

8. **R & M of Vehicles** (5 Nos.)

Considering one Jeep for each of four Sub Division and one Division i.e. 5 vehicles running 1600 km. (1000 miles) per month @ Rs. 20/- per Km, Amount = 5× 1600× 12× 20 = Rs1920000.

9. **Miscellaneous**

Ordinary T & P @ Rs.250/- Per mile = Rs.124250.

Plantation @ Rs.500 per mile = 497× 500 = Rs 248500

Misc. (Lime, Paints, Kerosine, Tool basket etc) @ Rs.250/- per mile = Rs.124250

Total = 124250+248500+124250 = Rs.497000.

TOTAL AMOUNT OF WORKS REQUIRED

Sur grassing = 440833

Excavation by Dragline =3630263

Excavation by Excavators = 2233070

Excavation by Manual Labours =5875958

Weed Clearance =624000

Bank Work =5777128

Repairs to Structure =19030000

R & M Vehicles =1920000

Miscellaneous = 497000

Total = Rs.40028251

Therefore Rate per Actual Mile = 40028251 /497 = Rs.80540.

And Rate per virtual Mile = 40028251/573.8 = Rs.69760.

Total Scarp and other surface Drains = 5157.8 x 69760 = 359808128

= 359.808 Million

Yardstick for Medium Colony at Khairpur

Works

Present Capital Cost = Rs. 153791825/- (*See Appendix – C*)

i. Ordinary Repair 1 $^1/_2$ % + Special Repair $^1/_2$ Total 2% (inclusive of replacement and repairs of sanitary, sewerage System and roads). Rs. 3075836

ii. Electric Consumption for Street Lighting and Air-Conditions Rest House = Rs. 36000 x 12 = Rs. 432000

iii. Supplying & fixing mercury and Ordinary Bulbs & other Electric Appliance/ items Rs. 3600 x 12 = Rs. 432000

iv. Medicines and T & P articles and consumable material such as

Cement, Lime, Baskets, K Oil etc 10800 x 12 = Rs. 129600

v. R & M of Tubewells/Over Head Tank etc; for water Supply

= 10800 x 12 = Rs. 129600

vi. M & R to Gardens, Lawns, Seeds, Manure, Plants, Fertilizers

& Garden Tools = 2400 x 12 = Rs. 28800

vii. Therefore Reasonable requirement of M & R

To Medium Colony = Total: Rs. 3839036

12.7 Role of users, farmers' organizations or user associations in O&M of the project facilities and identifying training requirements and a training program.

Role of users, Farmer Organizations (FOs):

- The main purpose of FOs is to benefit farmers by improving water delivery and system maintenance. Accordingly, timely access to water in dependable quantity holds the key to good performance. The FO has to prepare an action plan to conduct various activities.
- Interact with the government agencies, involve and participate in all the management activities from the planning stage itself.
- Monitor the water deliveries at the heads of distributary/minor outlets, with the command area under the jurisdiction and control of the farmer organizations and water distribution among the members maintaining equity.
- Resolving the conflicts arising among the users in respect of water distribution ensuring equity and participation in maintenance activities.
- Coordinating and assisting the members of the management committees of different levels of farmer organizations for effectively discharging their operation and maintenance of responsibilities of the distribution system.
- Maintaining the office of the association according to the provisions in the bylaws.

The WUAs are established by the water users themselves, controlled and owned by them and serve as an independent and legal entity with full autonomy and authority for the distribution of irrigation water, maintenance of irrigation and drainage systems and mobilization and effective utilization of funds. The broad concept is that the WUAs and WUFs would eventually be accountable for the water received at the distributary/minor canal, responsible for water distribution among the members.

Importance of Farmer's Organizations

Farmers' voice cannot be obtained without farmers' organizations. In the world, for instance ,there are hundreds of millions of farmers. To engage in any sensible dialogue with the rest of society, farmers need their representative organizations, the farmers' organizations, structured from grassroots to the international level, as their legitimate voice. This is why farmers' movement gives a lot of importance to farmers' organizations, organizations by farmers and for farmers, as an important pillar of today's society.

Farmers' Organizations (FOs) are essential institutions for the empowerment, poverty alleviation and advancement of farmers and the rural poor. Politically, FOs strengthen the political power of farmers, by increasing the likelihood that their needs and options are heard by policy makers and the public.

Economically, FOs can help farmers gain skills, access inputs, form enterprises, process and market their products more effectively to generate higher incimes.

The Irrigation System of Pakistan is the largest integrated irrigation network in the world. Despite heavy investments in irrigation infrastructure by the government, the annual Operation and Maintenance (O&M) allocations for the Provincial Irrigation Departments (PIDs) gradually became insufficient. The O&M became increasingly ineffective due to insufficient funds and changing socio-economic conditions. Increases in O&M costs, low assessment of water charges and low recovery rates, all combined to form this imbalance in the irrigation sector (WSIP, 1990).

To overcome the poor performance of the canal irrigation system as compared to its expected return on investment in irrigation, the World Bank proposed a reorganization of the whole sector in the year 1994 and put forward the ideas of participatory irrigation management and decentralization . These proposed reforms started with the enactment of new laws commonly known as the Provincial Irrigation and Drainage Authority (PIDA) Acts of 1997 (World Bank,1994) Following this proposal , the Government of Sindh decided to initiate pilot projects at distributary level by involving the farmers in managing irrigation and drainage systems. Since July 1995, Farmer organizations have been formed at distributary level. Farmers of all outlets of these distributaries were assisted to organize into Watercourse Associations (WCAs). The success of these reforms with the help of farmer's organizations to manage parts of the irrigation system is heavily dependent on financial viability. This requires an accurate assessment of crops and collection of appropriate water charges for operation and maintenance (O&M) costs of irrigation and drainage facilities in the distributary command areas.

Disappointing performances of Government owned and Operated Irrigation Systems have compelled a number of countries to transfer rights and responsibilities for management of irrigation systems from government agencies to private or local persons or organizations using irrigation water. Many countries have made major efforts in this direction. Transferring responsibilities has come to be seen as a way forward to reduce pressures on thinly stretched government finances while at the same time improving irrigated agriculture production and ensuring the long term sustainability of irrigation systems.

The institutional reforms have been taken in Pakistan to restructure the frame work for irrigation and drainage services of the large canal systems. These reforms aim at withdrawing subsidy by creating autonomous entities at various levels of the irrigation and drainage system. Sindh Irrigation and Drainage Authority (SIDA) established in the light of "The Sindh Water Management Ordinance, 2002.

Provincial Irrigation and Drainage Authority (SIDA) have the mandate to establish for operation and maintenance (O&M) of irrigation and drainage facilities located within their area of jurisdiction. The AWB's will promote and encourage the farmers to organize into financially autonomous and self-reliant Farmer's Organizations (FO's) at secondary canal level to undertake O&M of their respective distributaries and drainage facilities and also pay for the O&M costs for the upstream System. The intention is to encourage efforts by individuals to take responsibility for the management of resources in the belief that individuals have greater stake and better information for making efficient resource allocations

The Government initiated the enactment of Sindh Irrigation and Drainage Authority (SIDA) Act in 1997 and revised through Sindh Water Management Ordinance (SWMO) 2002, which among other things, also provided for "encouraging the formation of farmer organizations (FOs) at the distributary canal level". The FOs formed at the minor /distributaries level with the functions as prescribed by the Regulations; provided that WUOs formed under the Water Users Association law shall be deemed as FOs under this Act, Section(29).

Farmer Organizations (FOs) are legal entities as defined under SWMO 2002. The SWMO 2002 assigns crucial functions in irrigation management to FOs formed at the distributary/minor level—the point where water control lies in Pakistan's irrigation system. It empowers them to receive water from AWBs, operate and maintain the parts of the irrigation system conferred on them to ensure efficient and equitable distribution of water, including small and tail end farmers, to supply non-agricultural users and to guarantee drinking water; operate and maintain the parts of the drainage system

conferred on them; carry out flood protection and maintain infrastructure within their command area; and advise Local Councils on any matter strategic or tactical, related to its role and functions.

The FOs collect abiana (water charges) and other dues, if any, from the water users and users of the drainage systems, including the costs charged for supply of irrigation water and conveyance and disposal of drainage effluent by the AWB and SIDA and surcharge for late payment on such dues and other charges. FOs have the authority to reduce irrigation water supply services to watercourse associations upon non-payment by one or more of its water users of due water charges. The FOs would pay 60% of their revenue target to the AWB and would retain 40% of the collected revenue for O&M of the system under their jurisdiction

Functions and Powers of FOs

As per clause 30, a Farmer's Organization shall:

a) Operate, manage and improve the irrigation and drainage infrastructure, comprising minors, distributaries and drains, together with any structures thereon located within the area relevant to the FO concerned;

b) Obtain irrigation water from the Authority or AWB concerned at the head of the minor, or the distributary, and to supply the same to their members and other water users, if any;

c) Receive the drainage effluent from their water users and to convey the same through field /collector drains to the designated nodal points of the drainage system;

d) Collect the agreed water charges/other dues, if any from its water users and to pay the agreed consideration for supply of irrigation water and conveyance and /or disposal of drainage effluent, to the Authority or AWB concerned;

e) Engage, hire or employ any consultants, advisors and employees as may be deemed necessary, or be otherwise reasonably required, for the due and effective performance of various powers and functions on such terms and conditions as may be prescribed, including terms and conditions relevant to the conclusion, or premature determination, of such engagements, etc., of any consultant, advisor or employ, as the case may be; and

f) Exercise any other power and perform such other functions, not being inconsistent with the functions and powers given above, which may be vested in the FOs under the bylaws and Regulations framed by the Authority under Section 35.

Tasks of Farmer Organizations

For managing parts of the irrigation and drainage systems on viable basis, following tasks will play a role in efficient working of the FOs:

- **Irrigation Management**

Irrigation management transfer is defined as the turning over of authority and responsibility to manage irrigation systems from government agencies to water user associations (Vermillion,2000). This involves two key roles: the authority to define what the irrigation services will be and the authority to arrange for the provisions of those services. Modernization of irrigation system is the act of upgrading or improving the system capacity to enable it to respond appropriately to the water service demands of the current times, keeping in perspective future needs and water delivery service to farms (FAO, 1999). The process involves institutional, organizational and technological changes at all operational levels of irrigation schemes from water supply and conveyance to the farm level. The sustainability of the water users associations is however dependent on their capacity to provide an adequate water delivery service and control and to allocate water and to provide an improved service to enable gains in agricultural productivity (Svendsen, 1997). This is essential for the capacity of farmers to pay for water and for the water users associations to be financially viable. The service definition will also specify the responsibilities of all parties (farmers, Water User Associations, operators of the tertiary canal, operators of the secondary canals, operators of the main canals, and

project authorities) in operation and maintaining all elements of the system. A main canal provides water, with a certain level of service to secondary canals. Each upstream layer in a hydraulic distribution system provides service to the layer immediately downstream of it. The actual levels of service at each layer must be examined to understand the constraints behind the level of service that is provided to the field. There is a wide range of levels of irrigation service, and the nature of the service may vary significantly from a highly flexible service differentiated at the farm level to an inflexible service provided on an undifferentiated basis to a large number of farmers. It is therefore important to qualify the level of service. The levels of service may be different at each layer.

- **Reliable Water Supply:**

The most important task of FOs would be to obtain a reliable water supply instead of getting more water. This would require an efficient flow monitoring system throughout agricultural seasons.

- **Equitable Water Distribution**

Once the water enters through the gate into the distributary, the first immediate task would be to maintain high degree of equity in water distribution to the best possible level among the outlets of the respective distributaries command area as per distribution criteria. FO is required to keep all hydraulic structures in functional condition, check the discharge rating of each outlet, and if necessary to make structural adjustments like resetting the B-Y dimensions and crest elevation for the affected outlets.

- **Efficient O&M of Distributary / Minor**

For efficient running of the system, FO would be responsible to carry out annual, seasonal and routine maintenance of the channel, which includes regular de-silting, repair of hydraulic and non-hydraulic structures, embankment and weed clearance.

- **Financing Irrigation Services:**

Legally, FO has to provide for the O&M of the distributary/minor with the help of the Watercourse Associations (WCAs) at the tertiary level. The assessment of the water charges, dues, fees, surcharge in case of defaulters, levy of charges for additional services, management service cost and collection of revenues is formally a responsibility of the FO.

- **Appropriate Staffing**

SIDA rules and regulations make it legally possible to employ a suitable number of technical and non-technical staff for the operation and maintenance of the system and assessment and collection of water charges. Therefore, FO will have to appoint appropriate staff for operation and maintenance of the channel for assessment and collection of water and other charges.

- **Water related conflict Resolution:**

Disputes relating to water resources such as problem of water stealing, controversy over labour contribution, sharing of water between old and new users, inclusion of un-irrigated land, revenue assessment and collection are serious problems within the jurisdiction of an FO. It would be the responsibility of the FO to resolve such conflicts by maintaining harmonious relations between the FO and farmers. The method of settlement of disputes may be adopted with the help of the concerned WUA by involving local influential persons. It should be ensured that chances to file cases in the SIDA or state courts should be minimal.

- **Drainage Tubewells:**

To benefit significantly from LBOD drainage facilities, FOs have to take a leading role in operating and maintaining the installed drainage facilities and tubewells. FO play a key role to get the benefits associated with the available LBOD drainage and other allied facilities.

- **O&M of Surface Drains(less than 15 cfs):**

The Farmer Organization (FO) for each distributaries will be responsible for the operation and maintenance of surface drains which have design discharge less than 15 cusecs. Each FO has to devise a maintenance program and operational plan with particular emphasis on combined management of the irrigation and drainage facilities.

Participatory irrigation management often have the stated objectives of providing sustainable and adequate financing for operation and maintenance of irrigation and drainage services and of facilitating investment in the required rehabilitation or upgrading of irrigation systems. It includes demand management to encourage efficient water allocation and imposes new externalities on irrigation systems in terms of environmental performance. In older schemes aged 40 to 50 years often demand rehabilitation which is related to operation and maintenance and modernization become increasingly important. The content and orientation of rehabilitation in context of participatory irrigation management is critical.

- **Revenue Assessment**

FO should obtain and maintain the record of land holdings, cultivators and ownership record should be compiled from the record of Revenue Department. Land record will be helpful in water allocations, water distribution to the new entrants. For the cases where changes occur, new and old record must be maintained.

- **Revenue Collection**

A staff member should prepare a bill on the basis of crop assessment survey by applying the prevalent water rate in the name of each water user. The crop assessment must be completed in accordance with the notified water rates by SIDA.

Training Requirements

Manpower training and development to improve the caliber of management and the skills of farmers involved in operational and technical affairs is necessary in WUAs and FOs, without which they would not be able to attend to the day-to-day affairs regarding their performance and tasks of duties entrusted to them.

Training can be provided within farmers organizations so as to honour their commitments for a stable irrigation and drainage system. SIDA can arrange special training program for WUAs within Area Water Boards (AWBs) and FOs. The training programs be tailored to the requirement of each water beneficiary.

Training contributes to changes in attitudes and skills. Continuing programs for training and orientation would contribute greatly to institutionalizing capacity for using participatory approaches, which otherwise would decline over time. One way to make WUA training more efficient and effective would be to use monitoring information on performance indicators to prioritize sites for training to help deal with particular problems. This would support a customized, better targeted approach to training. Further it would enable farmers and WUAs to initiate their own requests about what type of training they want.

The turnover to farmers of responsibilities for operation and maintenance is a process which directly benefits them. This “ownership” of the installation results in a greater awareness by users of their responsibilities for the prevention of damage or theft of equipment, and for repairs and maintenance in a timely manner without delay.

The use of performance based service contracts for O&M can also do away with the need under the direct supervision of the WUAs or FOs.

12.8 O&M Manual

An operation and maintenance (O&M) manual is a valuable tool. It defines the requirements and procedures for the effective operation and maintenance. The purpose of the operating and

Maintenance Manuals are to provide suitable, adequate and relevant information to the owner/operator to operate, manage and run the services and provides:

- A description of the systems installed together with drawings.
- Information for safe, efficient and correct operation of services and equipment.
- To operate and maintain the system and services in line with design standards.
- To comply with relevant health and Safety Regulations, Statutory and local Regulations.
- To maximize the economic life of the system and keep running costs to a minimum.
- Minimize energy consumption.

The Operational Manual should be redesigned as per seasonal variations and real time meteorological statistics. Maintenance should be carried out in a manner that prevents emergencies or unscheduled maintenance. All maintenance requires considerable skill, which can only be acquired by experience, study, and practice. The manual should remain on site and be located in a place that is easily accessible to operating and maintenance personnel at all times.

System maintenance and inspection activities are categorized as routine, special and emergency. Routine maintenance and inspection activities are those that are regularly performed and required to keep the system in satisfactory continuous operation.

Special maintenance activities are those that are not regularly performed, but which can be scheduled on a nonemergency basis. Emergency maintenance activities are those required to be performed to correct a situation where damage has already occurred or to prevent a potential damaging situation.

Standard Operating Procedure (SOP)

Step 1: Notify management personnel

Step 2: Arrive on site and implement appropriate procedures for the remedial action with associated material, labour and equipment, in accordance with the site health and safety plan.

Step 3: Determine the type of repairs that are required, and seek and receive approval from management authorized personnel before starting any activities.

Step 4: Document all activities so that an accurate record of all repairs is in place
Operating personnel should follow lock-out/tag-out procedures, and confined space entry procedures in accordance with the site health and safety plan, before conducting any maintenance activities.

Step 4: Resource estimation

Costing the activities of the maintenance program in order to determine the overall budget

The O&M Manual is a document covering a set of directions for implementing specific tasks in a pre-defined manner.

The O&M manual received from WAPDA are:

1. Plan for Operation and Maintenance (Inception Report) LBOD Stage-1 September 1992
2. Left Bank Outfall Drain(Maintenance Equipment) February 1986
3. Five Year Business Plan for Operation and Maintenance, December 1995

The Operation and Maintenance manual should include:

1. Introduction and Guide
2. Health and safety
3. General Description of the Project
4. Operating Procedures
5. Maintenance Procedures
6. Manufacturer’s Schedule
7. Commissioning data and Certification
8. Manufacturer’s Literature

9. Drawings
10. Activities Checklist

The O&M Plan presents the O&M activities and requirements which forms the basis for the O&M plan and provides the rationale for each activity. The O&M Manual describes in a step-by-step manner the field procedures required to comply with the O&M Plan. Effective operation and ongoing maintenance are critical to the long term viability of any project.

These activities makes easier to understand-especially by outlining what to do when- an operations manual can help ensure that project is efficiently operated and well maintained long into the future.

Embankments

1. **Stability/Scouring**

Visually check the conditions of the embankments with emphasis on slope failures of cut and fill embankments and scouring of fill embankments. Record the presence of landslips and scouring on embankment. Recommend the works required to ensure the stability of embankments and remove material deposited in drains.

2. **Vegetation**

Visually check the condition of any vegetation on embankments in the vicinity and its impact on drainage and the operation of the drain. Recommend the works required to trim vegetation and remove trees affecting the operation of the drainage system.

Culvert Pipe

1. **Structure**

Visually check the conditions of culvert pipes for signs of deterioration or structural failure. Culvert pipes should be replaced if their structure has collapsed. Based on the investigation recommend remedial works.

2. **Cleanliness**

Check the presence of silt and debris that is restricting the flow of water through the culvert pipe. All silt and debris should be removed from full length of the culvert pipe. Based on the investigation recommend remedial works.

Outlet Channel

1. **Cleanliness**

Check the presence of silt and debris that is restricting the flow of water through the outlet channel of culverts. All silt and debris should be removed from the outlet channel so water flows freely away from the culvert. Based on the investigation recommend remedial works.

Scouring

Check the presence of scouring in the outlet channel that may affect the stability of the embankments. Where scouring has the potential to undermine the embankments the scouring should be backfilled and the surface of the channel reinforced with either concrete or large stones. Based on the investigation recommend remedial works.

Vegetation

Visually check the condition of any vegetation in outlet channels and its impact on drainage and operation of the system. Recommend the works required to trim vegetation and remove trees affecting the operation of the drainage system.

Culvert Headwall

Structure

Visually check the conditions of culvert headwalls for signs of deterioration or structure failure. Culvert headwalls should be replaced or repaired if the headwall can no longer support the embankment above the culvert. Based on the investigation recommend remedial works.

Cleanliness

Check the presence of silt and debris that is restricting the flow of water through the headwall. All silt and debris should be removed from the floor of the headwall. Based on the investigation recommend remedial works.

Drains

Cleanliness

Check the presence of silt and debris that is restricting the flow of water along drains. All silt and debris should be removed from drains. Based on the investigation recommend remedial works.

Shape

Check the presence of scouring in drains that may affect the stability of the embankments. Where scouring has the potential to undermine the drain embankment the scouring should be backfilled. Based on the investigation recommend remedial works.

Bridges

Visually check the condition of any vegetation in the waterway channel under the bridge and its impact on drainage. Recommend the works required to trim vegetation and remove trees affecting the flow of water under the bridge.

Scouring

Check the presence of scouring in the waterway channel that may affect the stability of the bridge abutments. Where scouring has the potential to undermine the bridge abutments scouring should be backfilled. Based on the investigation recommend remedial works.

Abutments

Structure/Foundation

Visually check the condition of the abutment structure for evidence of deterioration or structural failure. Based on the investigation recommend remedial works.

Deck

Visually check the condition of the deck structure for evidence of deterioration or structural failure. Based on the investigation recommend remedial works.

Pumps

Routine maintenance for each unit should consist of weekly adjustment and lubrication of the packing along with monthly lubrication of the bearings to ensure continued operation. Periodical inspection of the pumps should be conducted and recorded.

The pumping plant consists of the pump, motor, and coupling system. Pumping plant maintenance is used to maximize pumping plant efficiency and prolong pump and motor life.

Electric motors require little service. Protective rodent screens should be cleaned to provide proper air circulation and replaced if they are damaged. An overhead shelter will also insure that electric motors are properly cooled and that rainfall does not cause corrosion or electrical shorts.

Insuring proper lubrication of the line shaft is an essential part of deep-well turbine pump maintenance and is usually the only upkeep required for these pumps. Pump adjustment might also be appropriate but must be performed by a trained professional. Pumps impellers normally wear very slowly over their life. This causes pumping efficiency to slowly decrease. A system that pumps sand will wear much quicker and should be adjusted every 3-5 years by a trained professional, who will optimize the setting of the impellers in the pump bowls. A decreased flow rate or operating pressure

are signs that a pump has lost efficiency. However, changes in the distribution system also influence system operating characteristics. A professionally performed pumping test is the only way to accurately assess the condition of the pumping plant.

Electrical Reticulation

1. Only technically competent personnel should undertake cleaning/repair of electrical reticulation.
2. The demand for electricity should comply with the capacity of the system to supply it.
3. Electrical equipment with large demand for electrical energy , like welders, should only be used in accordance with the operational guidelines provided by the designers of the system.
4. Power Supply to the pumping system should have safety procedures associated with the O&M and the recovery system. The power supply should be stable and efficiently managed. The control panel should be fully operational.

Operational Plan

1. Operational staff should ensure a suitable Operational Plan using the full resources provided in the construction contract, their own resources and relevant technical specialists.
2. The Plan should be properly recorded and stored for future reference.
3. The Plan should detail tasks, resources required, roles and responsibilities and performance benchmarks.

Operational Training

1. Individuals shall be selected to perform each role in the Operational Plan. Individuals should be selected on their compete to either perform the tasks or successfully complete relevant training programs.
2. Operators shall undergo training , instruction and evaluation to ensure they attain levels of competence in the technical and administrative tasks they will need to perform. All Operators shall understand their level of authority, persons they should contact in case of emergency and environmental impact mitigation procedures.
3. Operators shall only be allowed to operate assets they have attained the required level of competency.
4. Operator should undergo refresher instruction especially in emergency and environmental tasks.

Establish Procedures

1. The necessary regulations, administrative and commercial steps required to implement the operational plan should be completed as part of the commissioning process and before the asset begins operation. These establishment tasks can be undertaken prior to the commissioning phase where the task can be identified.
2. The owner should legally establish the required regulations needed to operate the asset e.g. officers assigned their roles and responsibilities, revenue raising powers enacted.
3. Administrative steps should be completed. Administrative steps could include providing office space and advising higher authorities.
4. Commercial steps could include establishing bank accounts and supply and maintenance contracts.

Management Responsibility

Managerial responsibilities include the encouragement and motivation of O&M personnel, as well as overall supervision of the system. Specific responsibilities include but are not limited to:

- Ensure the efficient O&M of the system.
- Monitor the adequacy and content of the O&M records.
- Establish staff requirements, job descriptions, and personnel assignments.
- Provide O&M personnel with sufficient resources to properly operate and maintain the system.

- Provide adequate working conditions, safety equipment, and necessary tools for O&M personnel.
- Establish and maintain a harmonious working relationship with O&M personnel.
- Establish and maintain a training program for O&M personnel.
- Communicate importance of proper system performance to O&M personnel.
- Conduct periodic inspections of the system to discuss mutual problems with maintenance personnel and observe operational practices.
- Motivate personnel to achieve maximum operational efficiency.
- Prepare budgets and reports.
- Maintain good public relations.

Operating Personnel Responsibility

Operating personnel are responsible for the day-to-day O&M of the system. Specific responsibilities include but are not limited to:

- Knowledge of proper operational procedures.
- Effective operation of the system.
- Keep continuously updated on the best O&M practices.
- Maintain accurate and legible system O&M records.
- Inform management of potential major problems in O&M of the system
- Monitor the condition of the system
- Be aware of safety hazards and take necessary steps to avoid them.
- Be prepared to discuss the system operation with visiting personnel.

12.9 Cost Recovery Systems

"Drainage Cess" means the drainage cess levied for conveyance and disposal of effluent through the drains. As per Clause 23(2) 'Procedure for fixing of Rates 'the SIDA Authority shall supply water shall be so fixed as to provide for meeting the operation and maintenance cost of the system within a period of seven to ten years; provide always that before proposing any enhancement in the existing rates, and/or agreeing to the same, the Authority/AWBs concerned shall use their best endeavors to reduce the quantum of the proposed enhancement of rates by adopting the following measures:

Reducing cost;

i. Improving assessment and collection of water rates and drainage cess;
ii. Recovery of arrears
iii. Recovery of cost for providing drainage flood control to non-farming beneficiaries.
iv. De-investment of fresh water tubewells in SCARP areas.

with the commissioning of SCARP tubewells, the expenditure on account of Electricity bills increased manifold rising inflation exacerbated the situation and balance of earnings was disturbed very adversely against the earning capacity of the Department.

The socio-political setting did not allow proportional increase in water rates and Department went into deficit. This deficit kept on increasing with edition of more SCARP tubewells and it became rather impossible to allocate even the bare minimum requirement of O&M funds. The obvious result was deferred maintenance of Irrigation works which has been accumulating with time. The deferred maintenance also affects the stability and functioning of the structure and ultimately the system.

Poor maintenance can also produce negative environmental consequences, for example water logging and salinity caused by impeded drainage and adverse impacts on health from water-related diseases.

The O&M cost of the drainage system is expected to rise in future on account of the positive relationship between the age and physical deterioration of the system. There should be cost recovery system to cope with the rising costs of operation and maintenance (O&M) for which reasonable yardstick are required for each component of the drainage system. SIDA to establish a service-client

relationship between SIDA and AWBs, AWBs and FOs, FOs and individual farmers regarding O&M proportionate amount.

There is a need to improve the seriously deteriorated physical condition of the existing drainage system, which has been caused by the persistent accumulation of deferred maintenance. For physical improvement, the FOs will need to undertake optimal investments in O&M of their parts of the system. They also need to pay sufficient money to the AWBs for optimal O&M of the main drains of the system that evacuates water from their areas of concern.

The maintenance and repair (M&R) costs include construction, repair, silt removal, removal of weed growth. Maintenance and repair costs can be defined as the direct costs expended on the physical upkeep of the irrigation system. Another category of maintenance costs is referred to as "***rehabilitation and improvement***'' cost. These costs do not form part of the regular maintenance cost allocations but are prepared as development projects and are generally aimed at remodeling drainage system.

The O&M works likely to be undertaken by AWB's and FO's include weed growth clearance, debris removal, bed clearance, maintain banks and inlets, repair and maintenance of cross drainage works, bridges, Tubewells, Tile drainage Sumps and monitoring the drainage flows under their jurisdiction.

Collections

- The amount due in respect of water rates shall be deposited by the occupiers in the manner as determined by the Farmers Organization.
- The bill shall be deposited in full amount as shown thereon and partial payment shall not be allowed. Payment shall not be accepted after the date as determined for cut-off purposes to work out arrears for the next billing.
- In case the occupier or his representative deposits the bill of water charges in the Farmers Organization office, the receiving official will receive the bill and the receipt of the paid bill will be pasted or annexed with the original assessment sheet of the occupier.
- In case a bank is nominated by the Farmers Organizations for depositing the water charges, and the bills have been deposited in the FO Account in the nominated branch of the bank, the bank shall provide a list of recoveries of water charges along with receipt of the paid bills to the concerned Farmers Organization within stipulated period. The receiving official of the FO shall maintain the record.
- In case collection of water charges is made through FO Members (KP Chairmen), the procedure for collection will be determined by the Farmers Organizations and record of recovery shall be maintained in the manner as prescribed above.
- The Farmers Organization shall be responsible to keep record of the collections of water charges and shall ensure that the SIDA share as per agreement shall be deposited into the provincial Government's Account No. 1 in the prescribed manner with the designated Bank Treasury, or in other account as and when directed by the SIDA office.
- The collections of water charges shall be entered in Form NO.2 Part II. The Collections of water charges shall be totaled weekly and the weekly collections received upto, 15th, 22nd and 30th/31st of the month shall be prepared by the FO Treasurer and monthly progress of recoveries on the prescribed Form No.16 shall be submitted on 5th of each month in the office of the Area Water Board /Canal Circle with a copy to SIDA office.
- Billings and collections shall be entered in the individual account of the Farmer in "Water Rates Receivable Ledger". Separate ledger shall be maintained for each outlet. Receivable ledger shall be balanced quarterly particularly after the expiry of the due date and a list shall be prepared with the age analysis and total thereof shall be reconciled with the general ledger account. The listing of the balances of each register shall be provided to the concerned member for recovery purposes.

- Assessment, collection and maintenance of Farmers accounts shall be the exclusive responsibility of the Farmers Organization and bad debts shall be to its account. Therefore, control over receivables of water charges is the most important function of the Farmers Organization in so far as the strict control helps in alleviating shortages of working capital and in minimizing losses arising from defaults in payments. The quarterly/yearly trial balance of receivables shall show the age analysis of individual accounts. All out efforts shall be made to recover the outstanding through personal contacts, participatory approach as per rules.

Assessment and collection of Abiana:

Each FO will be responsible for assessment and collection of Abiana from the farmers in its area of jurisdiction in the prescribed manner.

Detailed procedure for Abiana Assessment and Collection is contained in the integral part of Financial Regulations.

Sharing of Abiana:

The FO shall be entitled to an agreed share of the collected Abiana, provided that:

The assessment of the said area shall not fall short of the average assessment of the last three in real terms or an amount agreed by SIDA.

Where the Abiana collection of a particular year exceeds the minimum pre- determined amount, the FO's share will be increased by an agreed percentage

Monitoring and Coordination

The FO shall maintain proper accounts for all receipts and expenditures and such accounts shall be available for inspection to AWB/SIDA. It is required to submit the following information to AWB/SE concerned:

- Monthly Abiana Collection Report
- Abiana Assessment Statement for each crop season with comparison with the corresponding last year statement
- Quarterly Budget Utilization Statement (item wise and works wise)
- Annual Budget Document
- Annual Audited Financial Statements

O&M Expenditure Requirements

In order to judge what proportion of O&M costs have been recovered in a particular year, it is necessary to determine actual O&M expenditure in a baseline year. Unadjusted revenue (recurrent) budget figures cannot be used. Adjustments must be made for:

- inclusion in the IPD revenue budget, of non-recurrent items not applicable to systems O&M;
- differences between budget and actual expenditure due to Department of Finance withholding release of budgeted amounts and approving items of supplementary expenditure (revised budget gives the nearest appropriation to "actuals"); and
- Expenditure that should be incurred on the existing systems in accordance with O&M yard-sticks (if "appropriate" or "full" O&M expenditures are to be .identified).

Detailed analyses of O&M expenditure by IPD formed part of the comprehensive "Nationwide study for improving procedures for assessment and collection of water charges and drainage cess".

Clearly the adequacy of O&M expenditure will depend upon the organizational efficiency and productivity of resources used. In addition to a comparison between actual expenditure and yardstick estimates, there are other forms of evidence that O&M is inadequate, given the present organizational structure, O&M practices and facilities.

There are three main ways for bridging the financial gap between payments by beneficiaries and

either actual O&M expenditure or higher desirable levels: improving collection, raising water and drainage charges and improving the efficiency and productivity of operation and maintenance. Achieving full cost recovery for irrigation O&M at existing levels of spending is clearly a first step towards adequate funding of O&M for both irrigation and drainage systems. Improving procedures for assessment and collection of water charges and drainage cess"

- transfer of Abiana assessment to IPD;
- issuing bills half-yearly instead of annually;
  surcharges (10 percent) on farmers for non-payment of bills in time; and
- improved collaboration between IPD and Revenue Departments on aspects such as collection of arrears and imposition of fines for offenses under the Irrigation Act.

The financial gap is too large to close by improved collection alone. The key issue therefore is how best to move forward with all three ways simultaneously.

Nevertheless it would be dangerous to defer a decision for too long. Bold leadership in raising charges is needed if this system of strategic importance to the economy of Sindh is to be sustained.

Regarding the third aspect, numerous studies and the Consultant's observations indicate opportunities for better levels of service and also better use of resources by IPD that would at least hold down, if not completely avoid, cost increases. Specifically, there is scope for:

a) changes in water management practices, from barrage to farm, that would enable more efficient' use of water and an improved service to farmers;

b) changes in maintenance practices that would improve the operational efficiency of canal and drainage systems while making the best use of equipment and manpower;

c) changes in organizational structures and staffing to facilitate the above through optimum manning levels, clear delineation of responsibilities and integrated control of irrigation and drainage functions and of mechanical services at the most appropriate level;

d) manpower training and development to improve the calibre of management and the skills of operational and technical personnel, including imparting the skills needed for O&M facilities provided under LBOD;

e) improved telecommunications and possibly new equipment related to a) and b) above; and

f) changes in the assessment and billing of water and drainage charges, to improve the levels of recovery.

Abiana and Cess:

The figures quoted are from the GoS Department of Finance Annual Estimates based on reports submitted by IPD. These reports are stated as covering water charges only and not drainage cess. Data requested from the GOS Revenue Department give figures considerably at variance with GoS published data: lower than reported water charges and much higher than seems feasible for drainage cess.

estimation of O&M requirements, whether for the LBOD area or for the whole of the Sindh Irrigation area, would require a detailed estimate of the staff and equipment needed for the recommended operation and maintenance practices related to the unit length of each category of irrigation and drainage facility and grossed up for the whole system. To this would need to be added the recurrent costs of water and drainage charge assessment/ verification, and also billing, if this activity is ever carried out by IPD.

The present system of water charges (Abiana) is based on the area cropped with a different rate related to water consumption for nine types of crop. This is similar to practice in other provinces and follows a GoS experiment in the 1970s with a flat rate charge.

Physical inspections of cropped lands are carried out by staff of both the Revenue and the Irrigation Departments. Prime responsibility for assessment, billing and collection of abiana rests with the former. For each season the tapedar carries out partal (booking of crops) by inspecting crops growing in each field and recording details in a Field Measurement Book. Details are consolidated by village (Deh). Inspections are scheduled to take place between specified dates shortly before harvest and,

under the Sindh Land revenue Rules, sample inspection by supervisory officers (Mukhtiarkar, Assistant Commissioner and Deputy Commissioner) are supposed to be carried out to verify and, where necessary, amend entries. IPD Abdars inspect cropped areas soon after sowing, recording data by watercourse and channel (to facilitate water management) and consolidating information by Deh. The Rules prescribe that the two sets of records are then reconciled and adjustments made where there are any discrepancies. After both Kharif and Rabi crops have been measured, the Revenue Department prepares bills for each land owner covering Abiana charges for the year, any drainage cess, land revenue and other charges plus any arrears. The Department issues the bills and collects dues, issuing receipts.

In practice inspections to verify partal and inter-departmental reconciliations rarely take place due to:

- increased work load on tapedars (rising irrigation intensities, sub-division of land, pressure of other duties) resulting in late completion of partal, often after harvest, that precludes inspection;
- pressure of other duties on supervisory staff and a reluctance to travel, in part due to security risks;
- general slackening in management, particularly a growing laxity in the exercise of inspection and supervisory roles by senior officers;
- increased incidence of unauthorized irrigation, tampering with moghas (outlets) and disputes over water rights that are of higher priority to IPD staff than recording or reconciling crop data; and
- difficulties in checking the two sets of the data where a deh is served by more than one watercourse and disappearance of the evidence (ie completion of harvest) by the time reconciliation is attempted.

For the last two reasons most Abdars make only rough estimates of cropped area and IPD Divisions appear to accept Revenue Department assessments. the causes of under-recovery, or leakages, of revenues due for abiana and drainage cess as: under-booking of cropped area;

erroneous recording of the crop as one for which a lower charge is payable; errors in preparing bills in favour of the land owner; non, or late, payment of bills and failure to collect arrears. Over the last six years abiana collected from beneficiaries (which appears to be overstated) has been less than 60 percent of the amounts spent on O&M, which represented under spending for sustainability of the system. An indication of farmers' capacity to pay increased charges for water and land drainage can be obtained from comparing amounts due with average incomes from the main crops grown.

The assessment of Abiana can be determined on the basis of crop share and its delta requirement. The four major crops of the province (Wheat, rice, sugarcane and cotton) occupy 69% of area. The weighted water requirements based on their delta needs is 77% of the total water required. Using these basic parameters, the Abiana rate can be determined both for flat rate crop based system of assessment.

The O&M expenditure partly can be financed through Abiana (water charges) and Drainage Cess. It has been learnt from the concerned agencies (SIDA & PID) that at present no drainage cess is being charged and collected as they require notification from the Provincial Department.

Flat Rate Assessment of Abiana will form the basis of assessment of water rates plus Drainage cess (Abiana) for Kharif & Rabi seasons. Assessment of water rate ((Abiana) plus Drainage cess is leviable per acre of CCA (Culturble Command Area). As such the procedure of entries of field data and assessment of occupiers' rates and formats have been provide for information and guidance of the Farmers Organizations. This procedure is required to be implemented by the FOs in assessment and collection of water rates, with the assistance of canal commettee (where formed) and water course committee.

12.10 Allocations of Funds for Operation and Mainteance (Budget Estimate for 2011-12)

Any fund, grant, donation or other money as received by Area Water Board from the Government or Sindh Irrigation and Drainage Authority shall be utilized to the extent and in the manner, as may be determined by Sindh Irrigation an Drainage Authority.

The Annual Budget proposals for recurring expenses of Area Water Board shall be prepared by Chief Executive and placed before the Area Water Board in its Ordinary Meeting during April of each calendar year for its concurrence which shall be sent to Sindh Irrigation and Drainage Authority upto mid of May for approval and allocation of funds on the basis of consolidated yardstick.

S. #	Component of Irrigation System (works only)		Unit	Rate	Amount
	A-13470-Irrigation				
1	Barrages and Headworks Repair & Replacement of Barrage gates and E&I works	5618.12 (cost of 3 barrages)	Million Rs.	@ 5% total up valued cost of all H.works	280900000
	A – 13401 Irrigation				
2	Main Canal and Branches (Flow Irrigation) (including irrigation colonies)	10257	Virtual Mile	160200	1643171400
Sub Total					**1924071400 (i)**
	A- 13470 Lift Irrigation				
3	Small irrigation scheme on canal	3705	Horse Power	65329	**242043945**
4	Flood Embankments				
	a) Main Bunds (River)	935	Miles	368140	344210900
	b) Loop Bunds (River)	339	Miles	296026	100352814
				Sub Total	**686607659 (ii)**
5	A – 13503 scarp/ Drainage works				
	i) SCARP Tubewells (3837 Nos)	77528.4	H.P	23286	1805326322
	ii) SCARP & other Pumps (31 Nos)	1804.2	H.P	21302	38433068
	iii) SCARP & other Surface Drain	5157.8	Virtual Mile	69760	359808128
	iv) SCARP Colonies	12 Nos			19842000
Sub Total					**2223409518**
	Add 10% Provision for E&I and other works				222340952
	Total SCARP & Drainage (0423)				**2445750470 (iii)**
				Grand Total i+ii+iii (Rs.)	**5056429529**
				Say	**5056.429 Million**

APPENDIX CHAPTER 12

Appendix- C.

Sr No	DESCRIPTION	Cost at the Time of Construction 1964	Escalation 125% in Year 1972	Cost in 1972	Escalation 35 % in 1976	Cost in 1976	No. of Building	Total Cost in 1976-77
	3Beded Bungalows	64,698.00	80,873.00	145,571.0	- 50,950.00	196,521.00	11	2161731.00
	2 Beded Bungalows	50,256.00	, 62,820.00	113,076.0	39,577.00	152,653.00	10	1526530.00 <
	D-I type Quarter	28,153.00	35,191.00	63,344.0	' 22,170.00	85,514.0	18	1539252.00
	C-I type Quarter	20,944.00	26,180.00	47,124.0	16,493.00	63,617.00	10	636170.00 1
	D-II type Quarter	9,997.00	12,496.00	22,493.0	7,873.00	30,366.00	10	303660.00.
	B-2 type Quarter	8,389.00	10,486.00	18,875.0	6,606.00	25,481.00	40	1019240.00
	D-type Quarter Garage	3,383.00	4,229.00,	7,612.0	2,664:00	10,276.00	34	349384.00
	Rest House & Out House	109,636.00	137,045.00	246,681.0	86,338.00	333,019.00	1	333019.00
	Office Building	90,872.00	113,590.00	204.462.0	71,562.00	276,024.00	1	276024.00
	Hospital Building	65,442.00	81,803.00	147,245.0	51,536.00	198,781.00	1	198781.Q0
	Workshop Building	149,963.00	187,454.00	337,417.0	118,096.00	455,513.00	1	455513.00
	Club Swimming Pool	124,570.00	155,713.00	280,283.00	98,099.00	378,382.00	1	378382.00
	Roads	82,947.00	103,684.00	186,631.00	65,321.00	251,952.00	-	251952.00
	Sewerage System	110,965.00	138,706.00	249,671.0	87,385.00	. 337,056.00	-	, 337056.00
	Sewerage Disposal System	62,915.00	78,644.00	141,539.00	49,546.00	191,105.00	-	191105.00
	Water Supply System	90,200.00	112,750.00	202,950.00	71,033.00	273,983.00	-	273983.00
	Compound Wall	56,000.00	70,000.00	126,000.00	44,100.00	170,100.00	-	170100.00
		1,129,330.00	**1,411,644.00**	**2540994.0**	**889349.00**	**3,430,343.00**	**138**	**10,401,882.00**

Note: Rate of Escalation = 10%
Rate of Depreciation = (-) 2%
Net Rate of Escalation = 8%

Present Cost (2011-12) = Rs. 10401882 x $(1 + .08)^{35}$

10401882 x 14.785 = 153791825

Yardstick for Small Colonies at Ranipur, Kotdiji & Gambat

Works

Capital cost of Colony @ Ranipur during 1978-79	= Rs. 702000
Capital cost of Colony @ Kotdigi during 1978-79	= Rs. 1404000
Capital cost of Colony @ Gambat during 1978-79	= Rs. 702000
Total cost of Three Colonies:	= Rs. 2808000
Up- Value cost during 2011-12 = $(1+.08)^{33}$ = 12.676 x 2808000=	= Rs. 35594208

i. Ordinary and Special Repairs @ 2 % =

$\frac{35594208 \times 2}{100}$ = =Rs. 711884

ii. Electric Consumption for street lighting etc:

Three colonies = 3 x 12000 x 12 = = Rs. 432000

iii. Supplying /Replacement of Bulbs, Wires, Motors,

Water Supply and Sanitary item etc;

Three colonies 3 x 3600 x 12 = = Rs. 129600

iv. Operation and maintenance of Water Pump/

Tubewell for Three Colonies 3 x 8400 x 12 = = Rs. 302400

v. Supplying T & P articles Buckets, Cement Consumable

Materials such as Lime, K. Oil, Seeds, Plants House Pipes Fertilizers

And Garden tools etc; for 3 Colonies = 3x6000 x 12 = Rs. 216000

vi. M & R to Internal Roads = 3x4800x12 = Rs. 172800

M & R to Water Supply & Sanitary Fitting

= 3 x 2400 x 12 = Rs. 86400

vii. Miscellaneous 3 x 2000 = = Rs. 6000

Total = Rs. 2057084

Therefore Amount of M & R require for each

Small Colony = $\frac{2057084}{3}$ = Rs. 685694 Each colony

Appendix –D

LIST OF BUILDINGS SCARP COLONIES @ RANIPUR, GAMBAT & KOTDIJI

Type of Buildings.	Nos.	Amount in Rupees
A) SCARP Colony at Ranipur (Drainage Sub Division No. III SCARP Gambat)		
1. C-1 type Bungalow	1	279000
2. E-II Type Quarter	1	127000
3. F-II (i) Type Quarter	1	28000
4. G-II (i) Type Quarter	1	66000
5. H-II Type Quarter	1	47000
6. Out House attached with C-I Bungalow	1	45000
7. Compound Wall	1	50000
(1978- 79)	**Total A-**	**70200**
B) SCARP Colony At Gambat (Drainage Sub Division No. III Gambat		
C- Type Bungalow	1	279000
E- II (i) Type Quarter	1	127000
F-II (i) Type Quarter	1	28000
G-II (i) Type Quarter	1	66000
H-II Type Quarter	1	47000
Out House attached with C-I Bungalow	1	45000
Compound Wall	1	50000
(1978- 79)	**Total C-**	**702000**
C) SCARP Colony at Kotdiji (drainage sub division no. IV kotdiji)		
C- Type Bungalow	1	550000
E- II (i) Type Quarter	1	254000
F-II (i) Type Quarter	1	176000
G-II (i) Type Quarter	1	132000
H-II Type Quarter	1	94000
Out House attached with C-I Bungalow	1	90000
Compound Wall	1	100000
(1978- 79)	**Total C-**	**1404000**

Annexure -I

LIST SHOWING CANALS ON LEFT SIDE OF RIVER INDUS
SIND IRRIGATION NET WORK

No.	Name of Feeder / Canal	Mileage	
		Perennial	Non-Perennial
I.	**FEEDER & MAIN CANALS**		
	GUDU BARRAGE		
1.	Ghotki Feeder	79.60	-
	SUKKUR BARRAGE		
1.	Rohri Canal	208.00	-
2.	Khairpur Feeder East	58.60	-
3.	Khairpur Feeder West	41.90	
4.	Nara Canal	226.00	-
5.	Nasrat	63.30	-
6.	Nasir	70.80	-
7.	Jamrao	124.00	-
8.	Mithrao	37.07	-
9.	Khipro	49.72	-
10.	Thar	5.30	-
		885.32	-

KOTRI BARRAGE

	Perennial	Non-Perennial
Fuleli	-	59.80
Pinyari	-	57.00
Akram Wah (Feeder)	76.20	-
Guni Brach Ex- Fuleli	-	42.00
Pinyari Branch Ex- Pinyari Feeder Lower	-	39.00
Daro Branch Ex-pinyari	-	35.00
Mirwah Talhar, Ex-Fuleli	-	46.24
	76.2 Miles	**279.04 Miles**

No.	Name of Feeder / Canal	Mileage	
		Perennial	Non-Perennial
II.	**Branch Canals.**		
GUDU BARRAGE			
1.	Masu	26.00	-
2.	Mahi	18.88	-
3.	Kazi	48.40	-
4.	Bumbly	29.72	-
5.	Dahar Wah Lower	35.40	-
6.	Dahar Wah Upper	23.00	-
	C. Over:	**181.40**	**-**

No.	Name of Feeder / Canal	Mileage	
		Perennial	Non-Perennial
III.	**Branch Canals.**		
SUKKUR BARRAGE			
1.	Naulakhi Branch	14.80	-
2.	Mehrabpur	7.56	-
3.	Amerjee	16.32	-
4.	Almani	4.52	-
5.	Dad Branch	12.00	-
6.	Hyderabad Branch	15.70	-
7.	Thul Branch	6.80	-
8.	Hala Branch	11.78	-
9.	Jam Branch	13.00	-
	C.O	**132.48**	**-**

No.	Name of Feeder / Canal	Mileage	
		Perennial	Non-Perennial
10.	Tando Adam Branch	12.20	-
11.	Dim Branch	32.00	-
12.	Shahu Branch	19.34	-
13.	Dalore Branch	18.60	-
14.	West Branch	59.20	-
15.	Nabi Sar Branch	20.60	-
16.	Naukot Branch	21.30	-
17.	Samaro Branch	14.89	-
18.	Hiral Branch	14.00	-
19.	Sathio Wah	14.36	-
20.	Ali Bahar	31.40	-
21.	Faiz Ganj	32.60	-
22.	Faiz Wah	26.28	-
23.	Abdul Wah	21.20	-
	C.Over:	**470.45**	-

No.	Name of Feeder / Canal	Mileage	
		Perennial	Non-Perennial
	KOTRI BARRAGE		
1.	Hasan Ali Ex-Gunni	-	12.10
2.	Shar Wah Ex- Hasan Ali	-	14.10
3.	Dubi Ex- Gunni	-	17.64
4.	Sorhandi Ex-Dubi	-	19.05
5.	Jhol Branch Ex-Gunni	-	21.80
6.	Imam Wah Jagir Ex-Gunni	-	34.16
7.	Mulchand Ex-Fuleli	-	31.72
8.	Morjhar Ex-Mirwah Talhar	-	23.20
9.	Nasir Branch Ex-Fuleli	-	20.20
10.	Miranpur Branch Ex-Pinyari Feeder Lower	-	16.52

11.	Ganj Bahar Ex-Pinyari Feeder Lower	-	14.00
12.	Malia Branch Ex-Pinyari Branch	-	18.50
13.	Mirkhana Ex- Pinyari Branch	-	16.40
14.	Gungri Large Ex-Dhoro Branch	-	20.20
15.	Satta Ex-Daro Branch	-	17.70
16.	Gaja Branch Ex- Akram Wah	12.48	-
17.	Shadi Large Ex-Akram Wah	30.80	-
18.	Kazia Ex-Akram Wah	22.00	-
19.	Sunni Gunni Ex- Akram Wah	11.78	-
	Total:	77.06	297.29 Miles

No.	Name of Barrage System	Perennial	Non Perennial
	Feeder and Main Canal		
1	Guddu Barrage	79.60	-
2	Sukkur Barrage	885.32	-
3	Kotri	76.20	279.04
	Sub Total	**1041.12**	**279.04**
	BRANCH CANALS		
1	Gudu Barrage	181.40	-
2	Sukkur Barrage	470.45	-
3	Kotri Barrage	77.06	297.29
	Sub Total	**728.91**	**297.29**
	Distributaries and Minors		
1	Gudu Barrage	991	-
2	Sukkur Barrage	3530	-
3	Kotri Barrage	1263	-
	Sub Total	**5784**	-
	Grand Total	**7554.03**	**576.33**

Annexure - II

LIST OF COLONIES (GOVERNMENT HOUSING)

(0422-Irrig)

A. Canal Irrigation

Large size	**Medium size**	**Small size**
1. Kashomre	1. Ghotki	1. Kandh Kot
2. Sukkur (Very Large Size)	2. T.M. Khan	2. Shikarpur
3. Kotri BarrageRight Bank		3. Jacobabad
4. Kotri Barrage Left Bank		4. Daharki
		5. Mirpur Mathelo
		6. Pano Akil
		7. Larkana
		8. Dadu
		9. Nawabshah
		10. Sanghar
		11. Mirpukhas
		12. Shahdad Kot
		13. Thatta
		14. Mirpur Sakro
		15. Badin
		16. Sujawal
4 Nos	2 Nos	16 No.
SCARP – Irrigation Colonies		
	1.Khairpur	1.Ranipur
	2.Naushehro feroze	2.Gambat
		3.Kotdiji
		4.Sakrand
		5.Nawabshah =2Nos
		6.Badin
		7.Sanghar
		8.Halla = 5 Nos.
		15 Nos.

Annexure - III

DETAILS OF LIFT IRRIGATION (PUMPING) WING SCHEMES

Name & Location		Discharge Design / Actual	No. of Pumps	H. Power of each	Total Horse Power	Cultivation Raised
SIDA. ALONG NARA CANAL (BARRAGE & K.F EAST DIVISION)						
Lift channel R.D	R 115	7.51	2 x	30 =	60	3097.50
-do-	L 116	11.43	3 x	30 =	90	5716.50
-do-	L 118	4.78	3 x	20 =	60	2151.00
-do-	R 130	9.69	3 x	30 =	90	5340.00
-do-	R 158	17.22	4 x	30 =	120	5088.00
-do-	L 159	14.92	3 x	30 =	90	6315.00
-do- •	LI 86	18.22	4 x	30 =	120	2490.00
Pharyaro Minor.	R 220	7.70	40+lx	20 =	60	3769.00
Chun Ko "	R 238	11.62	3 x	30 =	" 90	2328.00
Sorah "	R 261	13.92	3 x	30 =	90	2317.50
Dadu "	R 278	11.89	3 x	30 =	90	4104.00
Mumtaz "	R 300	13.10	3 x	30 =	90	8434.50
Gendaho "	L 226	23.83	3 x	40 =	120	7972.50
Saido "	L 250	22.76	3 x	40 =	120	6208.50
Gh: Hussain "	L 273	17.85	3 x	30 =	90	4966.80
Lai Wari "	L 311	13.21	3 x	30 =	90	5655.00
Tajjal "	L 349	14.59	3 x	30 =	90	5545.00
Kiriri "	L 387	12.31	3 x	30 =	90	5202.00
Dingri "	L 415	13.83	3 x	30 =	90	5362.50
Pir Bux "	L 453	14.47	3 x	40 =	120	4732.50
Limon "	320	16.36	3 x	40 =	120	5250.00
Nasrullah "	352	22.00	4 x	40 =	160	7500.00
Dedhano "	380	13.33	3 x	30 =	. 90	4200.00
Soomar Wari "	400	16.16	3 x	40 =	120	6000.00
Simni "	447	8.42	2 x	40 =	80	3300.0
Chicher "	480	19.50	3 x	40 =.	120	6750.00
		369.62			**2550 - C.Over**	

Name & Location	Discharge Design/ Actual	No. of Pumps	H. Power of each	Total Horse Power	Cultivation Raised
Kotri Region					
Wadhu & Fisadi Wah	9.87	3x 45+	1x 40=	175	5124.00
Seri Fazal Link Lift Scheme	36.58	-	=	250	10710
Pandhi wah Lift Scheme (Rabi only) (Y2)	73.03	1x 85+	7x 75=	610	5467.50
Muhammad Khan Distry: Lift Scheme	17.54	-	=	120	4470.00
Sub Total	**137.02**	**-**	**Sub Total**	**1115**	
Total Discharge.	**506.64 Cusecs (+ 30.0 Stand By)**	**Total**	**H.P = (+ 175 Stand By)**	**3705**	**160607 Total Cultivation**

Note: (U) Figures are tentative

(Y) Length of Wadhu and Fisadi Wah = 6.56 miles.

(Y) Length of Pandhi Wah. = 9.22 miles

(Z) i. The Design discharge of Wadhu Wah At Head is 28 cusecs.

i. Fisadi Wah off takes from wadhu wah & has designed discharge of 11.32 cusecs.

Annexure - IV

Abstract of Reasonable Requirements for M & R To Regulators, Bridges & Other Hydraulic Structures

Canal Regulators & Bridges, the Same Provisions as in 1987-88 Green Book is adopted as under.

Repair & Inspection to Regulators and Canal Bridges

	M & R	Inspection	Total
Regulators on Feeders & Main Canals	@ Rs. 60000 +	3000	= Rs. 90000
Regulators on Branches.	@ Rs. 15000 +	20000	= Rs. 35000
Regulator on D&M	@ Rs. 10000 +	12000	= Rs. 22000
Bridges	@ Rs. 1000 +	-	= Rs. 10000

Therefore Reasonable Requirement of M & R to:

	No.	Inspection	Total
Regulators on Main Canals & Feeders	147 x	90000	= Rs. 13.23
Regulators on Branches.	155 x	35000	= Rs. 5.43
Regulator on D&M	390 x	22000	= Rs. 8.58
Bridges	1125 x	10000	= Rs. 11.25
			= Rs. 38.49 Million

(B) River Bridges Very few components of these structures Are affected by Wear & Tear and hydraulic Action hence nominal provisions.

(1) **Thatta Sujawal** – Up- Valued cost Rs. 800.00 Million
@ $^1/_2$ percent taken M&R Rs. = 4.0 Million

(2) **Dadu – Moro** – Up – Valued cost Rs. 2000.00 Million
@ ½ percent M&R for Rs. = 10.00 Million
This Bridge Total Rs. = 14.00 Million

(C) Syphons & Aqueducts

- **Begari Syphon**
  Up – Valued cost Rs. 25 million = Rs. 0.13
  @ ½ percent Reasonable M&R

(iii) Other Siphons
5 Nos. @ Rs. 10000 = Rs. 0.50

Total: Rs. 0.63 Million

A + b + c = 38.49 + 14.0 + 0.63 = 53.12 Million

Total M&R to Structures.
(Regulators, Canal & River Bridges, Syphons & Aqueducts)= Rs. 53.12

$\frac{53120000}{11846}$ = 4484/- say Rs. 4500/- Per Mile

Annexure V

Present Capital Cost of One Tubewell Pumping Set (Breakup of Item – Wise Cost)

Item	Cost
Control	Rs. 200000
Low Tension Wire	Rs. 5600
Electric Motor	Rs. 20000
Discharge Head	Rs. 120000
Column Socket	Rs. 60000
Column Pipes	Rs. 200000
Bearing Bush	Rs. 10000
Column Shaft	Rs. 200000
Top Shaft	Rs. 30000
Sand Guard	Rs. 5000
Protective Sleeve	Rs. 20000
Bowl Assembly	Rs. 225000
Suction Pipe	Rs. 50000
Therefore Total Cost:	Rs. 1145600

1145600 x $(1.02)^3$

= 105000 x 1.061

= 1215480 (for year 2011-12)

Annexure-VI

Abstract of Reasonable Request Requirement for SCARPS & Other Facilities for 2011-12 (WORK ONLY) HEAD (0423)

Name of SCARP	Tubewells					Pumps					Surface and Carrier			Colonies		
	No.	Aver: H.p	Total H.P	Rate Per H.P	Total Amount Million Rs.	No.	Aver: H.P	Total H.P	Rate per H.P	Total Amount million Rs.	Virtual Miles	Rate Per mile	Total Amount million Rs.	No.	Rate Rs.	Total Amount million Rs.
1. Khairpur	640	24	15360	23286	277.432	31	58.2	1804.2	21302	38.433	573.8	69760	39.548	1 Medium 3 small	3839036 685694	3.839 2.057
2. North Rohri	1092	25.5	27846	18062	502.954	-	-			-	-	-	-	1 Medium	3839036	3.839
3. South Rohri														1 small	685694	0.686
a. Halla Unit	180	15	2700	18062	48.767	-	-			-	-	-	-	-		
b. Other	250	15	3750	18062	67.733	-	-			-	-	-	-	-		
4. Kotri Surf	-	-	-	-	-	-	-			-	2070	68923	142.671			
5. LBOD																
6. Drainage Div: Badin	191	17.74	3388.34	18062	61.200	-	-			-	730	68923	50.314	1 small	685694	0.686
7. Drainage Div: Sanghar	965	15	14475	18062	261.447	-	-			-	730	68923	50.314	1 small	685694	0.686
8. Drainage Div: Nawabshah	519	19.3	9861	18062	178.109	-	-			-	730	68923	50.313	2 small 2 Soft Block	685694 3839036	1.371 6.678
Total	**3837**		**77528.4**		**1805.33**	**31**		**1804.2**		**38.433-**	**5157.8**		**359.808**	**12 No.**		**19.842**

Annexure- VII

STATEMENT OF H.P OF TUBEWELLS IN SCARP NORTH ROHRI PROJECT

Name of Division	No. of T/Wells	15 H.P	20 H.P	25 H.P	30 H.P	35 H.P	40 H.P	Total
Tube Well Operation Division No. I	562	91x 15 =	4x 20 =	137 x 25 =	-	156 x 35 =	174x 40 =	
Naushero Feroz		1365	80	3425	-	5460	6960	17290
Tube Well Operation Division No. II	530	193x 15=	205x 20=	95x 25=	36x 30=	1x 35 =	-	
Sakrand	-	2895	4100	2375	1080	35	-	10485
Average H.P = 27775/ 1092=		**25.5 per Tubewell**						

Statement of Various Irrigation Components on the Left Bank of River Indus

Maintenance & Repair Consolidated Amount According To Yardstick -2012

S. #	Component of Irrigation System		Unit	Rate	Amount
	A-13470-Irrigation (works only)				
1	Barrages and Headwork's Repair & Replacement of Barrage gates and E&I works	5618.12 (cost of 3 barrages)	Million Rs.	@ 5% total up valued cost of all H. works	280900000
	A – 13401 Irrigation				
2	Main Canal and Branches (Flow Irrigation) (including irrigation colonies)	10257	Virtual Mile	153407	1573495599
				Sub Total	**1854395599 (i)**
	B- 13470 Lift Irrigation				
3	Small irrigation scheme on canal	3705	Horse Power	65329	**242043945**
4	Flood Embankments				
	c) Main Bunds (River)	935	Miles	368140	344210900
	d) Loop Bunds (River)	339	Miles	296026	100352814
				Sub Total	**686607659 (ii)**
5	A – 13503 SCARP/ Drainage works				
	v) SCARP Tubewells (3837 Nos)	77528.4	H.P	23286	1805326322
	vi) SCARP & other Pumps (31 Nos)	1804.2	H.P	21302	38433068
	vii) SCARP & other Surface Drain	5157.8	Virtual Mile	69760	359808128
	viii) SCARP Colonies	12 Nos			19842000
				Sub Total	**2223409518**
	Add 10% Provision for E&I and other works				222340952
				Total SCARP & Drainage (0423)	**2445750470 (iii)**
				Grand Total	**4986753728**
				say	4986.754 Million

Summary of Yardstick Operation & Maintenance of Irrigation & Drainage 2012

Facility	Annual Yardstick Unit Rate	Remarks
a. Irrigation works only (0422)		
Flow Irrigation (including Irrigation colonies)	153407	
Repair and Replacement of Barrages Gates & other E&I works	5% of total capital cost of all head works	
b. Lift irrigation (Small Irrigation Scheme)		
On canal	65329	
c. Flood Embankments		
(c) Main Bunds (River)	368140	
(d) Loop Bunds (River)	296026	
d. Land Reclamation (0423) Works		
(5) SCARP Tube wells (3837 Nos.)	23286 Per H.P	
(6) SCARP & other Pumps (31 No.)	21302 Per H.P	
(7) SCARP & other surface Drains	69760 Per Mile	
(8) SCARP Colonies	Various Colony	
II. Add 10% Provision for E & I and other works		

Annexure VIII

Maximum schedule of rates (Abiana) for Sugarcane crop mentioned

Abiana	Sukkur		Guddu		Kotri	
	All Perennial	Non-Perennial (Rice)	Left Bank (Ghotki)	Right Bank (DPF, BSF)	All Perennial (Akram Wah) (KB Feeder)	Non-Perennial (Pinyari) (Fuleli)
CROPS (Rate/Acre)	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Rice, Jute, Water nuts, Lotus products	88/78	88/78	88/78	88/78	88/78	88/78
Cotton	93/09	80/33	93/09	84/53	80/33	85/28
Sugarcane	181/87	137/89	181/87	132/83	177/62	158/33
Wheat, Barley, Oats	53/30	44/10	53.30	39/85	44/05	46/44
Kharif & Rabi)	142/14	93/09	142/14	84/53	142/14	124/36
Gardens, Orchards, Banana & Vegetables						
Miscellaneous - Kharif Crops:						
1) Pulses, Jowar, Bajra, Maize, Fodder, other Kharif Crops.	39/85	39/85	39/85	39/85	39/85	39/85
2) Poppy, Drugs, Dyes, Melons, Soyabeans, Chilies, Oil Seeds etc.	75/33	75/33	75/33	75/33	75/33	75/33
Miscellaneous - Rabi Crops:						
1) Oil Seeds, Fodder, Pulses etc.	53/30	41/29	53/30	41/29	53/30	41/29
2) Forest Plantation	61/81	61/81	61/81	61/81	61/81	61/81
3) Villages & Districts,						
Councils Plantation &	27/03	27/03	27/03	27/03	27/03	27/03
Hurries: Kharif - Rabi	27/03	13/51	27/03	13/51	27/03	27/03 I

Maximum schedule of rates (Abiana) for Sugarcane crop mentioned in Annexure-VIII = Rs. 181.87 /acre and the consolidated yardstick rate per acre of CCA = Rs. 580 per acre, which is Rs. 400 /acre less.

13 Summary Recommendations

The Phase III report outlines a regional master plan strategy for interventions in the left bank of Indus, delta, and the coastal areas to ensure safe disposal of drainage effluent, storm water and river floods in to the LBOD system, reducing waterlogging and salinity in the existing and the areas left over from earlier drainage plans, and supporting livelihood by utilizing the drainage surplus. This will be achieved through i) rehabilitation of the LBOD and drainage network; ii) revival of waterways; iii) rehabilitation of SCARP saline groundwater tubewells; iv) divestment of SCARP fresh groundwater tubewells and its replacement with private tubewells, and v) efficient utilization of usable surplus in the drainage network, and improvement in the productivity of water bodies.

To achieve the above objectives feasibilities of various interventions, selected in consultation with the stakeholders, has been formulated detailing the rationale, output, impact, along with an assessment of technical and economic viability, sustainability, and socially acceptability. These interventions have been grouped as a) core projects that need to be implemented on urgent basis; b) second priority projects; and c) projects to be processed by the relevant line agencies.

C. Core Projects be Selected as First Priority

The following feasibilities are recommended for formulating detailed design during the Phase-IV.

vi. rehabilitation and improvement of LBOD drainage infrastructure;

vii. revival of natural water ways (*dhoras*) to drain out the storm water;

viii. protective plantation of mangroves in the coastal areas of left bank.

D. Second Priority Projects

The following second priority interventions are considered for updating during the phase IV.

iii. Privatization of FGW SCARP tubewells; and

iv. Rehabilitation of the LBOD and SCARP tubewells,

E. Projects to be Processed by the Relevant Line Departments

Following are the third priority interventions that would be contracted out by SIDA for implementation to the relevant line agencies for further processing. These include:

i. Bio-saline agriculture in Badin and Thatta districts

ii. Use of drainage water for forestation in the LBOD and Kotri areas

iii. Rehabilitation of Deh Akro II and Chotiari wetland complex;

iv. Rehabilitation of coastal wetland complex;

v. Shrimp and mud-crab farming in the coastal area of the left bank;

vi. Brackish water fish farming in the LBOD areas..

F. Projects Not Recommended for Further Pursuing and Dropped.

The analyses of six of the prefeasibility suggest that they do not merit considerations for further pursuing, either they are unfeasible, or private sector activity, socially not acceptable, and or risk of sustainability. They are:

i. Ghotki SCARP in saline zone (unfeasible);

ii. Elevated platforms for flood displaced persons (not sustainable); however widened and strengthened drain and canal banks, and raised and widened section of roads could be a cost effective alternative.; and

iii. Second line of defence for left bank of Indus d/s Kotri. (Socially not acceptable)

G. Non Structural Interventions/Pre Requisites

i. It is recommended that SIDA and PID should ensure that the irrigation canals are closed at least one week before the rain warning.

ii. It is further recommended that before the ensuing monsoons, the heavy machinery should be mobilized to vulnerable point on the drainage network by July 30 each year,

iii. As it is anticipated that that the coming years will experience high level of precipitation of about 2011 magnitude, SIDA/PID should ensure that the information regarding expected floods and its intensity is widely and timely disseminated, and coordinate with PDMA, district administrations, and relevant NGOs for flood preparedness.

H. Effective Compliance and Enforcement of EPA regulations for Sugar mills.

i. The EPA should monitor that the sugar mills comply with the environmental protection laws, and do not dump their untreated toxic effluent directly into the water bodies including drains.

ii. EPA should also rationalize the fines on the sugar mills for non-compliance.

I. Initiation and Facilitation of Inter-Provincial Dialogue

To address the concerns expressed by the stakeholders located in the northern strip of Ghotki, regarding the encroachment of saline effluent from SCARP VI adversely affecting the fertile cropped lands, the environment water table and quality of ground water, SIDA needs to initiate and facilitate an interprovincial dialogue, at the appropriate level. The Consultants recommend implementing the project as per the original design.

13.1 Indicative Financial Outlay of Master Plan (REVISED)

The indicative cost of interventions was estimated for all the pre-feasibilities using current 2012 prices. The base costs include a two per cent provision as physical contingency. Total cost was also computed accounting for three per cent as price escalation for construction industry.

It is estimated that the overall base cost of recommended and not recommended intervention is about Rs.93.8 billion. With the provision of price contingency the total cost is about Rs.121 billion. Out of this, the estimated base cost of the recommended interventions is about Rs.75 billion, and the total cost inclusive of price contingency is Rs.91.8 billion. It may be noted, that the total cost includes 17.5 per cent as taxes, suggesting that the net financing requirement will be reduced by about Rs.15.8 billion. Following table summarises the financial outlay for the priority interventions.

Table 13.1: Indicative Financial Outlay of Master Plan

	Prefeasibility	Investment (Rs.Million)[a]
A	**First Priority Core Interventions**	
1	Rehabilitation and improvement of LBOD drainage infrastructure [b]	18,301
2	Revival of natural waterways to drain out storm water [b]	55,328
3	Protective plantation of mangroves in the coastal areas of left bank	749
	Subtotal	**74,377**
B	**Second Priority Interventions**	
1	Privatization of FGW SCARP tubewells	9,285
2	Rehabilitation of LBOD and SCARP tubewells	3,098
	Subtotal	**12,382**

C	**Third Priority Interventions**	
1	Bio-saline Agriculture in Badin and Thatta districts	2,961
2	Use of drainage water for forestation in the LBOD and Kotri areas	270
3	Rehabilitation of Deh Akro II and Chotiari wetland complex	637
4	Shrimp and Mud Crab Farming in Coastal areas of Left Bank	193
5	Brackish Water Fish Farming in LBOD Area	542
6	Rehabilitation of Coastal Wetlands	466
	Subtotal	**5,068**
	Total Base Cost of Intervention	**91,828**
	Price contingency @ 3% yearly for construction sector escalation	**29,385**
	Total Investment cost	**121,213**

a: These costs are base costs and include provision of 2 percent for unforeseen and physical contingency.

b: includes Rs.1,500 million and Rs.102 million cost to be incurred as emergency works respectively for LBOD and Dhoras during April 2012 and 30 June 2012

Annexure 6-A: Distinctions Used In Disaster Risk Management

Terminology: Basic terms of disaster risk reduction[49]

The ISDR Secretariat presents these basic definitions on disaster risk reduction in order to promote a common understanding on this subject, for use by the public, authorities, and practitioners. The terms are based on a broad consideration of different international sources. This is a continuing effort to be reflected in future reviews, responding to a need expressed in several international venues, regional discussions and national commentary.

Acceptable risk	*The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.* *In engineering terms, acceptable risk is also used to assess structural and non-structural measures undertaken to reduce possible damage at a level which does not harm people and property, according to codes or "accepted practice" based, among other issues, on a known probability of hazard.*
Building codes	*Ordinances and regulations controlling the design, construction, materials, alteration and occupancy of any structure to insure human safety and welfare. Building codes include both technical and functional standards.*
Capacity	*A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster.* *Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.*
Capacity building	*Efforts aimed to develop human skills or societal infrastructures within a community or organization needed to reduce the level of risk.* *In extended understanding, capacity building also includes development of institutional, financial, political and other resources, such as technology at different levels and sectors of the society.*
Climate change	*The climate of a place or region is changed if over an extended period (typically decades or longer) there is a statistically significant change in measurements of either the mean state or variability of the climate for that place or region.* *Changes in climate may be due to natural processes or to persistent anthropogenic changes in atmosphere or in land use. Note that the definition of climate change used in the United Nations Framework Convention on Climate Change is more restricted, as it includes only those changes which are attributable directly or indirectly to human activity.*

[49] ISDR (2004), Terminology: Basic Terms of Disaster Risk Reduction, United Nations International Strategy for Disaster Reduction, Secretariat, Geneva, March 2004 http://www.unisdr.org/eng/library/lib-terminology-eng-p.htm

Coping capacity	*The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster.* *In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards.*
Counter measures	*All measures taken to counter and reduce disaster risk. They most commonly refer to engineering (structural) measures but can also include non-structural measures and tools designed and employed to avoid or limit the adverse impact of natural hazards and related environmental and technological disasters.*
Disaster	*A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.* *A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.*
Disaster risk management	*The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.*
Disaster risk reduction (disaster reduction)	*The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.* *The disaster risk reduction framework is composed of the following fields of action, as described in ISDR's publication 2002 "Living with Risk: a global review of disaster reduction initiatives", page 23:* • *Risk awareness and assessment including hazard analysis and vulnerability/capacity analysis;* • *Knowledge development including education, training, research and information;* • *Public commitment and institutional frameworks, including organisational, policy, legislation and community action;* • *Application of measures including environmental management, land-use and urban planning, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments;* *Early warning systems including forecasting, dissemination of warnings, preparedness measures and reaction capacities.*

Early warning	*The provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response.* *Early warning systems include a chain of concerns, namely: understanding and mapping the hazard; monitoring and forecasting impending events; processing and disseminating understandable warnings to political authorities and the population, and undertaking appropriate and timely actions in response to the warnings.*
Ecosystem	*A complex set of relationships of living organisms functioning as a unit and interacting with their physical environment.* *The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study. Thus the extent of an ecosystem may range from very small spatial scales to, ultimately, the entire Earth (IPCC, 2001).*
Emergency management	*The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation.* *Emergency management involves plans, structures and arrangements established to engage the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. This is also known as disaster management.*
Environmental impact assessment (EIA)	*Studies undertaken in order to assess the effect on a specified environment of the introduction of any new factor, which may upset the current ecological balance.* *EIA is a policy making tool that serves to provide evidence and analysis of environmental impacts of activities from conception to decision-making. It is utilised extensively in national programming and for international development assistance projects. An EIA must include a detailed risk assessment and provide alternatives solutions or options.*
Environmental impact assessment (EIA)	*Studies undertaken in order to assess the effect on a specified environment of the introduction of any new factor, which may upset the current ecological balance.* *EIA is a policy making tool that serves to provide evidence and analysis of environmental impacts of activities from conception to decision-making. It is utilised extensively in national programming and for international development assistance projects. An EIA must include a detailed risk assessment and provide alternatives solutions or options.*
Environmental degradation	*The reduction of the capacity of the environment to meet social and ecological objectives, and needs.* *Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards.* *Some examples: land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion.*
Forecast	*Definite statement or statistical estimate of the occurrence of a future event (UNESCO, WMO).* *This term is used with different meanings in different disciplines.*

Geological hazard	*Natural earth processes or phenomena that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.* *Geological hazard includes internal earth processes or tectonic origin, such as earthquakes, geological fault activity, tsunamis, volcanic activity and emissions as well as external processes such as mass movements: landslides, rockslides, rock falls or avalanches, surfaces collapses, expansive soils and debris or mud flows.* *Geological hazards can be single, sequential or combined in their origin and effects.*
Geographic information systems (GIS)	*Analysis that combine relational databases with spatial interpretation and outputs often in form of maps. A more elaborate definition is that of computer programmes for capturing, storing, checking, integrating, analysing and displaying data about the earth that is spatially referenced.* *Geographical information systems are increasingly being utilised for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures.*
Greenhouse gas (GHG)	*A gas, such as water vapour, carbon dioxide, methane, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), that absorbs and re-emits infrared radiation, warming the earth's surface and contributing to climate change (UNEP, 1998).*
Hazard	*A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.* *Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.*
Hazard analysis	*Identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behaviour.*
Hydro-meteorological hazards	*Natural processes or phenomena of atmospheric, hydrological or oceanographic nature, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.* *Hydro-meteorological hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches. Hydro-meteorological hazards can be single, sequential or combined in their origin and effects.*

Land-use planning	*Branch of physical and socio-economic planning that determines the means and assesses the values or limitations of various options in which land is to be utilized, with the corresponding effects on different segments of the population or interests of a community taken into account in resulting decisions.* *Land-use planning involves studies and mapping, analysis of environmental and hazard data, formulation of alternative land-use decisions and design of a long-range plan for different geographical and administrative scales.* *Land-use planning can help to mitigate disasters and reduce risks by discouraging high-density settlements and construction of key installations in hazard-prone areas, control of population density and expansion, and in the siting of service routes for transport, power, water, sewage and other critical facilities.*
Mitigation	*Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.*
Natural hazards	*Natural processes or phenomena occurring in the biosphere that may constitute a damaging event.* *Natural hazards can be classified by origin namely: geological, hydro-meteorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.*
Preparedness	*Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.*
Prevention	*Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters.* *Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behaviour contribute to promoting a "culture of prevention".*
Public awareness	*The processes of informing the general population, increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster.* *Public awareness activities foster changes in behaviour leading towards a culture of risk reduction. This involves public information, dissemination, education, radio or television broadcasts, use of printed media, as well as, the establishment of information centres and networks and community and participation actions*
Public information	*Information, facts and knowledge provided or learned as a result of research or study, available to be disseminated to the public.*

Recovery	*Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk.* *Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.*
Resilience / resilient	*The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.*
Retrofitting (or upgrading	*Reinforcement of structures to become more resistant and resilient to the forces of natural hazards.* *Retrofitting involves consideration of changes in the mass, stiffness, damping, load path and ductility of materials, as well as radical changes such as the introduction of energy absorbing dampers and base isolation systems. Examples of retrofitting includes the consideration of wind loading to strengthen and minimize the wind force, or in earthquake prone areas, the strengthening of structures.*
Risk	*The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.* *Conventionally risk is expressed by the notation Risk = Hazards x Vulnerability. Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.* *Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.*
Risk assessment / analysis	*A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.* *The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.*
Structural / non-structural measures	*Structural measures refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure.* *Non-structural measures refer to policies, awareness, knowledge development, public commitment, and methods and operating practices, including participatory mechanisms and the provision of information, which can reduce risk and related impacts.*

Sustainable development	*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs. (Brundtland Commission, 1987).* *Sustainable development is based on socio-cultural development, political stability and decorum, economic growth and ecosystem protection, which all relate to disaster risk reduction.*
Technological hazards	*Danger originating from technological or industrial accidents, dangerous procedures, infrastructure failures or certain human activities, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.* *Some examples: industrial pollution, nuclear activities and radioactivity, toxic wastes, dam failures; transport, industrial or technological accidents (explosions, fires, spills).*
Vulnerability	*The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.* *For positive factors, which increase the ability of people to cope with hazards, see definition of capacity.*
Wildland fire	*Any fire occurring in vegetation areas regardless of ignition sources, damages or benefits.*

Annexure 6-B: NGOs Working On Disaster Risk Management[50]

1. Action Against Hunger
2. Aga Khan Planning and Building Services (AKPBS)
3. Anjuman-e-Islah
4. Association of Physicians of Pakistani Descent of North America (APPNA)
5. Balochistan Environmental Foundation
6. CARE International
7. Church World Service (CWS)
8. Citizen's Foundation
9. Concern Worldwide Pakistan (CWP)
10. Doaba Foundation
11. Eco Friends Society
12. Focus Humanitarian Assistance (FHA)
13. GTZ (German Technical Cooperation)
14. Hamdam Development Organization
15. International Organization for Migration (IOM)
16. International Union for Conservation of Nature (IUCN)
17. International Rescue Committee (IRC)
18. Islamic Aid
19. Islamic Relief
20. Jhelum Valley Human Welfare Society (JVHWS)
21. Khwendo Kor
22. Laar Humanitarian Development Programme (LHDP)
23. Mercy Corps
24. Muslim Aid
25. OXFAM
26. Pakistan Fisher Forum (PFF)
27. Pakistan Participatory Development Initiatives (PPDI)
28. Pakistan Red Crescent Society (PRCS)
29. Pattan Development Organization
30. Plan International
31. Roots Work
32. Rural Development Policy Institute (RDPI)
33. Sangi Development Foundation
34. Sangi Welfare Society
35. Sindh Agricultural and Forestry Workers Coordinating Organization (SAFCO)
36. Tharparkar Rural Development Programme (TRDP)
37. Worldwide Fund for Nature
38. World Vision
39. Young Sheedi Welfare Organization

[50] This list is not exhaustive and may not cover all organizations working on Disaster Risk Management in Pakistan.

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