SINDH IRRIGATION & DRAINAGE AUTHORITY

3 Days Training on Geographic Information System-GIS 8th to 10th, Feb 2023 Under ADP Scheme No. 1455 / 2022-23

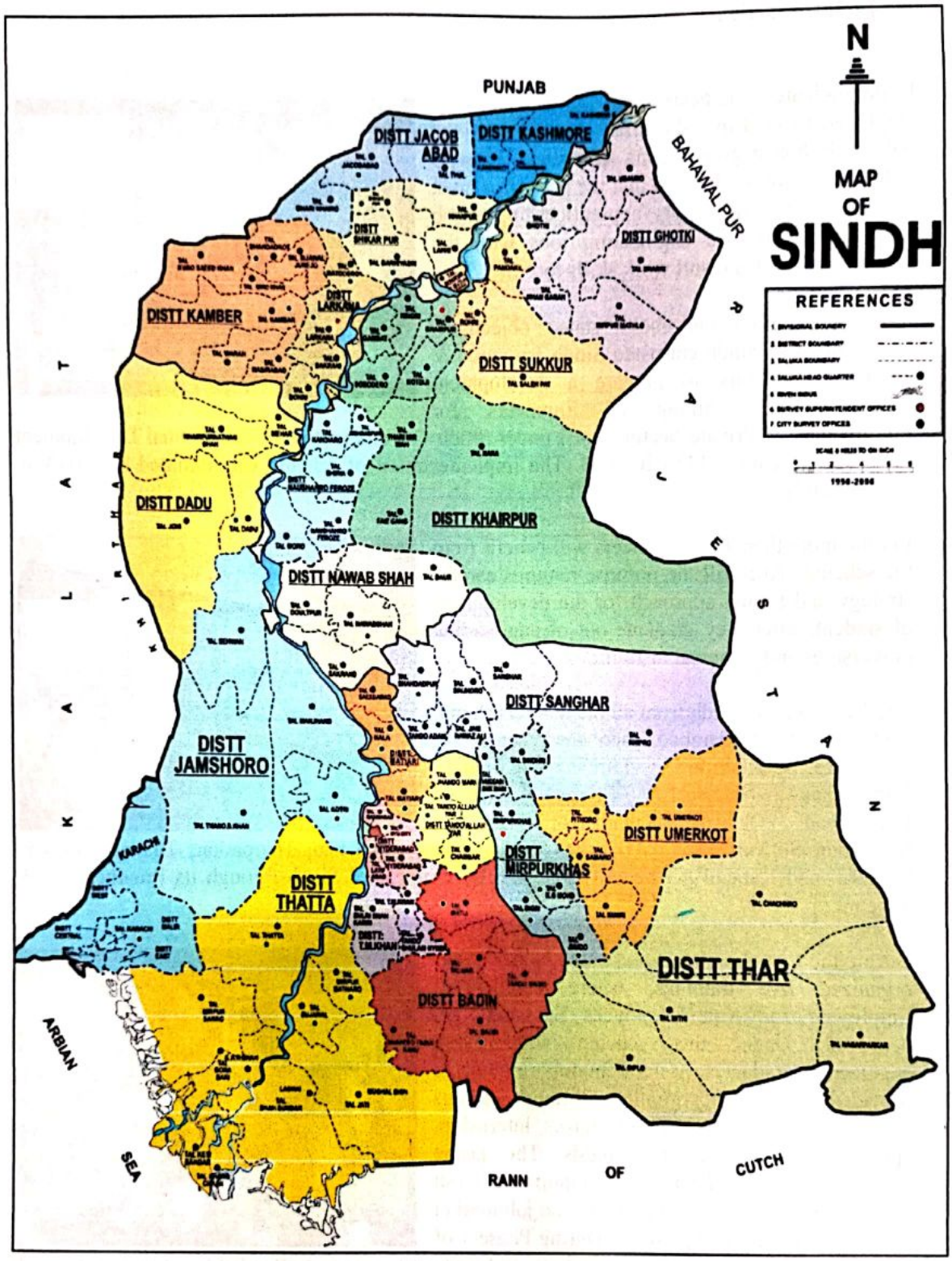
REPORT

SIDA

2/17/2023

Government of Sindh entrusted Sindh Irrigation & Drainage Authority to prepare a development scheme title "Training of Engineers for Employment in Private Sector (ToE) under Sindh Government approved Annual Development Program, Scheme # 1455/2022-23. The implementation of scheme was initiated by SIDA in October 2021.

Contents



1- Introduction

Undergraduate engineers are not exclusively employed to land into the direct engineering jobs only with their degree-bearing specialties. Today's industry employers demand that the new hires must be fit-for their preliminary apprenticeship, on-job training, and trainee engineering jobs with the preliminary hard and soft work skills too.

Keeping in mind the above stated objectives, Government of Sindh entrusted Sindh Irrigation & Drainage Authority to prepare a development scheme title "Training of Engineers for Employment in Private Sector (ToE) under Sindh Government approved Annual Development Program, Scheme # 1455/2022-23. The implementation of scheme was initiated by SIDA in October 2021.

In total more than 4000 engineers will benefit from the scheme. To fulfill the purpose requires careful strategy and formal approach for the development of students after they graduate out of engineering universities and technical institutions.

The Engineers of Sindh from all the districts Badin, Dadu, Ghotki, Hyderabad, Jacobabad, Jamshoro, Kashmore, Khairpur, Larkana, Matiari, Mirpurkhas, Naushahro Feroze, Shaheed Benazirbad, Qambar Shahdadkot, Sanghar, Shikarpur, Sukkur, Tando Allahyar, Tando Muhammad Khan, Tharparkar, Thatta, Umerkot, Sujawal, and Karachi get benefit from the Government of Sindh through its Provincial ADP Scheme.

During the first phase of the scheme, the SIDA has organized five trainings, where number of Employees and Non Employees Engineers get benefited. Under this scheme 4000 fresh engineering graduates (Male/ Female) are going to provided learning opportunities through various short courses, distance learning courses, Internship, apprenticeship and other methods. The prime objective of this scheme is to equip the fresh engineer of the province to compete the job market through required trainings/skills. During Phase-1 of the scheme overall 64 Employed and 89 Un-Employed engineers attended five trainings by 30th June 2022. Details are given as under:

S#	Date	Title of Training	No. of Participants	Venue
1	25th to 29th Oct 2021	Hydraulic structures designing	24	SIDA Secretariat
2	03rd to 07th Jan 2022	Surveying & Levelling	40	SIDA Secretariat
3	16th to 20th May 2022	IoT Based Smart Automation Engineering	30	ISRA University
4	25th to 27th May 2022	Behavioral Development & Enhancement of Engineers	29	ISRA University
5	28th to 30th June 2022	Professional Communication and Soft Skills Improvement	30	ISRA University
		Grand Total	**153**	

2- Importance of Geographic Information System

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. By relating seemingly unrelated data, GIS can help individuals and organizations better understand spatial patterns and relationships. General-purpose GIS software performs six major tasks such as input, manipulation, management, query and analysis, Visualization. The important input data for any GIS is digitized maps, images, spatial data and tabular data.

Geographic Information Systems are powerful decision-making tools for any business or industry since it allows the analyzation of environmental, demographic, and topographic data. Data intelligence compiled from GIS applications help companies and various industries, and consumers, make informed decisions. Here are 20 ways GIS Data is used in Business and Everyday Life:

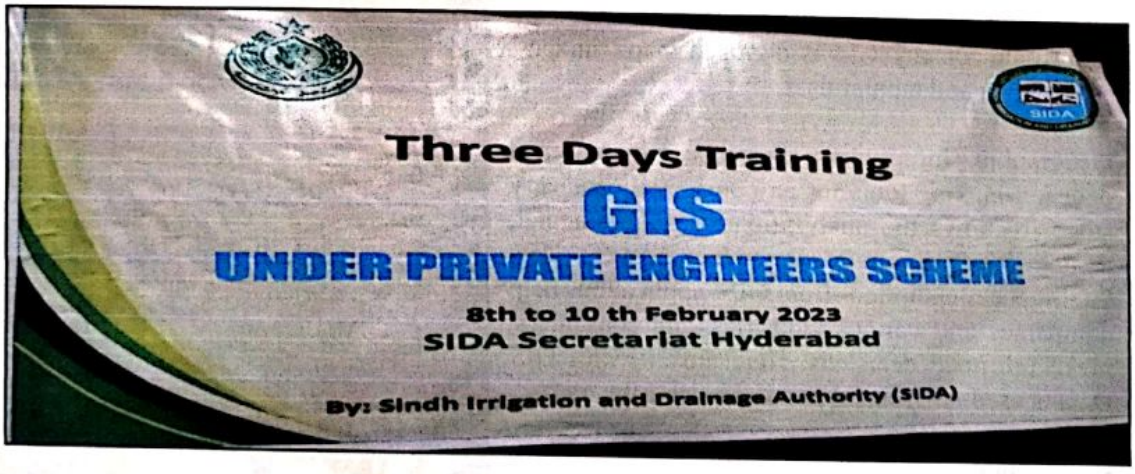
- Mapping
- Telecom and Network Services

- Accident Analysis and Hot Spot Analysis
- Urban planning
- Transportation Planning
- Environmental Impact Analysis
- Agricultural Applications
- Disaster Management and Mitigation
- Navigation
- Flood damage estimation
- Natural Resources Management
- Banking
- Taxation
- Surveying
- Geology
- Assets Management and Maintenance
- Planning and Community Development
- Dairy Industry
- Irrigation Water Management
- Pest Control and Management

3- 6th Training on "Geographic Information System"

In Phase-2 of the scheme, the sixth training on **"Geographic Information System"** was organized at SIDA Secretariat Hyderabad from **8th to 10 Feb 2023**. The overall 31 un-employed participants from various departments of Engineering discipline attended the training. ***(List of participants is given in end of the report)***

The key resource person of the training was renowned GIS Expert, Professor Altaf Ali Sial, Dean Faculty of Agriculture Engineering, Sindh Agriculture University Tando Jam. A special lecture on participatory Irrigation Management is also planned during the training. Ms. Farzana Abbassi, Social Development Specialist, SIDA delivered the lecture.



4- Session Plan for three days training:

Day	Time	Topic /Activity	Resource Persons
DAY-1	10:00 – 11:00	Introduction to GIS. Application of GIS, Importance, and benefits of GIS. Cartography. Coordinates and Coordinate systems	Prof. Dr. Altaf Ali Siyal
	11:00 – 11:30	**TEA BREAK**	
	11:30 - 13:00	Creating KMZ and shapefiles using GoogleEarth	Prof. Dr. Altaf Ali Siyal
	13:00 – 14:00	**LUNCH AND PRAYER BREAK**	
	14:00 - 16:00	Geo-refencing of the raster data, Creatingbuffers	Prof. Dr. Altaf Ali Siyal
Day-2	10:00 – 10:45	Digitization of a raster image/Google Earth;preparing shapefiles	Prof. Dr. Altaf Ali Siyal
	10:45 - 11:15	Participatory Irrigation Management Ms.	Ms. Farzana Abbassi, SDS, SIDA
	11:15 – 11:30	**TEA BREAK**	
	11:30 - 13:00	Creating, labelling, and printing of GIS maps	
	13:00 – 14:00	**LUNCH AND PRAYER BREAK**	
	14:00 - 16:00	Combining and extraction of a polygons fromcombined polygon shape file	Prof. Dr. Altaf Ali Siyal
Day-3	10:00 – 11:00	Data models, DEM, how to download DEM	Prof. Dr. Altaf Ali Siyal
	11:00 to 11:10	Brief on Training Evaluation Form	Mr. Masroor A. Shahwani Manager SM&G, SIDA
	11:10 – 11:30	**TEA BREAK**	
	11:00 – 11:30	Watershed delineation, creation of streamlines,Use of hydrology Tool	Prof. Dr. Altaf Ali Siyal
	13:00 – 14:00	**LUNCH AND PRAYER BREAK**	
	14:00 - 16:00	Determination of volume of a reservoir	Prof. Dr. Altaf Ali Siyal

5- Overall Progress of the Training

The three days training was attended by 28 numbers of engineering discipline un-employed engineers. The key topic of the training was "Geographic Information System (GIS)". Following are the details of lectures delivered by the resource person.

5.1- Lectures description

5.1.1- Day-1:

During various sessions of day-1, the resource person gave brief lecture on following topics:

i- Introduction to GIS
ii- Application of GIS
iii- Importance, and benefits of GIS
iv- Cartography
v- Coordinates and Coordinate systems
vi- Creating KMZ and shapefiles using Google Earth
vii- Geo-refencing of the raster data, Creating buffers

5.1.2- Day-2:

During various sessions of day-2, the resource person gave brief lecture on following topics and also prepared digitized maps on laptops. All participants also did practical exercise and develop various digitized maps.

i- Digitization of a raster image
ii- Google Earth
iii- Preparing shapefiles
iv- Creating, labelling, and printing of GIS maps
v- Combining and extraction of a polygons fromcombined polygon shape file

5.1.3- Day-3

During various sessions of day-3, the resource person gave brief lecture on following topics

i- Data models
ii- DEM, how to download DEM
iii- Watershed delineation
iv- Creation of streamlines
v- Use of hydrology Tool
vi- Determination of volume of a reservoir

6- Special Lecture:

A special lecture on Participatory Irrigation Management was arranged during third day. The lecture was delivered by Ms. Farzana Abbassi, Social Development Specialist. SIDA. The resource person briefed the participants about institutional reforms in irrigation sector. Following topics were well defined:

a) SWMO-2002
b) History of SIDA
c) Institutional Reforms in Irrigation Sector
d) Participatory Irrigation Management
e) Role of SIDA and AWB
f) Role of Farmers Organizations in managing water resources
g) Role of Water Course Associations in water management

Detailed lectures handouts are enclosed as Annexures

7- Training Evaluation

Training evaluation is the systematic process of analyzing training programs to ensure that it is delivered effectively and efficiently. Training evaluation identifies training gaps and even discovers opportunities for improving training programs. By collecting feedback, trainers and human resource professionals are able to assess whether training programs are able to achieve its intended outcome, and if the training materials and resources used are aligned with or meet departmental standards.

In this regard, a detailed training evaluation form was developed (enclosed as Annexure-1). The overall status of participants of training and responses received are given as under:

Criteria	Strongly Agree	Agree	Disagree	Strongly Disagree
The subject training will improves my skill	40%	55%	5%	0%
Materials provided were helpful	45%	50%	5%	0%
Length of training was sufficient	85%	15%	0%	0%
Content was well organized	65%	35%	0%	0%
Questions in Training were encouraged	75%	15%	5%	5%
Training Sessions were clear and understandable	75%	15%	10%	0%
Training met my expectations	50%	50%	0%	0%
The Resource Person communication skills were perfect	80%	15%	5%	0%
Hand on Training opportunity	50%	50%	0%	0%
Training Environment was Comfortable	90%	10%	0%	0%
The Quality of Food supplied in training was good	100%	0%	0%	0%

7.1- What did you enjoy most in Training?

The most of the participants responded:

a) Environment of the training was good

b) Staff was so professional very cooperative & supported
c) Food quality was excellent

7.2- What did you learn that you anticipate using in your job?

The most of the participants responded:

a) This training will definitely supported in their job
b) As there are multi departmental degree holders from Engineering discipline, this training is now essential part of the job.
c) Definitely we will replicate in our future job

7.3- How will you implement this training into your office?

The most of the participants responded:

a) Definitely this will reduce our time constraints
b) We are now able to develop maps of any focused area
c) If the department allow us we'll implement this in our future organization

7.4- What are your suggestions to improve the quality of the trainings to be imparted in future?

The most of the participants responded:

a) The time for this training should be increased
b) This training required two months' time
c) Time allocation for practical work should be allocated for one or two days.

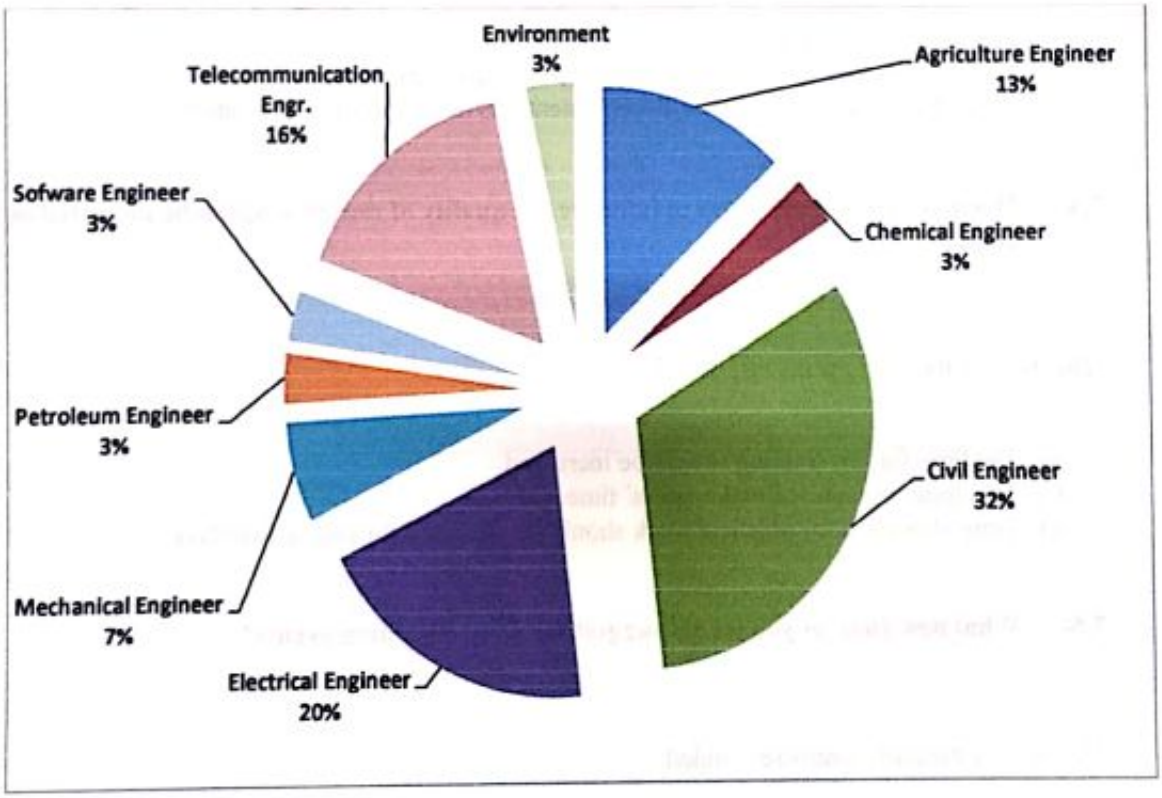
7.5- What new courses you would suggest for future training events?

The most of the participants responded:

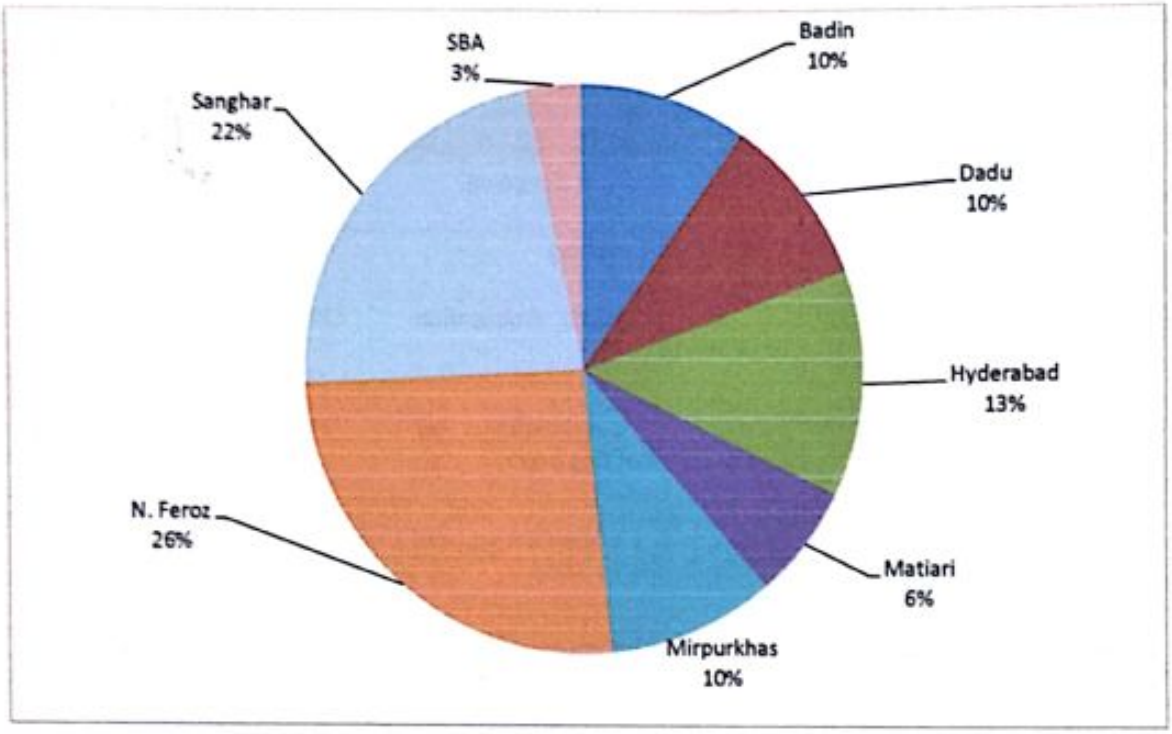
a) Autocad
b) Software and programming software

c) SCAMBAT Software
d) Paython
e) Artificial Intelligence
f) Web Designing and E-Commerce
g) ETAP
h) MAT LAB
i) MS-OFFICE
j) 3D Modelling and Digital Marketing
k) Quality Control
l) Risk Management
m) Financial Management
n) Modern Irrigation Tactics
o) Remote Sensing
p) Communication skills
q) Construction Management

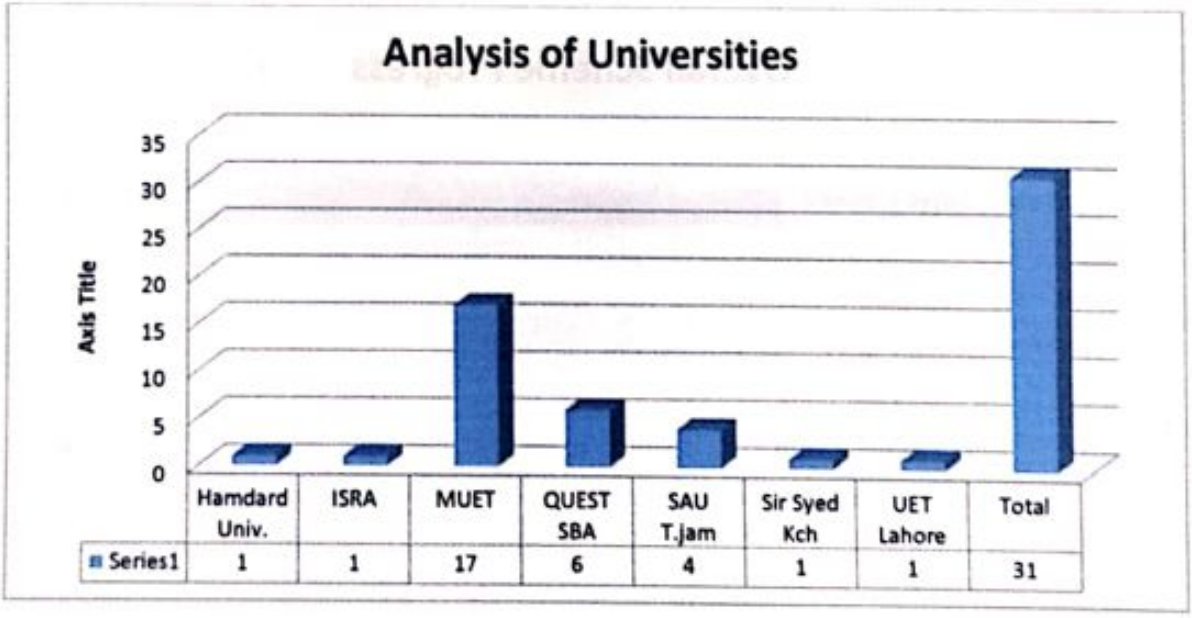
7.6- Sector wise participants analyzes



7.7- District wise Participants Analyzes



7.8- University wise Participants Analyzes



8- Overall Progress of ADP Scheme

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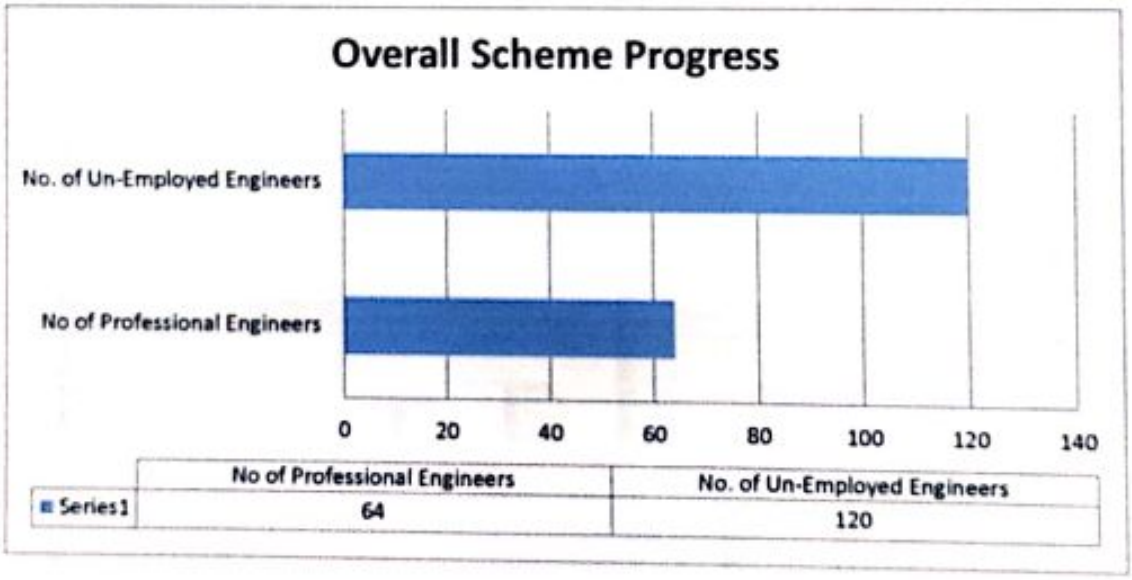
6	8th to 10th Feb 2023	Geographical Information System	31	SIDA Secretariat
		Grand Total	**184**	



9- Attendance Sheet

S#	Name	Department	University	Domicile	Contact Number
1	Avais Babar	Agri. Engineer	SAU T.Jam	N. Feroz	0300-3047388
2	Ahmer Shabir	Agri. Engineer	SAU T.Jam	Dadu	0323-8233597
3	Ghulam Mustafa	Agri. Engineer	SAU T.Jam	Badin	3083541855
4	Muntaha	Chemical	QUEST SBA	Hyderabad	0317-9661842
5	Aakash Oad	Civil	ISRA	SBA	0315-5562751
6	Absar Baig	Civil	MUET	Sanghar	0304-3261145
7	Faizullah	Civil	MUET	Mirpurkhas	0345-8800484, 0336-0823211
8	Farhad Anwar	Civil	MUET	Mirpurkhas	0333-2756393
9	Farhan Mustafa	Civil	MUET	Sanghar	0333-3887262
10	Mubashir Shaikh	Civil	MUET	Sanghar	0310-3516251
11	Muhammad Asad	Civil	Sir Syed Karachi	Hyderabad	0335-2036561
12	Mujahid Ali	Civil	UET Lahore	N. Feroz	0300-0352415
13	Shoaib Ahmed	Civil	MUET	N. Feroz	0312-3156901
14	Zeeshan	Civil	MUET	Dadu	0333-7072662, 0346-3653503
15	Abdul Samad Memon	Electrical	MUET	N. Feroz	0336-3078989
16	Ariba Talpur	Electrical	MUET	Badin	0335-2855751
17	Mahwish Memon	Electrical	MUET	Matiari	0335-2864441
18	Nafees Baig	Electrical	QUEST SBA	Sanghar	0302-3927117
19	Saira	Electrical	QUEST SBA	N. Feroz	0335-7224766
20	Sarmad Baig	Electrical	MUET	Sanghar	0305-3050027
21	Waseem Sajjad Ujjan	Mechanical	Hamdard Univ.	Mirpurkhas	0301-2612596
22	Yasir Ali Fazlani	Mechanical	QUEST SBA	N. Feroz	0306-3122690
23	Abdul Ghaffar Baig	Petro. & Gas	MUET	Sanghar	0333-1238806
24	Muqadis Almani	Software	MUET	N. Feroz	0316-1381588
25	Hira Fatima	Telecom	QUEST SBA	N. Feroz	0306-5876755
26	Mashood Mangrio	Telecom	MUET	Hyderabad	0310-3109151
27	Saqib Baig	Telecom	MUET	Sanghar	0331-7630221
28	Muhammad Ali Shah	Telecom	MUET	Matiari	0334-7575127
29	Faraz Ali	Agri. Engineer	SAU T.Jam	Dadu	0305-3358807
30	Israr Abro	Environment	QUEST SBA	Hyderabad	0333-2750635
31	Rameen	Telecom	MUET	Badin	0344-3435292

10- Certificate Distribution

11- News Glimpse

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HANDOUTS

LAB# 04

OBJECT: **Digitizing a raster map and creating shapefile from a Raster Image**

Objectives: i. To learn basic digitizing techniques using ArcMap
ii. To create and export shapefile by digitizing a map

Outcome: Students will be able to digitize a map and create shapefile

Material Required: A workstation equipped with ArcMap installed and a scanned map (Sindh_Map.jpg)

Background:

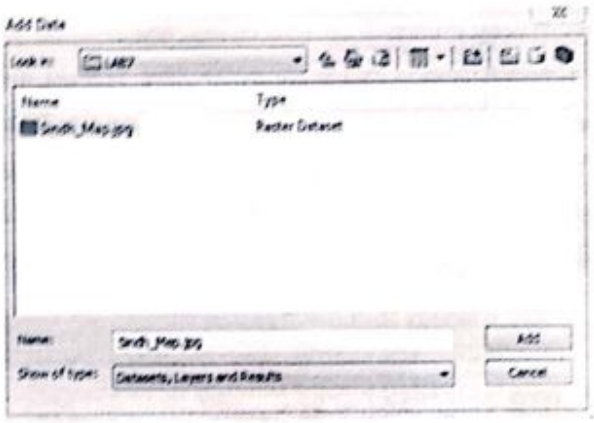
Digitizing is the process of interpreting and converting paper map or image data to vector digital data. There are two types of digitizing e.g. i) manual and ii) on screen or heads up. In manual digitizing the lines or points are traced directly from the source media. The digitizer uses a digitizing tablet (also known as a digitizer, graphics tablet, or touch tablet) to trace the points, lines and polygons of a hard-copy map. Digitizing directly on screen is also called "heads-up" or softcopy digitizing. This method involves scanning a map or image into a computer. The digitizer then traces the points, lines and polygons using digitizing software. This method of digitizing has been named "heads-up" digitizing because the focus of the user is up on the screen, rather than down on a digitizing tablet. It has largely replaced manual digitizing because of its speed and accuracy. It is, however, limited to using scans of high quality maps and images

Procedure

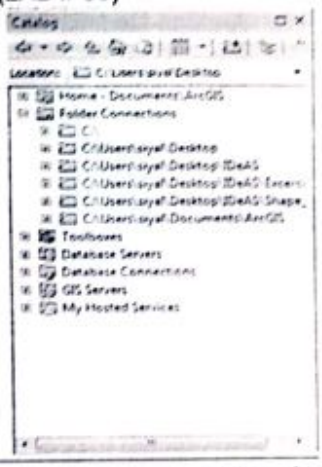
- Double click  on Desktop or Start ->All Programs->ArcGIS->ArcMap to start ArcMap program.
- ArcMap-Getting Started will open. Click on New Maps->Blank Map->OK
- Right click on '**Data/Map**' window, click on '**data frame properties**'. A new popup "data frame properties" window will open.
- Go to "coordinate system" tab ->**Geographic coordinate systems->World->WGS1984**. Click OK

- **Add** (click on the add data icon) and browse the location/folder (Desktop:/Lab7) where the **Sind_Map.jpg** is saved in your computer.

- Click on **Sindh_Map.jpg** and press **Add** button in popup window. It will ask for creating pyramids in another popup window. Click Yes. The image will be added in '**Data/Map**' window of ArcMap



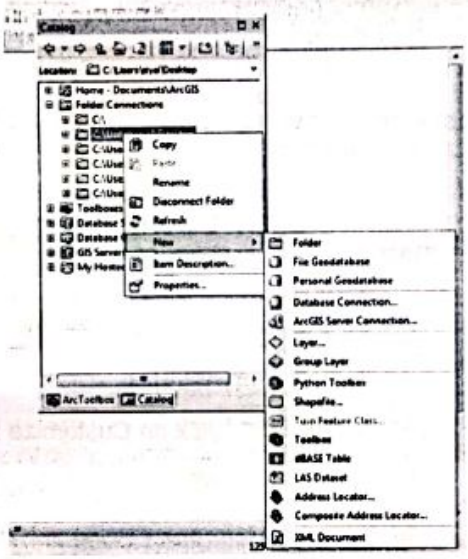
- Geo-reference the map in the same way as we did in our last lab (LAB # 06)



i. **Create a New Shapefile Using ArcCatalog**

- Click Catalog and New Catalog window will open.

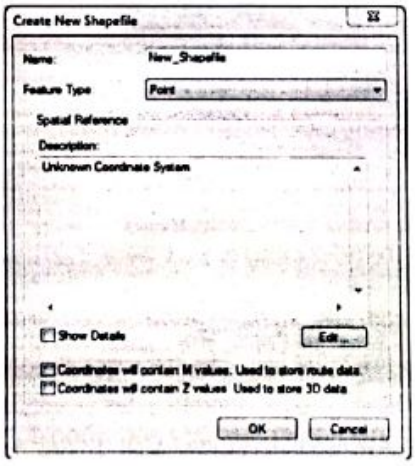
- Navigate the directory structure to the left of the widow and single-click the directory/folder where you would like to create the new shapefile in. Right click the folder (Desktop:/Lab7) and choose options ->New->click on shapefile



- New 'Create New Shapefile' window will open.

- In the '*Create New Shapefile'* Dialog, write a file name "Khairpur", and select a geometry based on what type of features you are trying to draw (the feature type i.e. point, line or polygon).

- Use the Edit button to select the coordinate system that you are using in your ArcMap project

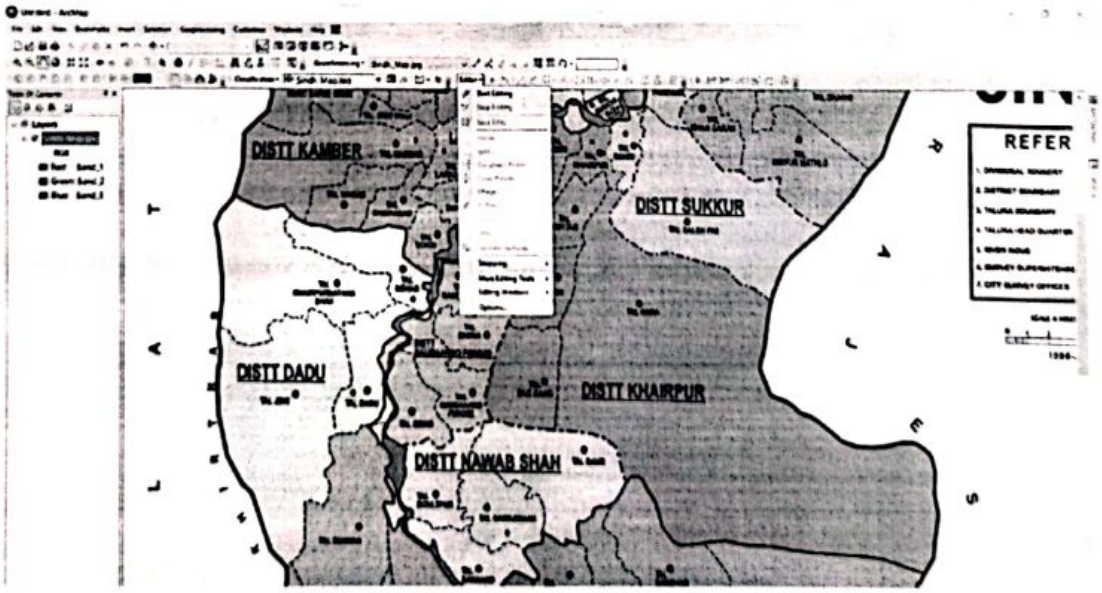


- Choose the Geographic Coordinate Systems->World->WGS1984 in the *Spatial Reference Properties* dialog. Click OK twice.

- The new shapefile may now be opened in an ArcMap project and used for on-screen digitizing.

ii. Digitizing the map

- Zoom to District "Khairpur Mirs" using zoon in tool
- If Editor toolbar is not active, then click on Customize in menu bar. Then toolbars and Click on Editor to activate the Editor toolbar
- Click the *Editor* button, and choose *Start Editing* and then click *create features* button .
- A new popup window will open. Click the newly created/named shapefile the cursor will change its shape. Make sure the new shapefile is listed as the *Target*.



- Click the newly created/named shapefile, the cursor will change its shape. Now start drawing polygon.
- For a polygon, single-click along the boundary and when completed the polygon, double-click.
- Choose stop digitizing in the *Editor* button when complete.

- It will ask "Do you want to save your edits". Click Yes button. Your shapefile will be updated and saved.
- Modifications to an existing layer can be made using the *Edit vertices* , rather than *Create New Feature*. Using the Edit Tool individual vertices can be moved, added or deleted. Right-click the vertices with the edit tool to see all options available.

NOTE: **Show me shapefile of district Khairpur which you created after digitizing scanned Map of Sindh**

LAB # 03

Object: **Geo-referencing a raster image in ArcMap and visualizing the georeferenced map in Google Earth**

Objectives:

i. To geo-reference a scanned image in ArcMap
ii. To visualize geo-refenced Map in Google Earth

Material Required: Work Station equipped with Google Earth Pro and ArcMap; scanned map of Sindh

Background:

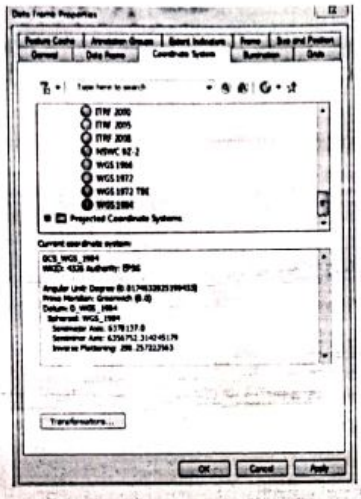
Geo-referencing is the process of aligning a raster data set to known map coordinates and assigning a coordinate system or it is the process of assigning a geographic coordinate system to a scanned image. Georeferencing creates additional information within the file itself and/or in supplementary files that accompany the image file that tells GIS software how to properly place and draw it.

Many images are provided in digital formats and already "registered" to projected coordinate systems, many times they are not. This is particularly true for historical images, which often are only available in paper or film media. These are often scanned, and must then be georeferenced. Geo-referencing an image, often called an image transformation, converts the image from a file or scanner coordinate system to a projected map coordinate system.

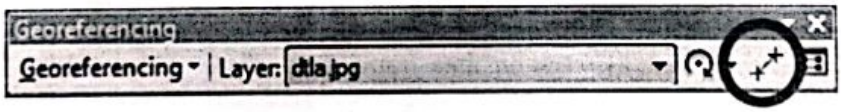
Procedure:

How to geo-reference a scanned image in ArcMap

1. **Start** menu, select **All Programs>ArcGIS>ArcMap.** Click **Cancel** to begin with **a new empty map**.
2. Right click on map window, click on **data frame properties**. A new popup "data frame properties" window will open.
3. Go to "coordinate system" tab ->Geographic coordinate systems->World->WGS1984. Click OK



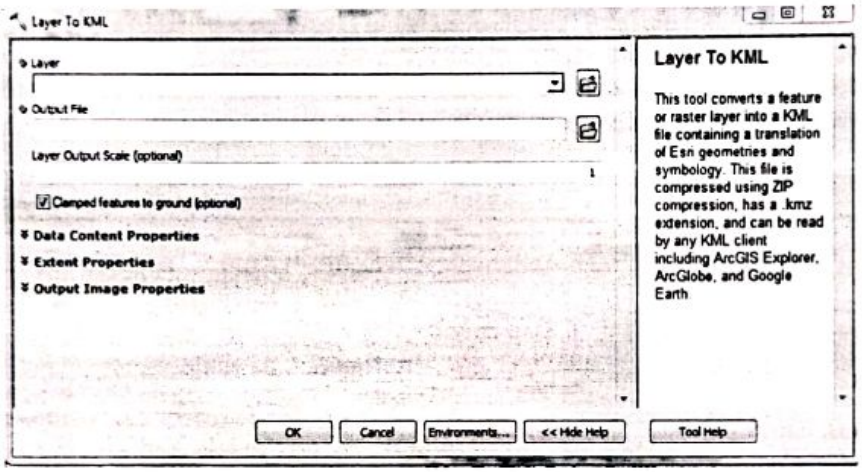
4. **Add** (click on the add data icon) and add the **Sindh.jpg** raster from the folder.
5. You need at least 6 distinctive locations to be used as control points to geo-refence this scanned map
6. Open Google Earth and zoom in to Sindh and select six distinctive locations/points. Put the place marks above those locations and note the longitudes (x) and latitudes (y) of the locations.
7. From the geo-referencing toolbar, click the "add control points" button



8. Zoom to one of the distinctive locations and hover over it, LEFT click once
9. Now, RIGHT click once and click on "Input X and Y..."
10. Add the correct coordinates for this location already obtained for similar location in Google earth.
11. Repeat the process for the remaining 5 control points. If the map disappears from your view port, just right click on the layer, and select "Full Extent"
12. To finish your geo-referencing, click on the "Geo-referencing" menu item from the toolbar, and select "update geo-referencing"
13. Rectify it. Export the image

(C) Converting georeferenced layer into KML file

- Click on Arc toolbox→ Conversion Tools → To KML→ Layer to KML. A "layer to KML" window will open.



- Click in "layer" and browse the layer which you want to convert into KML
- Click on output file and browse the location where the KML file shall be saved. Name the file as "Sindh.kml".
- Click OK

(B) Visualizing the georeferenced map in Google Earth

- Double click on Desktop or Start →All Programs→Google Earth Pro.
- Click on file→Open. A window shall open. Browse the newly created "Sindh.kml". Then click open
- The file will open in temporary places folder and all the point data shall be visible in the Main window.
- Check whether the Sindh map appears exactly above the boundaries of Sindh

LAB#09

Object: **John Snow and Kernel Density for solution of Cholera Epidemic in London**

Aim: Students will learn the essential steps in an epidemiology investigation by studying John Snow's classic investigation of the cholera epidemic in London in 1854.

RATIONALE: During epidemic of diseases, students can take on the roles of epidemiologist to investigate the outbreaks of illness in cities of Pakistan

Data: Raster and vector data related to London Cholera Outbreak (Ghost_Map.png, DEATHS.dbf, PUMPS.dbf)

Background:

Cholera first hit England through the town of Sunderland, on October 26, 1831. Dr. John Snow is regarded as one of the founding fathers of modern epidemiology. During a major cholera epidemic in 1854 London, he collected and mapped data on the locations (street addresses) where cholera deaths occurred. His process was laborious and slow, but ultimately very informative. By charting the incidence of the disease, he showed that over 500 cases occurred within 10 days over a radius of some 250 yards centered on London's Broad Street. His painstaking and detailed analysis led to the identification of the epidemic's source—a contaminated public water pump. Dr. Snow died in 1858 not knowing what caused cholera. It wasn't until 1876 that a German doctor, Robert Koch discovered the comma-shaped bacillus, *vibrio cholera*, that causes cholera.

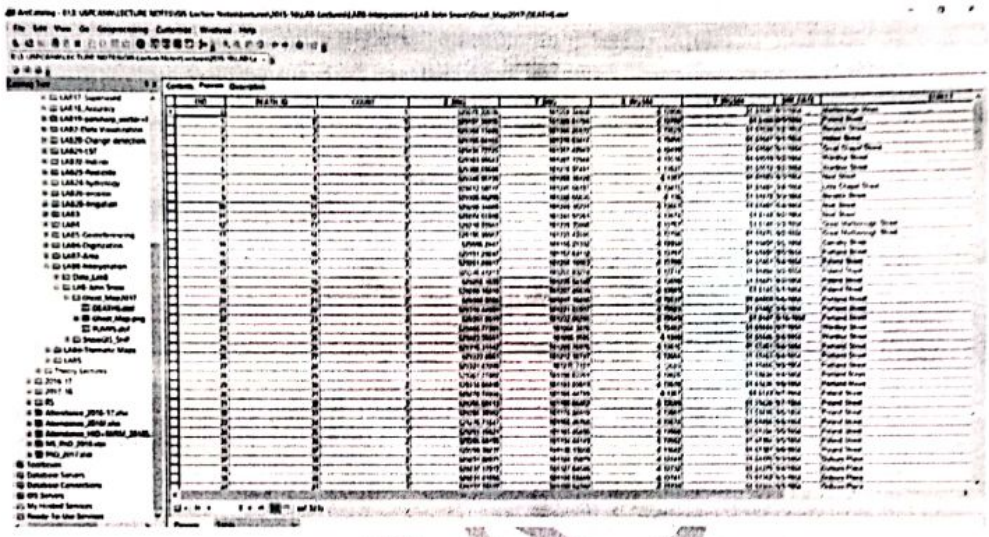
Women were drawing water from a hand pump located on Broad Street in London during the 1800's. London experienced great change during the life of John Snow. The city grew dramatically between 1813 and 1858 and was at the center of a financial and social empire, which reached around the world. Yet during these same years, residents of London suffered greatly from death and disease, including epidemics of cholera. In addition, they faced extensive environmental pollution, most notably of the majestic River Thames

Source: The Broad Street Pump, Sufi & Sound, Penguin, 1971 in English MP, Victorian Values – The Life and Times of Dr. Edwin Lankester, 1990.

Procedure

i. Check the data in all three files using ArcCatalog. To open Catalog, click Start -> ArcGIS-> ArcCatalog

ii. Browse the folder containing data files in Catalog Tree. Click the file and sea the data in preview.



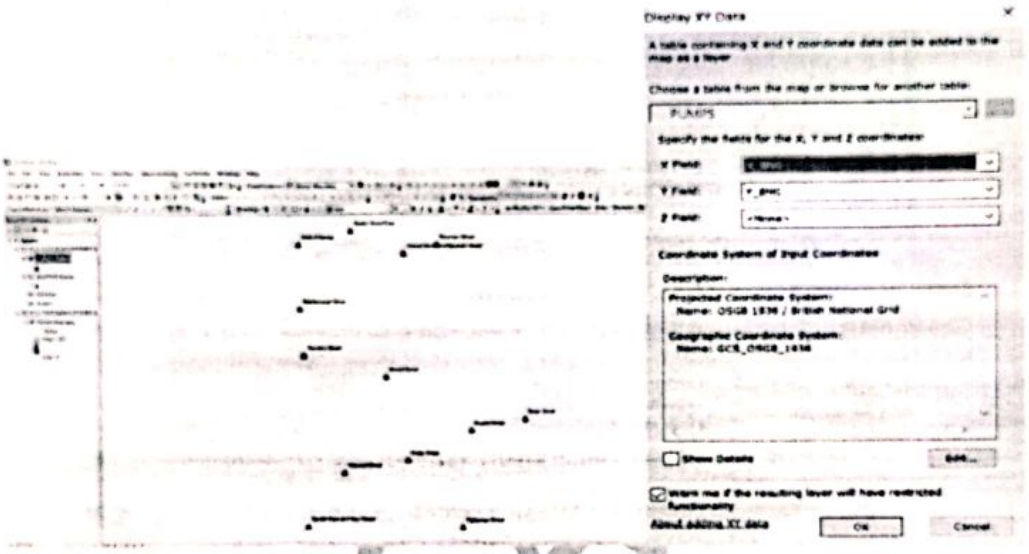
iii. Double-click the ArcMap icon on your computer's desktop. (If you do not have the icon on your desktop, click Start -> ArcGIS-> ArcMap)

iv. Add "Ghost_Map" using Add button or through drag and drop in ArcCatalog. Also add DEATHS and PUMPS database files.

v. Set the coordinates of the map. Right click the data frame in "Table of Contents" -> Properties-> Coordinate System-> Projected Coordinate System -> National Grids -> Europe -> British National Grid

vi. Right-click the PUMPS file in "Table contents" and click on display xy data. A new popup window will open. Click ok to display data points in data/map window

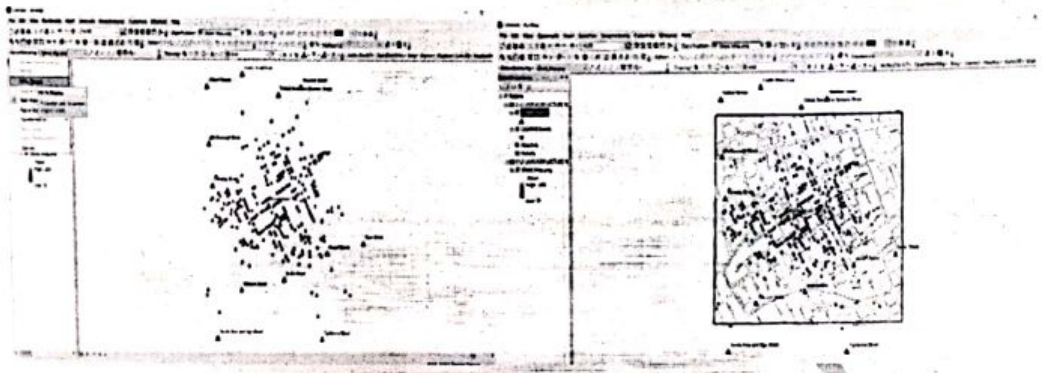
vii. Right-click the PUMPS file in "Table contents" and Label the features



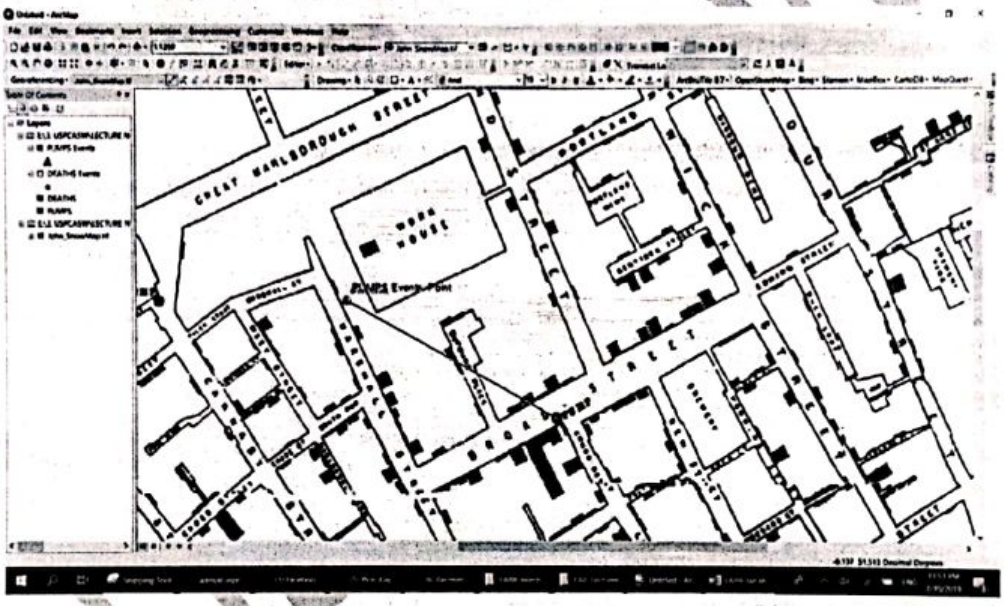
viii. Similarly right-click the DEATHS file in "Table contents" and click on display xy data. A new popup window will open. Click ok to display data points in data/map window

ix. Georeference the Ghost_Map.png by fitting the pumps in database file with pumps shown in Ghost_Map.

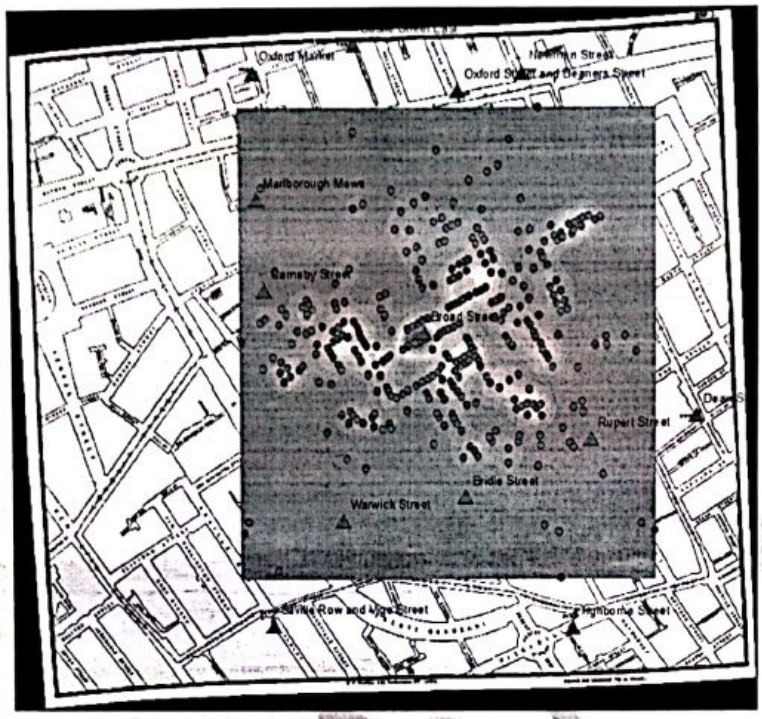
x. Click on Georeferencing-> Fit to Display



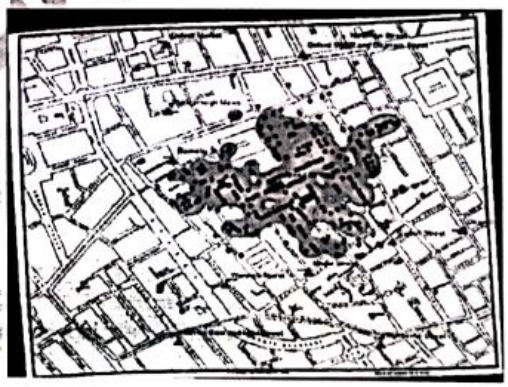
xi. Zoom to Broad Street Pump. Click on Add Control Point. Click on Pump point on Ghost_Map first and then go to Broad Street Pump and click. The will add Control Point by overlaying both points. Similarly Add control points for other pumps.



xii. Spatial Analyst Tool -> Density-> Add Death Events in Input point or polyline features. Select the Population Field as "Count". Leave all other default options -> OK



xiii. Right clock the layer and go to Symbology. Select the required color ramp. Change the color of first class (0-0.0008089) as "No Color". Also click on "Display Tab" and change the "Resample during display using" to Bilinear Interpolation. OK



LAB#08

Object: **Spatial Interpolation of Groundwater Quality (EC) of District Larkana**

Aim: To prepare thematic maps from sampled point values using interpolation techniques

Data: EC_Larkana.xls; Larkana_towns.xlsx and Larkana.shp

Background:

Spatial Interpolation is the process of using points with known values to estimate values at other points. There are a variety of ways to derive a prediction for each location; each method is referred to as a model. With each model, there are different assumptions made of the data, and certain models are more applicable for specific data—for example, one model may account for local variation better than another. Each model produces predictions using different calculations. The spatial interpolation tools are generally divided into deterministic and geostatistical methods.

The ***deterministic interpolation methods*** assign values to locations based on the surrounding measured values and on specified mathematical formulas that determine the smoothness of the resulting surface. The deterministic interpolation methods include IDW (inverse distance weighting), Natural Neighbor, Trend, and Spline geospatial tools.

The ***geostatistical methods*** are based on statistical models that include autocorrelation (the statistical relationship among the measured points). Kriging is a geostatistical method of interpolation.

The **IDW** (Inverse Distance Weighted) tool uses a method of interpolation that estimates cell values by averaging the values of sample data points in the neighborhood of each processing cell. The closer a point is to the center of the cell being estimated, the more influence, or weight, it has in the averaging. The best results from IDW are obtained when sampling is sufficiently dense regarding the local variation you are attempting to simulate. If the sampling of input points is sparse or uneven, the results may not sufficiently represent the desired surface.

Kriging is an advanced geostatistical procedure that generates an estimated surface from a scattered set of points with z-values. More so than other interpolation methods, a thorough investigation of the spatial behavior of the phenomenon represented by the z-values should be done before you select the best estimation method for generating the output surface. It is a processor-intensive process. The speed of execution is dependent on the number of points in the input dataset and the size of the search window.

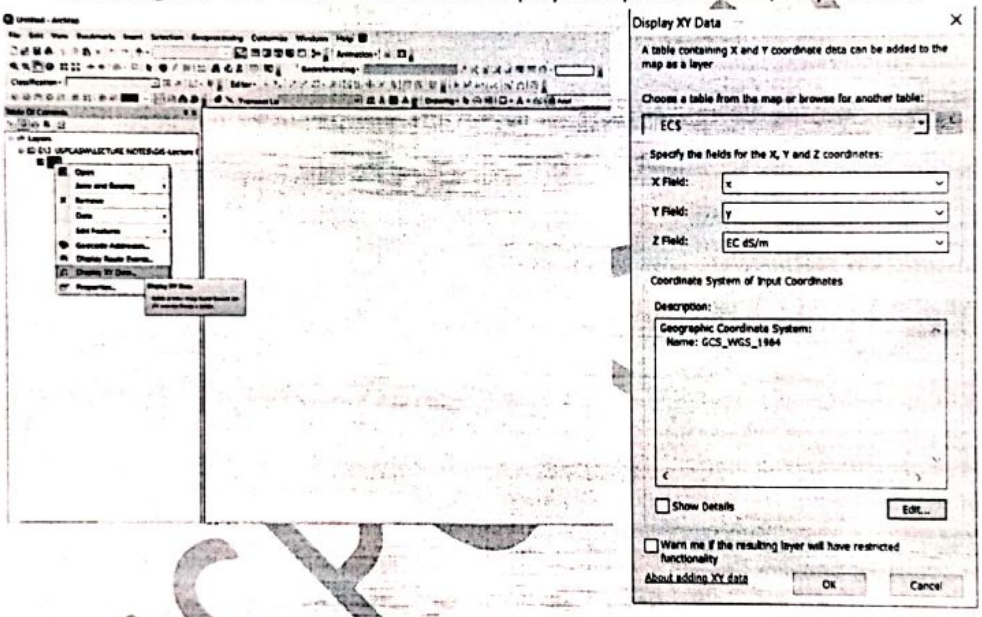
The **Spline** tool uses an interpolation method that estimates values using a mathematical function that minimizes overall surface curvature, resulting in a smooth surface that passes exactly through the input points. Interpolates a raster surface from points using a two-dimensional minimum curvature spline technique

Natural neighbor interpolates a raster surface from points using a natural neighbor technique. It is recommended that the input data be in a projected coordinate system rather than in a geographic coordinate system

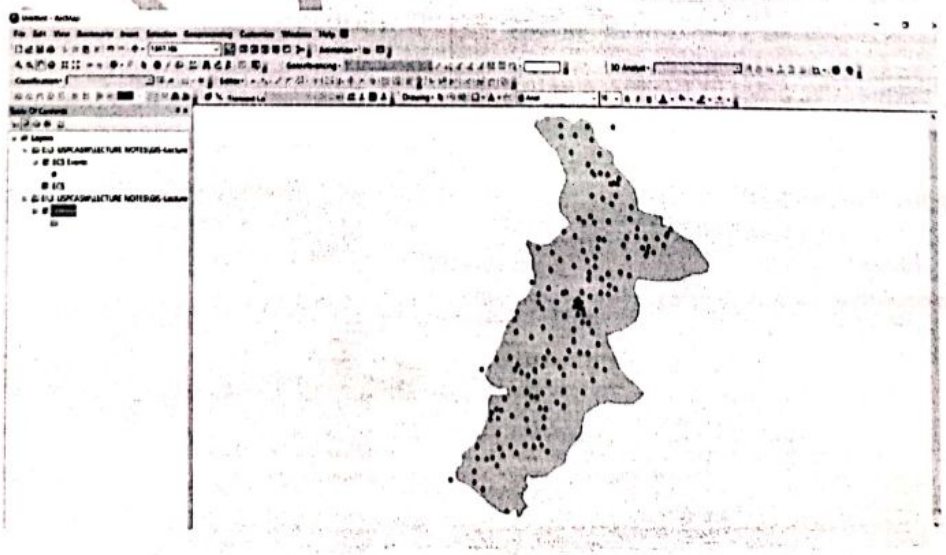
Procedure

i. Double-click the ArcMap icon on your computer's desktop. (If you do not have the icon on your desktop, click Start -> All Programs ->ArcGIS-> ArcMap)

ii. Add Excel file/sheet containing data points of EC of groundwater of district Larkana. Right-click the Excel file in "Table contents" and click on display xy data. A new popup window will open. Specify fields, i.e., x in x, y in y and EC in Z. Set the coordinate system by clicking the "Edit" button. Click ok to display data points in data/map window



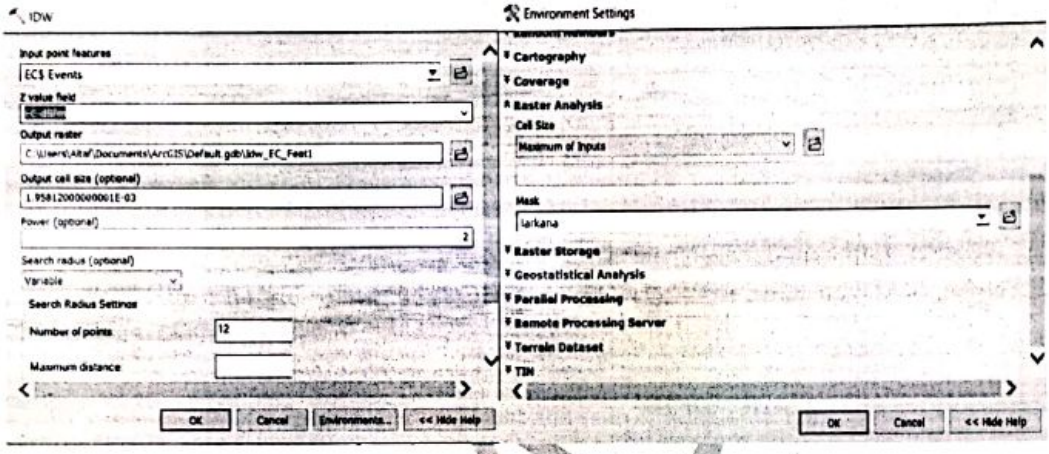
iii. Add shapefile of Larkana add data button or drag and drop using the catalog.



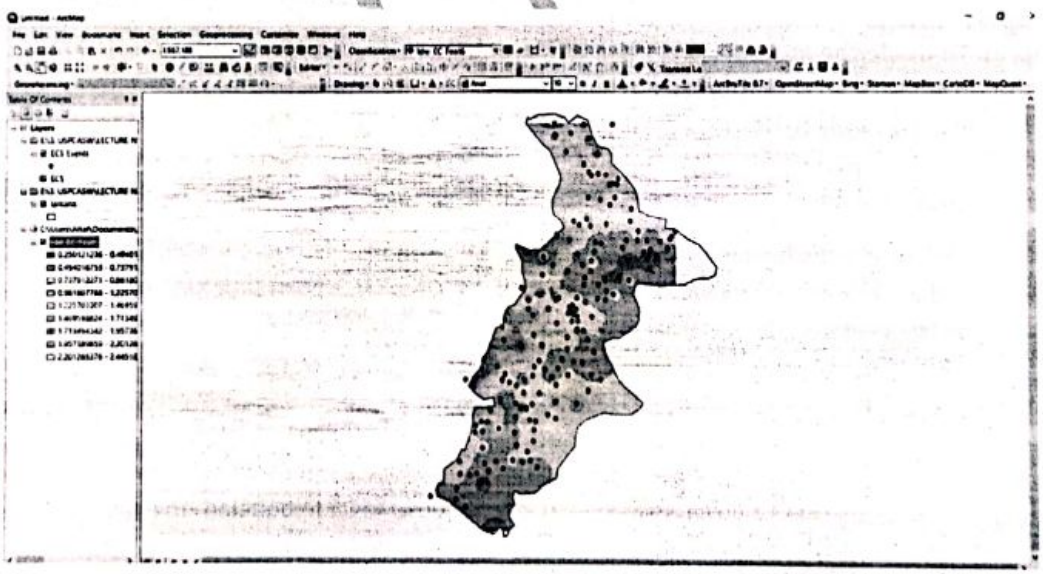
iv. Initiate the IDW interpolator (ArcToolbox ->Spatial Analyst Tools ->Interpolation -> IDW). The window that appears gives you options for selecting the input point features (EC_Larkana), the Z value or the variable to interpolate (EC dS/m), the location of output raster.

v. Leave the default output cell size, power and search radius settings

vi. Click on Environment -> Raster Analysis -> click on Mask. Browse the Larkana.shp as an input.

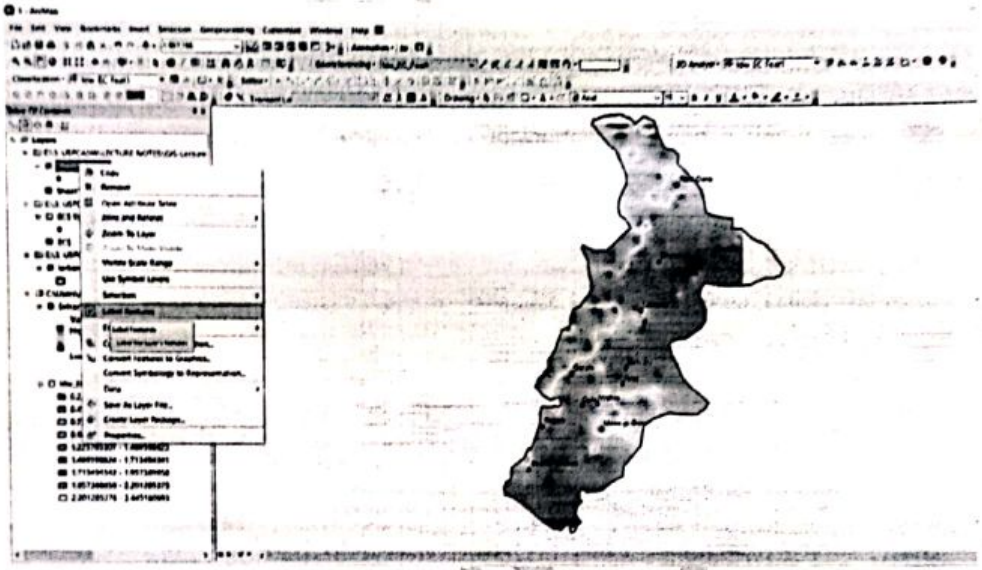


The resulting interpolation of EC of Groundwater of Larkana is given below



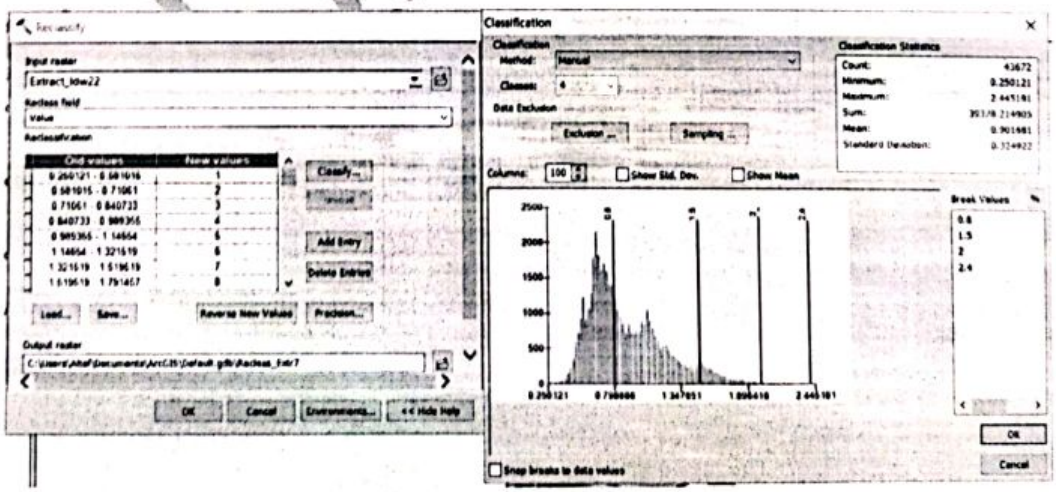
vii. Add Excel file/sheet containing the location of different towns of Larkana district. Right-click the Excel file in "Table contents" and click on display xy data. A new popup window will open. Specify fields, i.e., x in x, y in y. Set the coordinate system by clicking the "Edit" button if they are already not set. Click ok to display data points in the data/map window.

xi. Right-click excel sheet containing names of towns->click on Label Features.

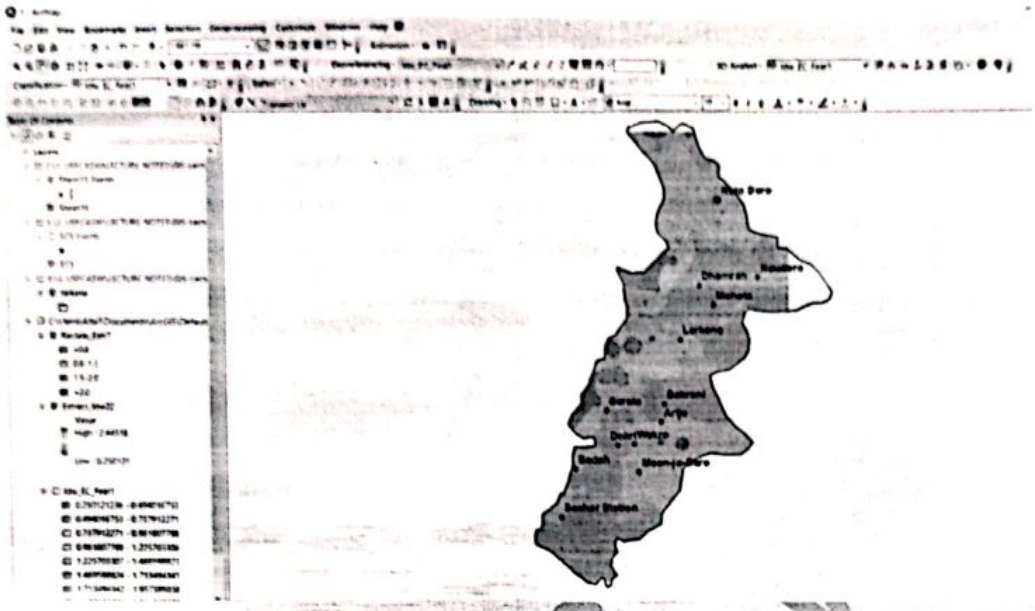


xii. To divide the groundwater of the entire district into four water quality classes (<0.8; 0.8-1.5; 1.5-2.0 and greater than 2.0), click ArcToolbox→ Special Analyst tools → Reclass → Reclassify. A 'reclassify' popup window will open. In 'input raster' click on the small arrow in the dropdown and then click on newly extracted AOI raster in the dropdown menu.

xiii. Click on classify button, a new pop up window will open. Method: Manual; Classes: 4 and write break values like 0.8, 1.5, 2.0 and 2.4. Click 'OK.' Again click 'OK' to complete reclassification.



The reclassified map shown below will be the outcome of reclassification into four classes.

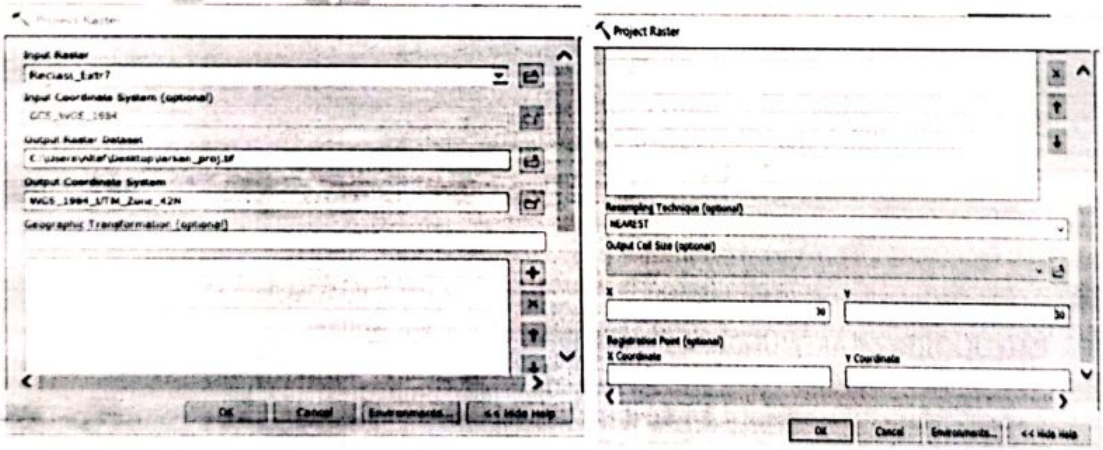


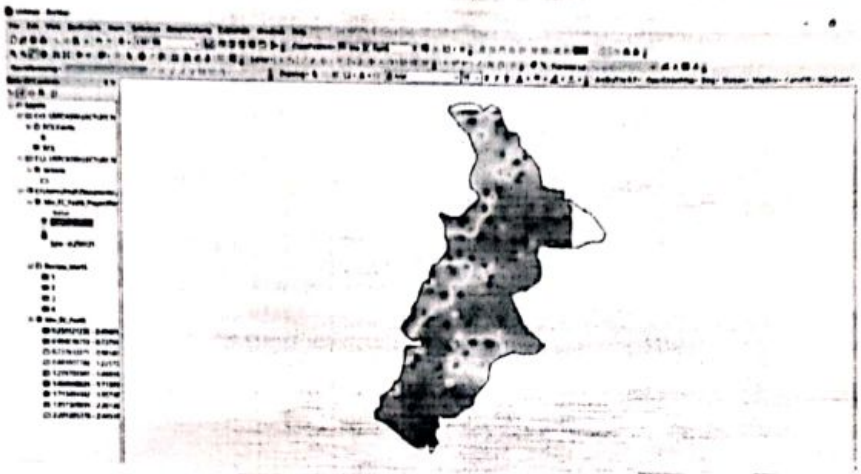
Changing the Coordinate system

-First of convert Global Coordinate System of raster to UTM.

-ArcToolbox → Data Management tools→ Projections and Transformations → Raster → Click on Project Raster. A popup window will open.

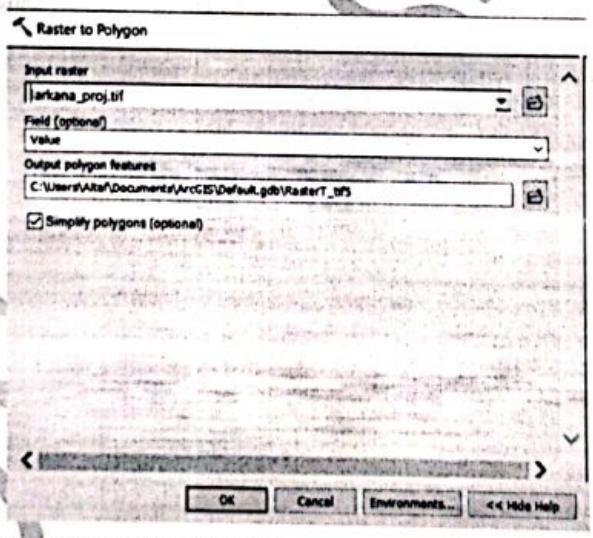
Put newly reclassified raster as "Input Raster"; Give location and name "Larkana_proj" to the raster being projected in 'output raster dataset"; in 'output coordinate system' assign "WGS_1984_UTM_Zone_42N". Give x and y values as 30 to make resolution of raster as 30 m x 30 m. Press OK.





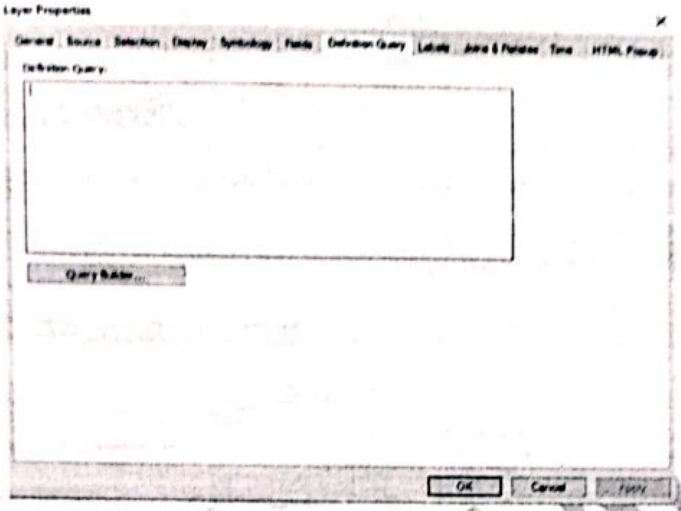
Convert Raster to Vector data and calculation of the area under each class

- Arc toolbox→Conversion tools→From Raster→ Raster to polygon
- Add reclassified raster as input raster, Field = value, browse location for output polygon features. Click OK

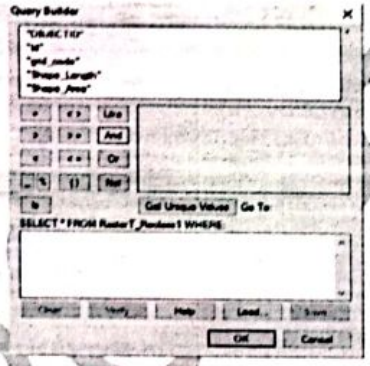


CALCULATION OF AREA UNDER EACH CLASS

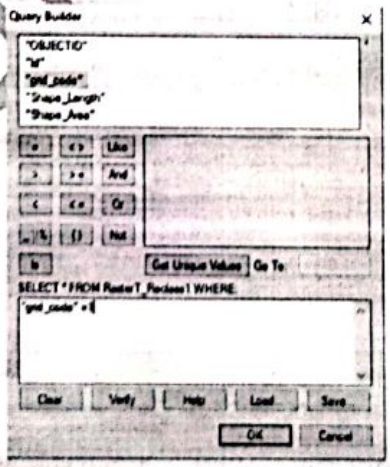
- Double-click the newly created vector file, 'layer properties' a popup window will open



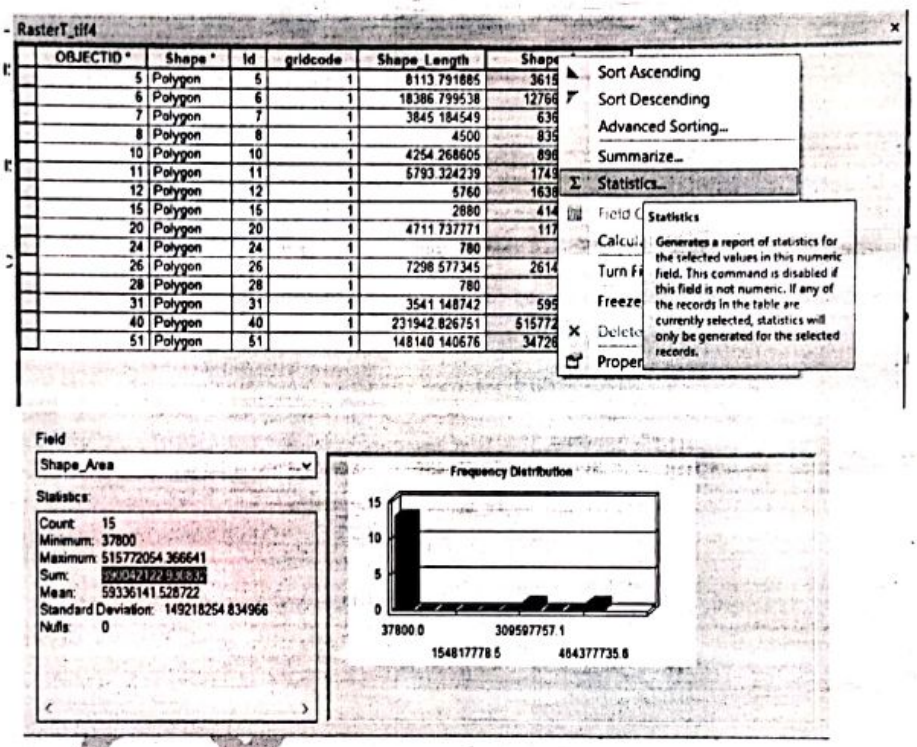
- Click on Definition Query tab, and then Query Builder.



- double click "grid_code", then click "=" sign. Then assign the number of code/color of which area is to be determined then click OK and again OK



- Now only those areas under grid code one will be highlighted. Right-click to open the attribute table of the vector data, areas of all polygons of same grid code should be given in the table.
- Highlight the 'shape area' then right click at the header and click on statistics. A popup "Statistics of Raster" window will open. There should be given a total area of the class in m^2 against "**sum.**" Convert m^2 to km^2 by dividing it with 1000000.



- Repeat the process by changing grid codes to 2, 3 and 4 and determine the respective area under each class.

Result:

i. Area under class EC <0.8 dS/m ---------- km^2

ii. Area under class EC 0.8 – 1.5 dS/m---------- km^2

iii. Area under class EC 1.5 – 2.0 dS/m---------- km^2

iv. Area under class EC >2.0 dS/m---------- km^2

PRINCIPLES, CONCEPTS & APPLICATIONS OF GIS

PROF. DR. ALTAF ALI SIYAL

PARTICIPANTS' INTRODUCTION

- Name
- Education
- Department
- Why are you taking this training?
- Are you familiar with these terms GPS / GIS / Remote Sensing?
- What are your expectations from this training

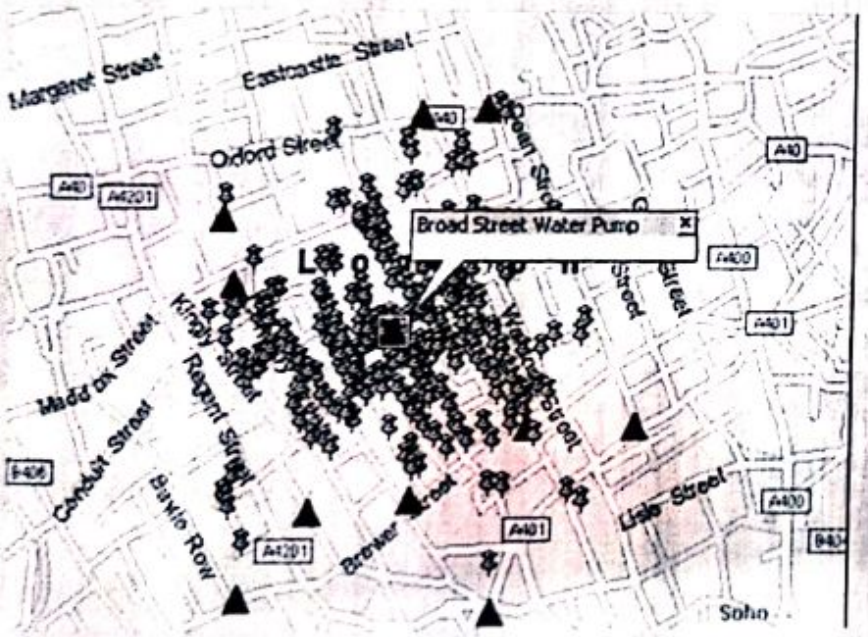
GIS concept not new!

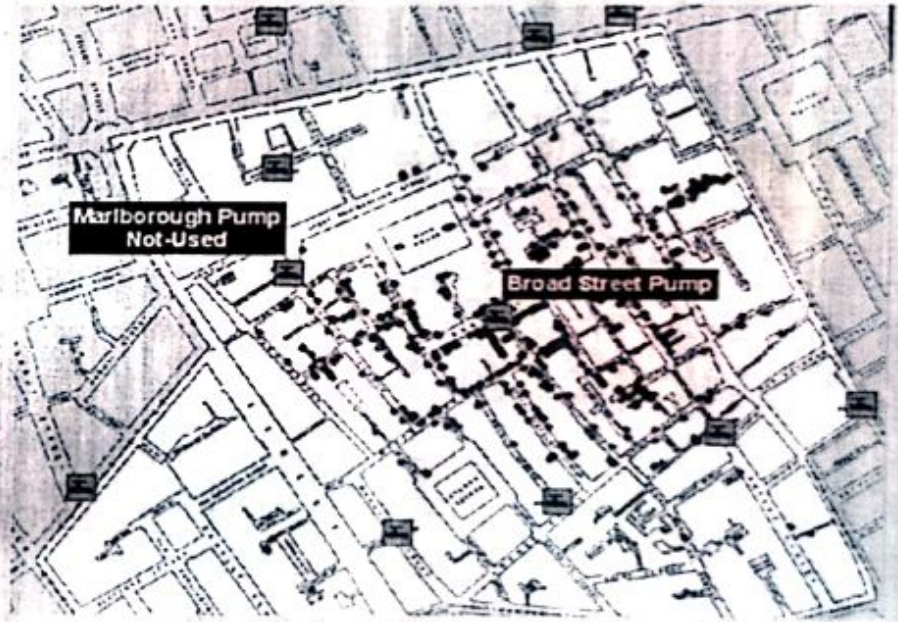
London cholera epidemic 1854

- A major outbreak of cholera struck Soho, London.
- Many people thought the disease was propagating through miasma in the air.
- John Snow, the physician used a spot map to illustrate how cases of cholera were centered around a pump.
- John Snow later used a spot map to illustrate how cases of cholera were centered on the pump.
- He eventually linked the outbreak to contaminated water
- He also made a solid use of statistics to illustrate the connection between the quality of the source of water and cholera cases

GIS concept not new!

London cholera epidemic 1854





WHAT IS GIS?

- GIS Stands for:

G? Geographical

I? Information

S? System

WHAT IS GIS?

GEOGRAPHIC — **based on or derived from the physical features of an area.**

INFORMATION — facts provided or learned about something.

SYSTEM — a set of things working together as parts of a mechanism or an interconnecting network; a complex whole.

What is a GIS?

A GIS is a system that creates, manages, analyzes, and maps all types of data.

A **GIS** is a computer system that allows you to map, model, query, and analyze large quantities of data within a single database according to their location.

What is a GIS?

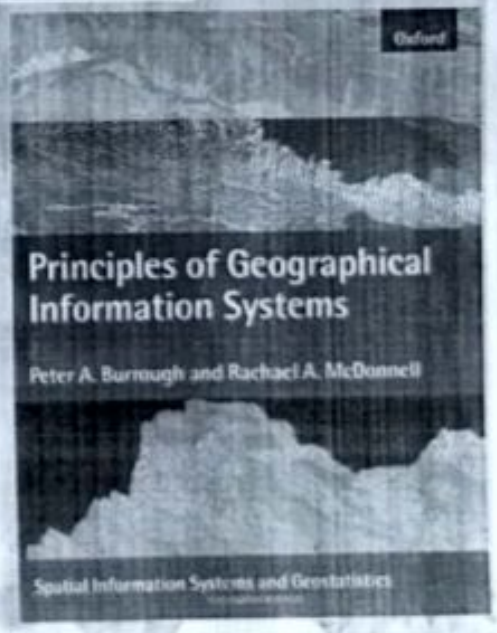
GIS

GEOGRAPHY

INFORMATION SCIENCE

GIS is a is a computer system for the acquisition and management of geographically referenced information.

GIS is a powerful *set of tools* for collecting, storing, retrieving, transforming, and displaying spatial data from the real world. (Burroughs, 1986)

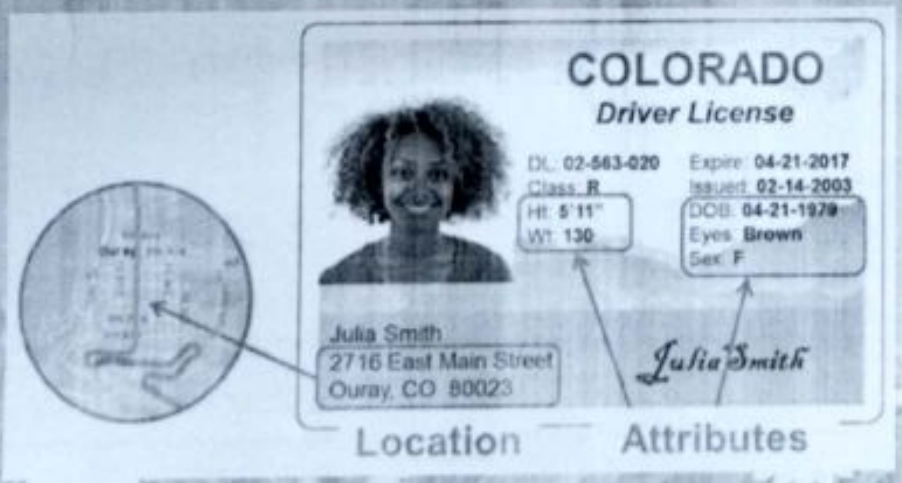


DESCRIBING OBJECT ON EARTH'S SURFACE

Two types of Information is required:

- Spatial (Location)
  - Real world x and y coordinates
- Non-spatial (Attribute)
  - attributes of a road might include its name, length, and kind (paved or gravel)

GIS integrates location and attribute information, storing information about where something is with information about what something is.



Ways of describing any element/object on the Earth

Location Information: Where is it?

Attribute Information: What is it?

X° East/West

Y° North/South

Type	.....
Species	.....
Heights	.....
Use	.....

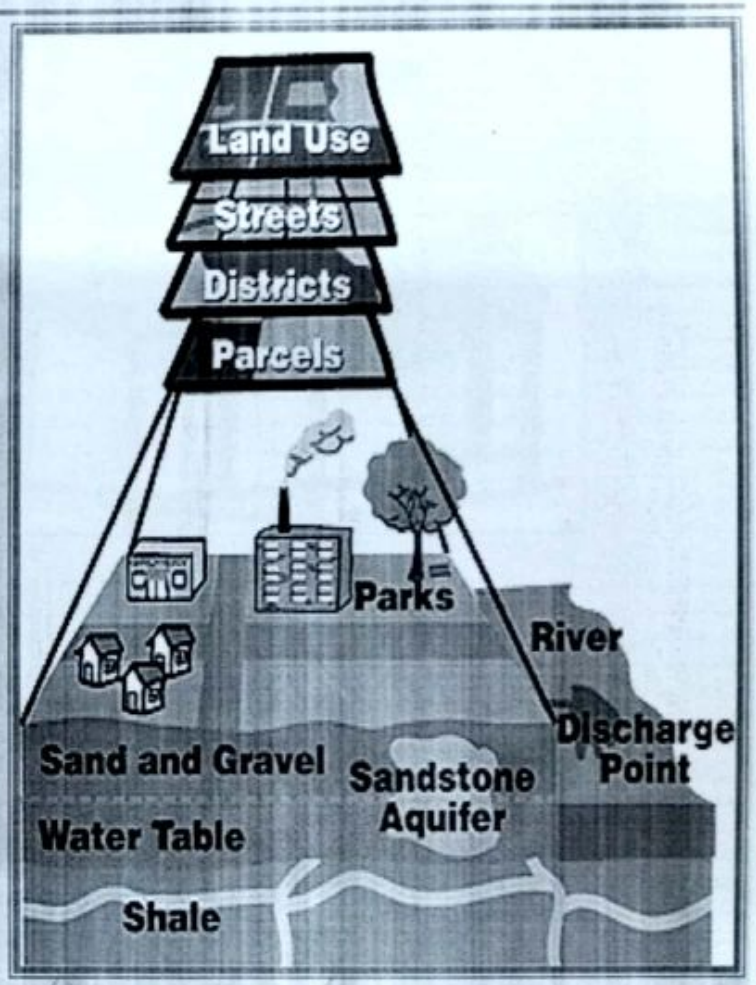
GIS can tell us *Where* and *What*

GEOGRAPHIC OBJECTS

The question arises: "How do we represent real world geographic information with computer?"

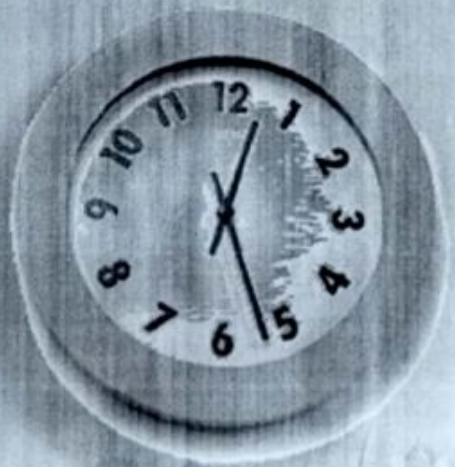
The answer is:

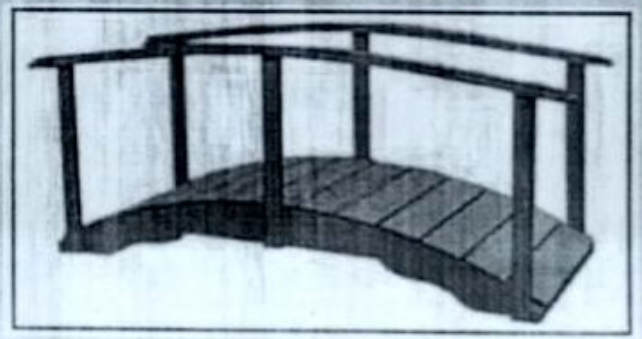
Through GIS



GEOGRAPHIC PRIMITIVE

$$G = f(x, y, z, t, F)$$

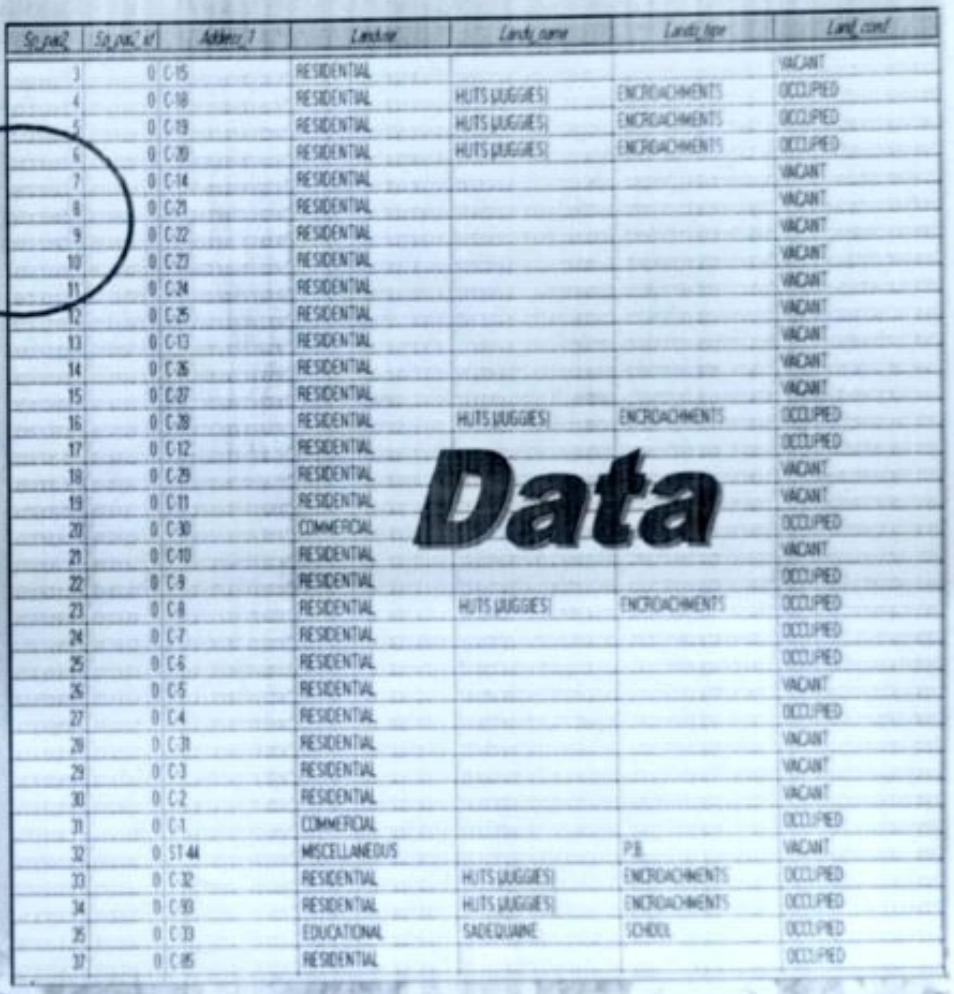




Conventional Ways to Store Data

DATABASES

- A Database comprises of tables having fields with specific data structure.
- The tables are linked with each other through various common fields.



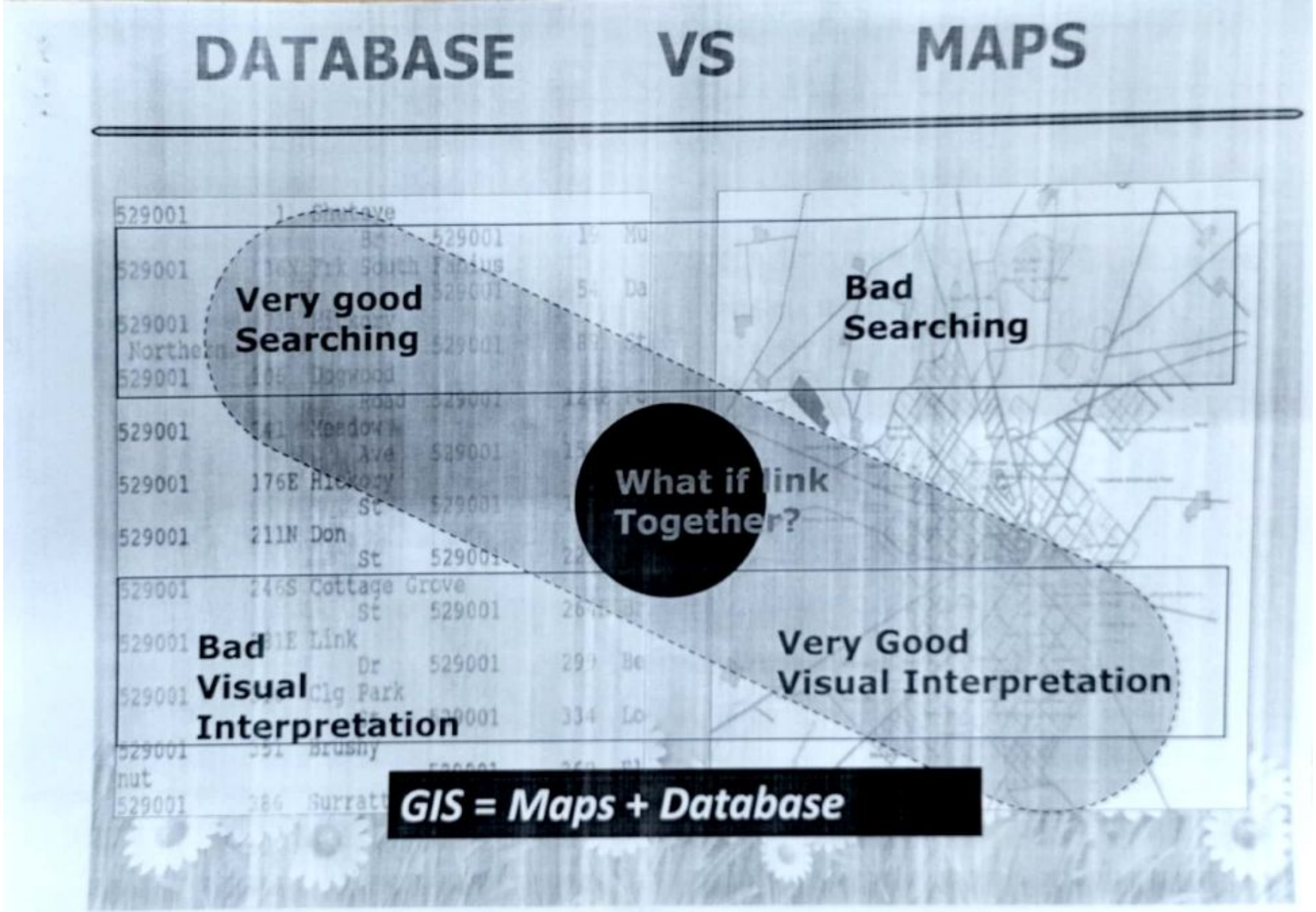
Sr_no2	Sr_no_of	Address_1	Landuse	Landuse_name	Landuse_type	Land_conf
3	0	C-15	RESIDENTIAL			VACANT
4	0	C-18	RESIDENTIAL	HUTS (JUGGIES)	ENCROACHMENTS	OCCUPIED
5	0	C-19	RESIDENTIAL	HUTS (JUGGIES)	ENCROACHMENTS	OCCUPIED
6	0	C-20	RESIDENTIAL	HUTS (JUGGIES)	ENCROACHMENTS	OCCUPIED
7	0	C-14	RESIDENTIAL			VACANT
8	0	C-21	RESIDENTIAL			VACANT
9	0	C-22	RESIDENTIAL			VACANT
10	0	C-23	RESIDENTIAL			VACANT
11	0	C-24	RESIDENTIAL			VACANT
12	0	C-25	RESIDENTIAL			VACANT
13	0	C-13	RESIDENTIAL			VACANT
14	0	C-26	RESIDENTIAL			VACANT
15	0	C-27	RESIDENTIAL			VACANT
16	0	C-28	RESIDENTIAL	HUTS (JUGGIES)	ENCROACHMENTS	OCCUPIED
17	0	C-12	RESIDENTIAL			OCCUPIED
18	0	C-29	RESIDENTIAL			VACANT
19	0	C-11	RESIDENTIAL			VACANT
20	0	C-30	COMMERCIAL			OCCUPIED
21	0	C-10	RESIDENTIAL			VACANT
22	0	C-9	RESIDENTIAL			OCCUPIED
23	0	C-8	RESIDENTIAL	HUTS (JUGGIES)	ENCROACHMENTS	OCCUPIED
24	0	C-7	RESIDENTIAL			OCCUPIED
25	0	C-6	RESIDENTIAL			OCCUPIED
26	0	C-5	RESIDENTIAL			VACANT
27	0	C-4	RESIDENTIAL			OCCUPIED
28	0	C-31	RESIDENTIAL			VACANT
29	0	C-3	RESIDENTIAL			VACANT
30	0	C-2	RESIDENTIAL			VACANT
31	0	C-1	COMMERCIAL			OCCUPIED
32	0	ST-44	MISCELLANEOUS		P.S.	VACANT
33	0	C-32	RESIDENTIAL	HUTS (JUGGIES)	ENCROACHMENTS	OCCUPIED
34	0	C-93	RESIDENTIAL	HUTS (JUGGIES)	ENCROACHMENTS	OCCUPIED
35	0	C-33	EDUCATIONAL	SADEQUANE	SCHOOL	OCCUPIED
37	0	C-85	RESIDENTIAL			OCCUPIED

Data

Conventional Ways to Store Data

MAPS

- Map can be defined as ***"A Facility for displaying interpretation of geographic information on a flat surface."***
- Location information describes the position of a particular geographic feature on earth's surface & provides the basis for representing spatial relationships between these features.



GIS components

Spatial data

GIS

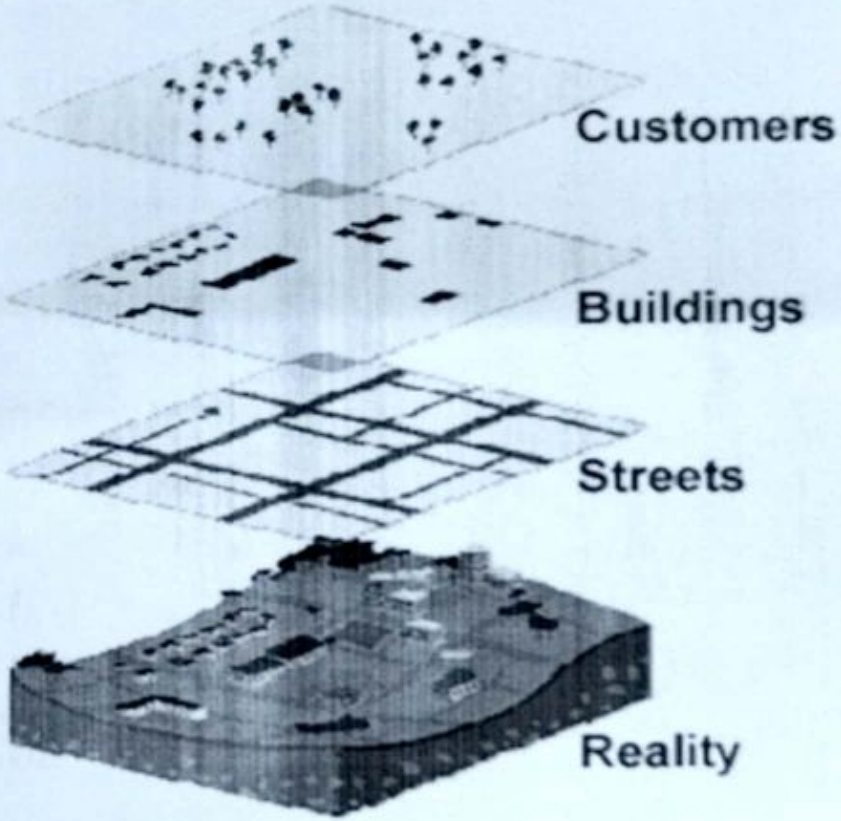
?

Computer hardware / software tools

Specific applications / decision making objectives

BASIC GIS FUNCTIONS

- Capture
- Store
- Query
- Analyze
- Display
- Output



WHAT DOES GIS DO?

- Links databases and maps
- Manages information about places
- Helps answer questions such as:
  - Where is.... ?
  - What the location.... ?
  - What is the spatial relation between ...?
  - What is similar to ...?
  - Where has ...occurred ?
  - What has changed since ....?
  - Is there a general spatial pattern and where are the anomalies.

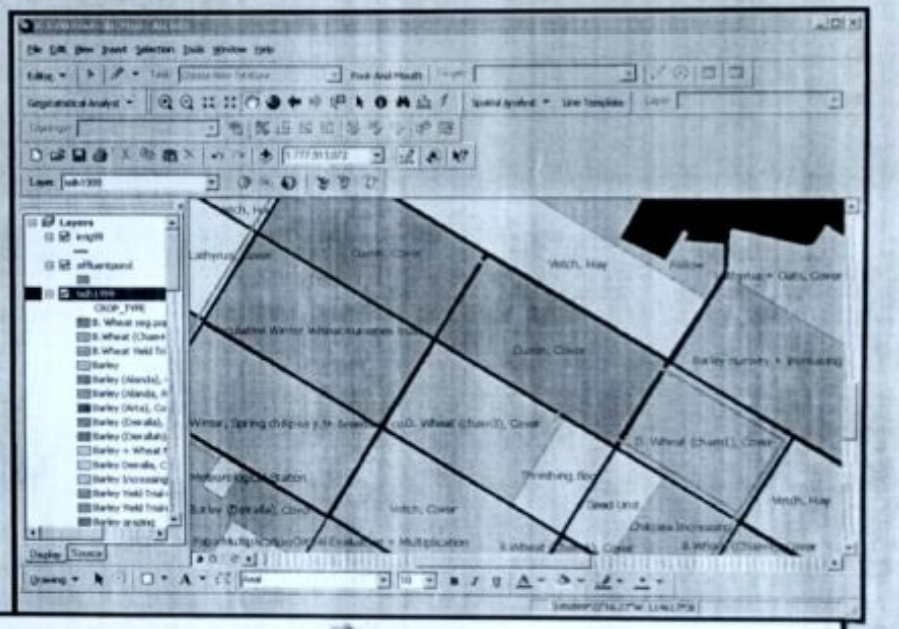
USE OF GIS

- Urban Planning
- Environmental Impact Analysis
- Oil & Gas Industry
- Disaster Management and Mitigation
- Landslide Hazard Zonation
- Land use/land cover changes
- Flood damage estimation
- Natural Resources Management
- Soil Mapping
- Land Information System
- Wetland Mapping
- Geology
- Planning & Community Development
- Dairy Industry
- Agricultural Applications
- Tourism Information System
- Irrigation water management
- Earthquake Information System
- Volcanic Hazard Identification

- ✓ Energy Use Tracking and Planning
- ✓ Fisheries and Ocean Industries
- ✓ Digital Media
- ✓ Water Reservoir Site Selection
- ✓ Biomass & Biofuel
- ✓ Forest Fire Hazard Zone Mapping
- ✓ Military and defense
- ✓ Traffic Density Studies
- ✓ Deforestation
- ✓ Desertification
- ✓ Development of Public Infrastructure Facilities
- ✓ Drainage Problems
- ✓ Public Health
- ✓ Defense Purpose
- ✓ Pipeline Route Selection
- ✓ Site Suitability Analysis
- ✓ Infrastructure Development
- ✓ Crime Analysis

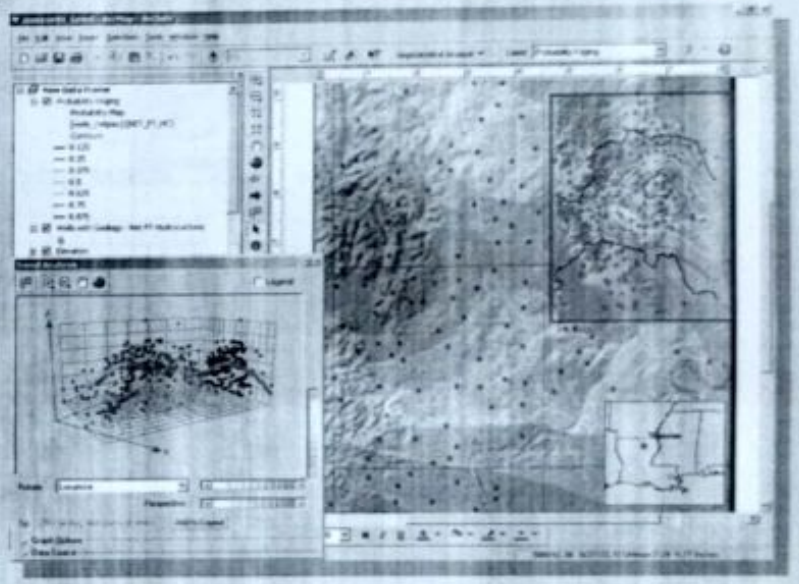
AGRICULTURE

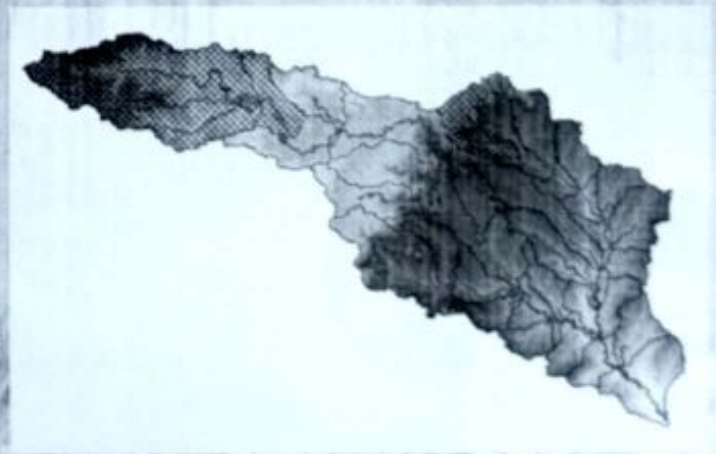
- Farm management
- Pest/Disease tracking
- Crop monitoring
- Yield prediction
- Soil analysis
- Land measurement



NATURAL RESOURCE MANAGEMENT

- Forestry
- Ecology
- Mining
- Petroleum
- Water Resources

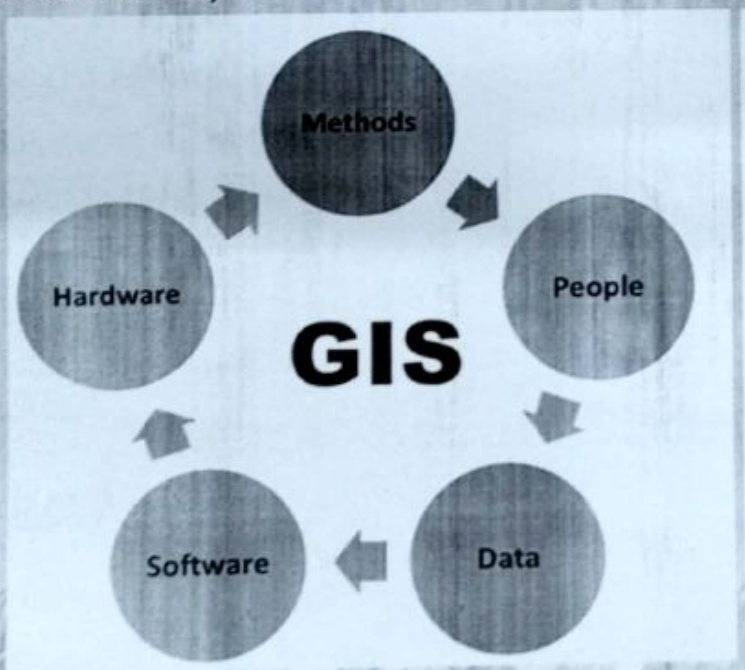


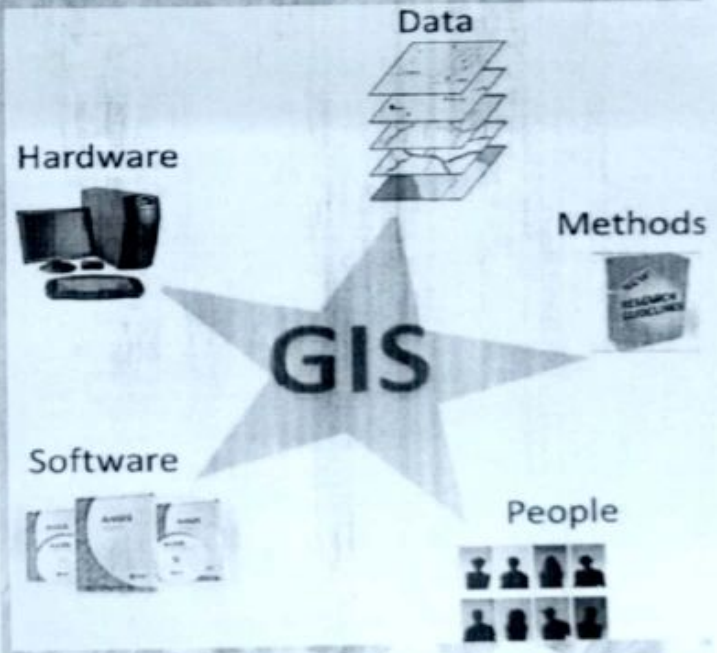


KEY COMPONENTS OF GIS

- GIS allows users to search for information about specific geographical areas, analyze spatial information, edit the data and create maps, charts and reports that show users the results in visual forms.

- GIS is an organized integration of key components:
  - Computer Hardware,
  - Software
  - Process
  - Personnel
  - Data

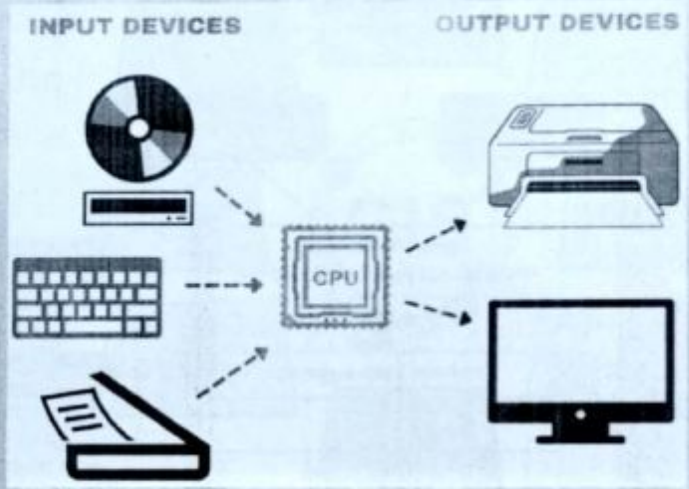




KEY COMPONENTS OF GIS

1. HARDWARE

- Hardware is the computer on which a GIS operates.
- GIS runs on a wide range of hardware types, from centralized computer servers to desktop computers used in standalone or networked configurations.



2. SOFTWARE

- GIS software provides the functions and tools needed to store, analyze, and display geographic information.

ArcGIS

QGIS

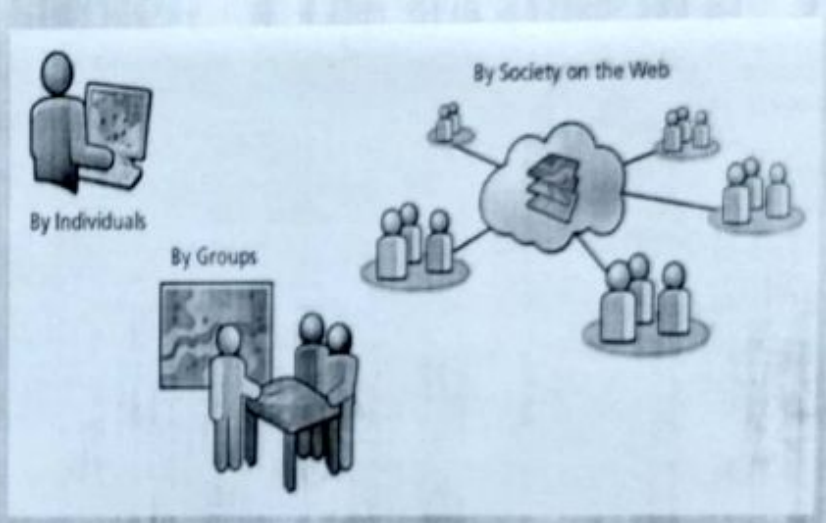
global mapper

SAGA
System for Automated Geoscientific Analyses

KEY COMPONENTS OF GIS

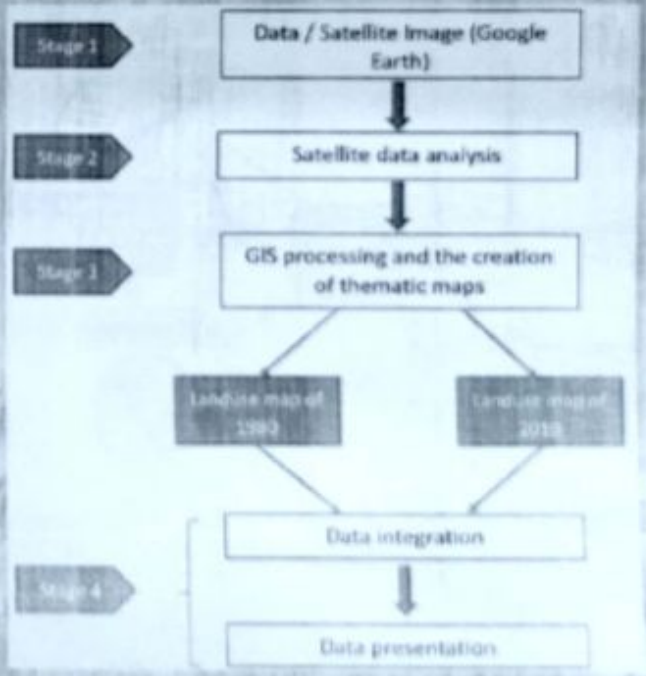
3. PEOPLE

- GIS technology is of limited value without the people who manage the system and to develop plans for applying it.
- GIS users range from technical specialists who design and maintain the system, to those who use it to help them do their everyday work.



4. PROCESS / METHOD

- Series of steps undertaken to achieve a desired outcome or goal.
- A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.



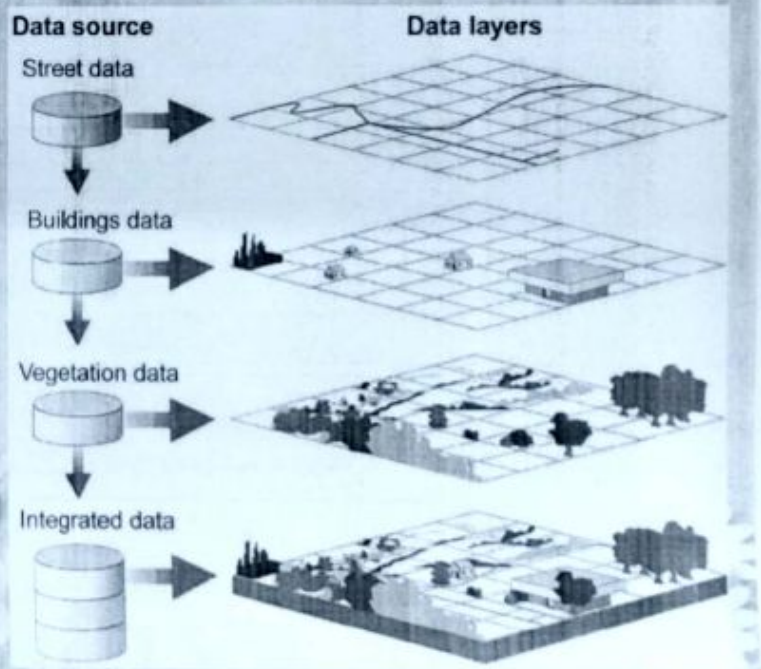
KEY COMPONENTS OF GIS

5. DATA

- Data is another word for information. The information we use in a GIS normally has a geographical aspect to it.
- Geographic data and related tabular data can be collected in-house or bought from a commercial data provider.
- GIS data is of two types.

Top ten free GIS Data Sources

1. Natural Earth Data
2. USGS Earth Explorer
3. OpenStreetMap
4. Esri Open Data Hub
5. NASA's Socioeconomic Data and Applications Center (SEDAC)
6. Open Topography
7. UNEP Environmental Data Explorer
8. NASA Earth Observations (NEO)
9. Sentinel Satellite Data
10. Terra Populus



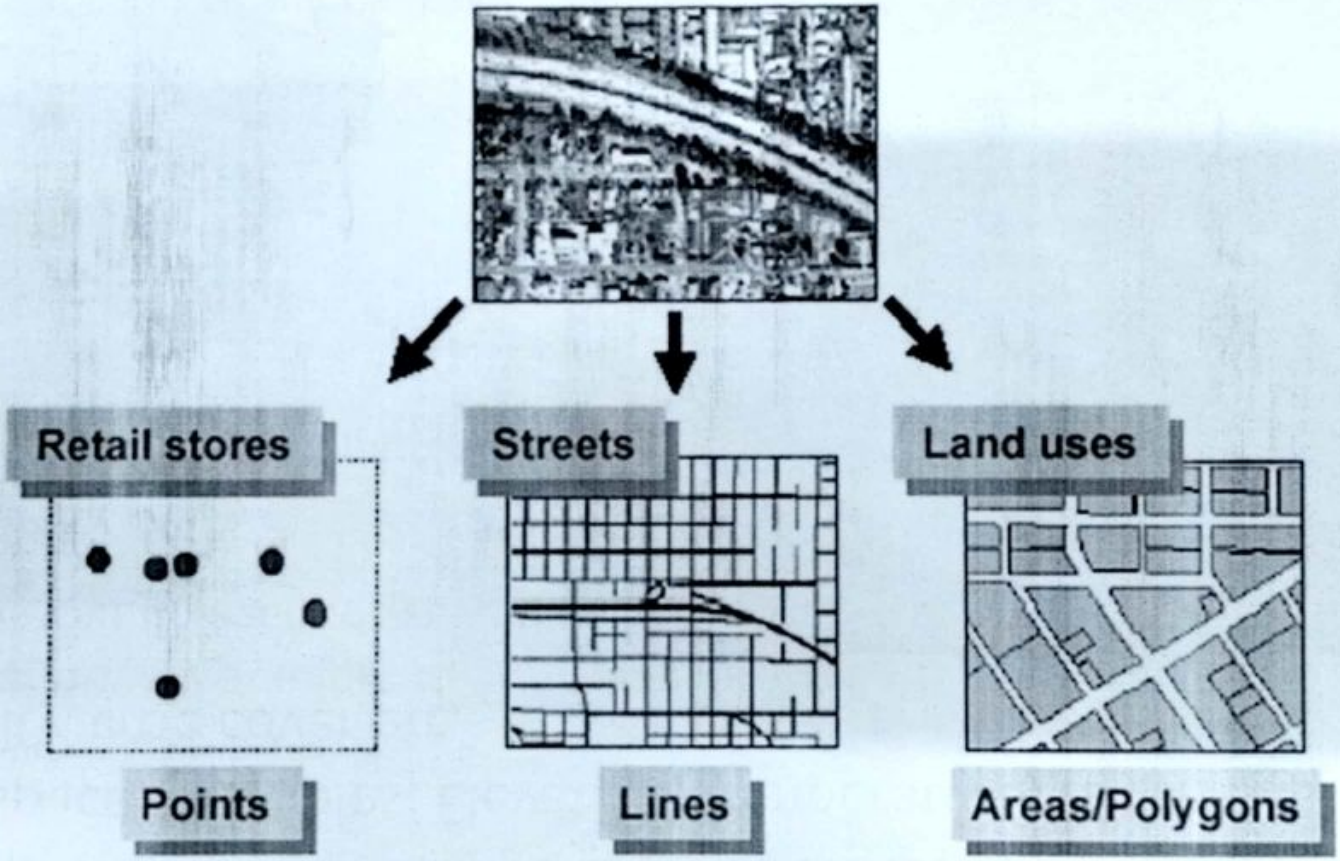
Spatial and non-spatial data

Part Number	Quantity	Description
1034161	5	Wheel spoke
1051671	1	Ball bearing
1047623	6	Wheel rim
1021413	2	Tire
1011210	3	Handlebars

Crimes during 2003		
Date	**Location**	**Type**
22-Jan	123 James St.	Robbery
24-Jan	22 Smith St.	Burglary
10-Feb	9 Elm St. #4A	Assault
13-Feb	12 Fifth Avenue	Breaking and Entering
14-Feb	17 Del Playa	Drunk and Disorderly

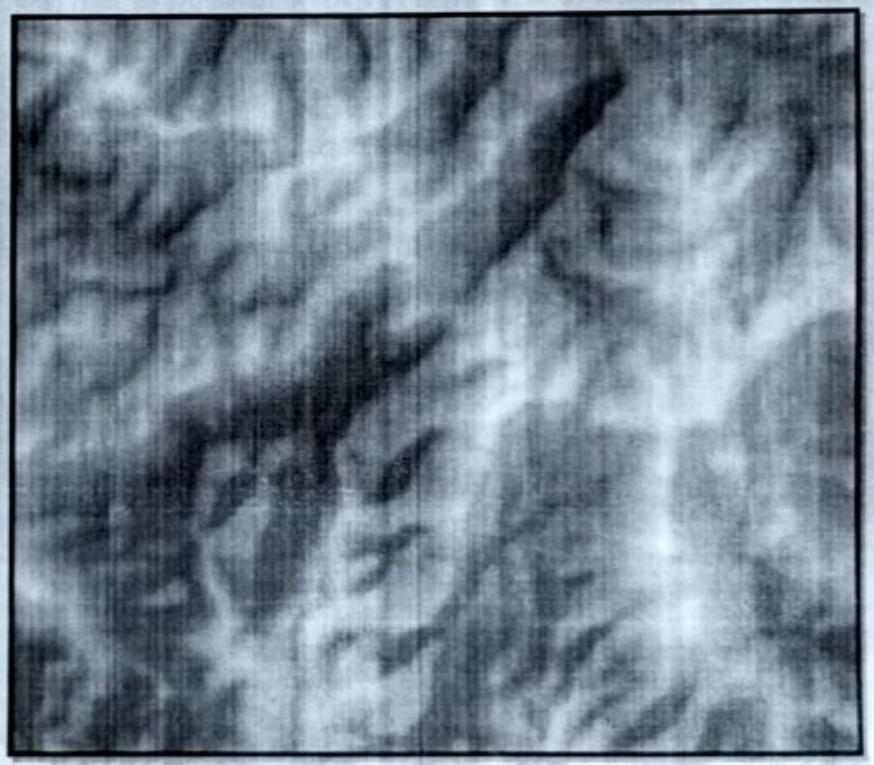
SPATIAL DATA TYPES - DISCRETE

- Real-world entities are abstracted into three basic shapes



SPATIAL DATA TYPES- CONTINUOUS

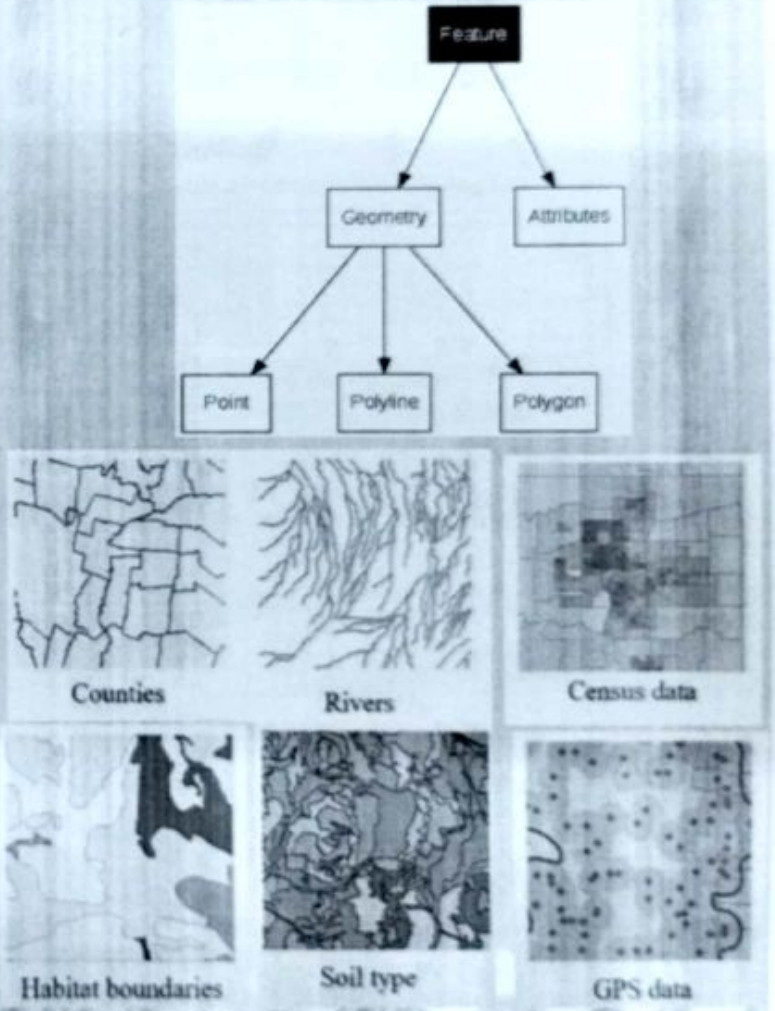
Data is organized into surfaces where one attribute value vary across the space, examples: Elevation, temperature, rainfall, ocean salinity, crop cover etc.



GEOSPATIAL DATA TYPES

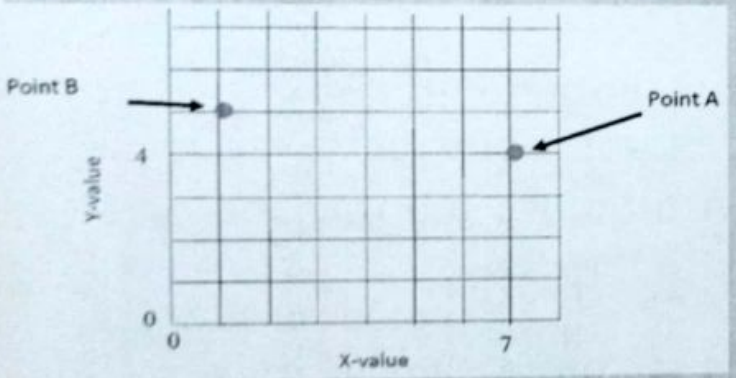
VECTOR DATA

- Represents specific **features** on the Earth's surface and it stores location using Cartesian coordinate (x, y) locations.
- A vector feature has a geometry:
  - ❖ Point Data
  - ❖ Line/Polyline Data
  - ❖ Polygon Data
- Each vector feature has **attribute data** that describes its properties.
- Vector data can be used for spatial analysis in a GIS application, for example to find the nearest hospital to a school.
- It is most useful to represent spatial phenomena that has discrete boundaries, such as streets, roads, provincial borders, etc.



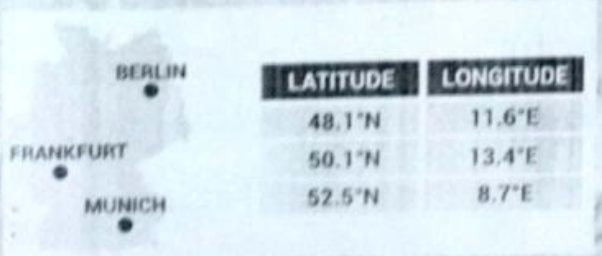
GEOSPATIAL DATA TYPES

Point, Line, & Polygon Features

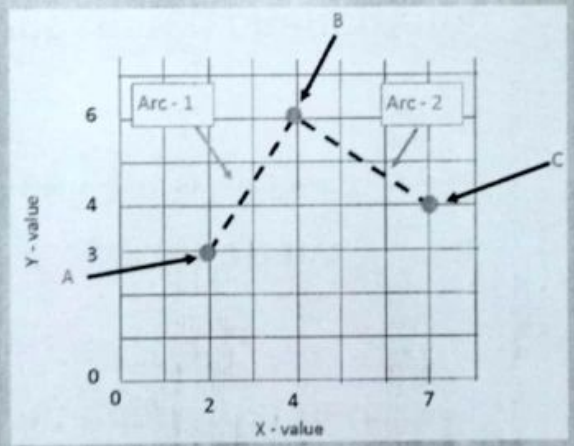


How the computer "sees" the points:

Point #	Coordinate
A	7,4
B	1,5



LATITUDE	LONGITUDE
48.1°N	11.6°E
50.1°N	13.4°E
52.5°N	8.7°E

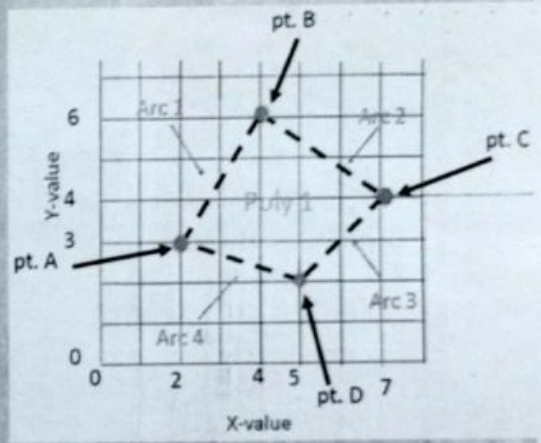


How the computer "sees" the points:

Point #	Coordinate
A	2,3
B	4,6
C	7,4

How the computer "sees" the line:

Arc ID	From Point	To Point
1	A	B
2	B	C



How the computer "sees" the points:

Point #	Coordinate
A	2,3
B	4,6
C	7,4
D	5,2

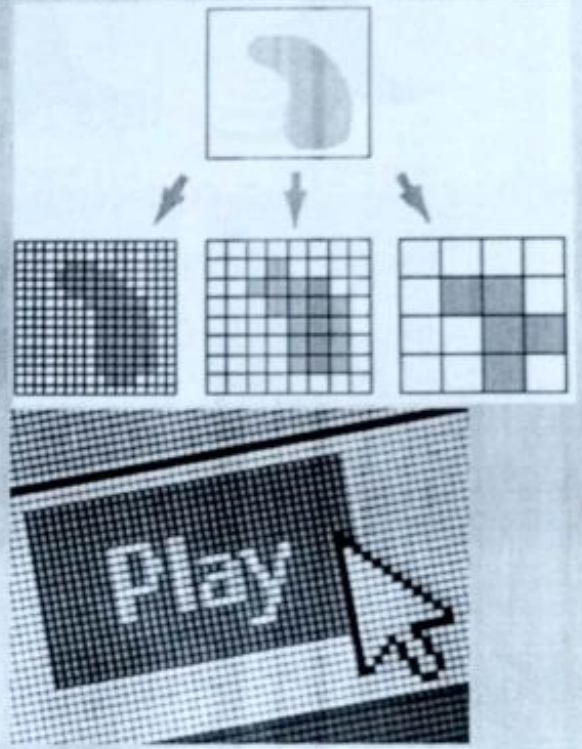
How the computer "sees" the polygon:

Line	From Point	To Point
1	A	B
2	B	C
3	C	D
4	D	A

GEOSPATIAL DATA TYPES

RASTER DATA

- Made up of matrix of **regularly** sized cells (or pixels) organized into rows and columns (or a grid) where each cell has a value representing information.
- Represents the fourth type of feature: **surfaces**.
- This is kind of similar way our regular display of television and smart phone works like pixels.
- Each cell is assigned a numeric value which reflect something continuous such as temperature.

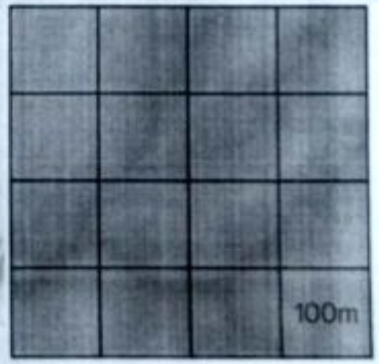


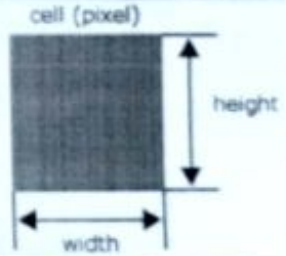
	4	4	3	3	3
4	4	4	4	1	1
4	3	3	1	1	1
4	3	3	1	1	1
4	3	3	2	2	1
4	4	2	2	2	

NoData

Number of cells

OID	VALUE	COUNT	TYPE	AREA	CODE
0	1	9	Forest	8100	FL010
1	2	5	Wetland	4500	WL001
2	3	9	Agriculture	8100	CL301
3	4	11	Urban	9901	UL040

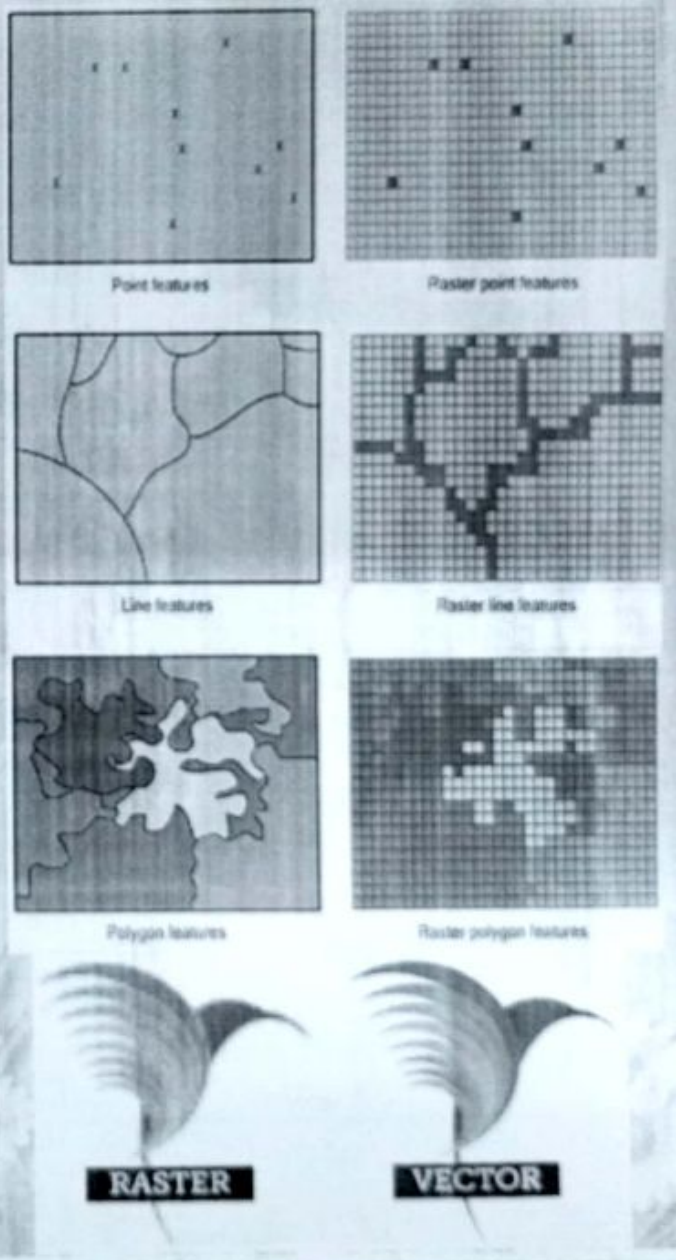




GEOSPATIAL DATA TYPES

What's the Difference?

VECTOR	RASTER
Depicts information that can easily be divided into vector features.	Displays information that is continuous across an area.
Represented through point, line, polygon	Represented through grid pixels (image/photo)
Resolution independent	Resolution independent
File size is small	File size is large
Not suitable for overlaying operations	Easy and efficient overlaying
Based on measurements	Determined by cell size



Raster vs Vector

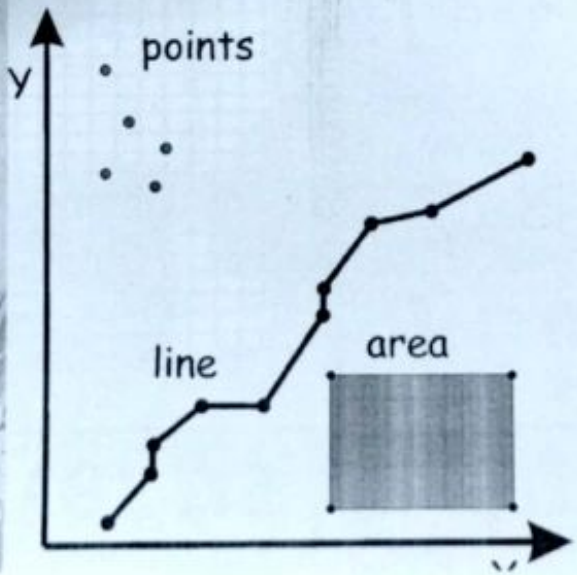
Vector

- **Point: Position, no area**
- **Line: Length, no width**
- **Polygon: Area and perimeter**

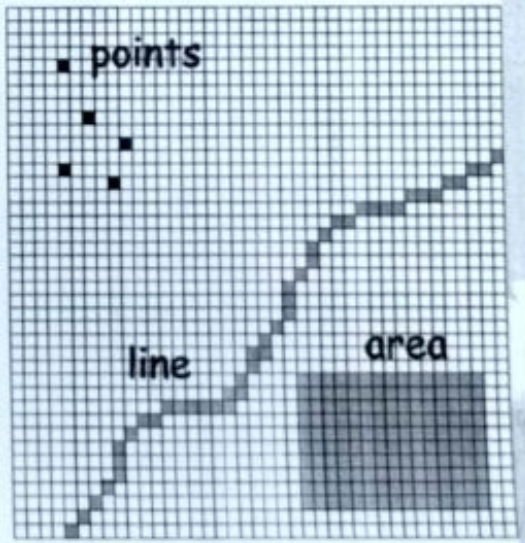
Raster

- **Point: 1 cell**
- **Line: Multiple cells joined at edges or corners, usually with only 1 or 2 neighbors**
- **Polygon: Group of contiguous cells joined at edges or corners**

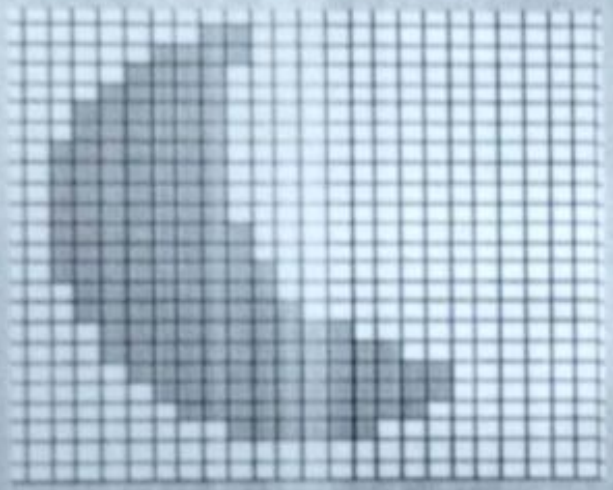
Vector

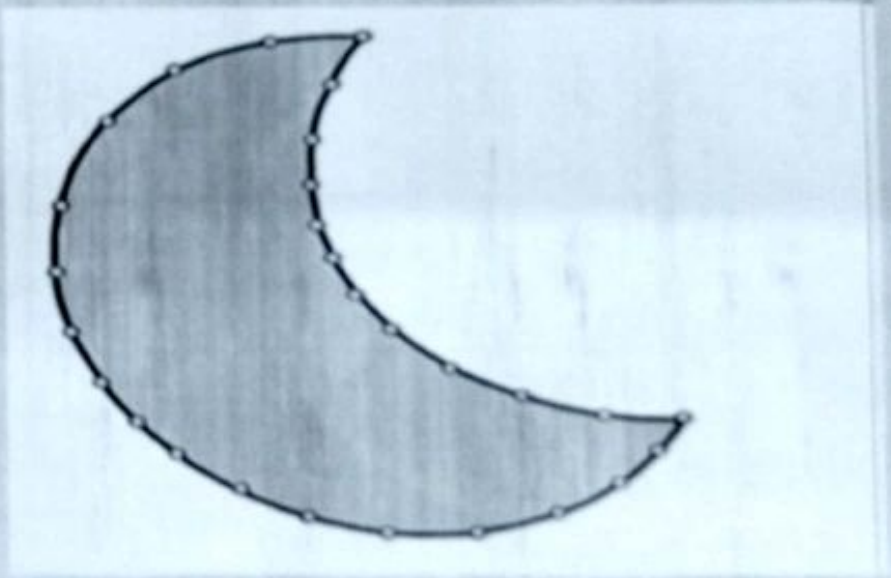


Raster



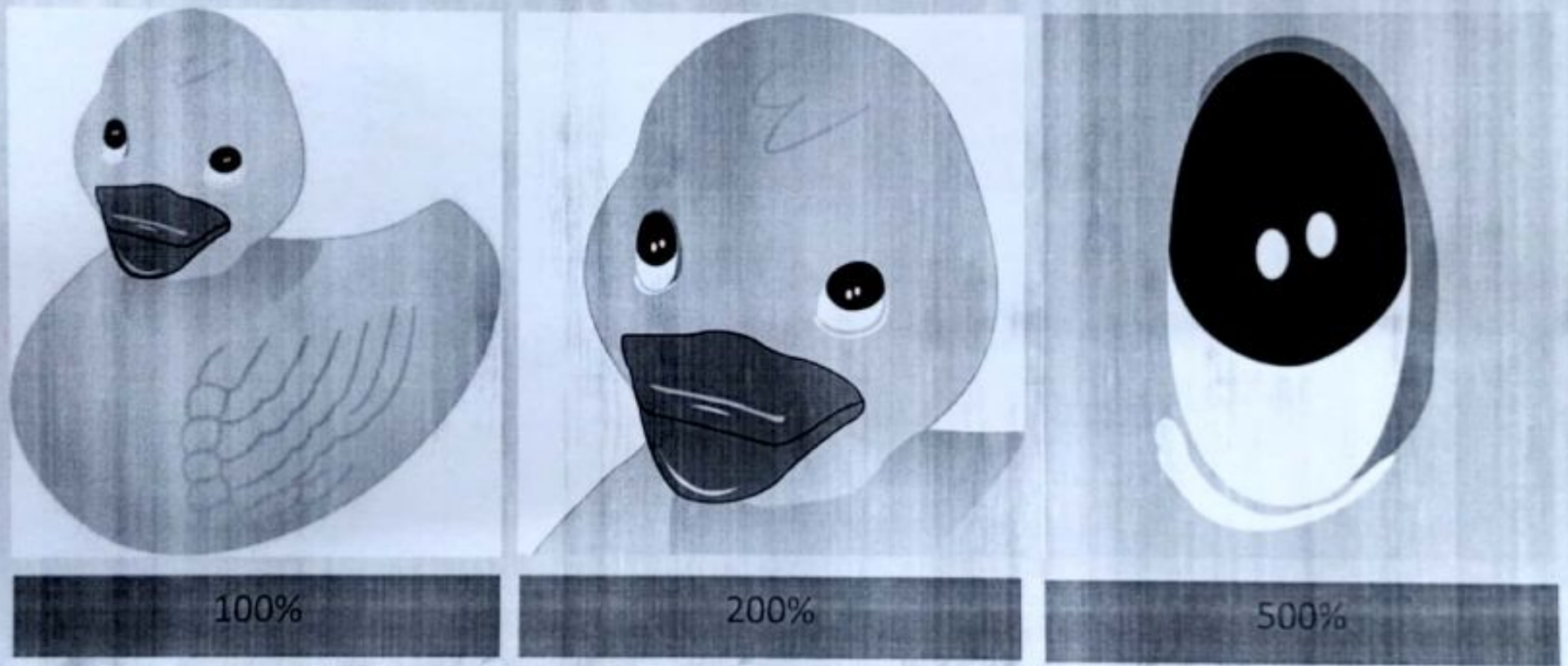
Raster vs Vector Images





Zoom Raster image

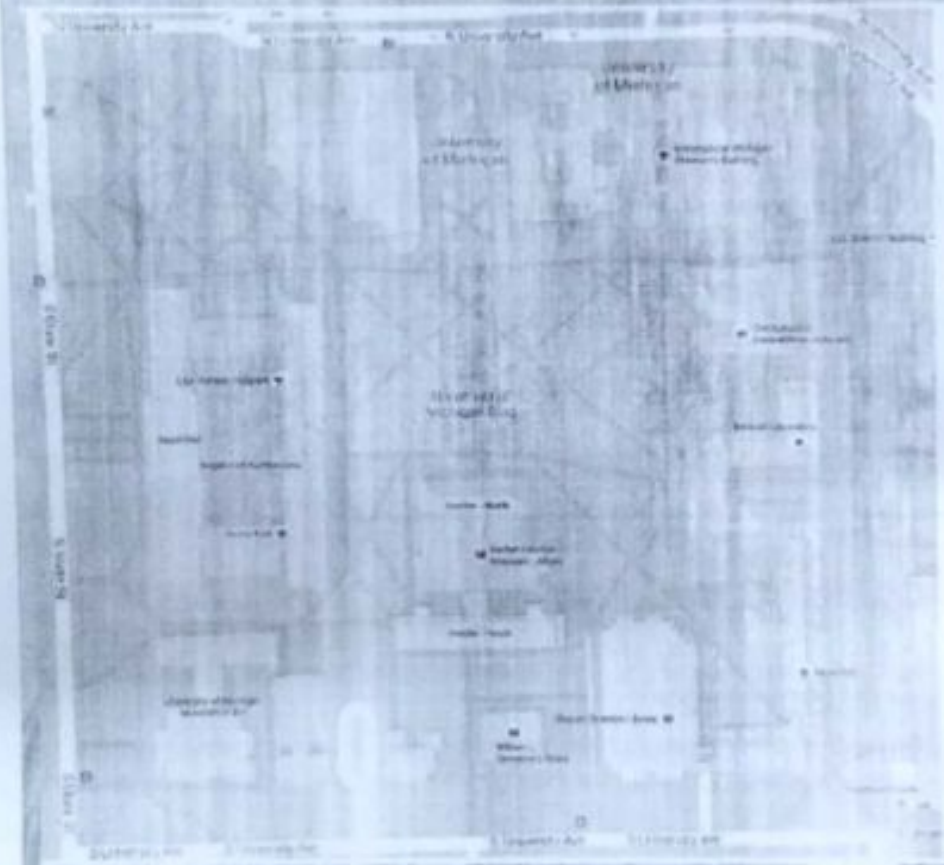
Vector Image



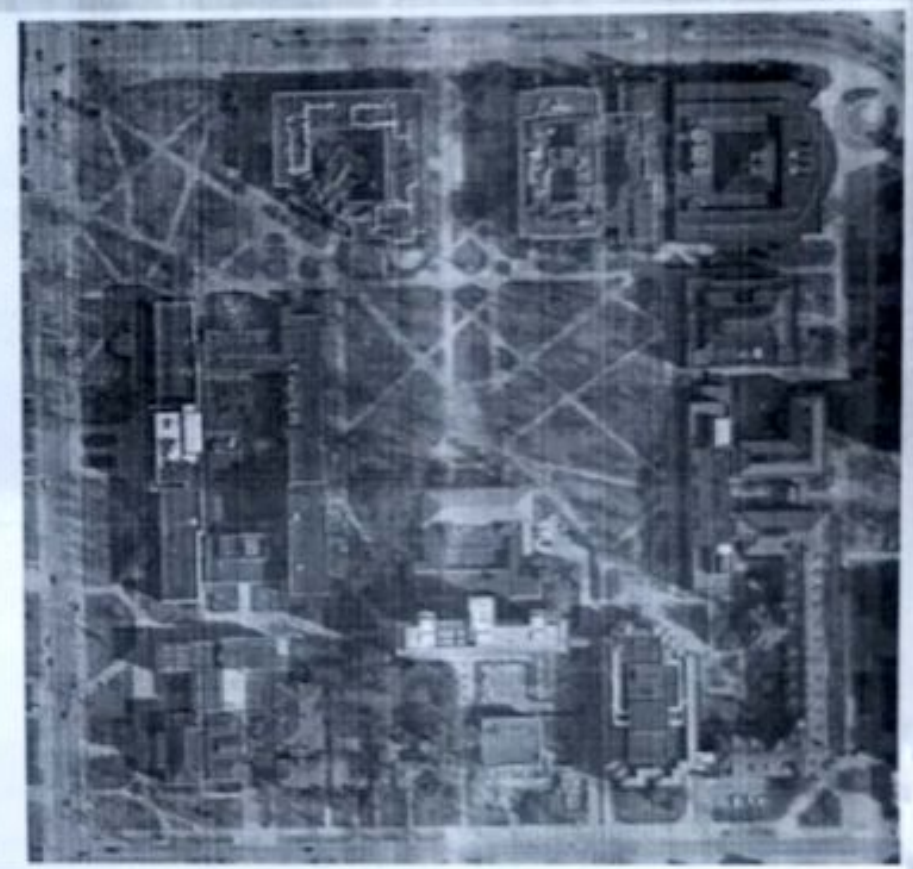
Vector Image

Which one is which one?

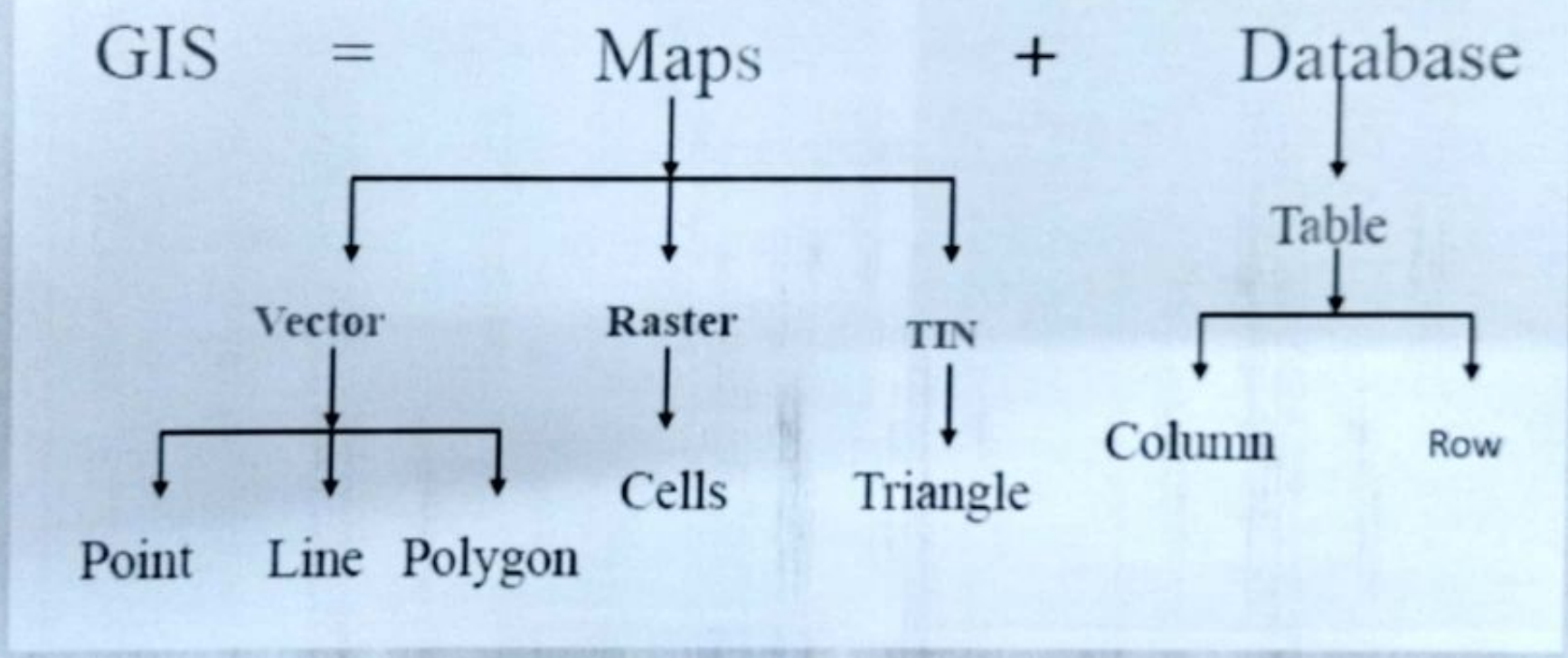
VECTOR



RASTER



GIS DATA MODELS



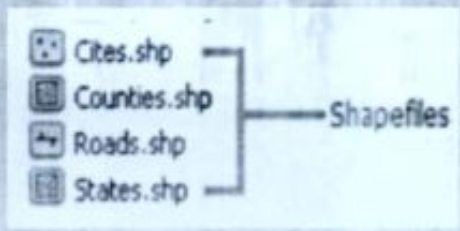
DATA CAPTURE SOURCES

	Raster	Vector
Primary	_ Remote sensing images	- GPS measurement
	_ Aerial photographs	- Survey measurement
Secondary	_ Scanned maps or photographs	- Topographic Maps
	_ DEM from maps	- Toponymy (place name) database

VECTOR DATA STRUCTURES IN ESRI GIS

SHAPEFILE

- A series of files (with extension including .shp, .shx, and .dbf) that make up one vector data layer.
- A shapefile is a format for storing the geometric location and attribute information of geographic features.
- Shapefiles actually consist of a several computer files. The data structure must have at least these three files:
  - shapefilename.shp — This file stores feature geometry
  - shapefilename.shx — This is an index file
  - shapefilename.dbf — This file stores attribute data



Depending on how the data has been processed, there may be additional index files with different extensions, for example:

- shapefilename.sbn — optimizes spatial queries
- shapefilename.sbx — works with .sbnfiles to optimize spatial queries
- shapefilename.prj — coordinate and projection system

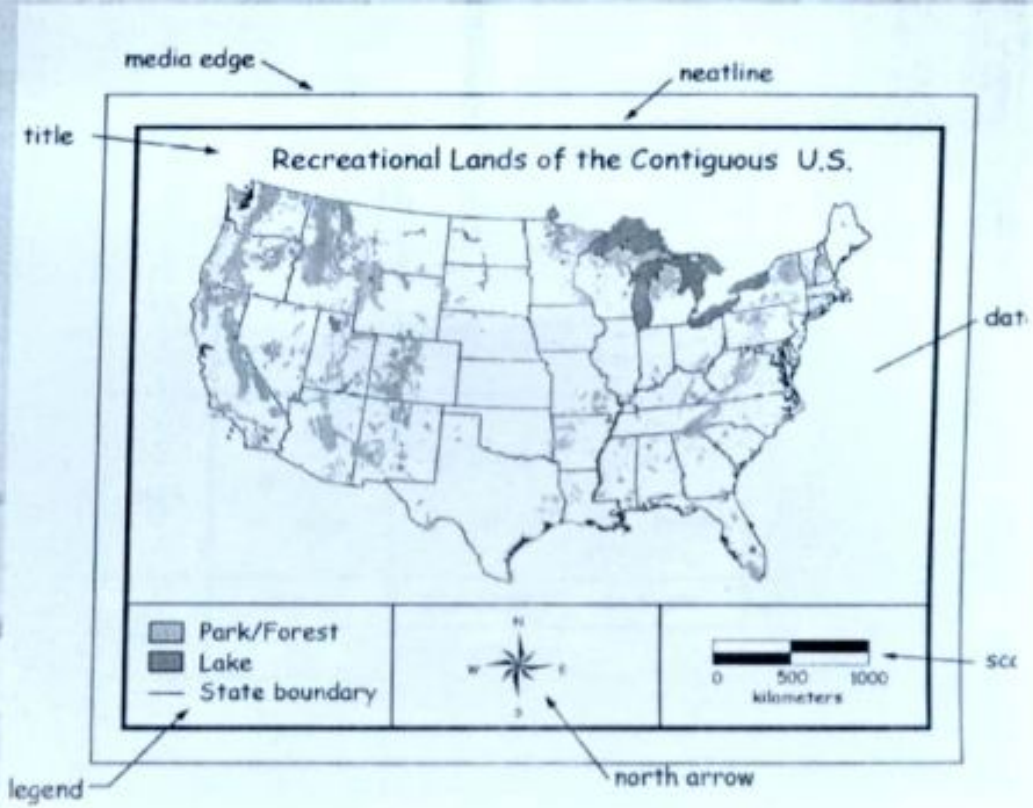
GIS KEY TERMS

MAP Vs LAYOUT

- A map is simply a set of layers with their symbology.
- A page layout (often referred to simply as a layout) is a collection of map elements organized on a virtual page designed for map printing.
- Common map elements include:
  - ❖ one or more map frames
  - ❖ Scale bar,
  - ❖ North arrow,
  - ❖ Map title,
  - ❖ descriptive text,
  - ❖ Legend
  - ❖ Data Source

map = layers + symbology

layout = map + other elements designed for print or export



GIS KEY TERMS

SYMBOLOGY

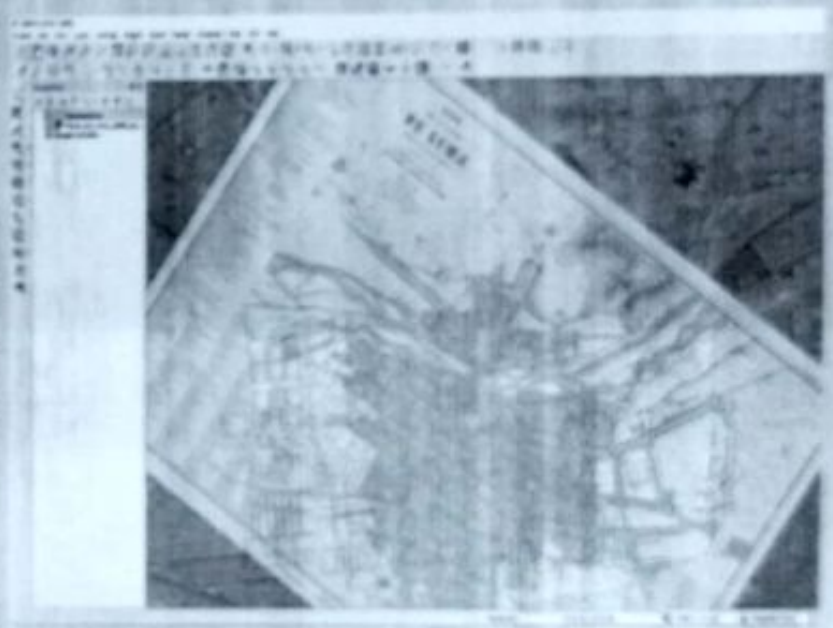
- The use of symbols to represent the features and attributes of a map layer.
- For example, in a layer of cities, red circles might symbolize the cities.
- Symbols are defined by visual properties such as shape, size, color, spacing, and (in 3D) perspective height

Feature Type	Visual Variable		
	Shape	Orientation	Color Hue
Point	Spring House Tower	Live Tree Dead Tree	Live Tree Dead Tree
Line	National Border Trail Section Line	Asphalt Road Concrete Road	National Border State Border
Area	Gravel Sand	Orchard Field Crop	Land Water

GIS KEY TERMS

GEOREFERENCING

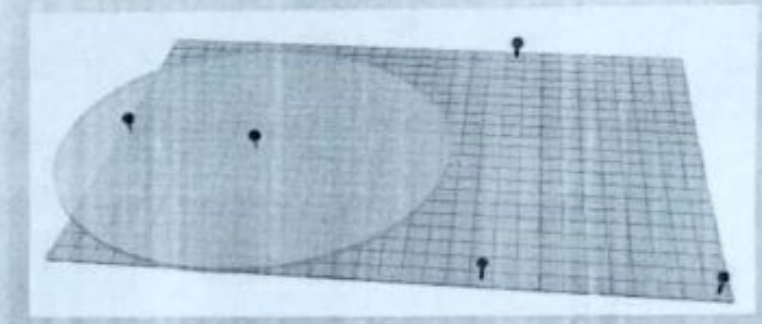
- Scanned maps and historical data usually do not contain spatial reference information.
- In these cases, you will need to use accurate location data to align or georeference your raster data to a map coordinate system.
- Georeferencing means that the internal coordinate system of a digital map or aerial photo can be related to a ground system of geographic coordinates (USGC).
- A georeferenced digital map or image has been tied to a known Earth coordinate system, so users can determine where every point on the map or aerial photo is located on the Earth's surface.



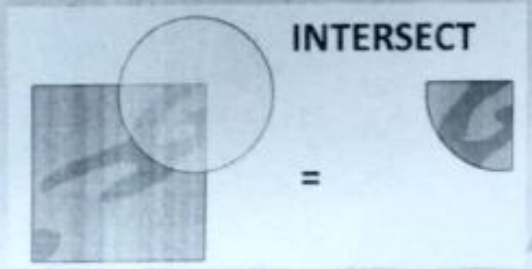
GIS KEY TERMS

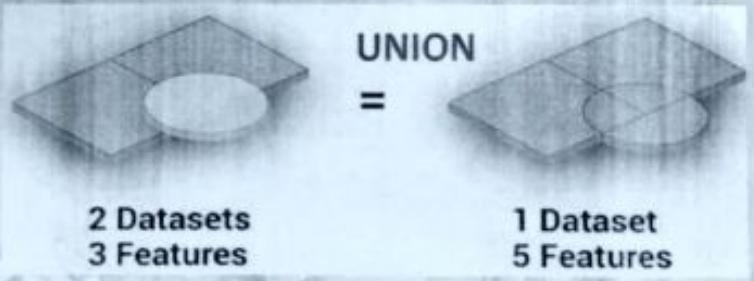
GEOPROCESSING PROCESSES

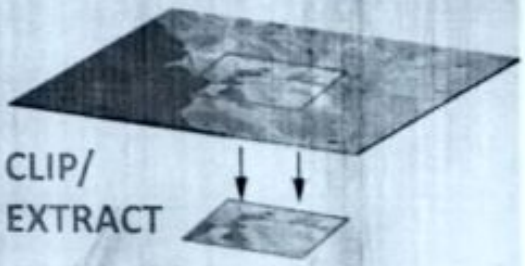
- Any operation or process that modifies data.
- A typical geoprocessing operation takes an input dataset, performs an operation on that dataset, and returns the result of the operation as an output dataset, also referred to as derived data.



MERGE

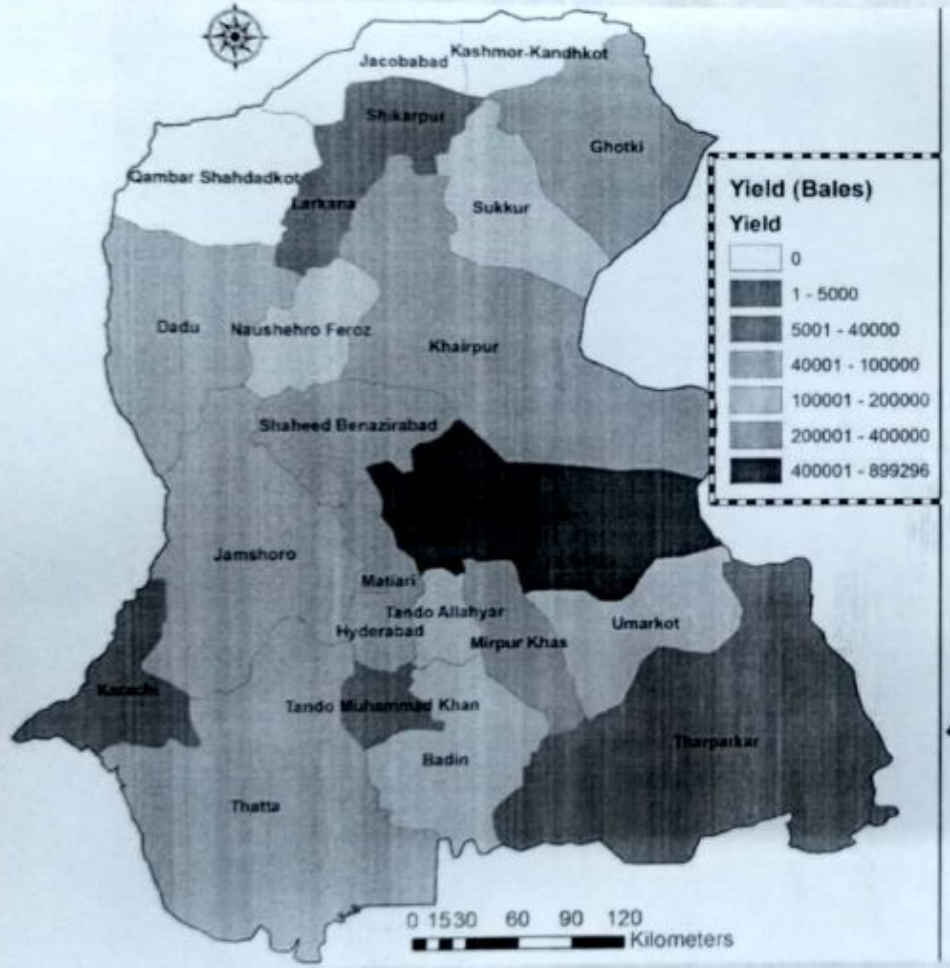


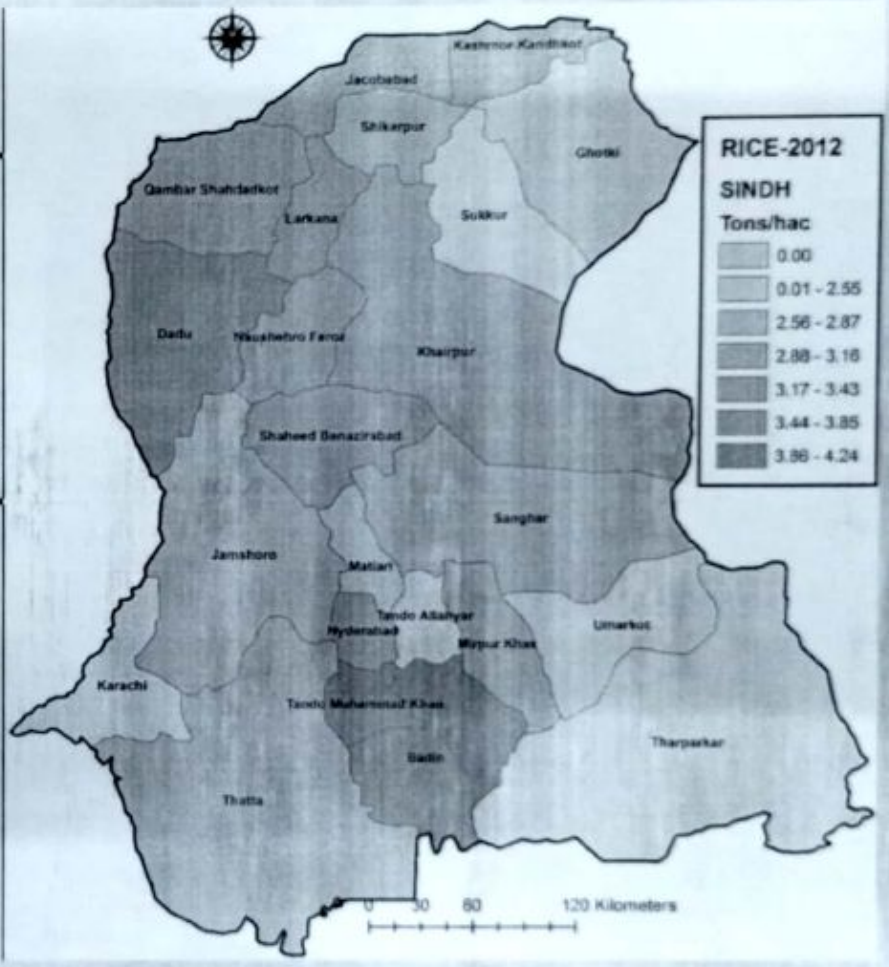




ADVANTAGES OF GIS

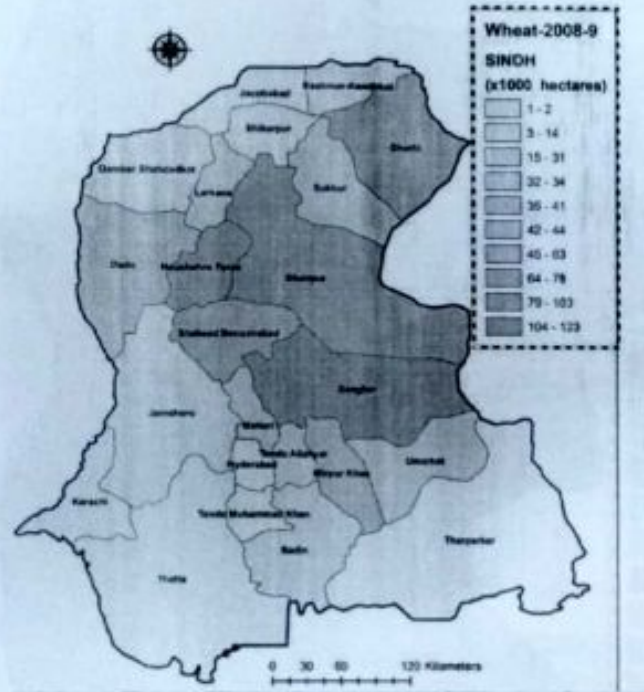
- ✓ Improved decision making
- ✓ Cost savings resulting from greater efficiency.
- ✓ Improved communication.
- ✓ Better geographic information recordkeeping.
- ✓ Managing geographically.



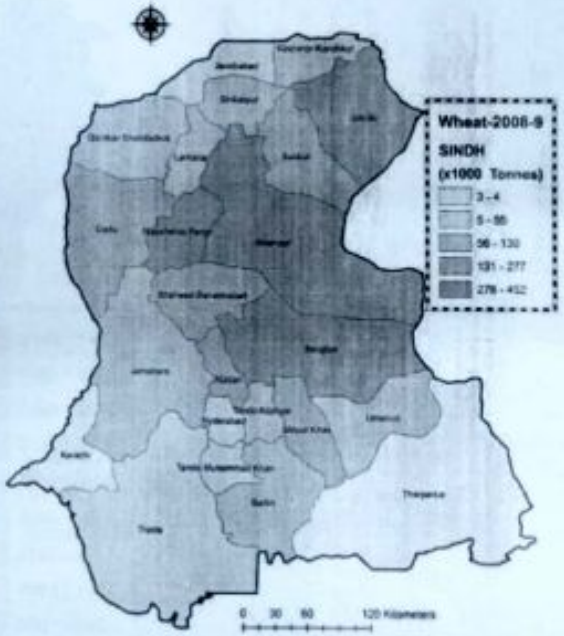


WHEAT IN SINDH 2008-9

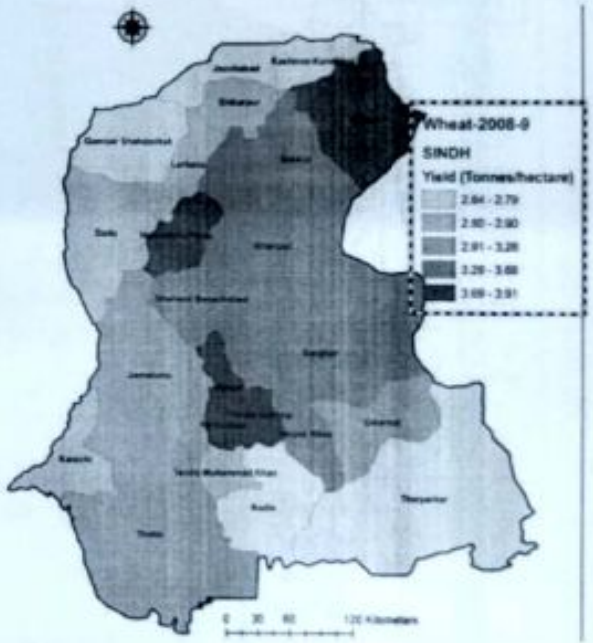
Area (x1000 ha) under cultivation

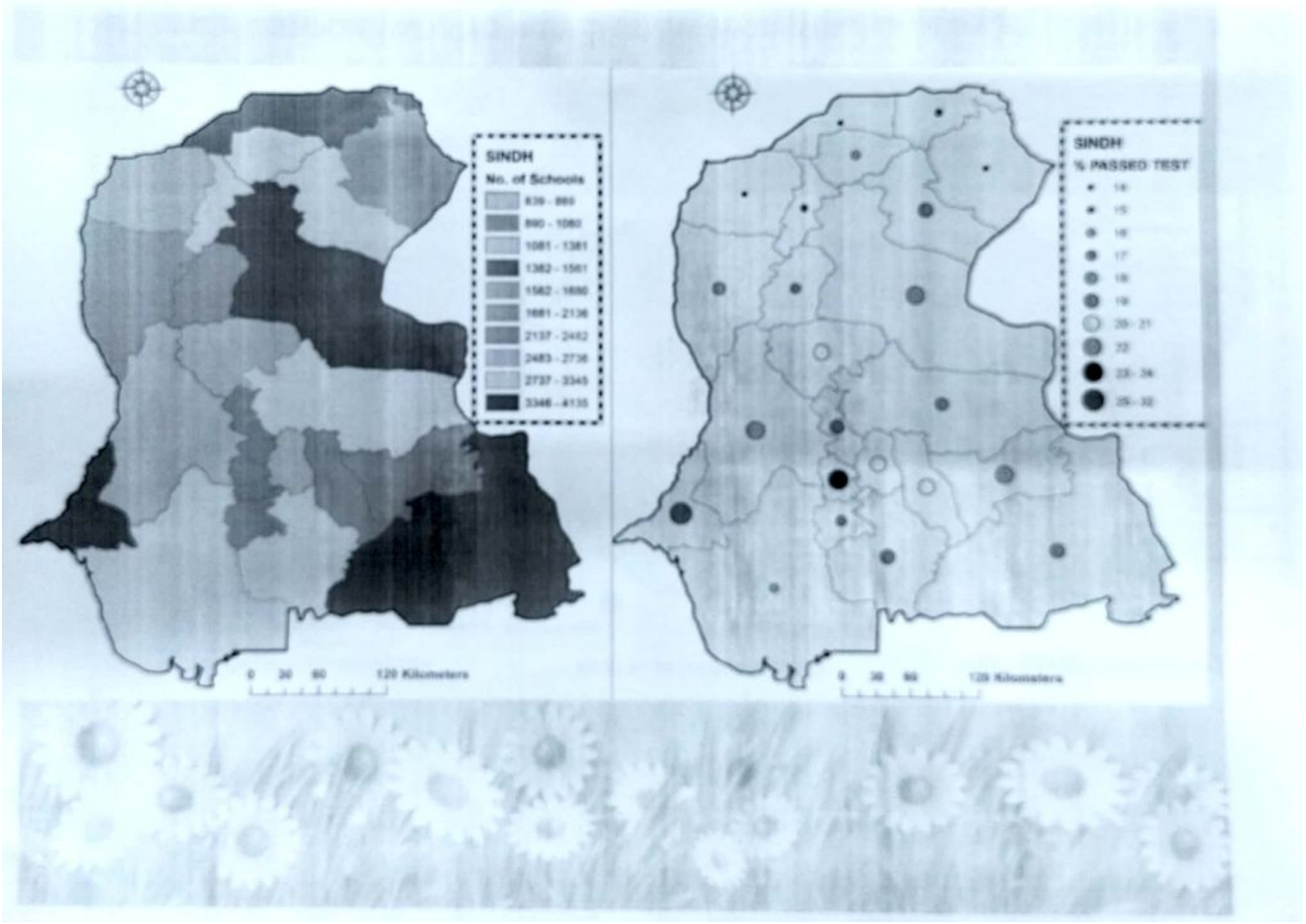


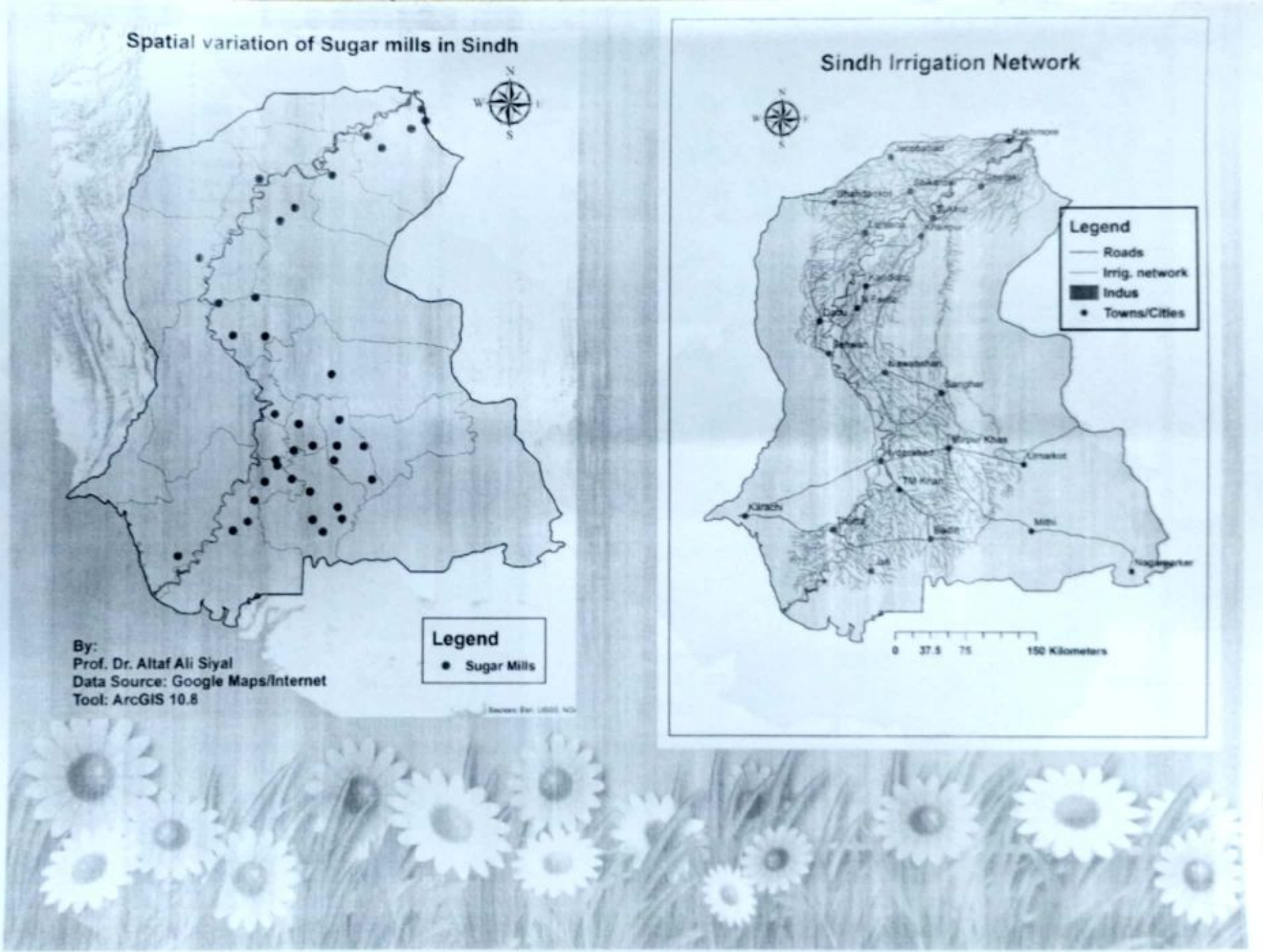
Total Yield (x1000 Tonnes)

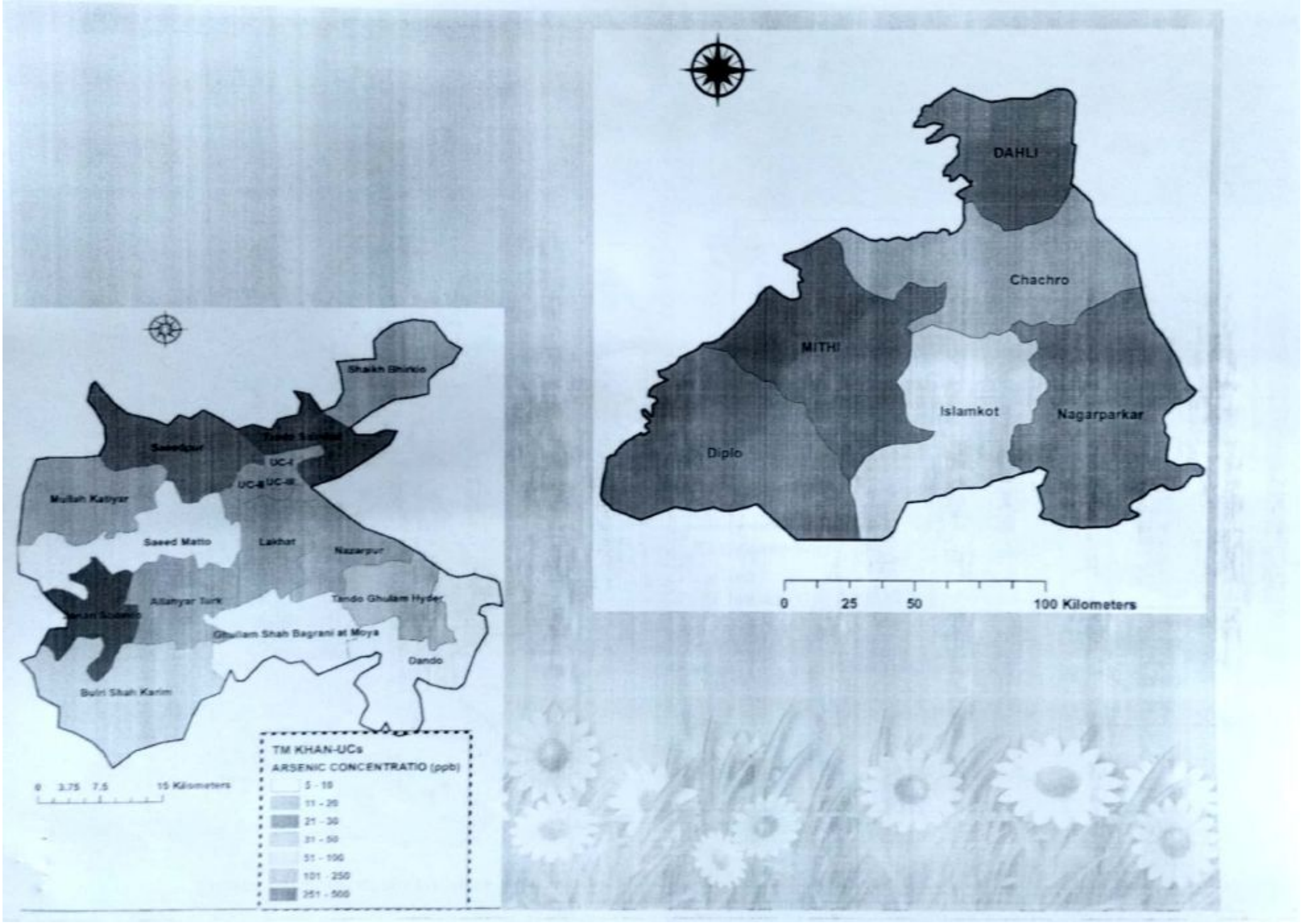


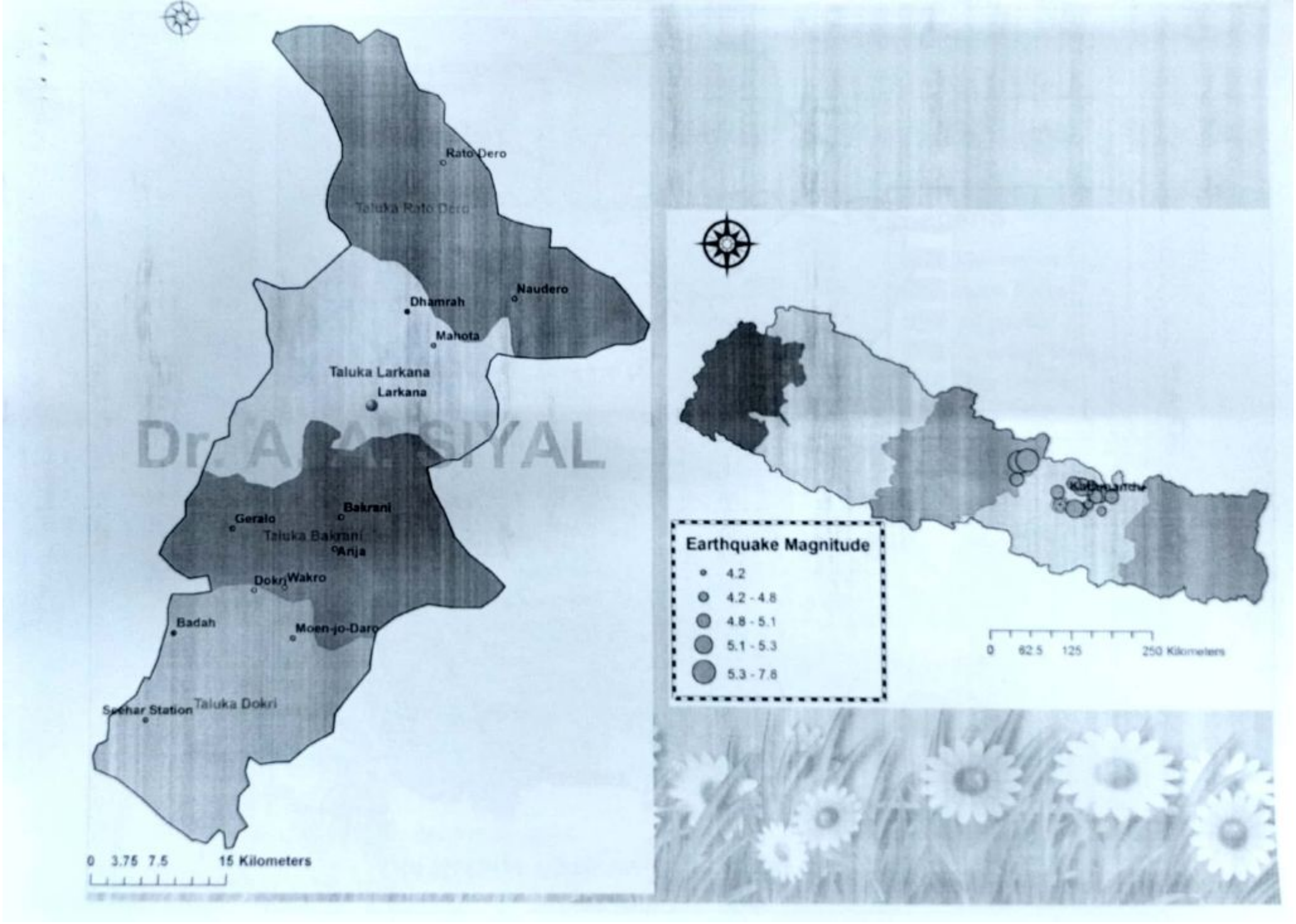
Yield (Tonnes per hectare)

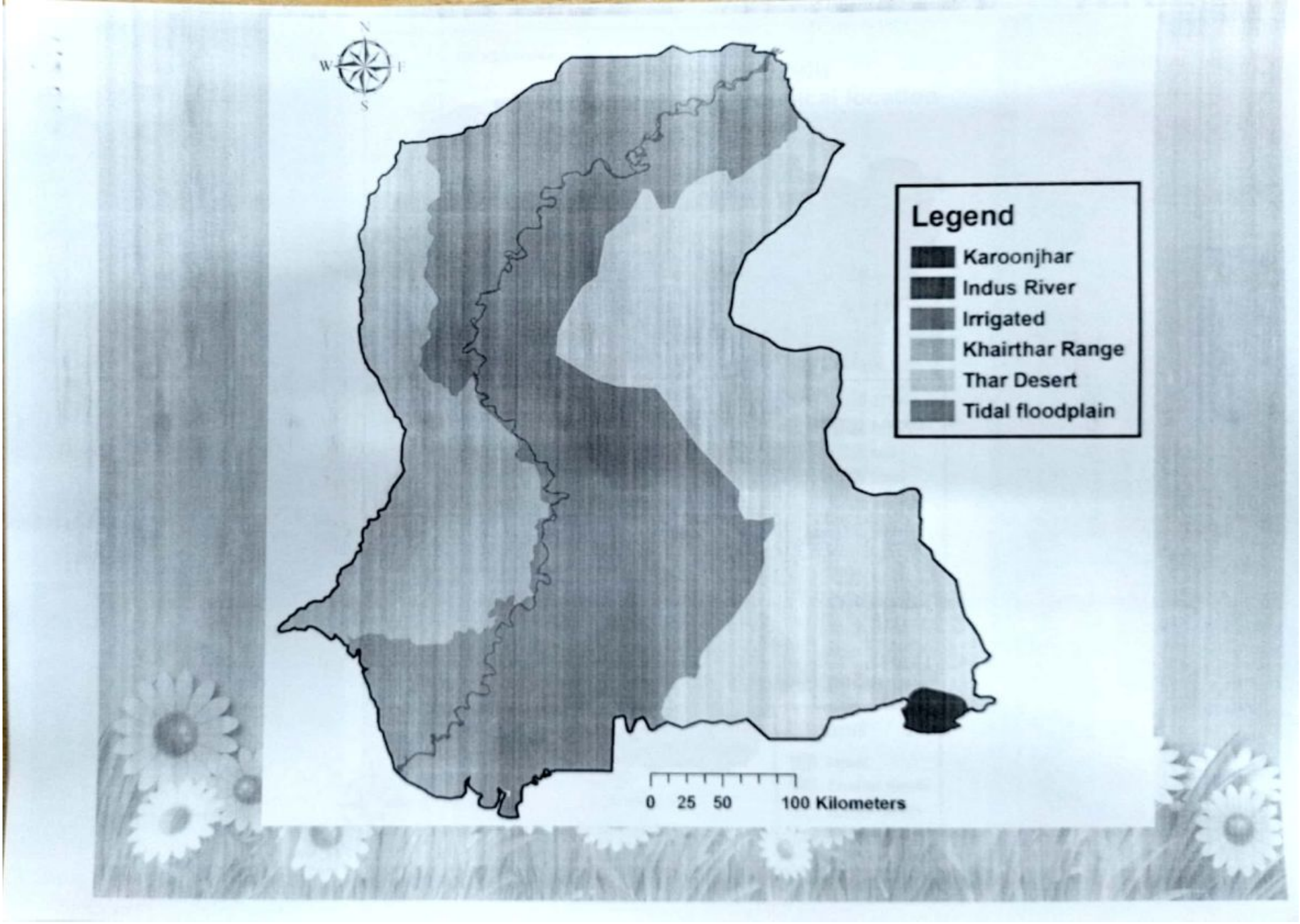




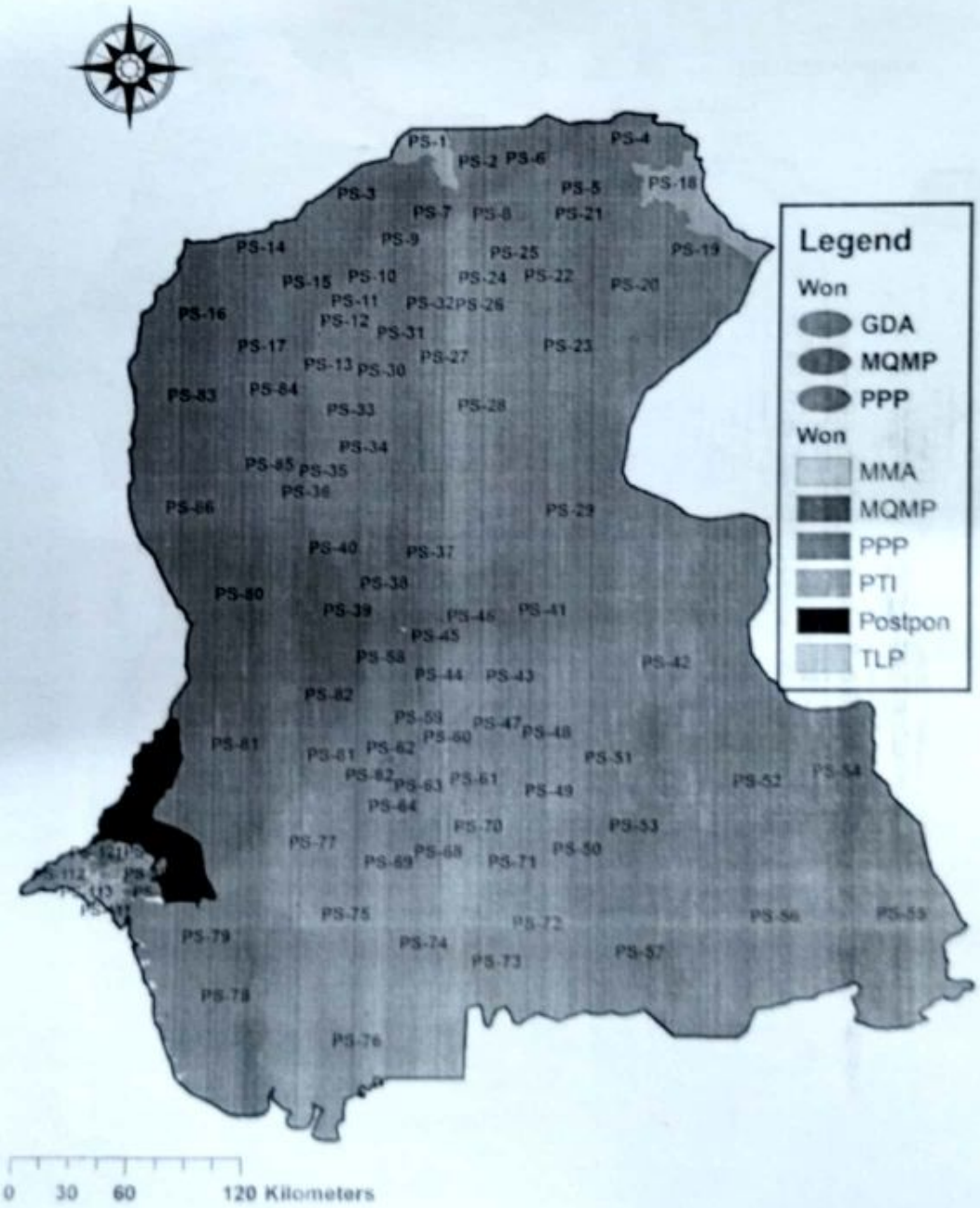


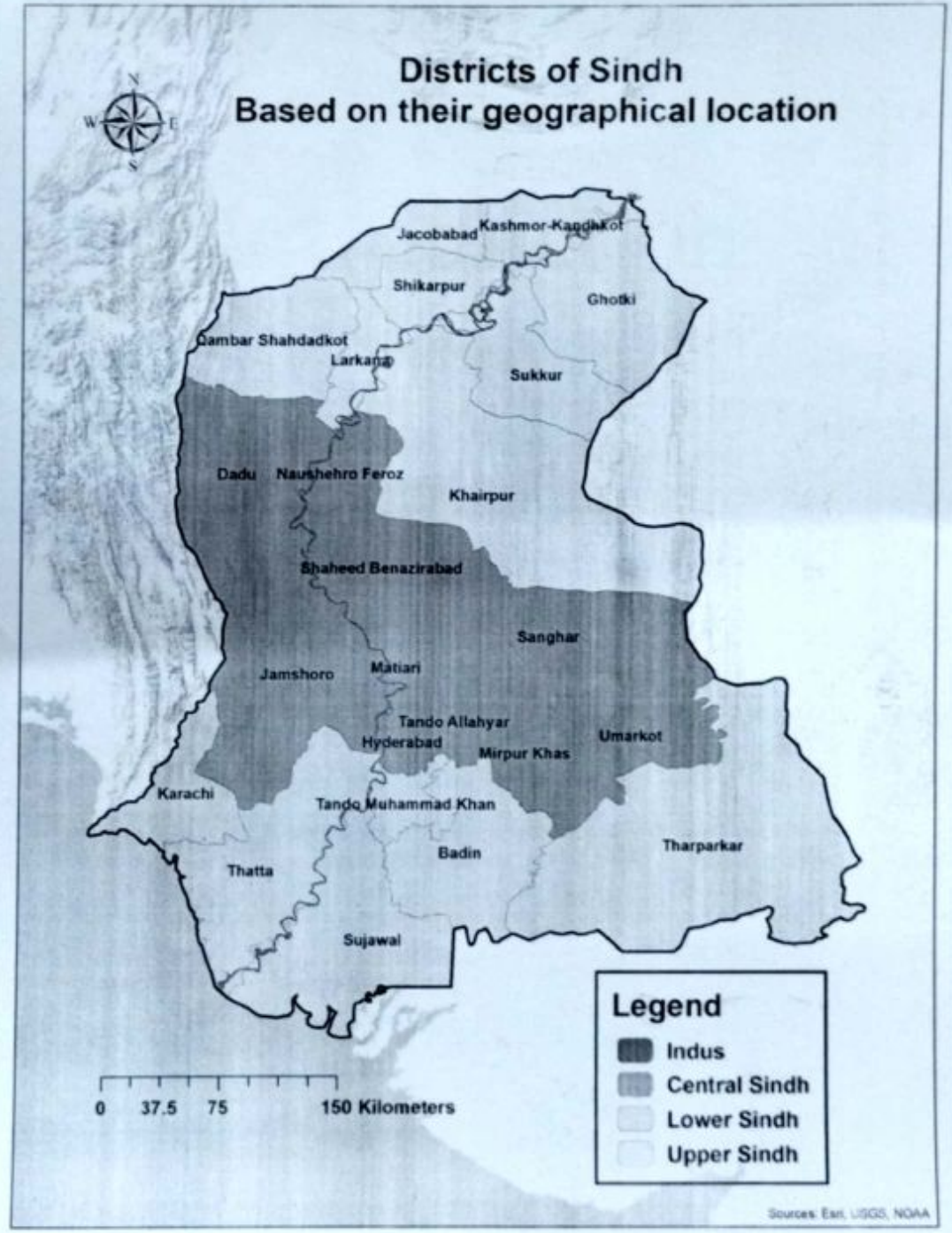


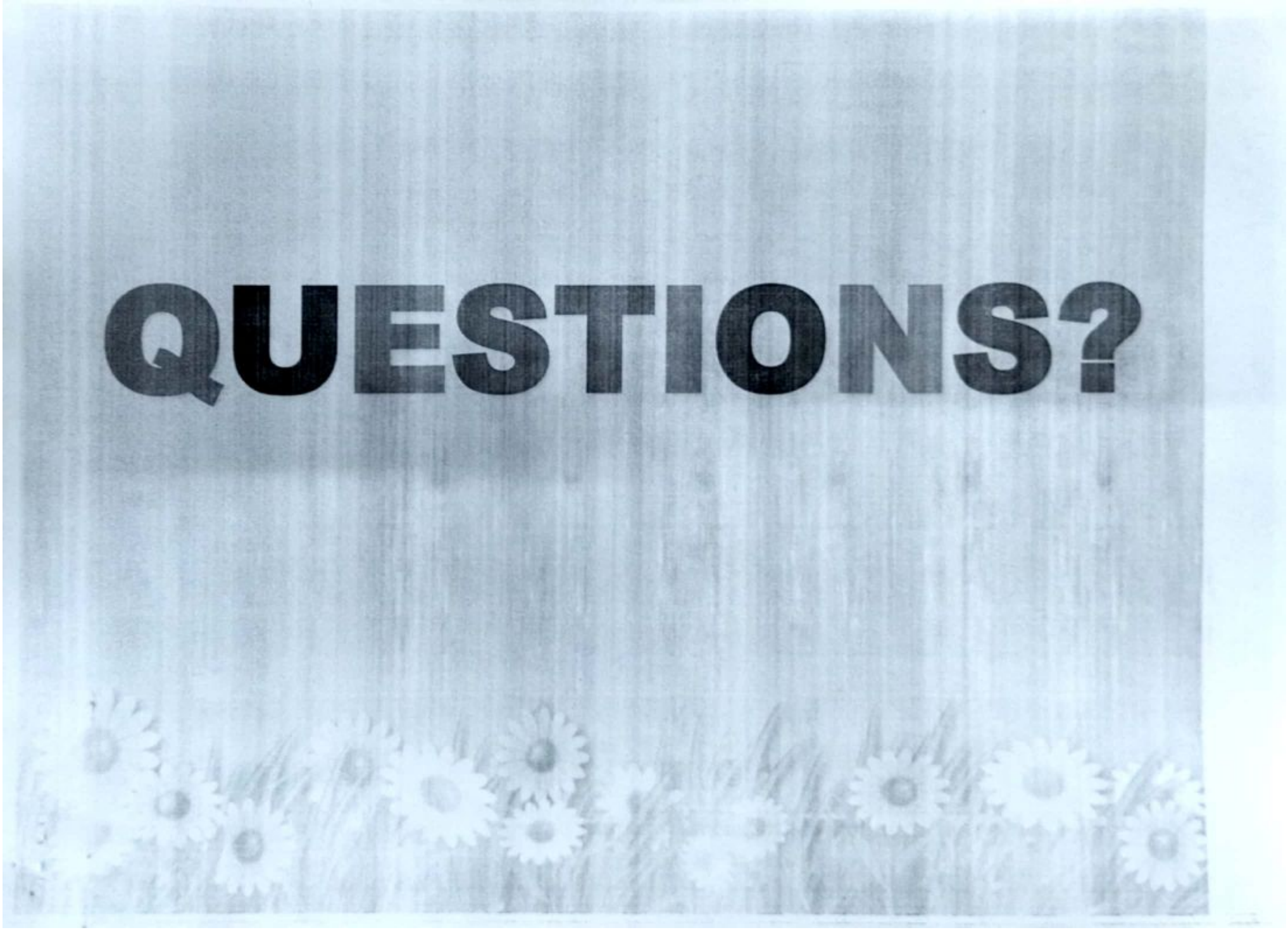




Election 2018: Sindh Assembly Results







Introduction to ArcMap

Prof. Dr. Altaf Siyal

ArcMap

ArcMap is a Map-centric GUI tool used to perform map-based tasks

- Mapping
  - Create maps by working geographically and interactively
- Display and present
  - Export or print
  - Publish on WWW
- Edit
  - Update data
  - Modify features
- Query
- Chart
- Reporting
  - Embed maps in reports

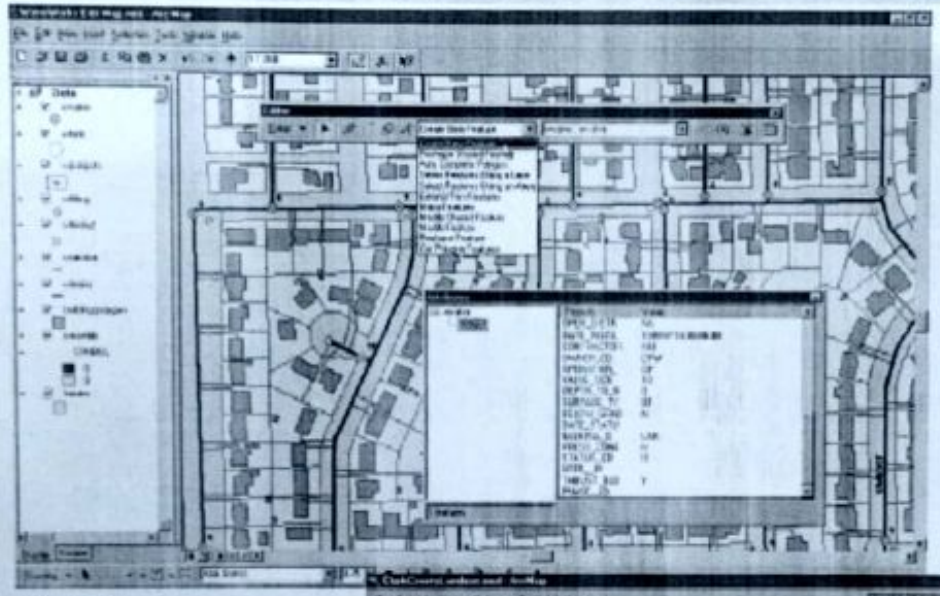
ArcMap

ArcMap is a Map-centric GUI tool used to perform map-based tasks

- Analyze
  - Visualize information
    - See patterns
    - Reveal hidden trends
    - Show relationships between features
  - Solve problems
    - Where is
    - How close
    - How much
    - What if
- Develop custom mapping applications based on ArcMap components

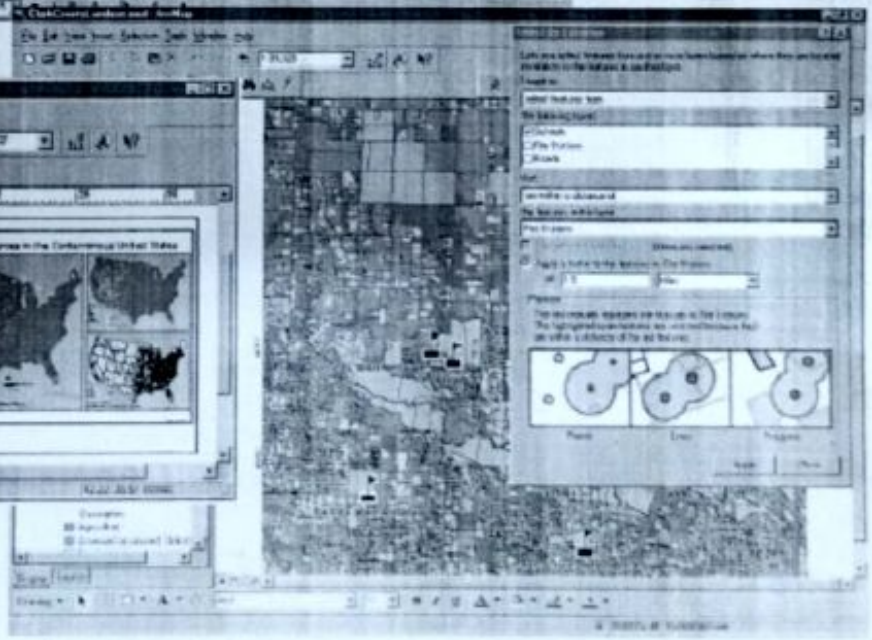
ArcMap

View and edit data

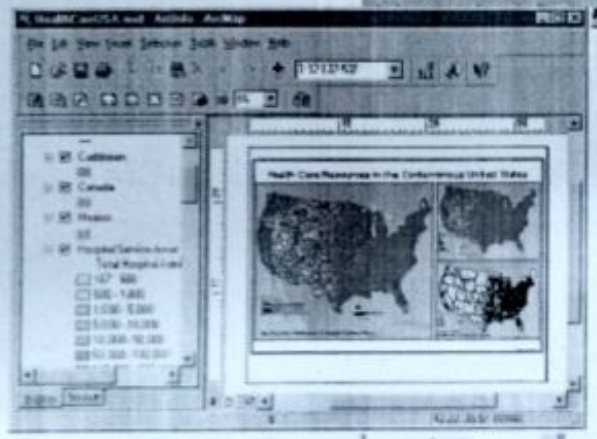


Edit data.

Analyze data (Geoprocessing)



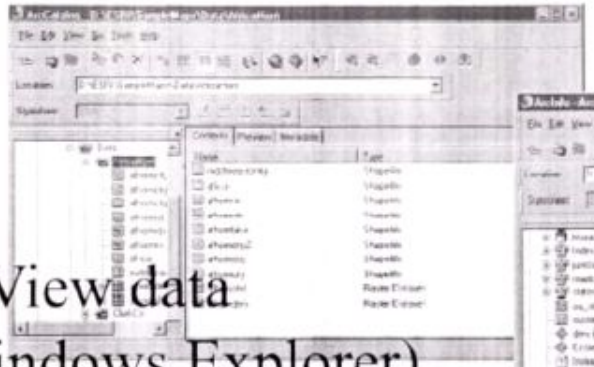
Analyze data.



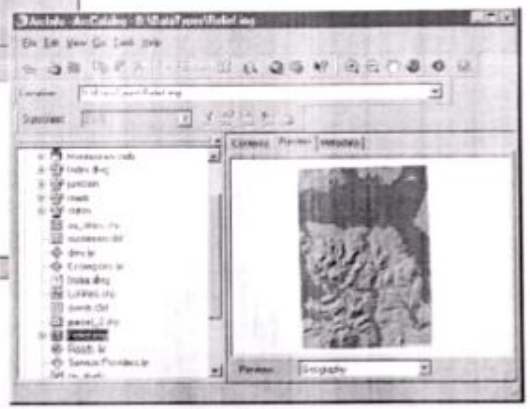
Design and create publication-quality maps.

Create maps

Arc Catalog



View data
(like Windows Explorer)



Graphical previews

Preview geographic information.

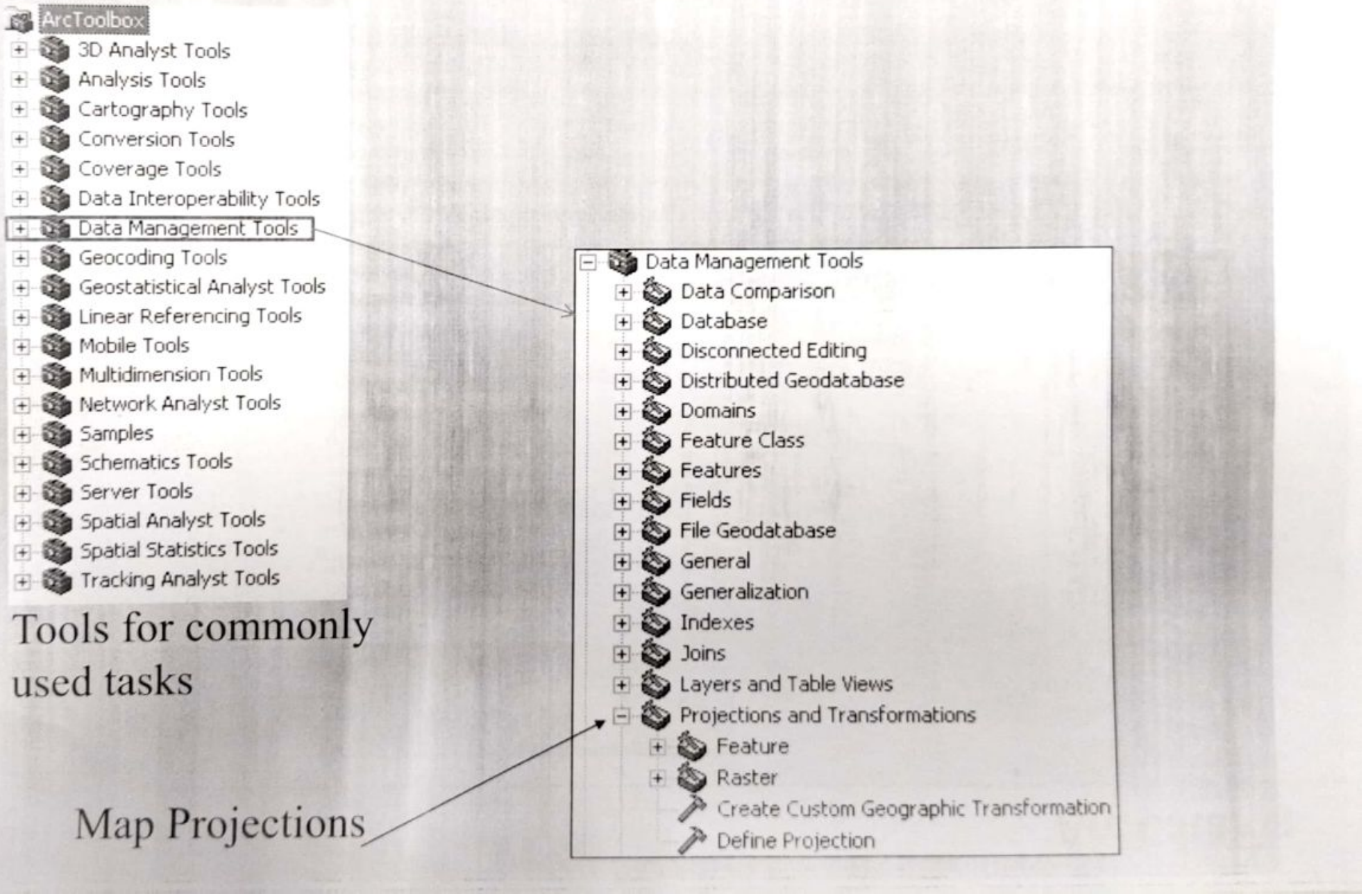
View and edit metadata.

Metadata

Tables

Work with tables.

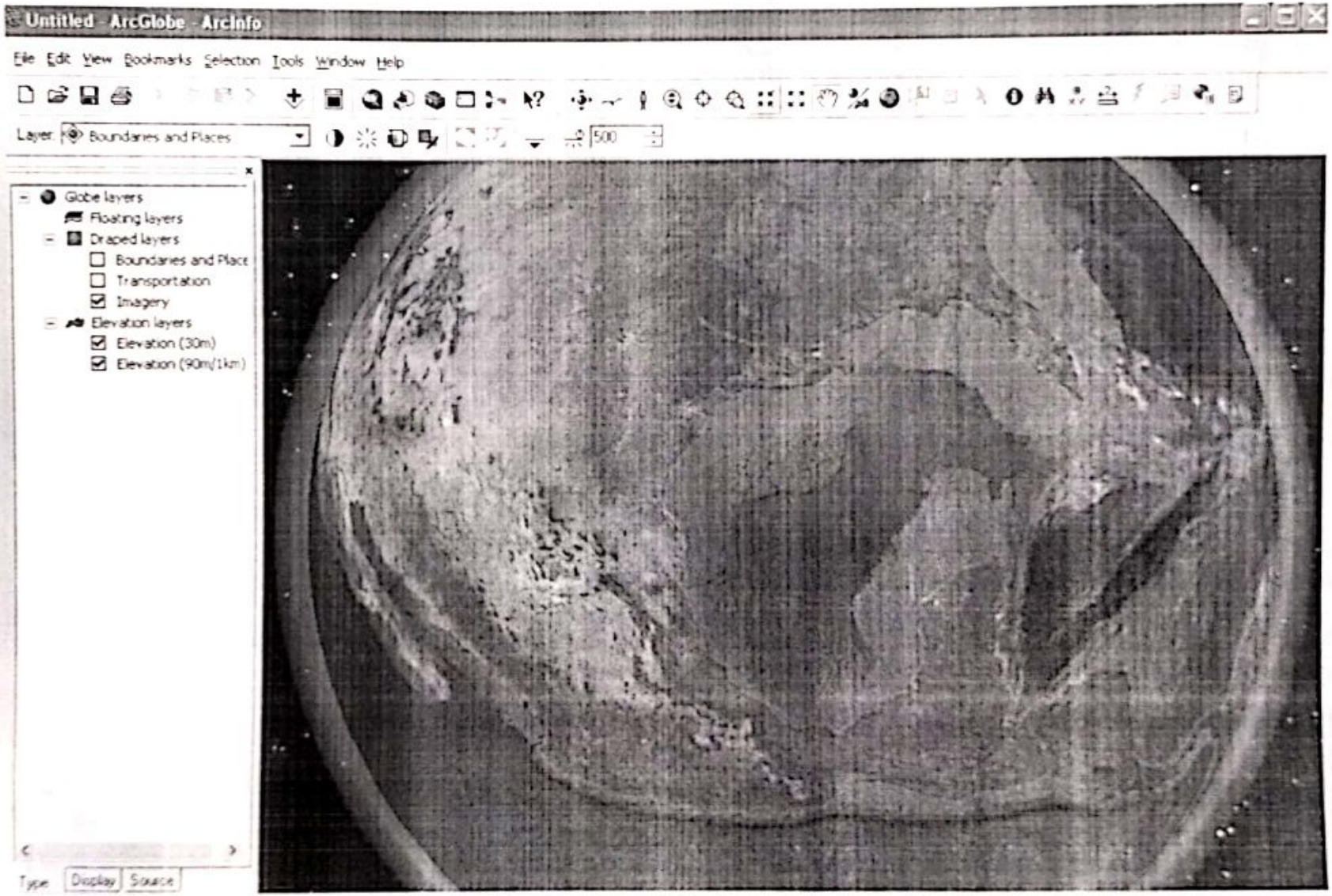
Arc Toolbox

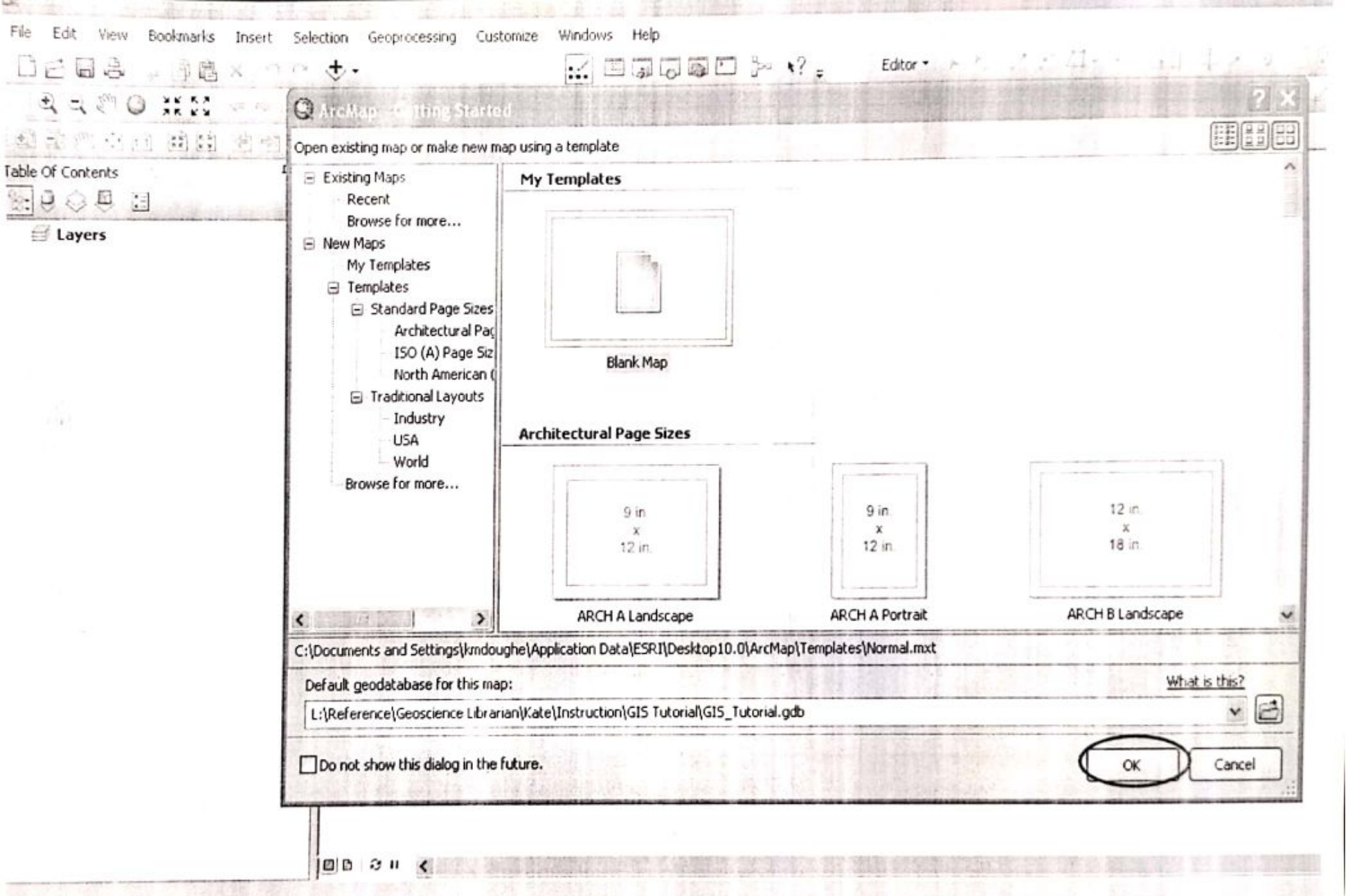


Arc Globe

- An alternative display to ArcMap
- Design to rapidly display image files and to zoom in rapidly from a global view to a local view
- Works on a spherical earth (not spheroidal)

Arc Globe





Terminology

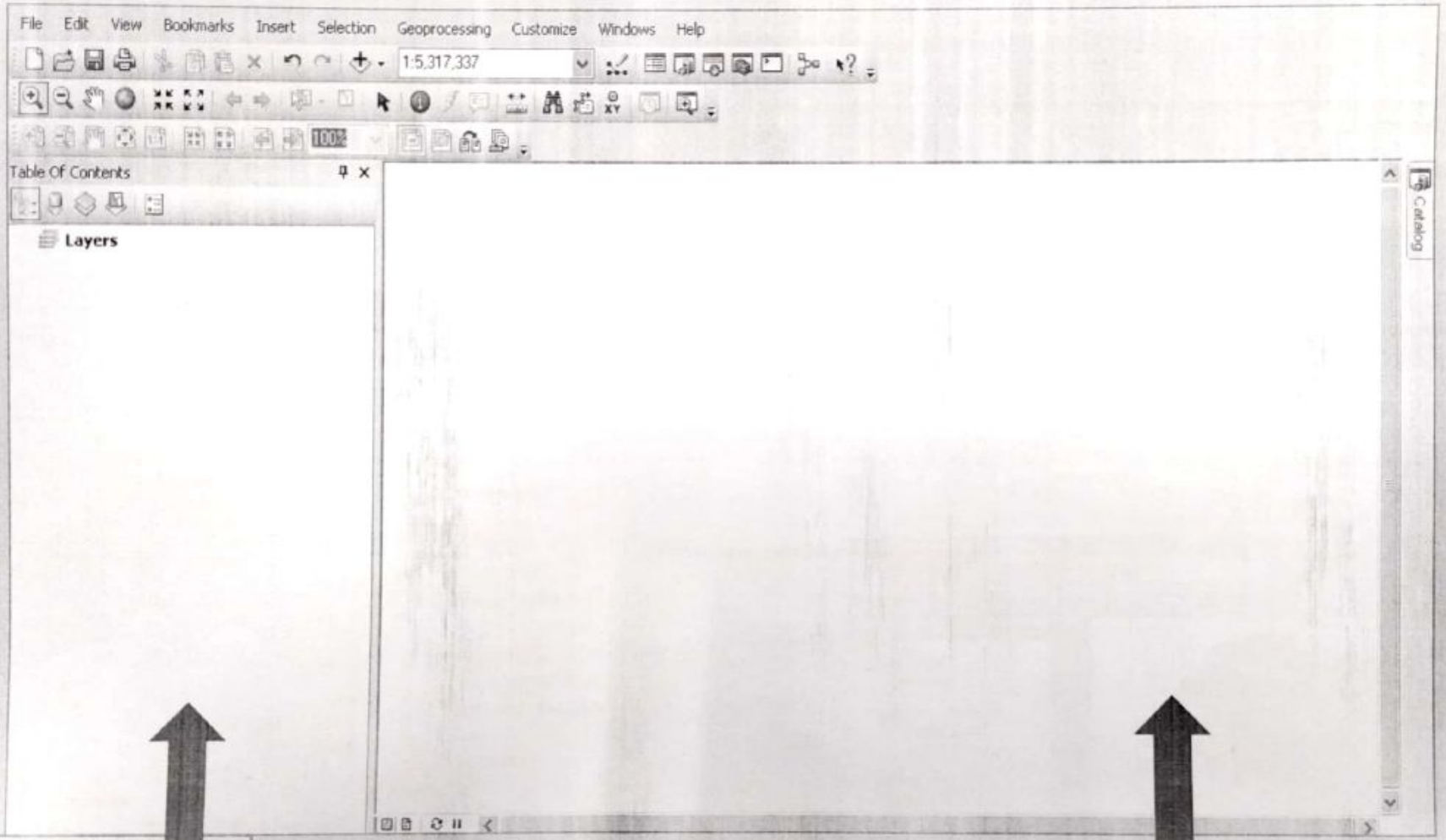


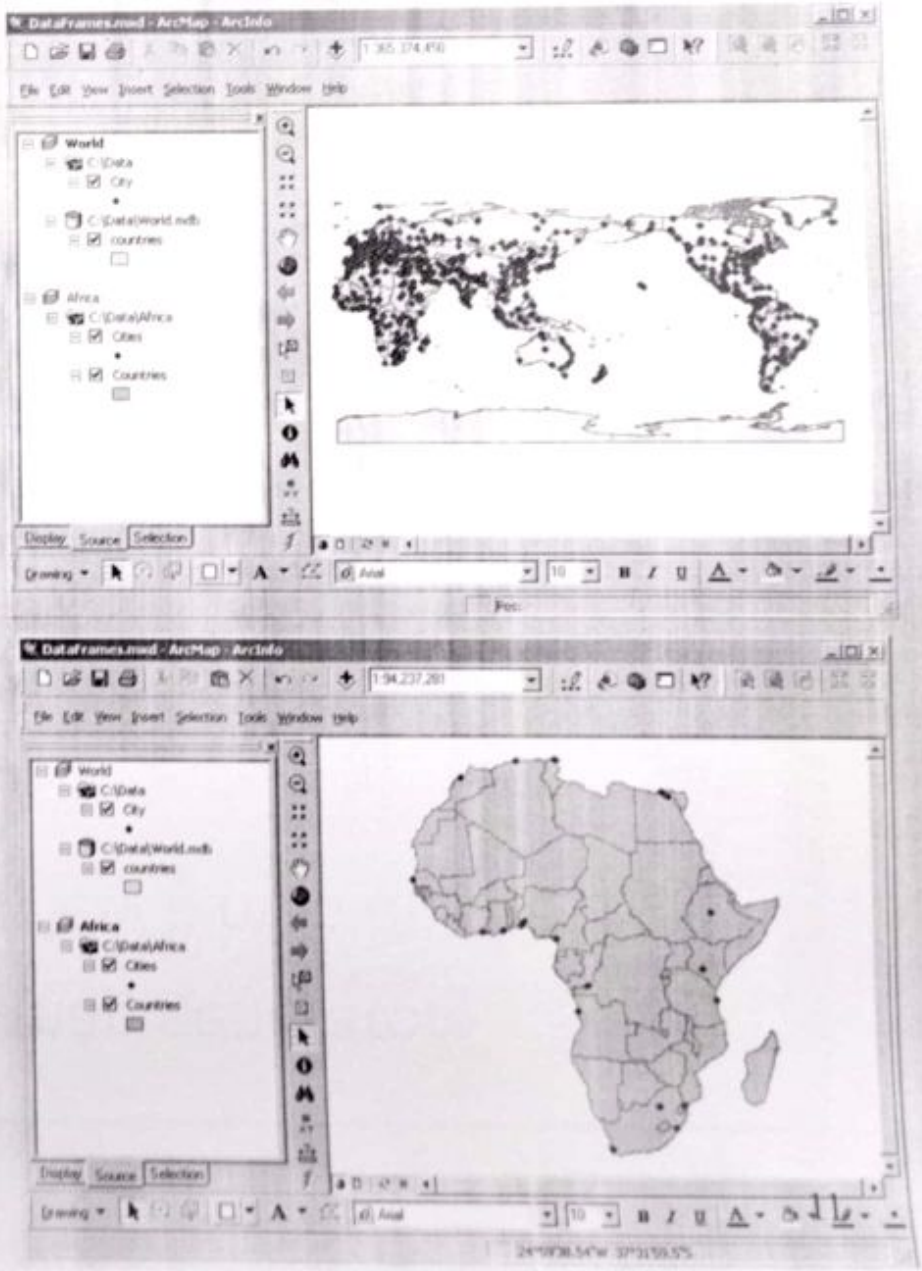
Table of contents that shows the doc's layers.

The "data frame" that displays the spatial data.

Terminology

- Data Frame
- Contains layers of map data
- Can have multiple data frames
- Each data frame has properties

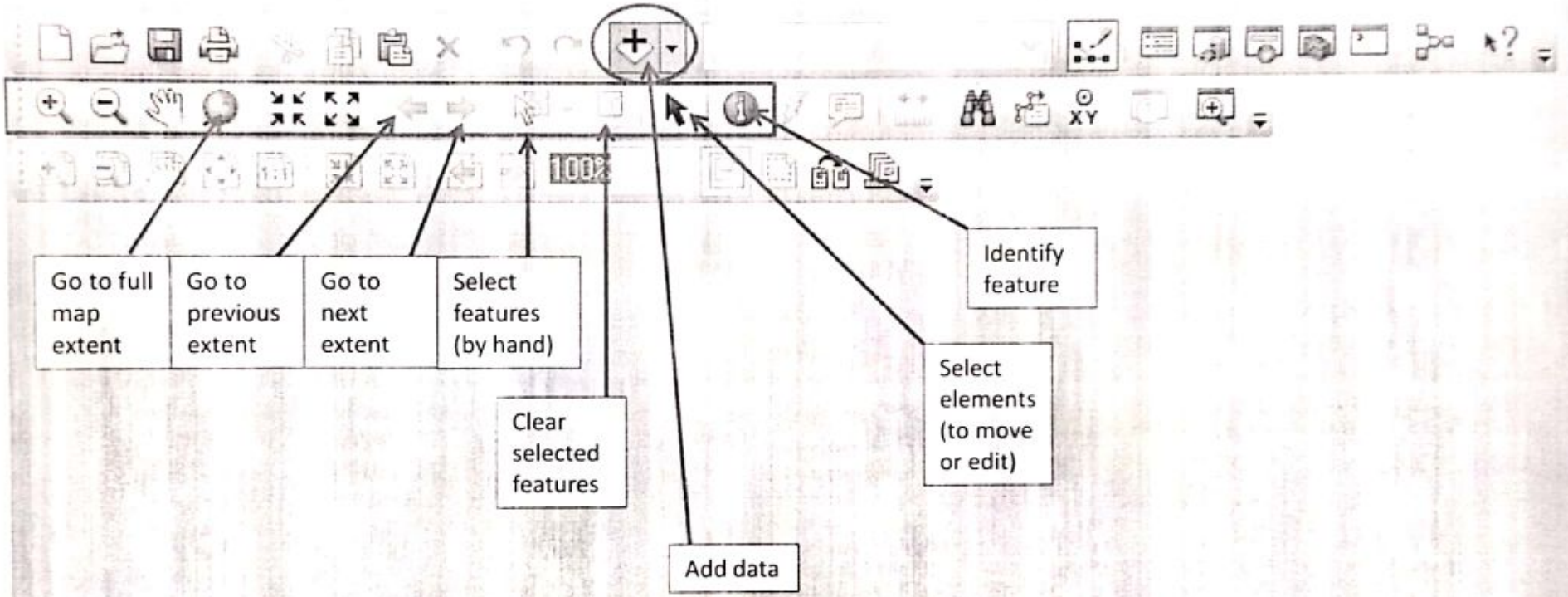
- Data View
- Default view where you do your mapping, analysis, etc.
- Can only see one data frame at a time
- Right-click/Activate or click/Alt



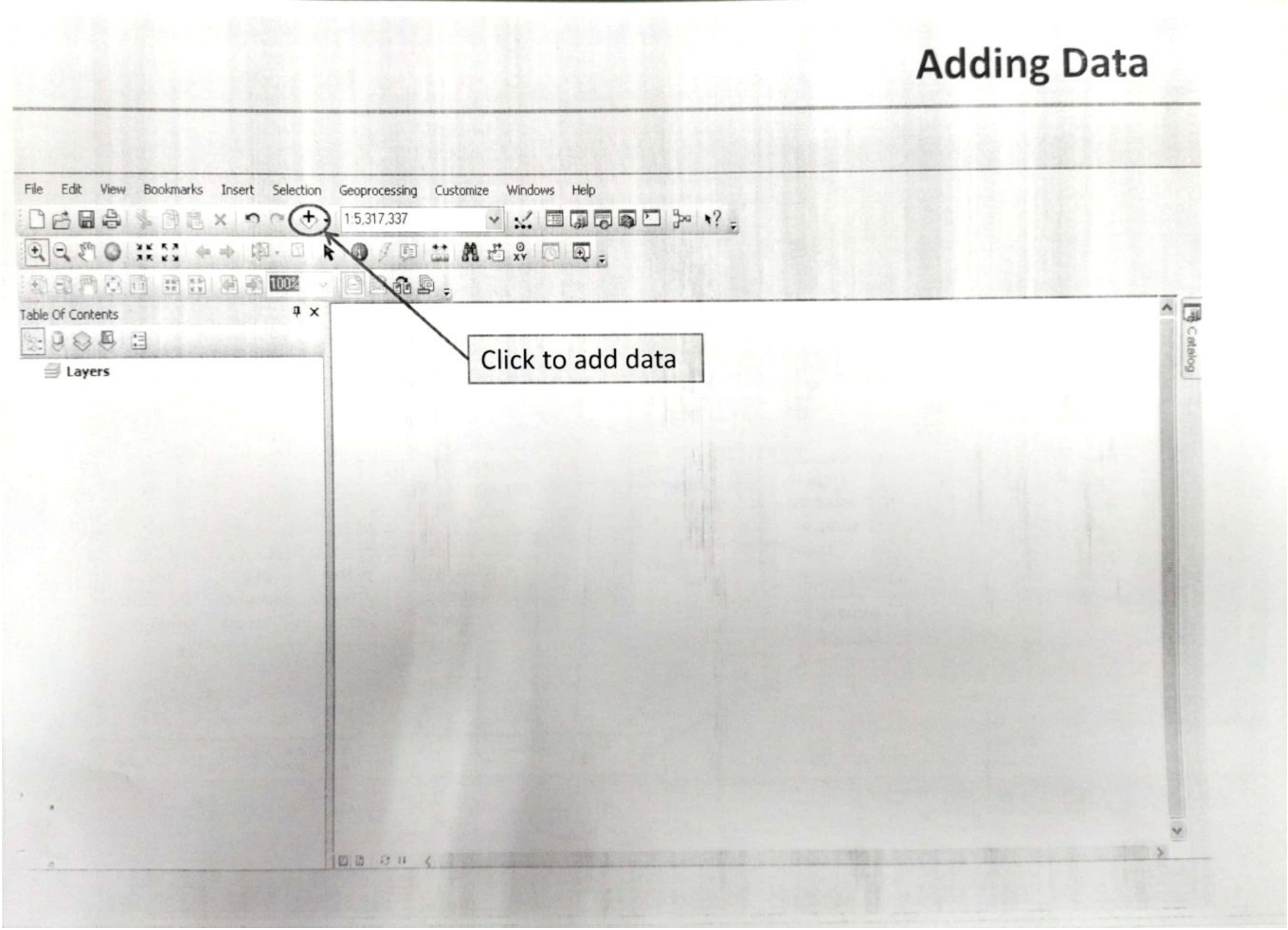
ArcMap

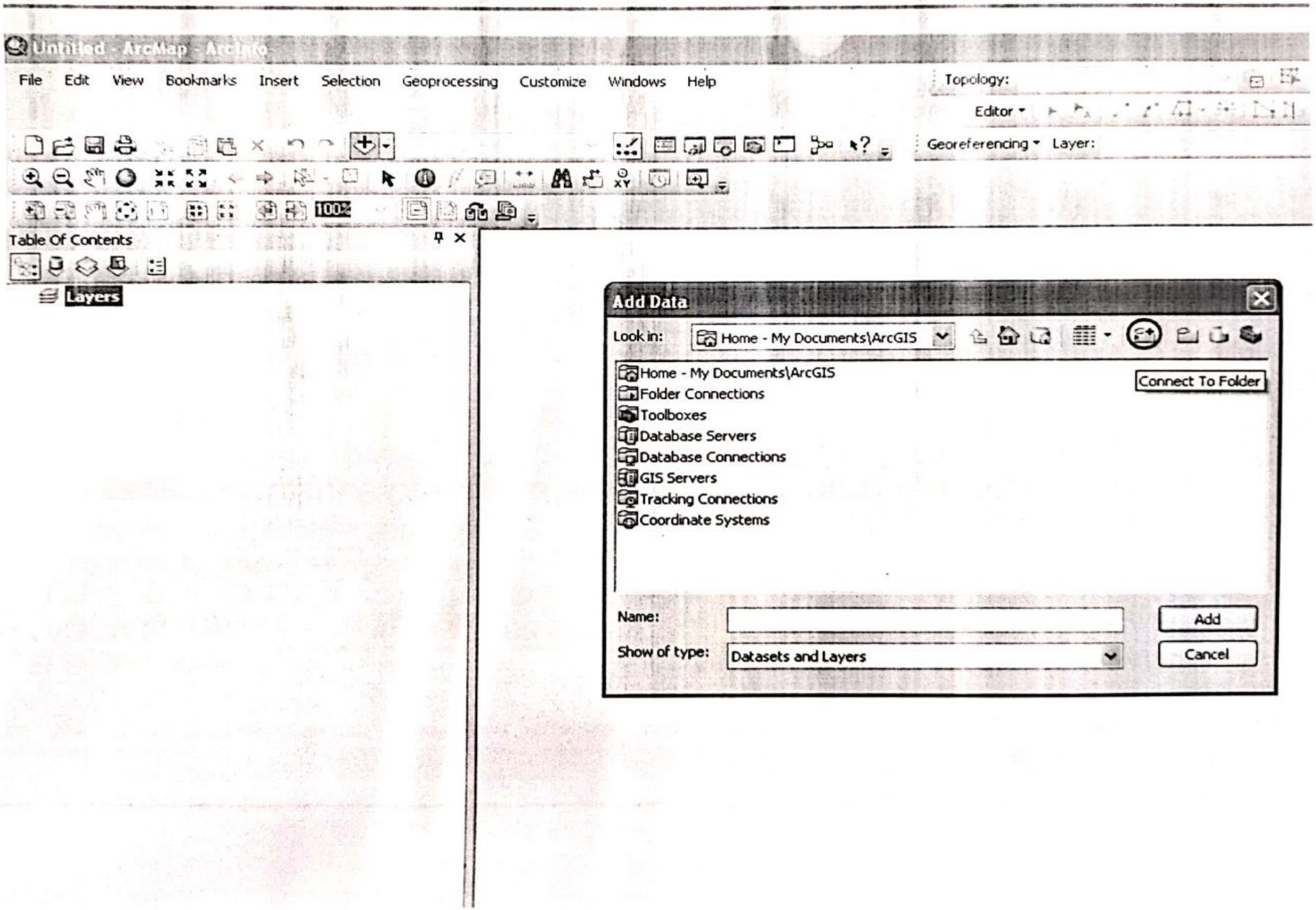
- Is both a data editor as well as map generator
- Provides two different ways to view a map on the fly
  - Data view
  - Layout view

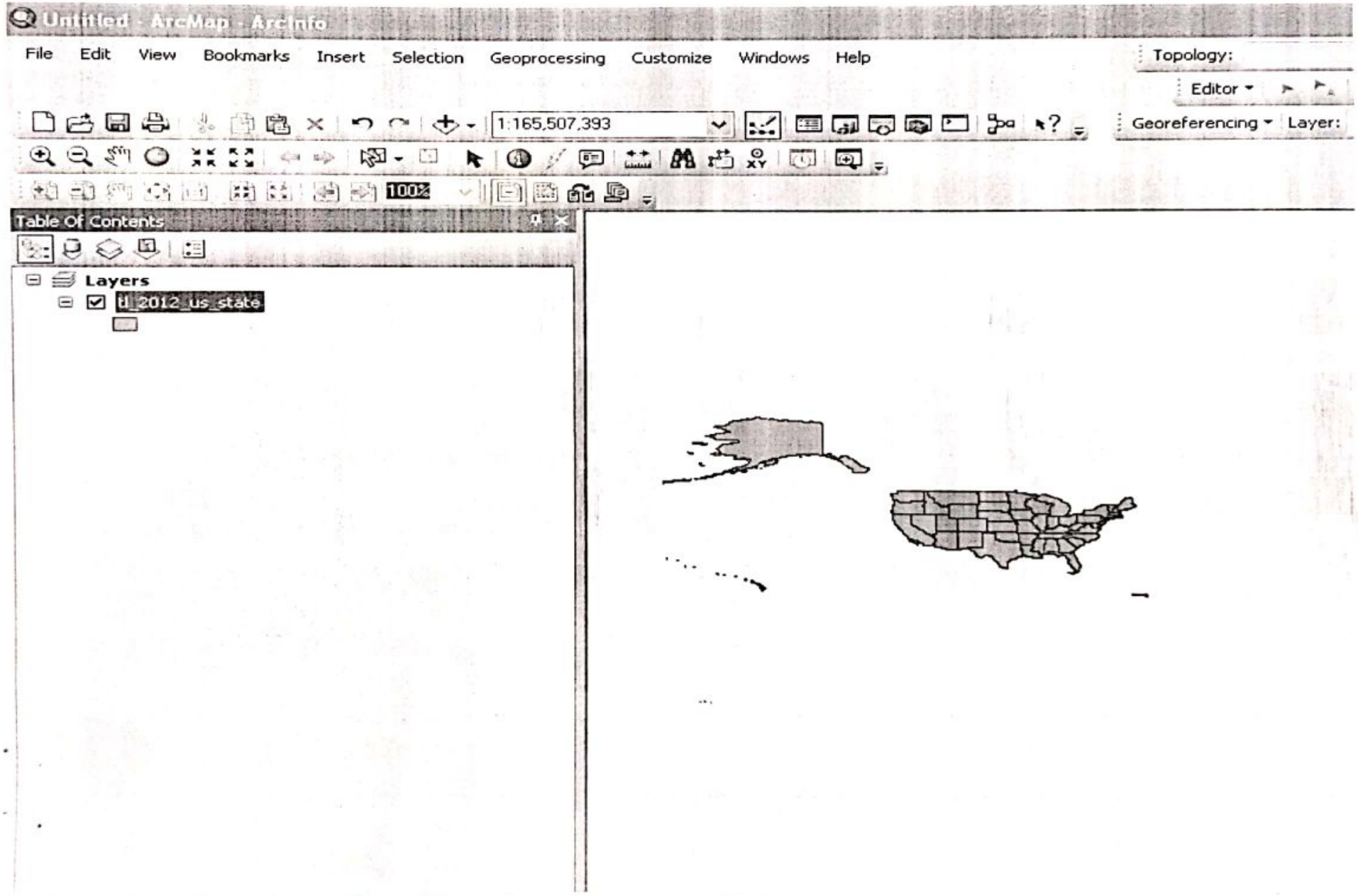
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help



Adding Data



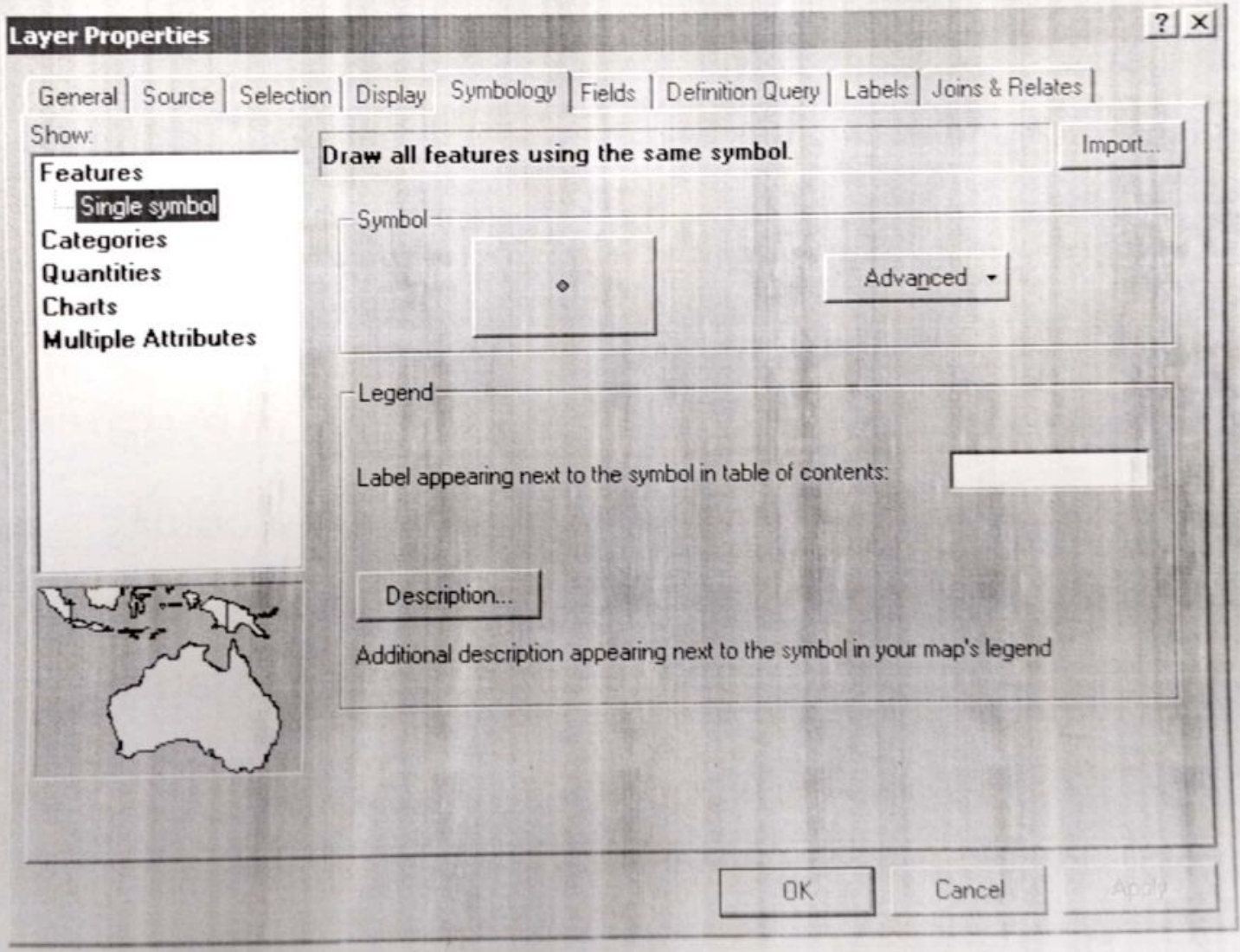


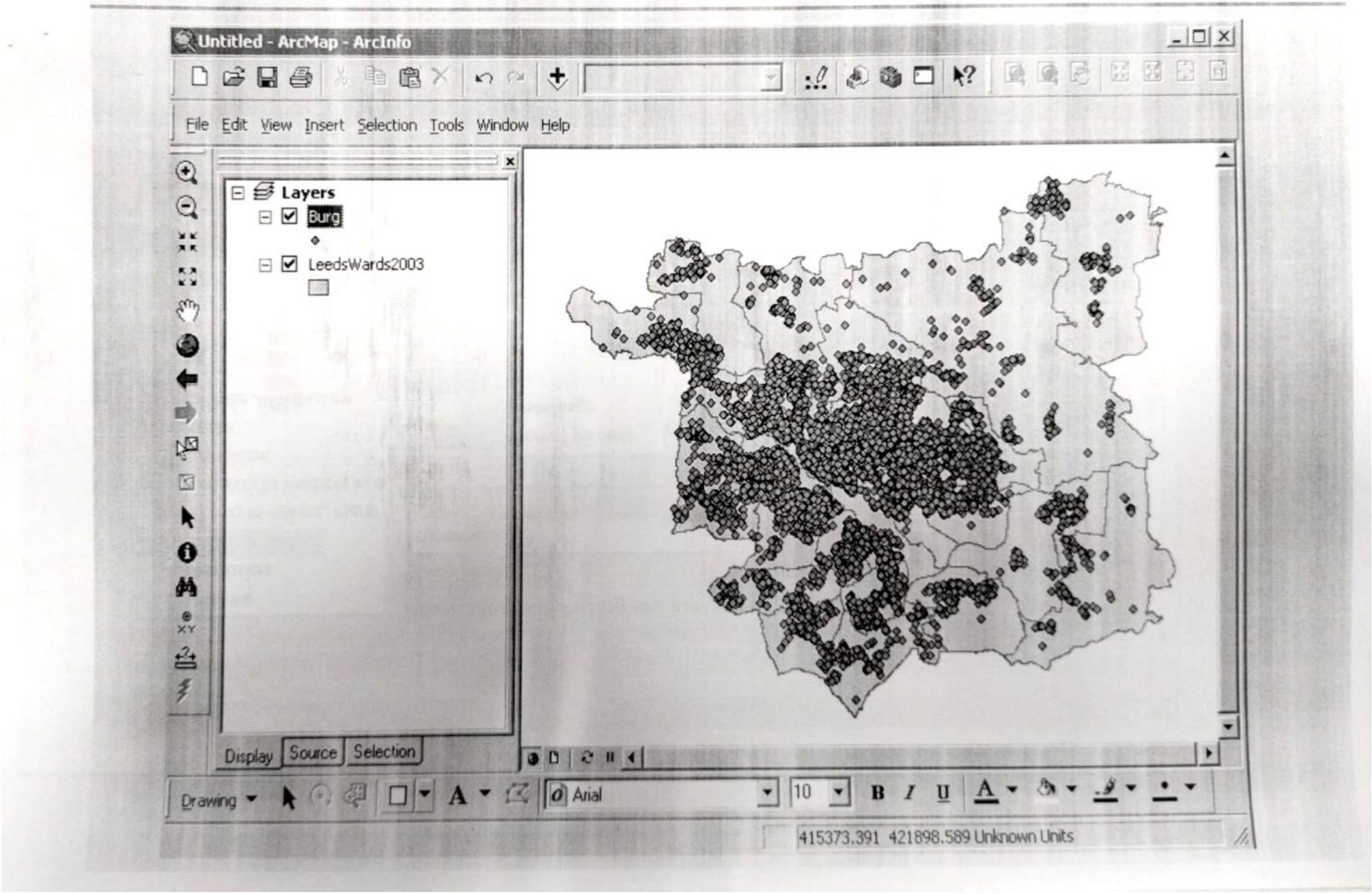


Types of Maps

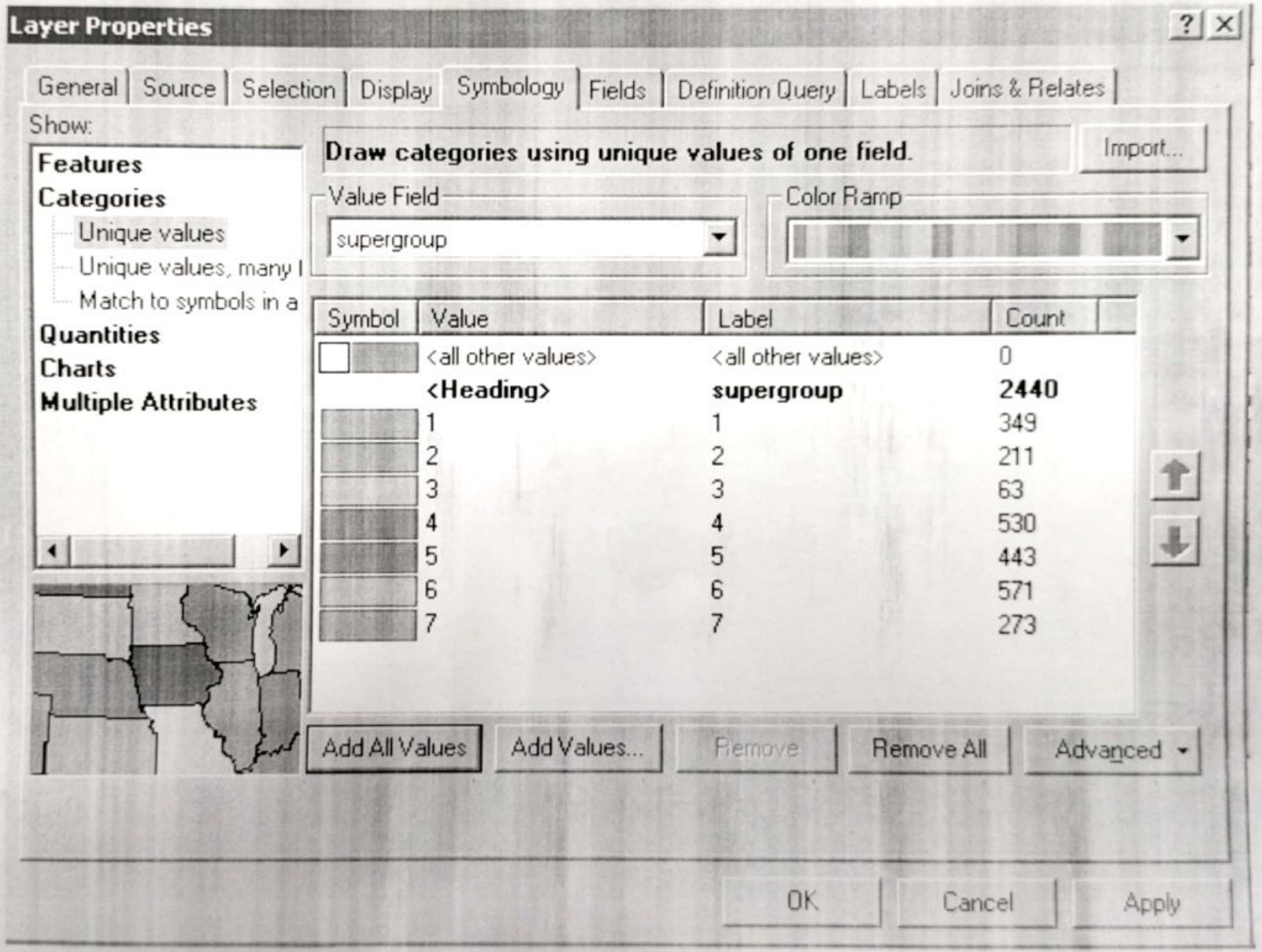
- General Map
  - Variety of information of equal importance
  - Not targeting a specific audience (e.g. topographic map)
  - Symbology
- Thematic Map
  - Focussed
  - Importance of information can vary on the map
  - Symbology can dominate
  - Qualitative (no importance in terms of size) vs quantitative (size differences)

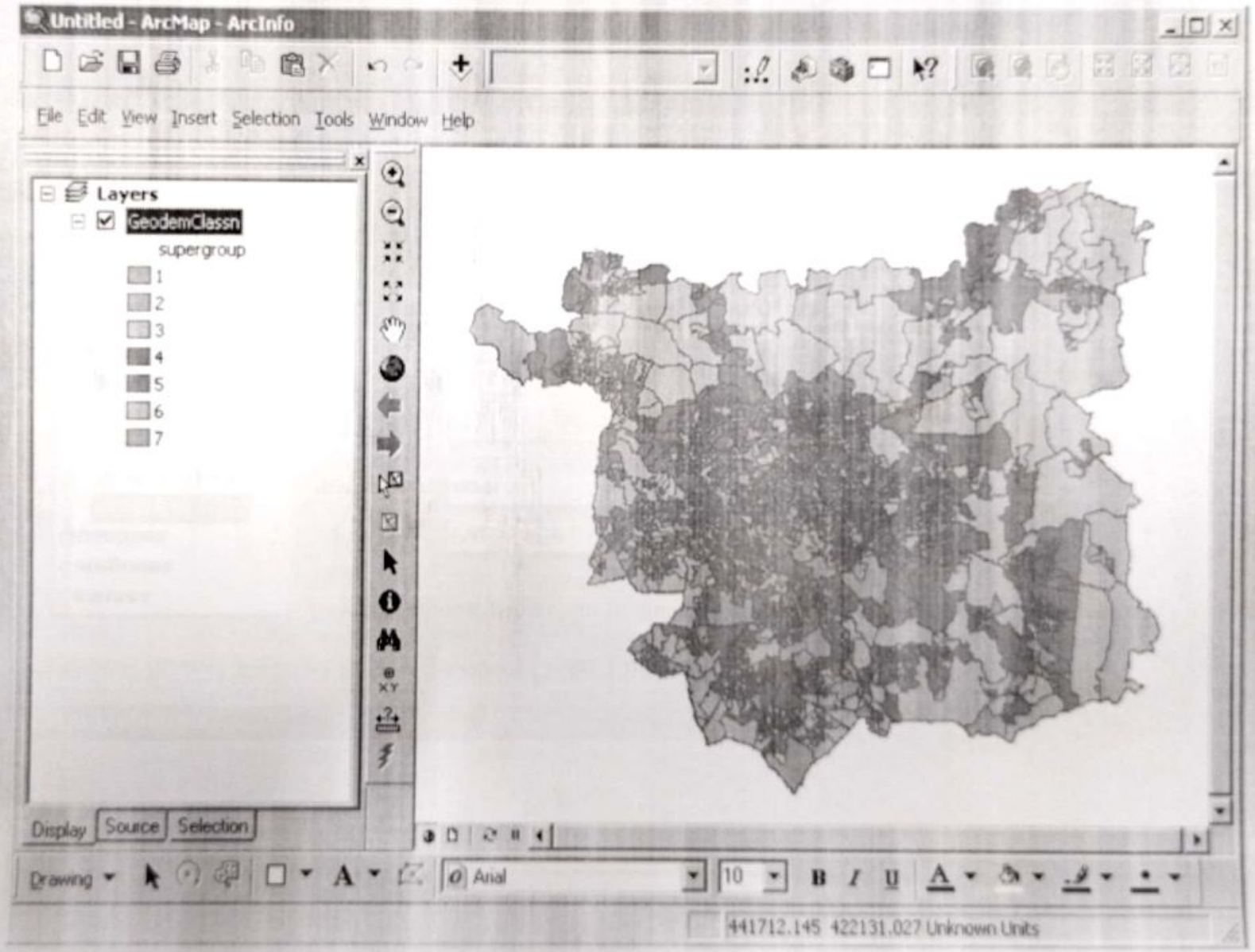
Symbology – Single Symbol



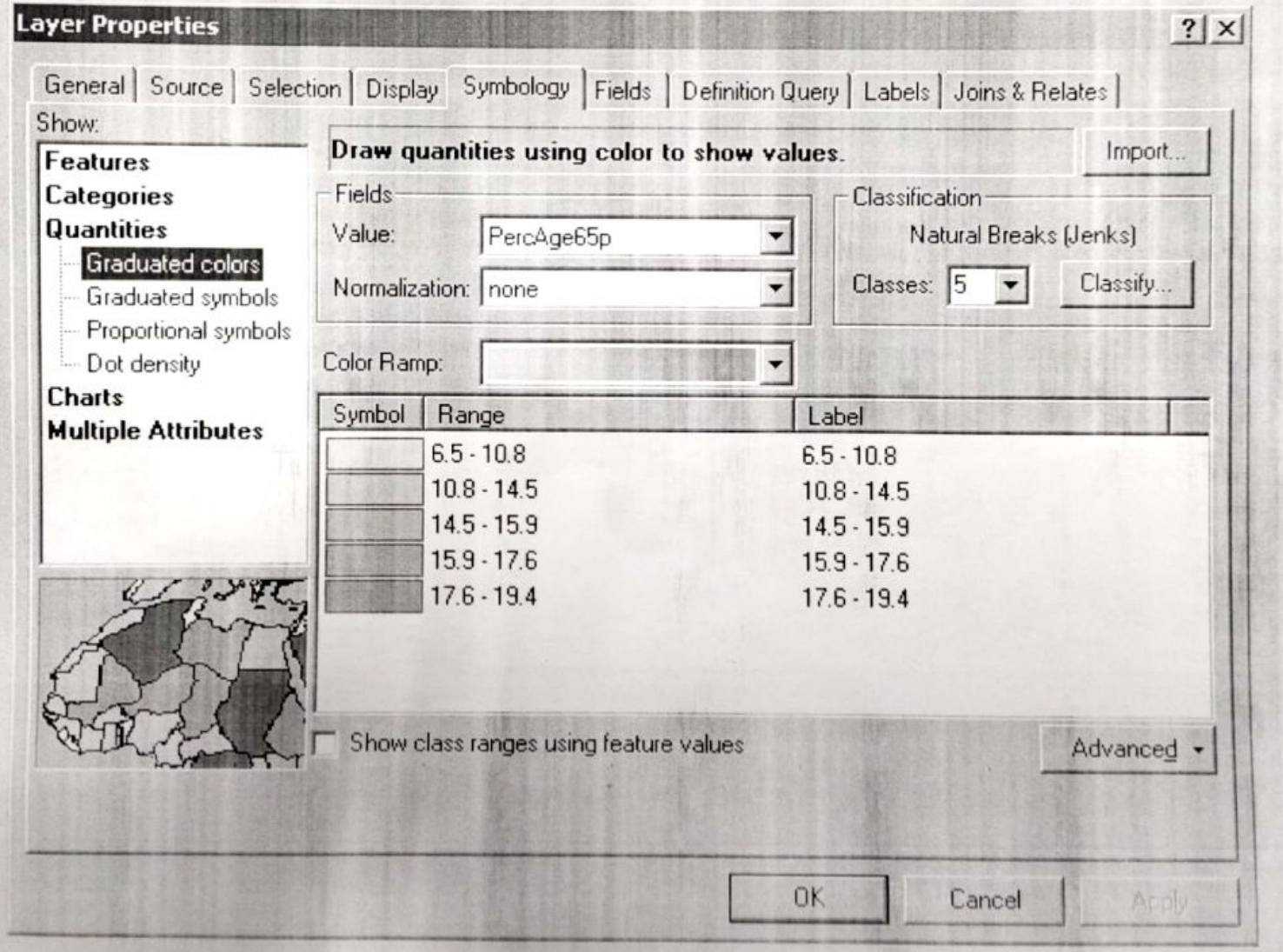


Symbology - Categories

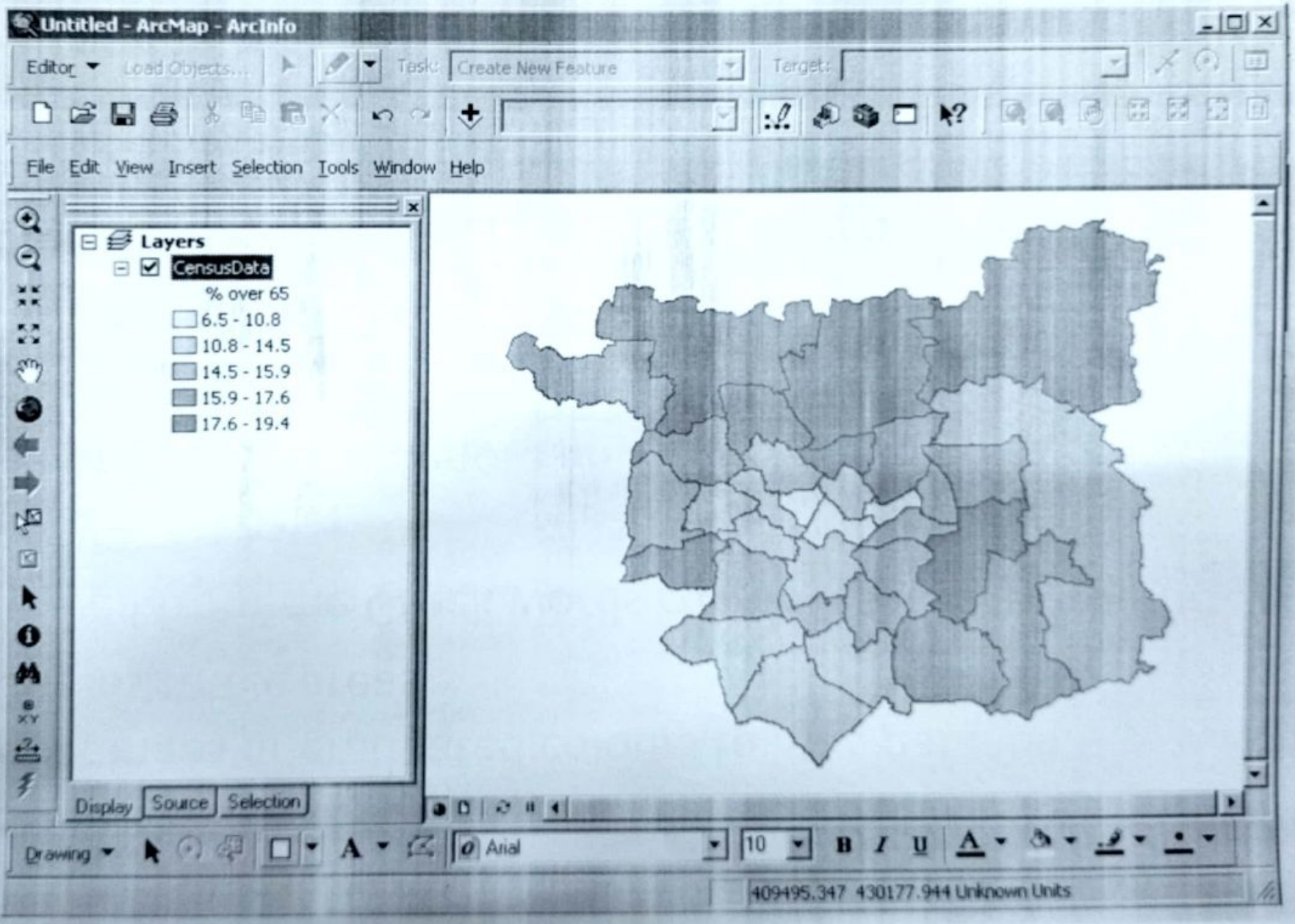




Graduated Colour



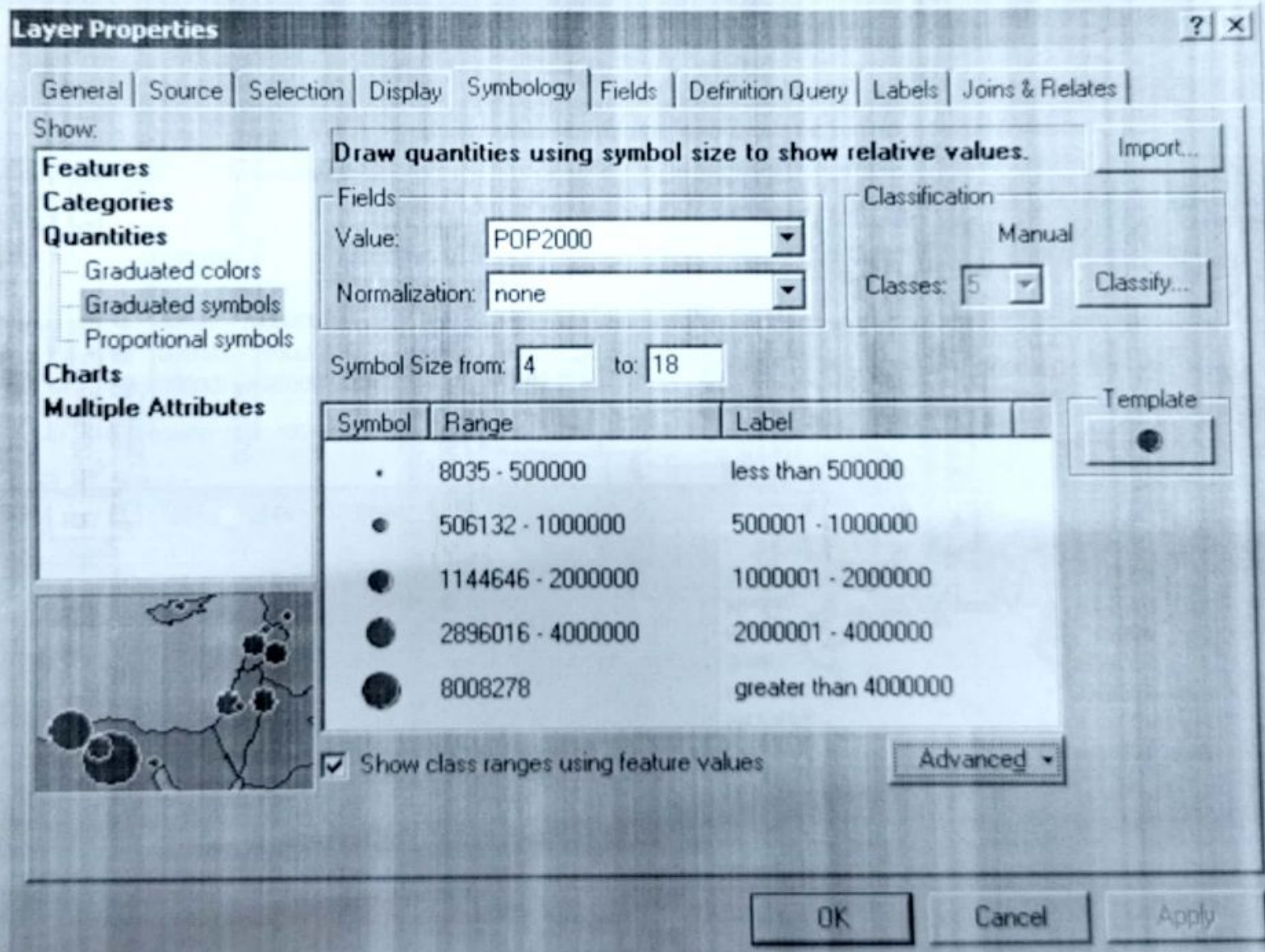
Graduated Colours



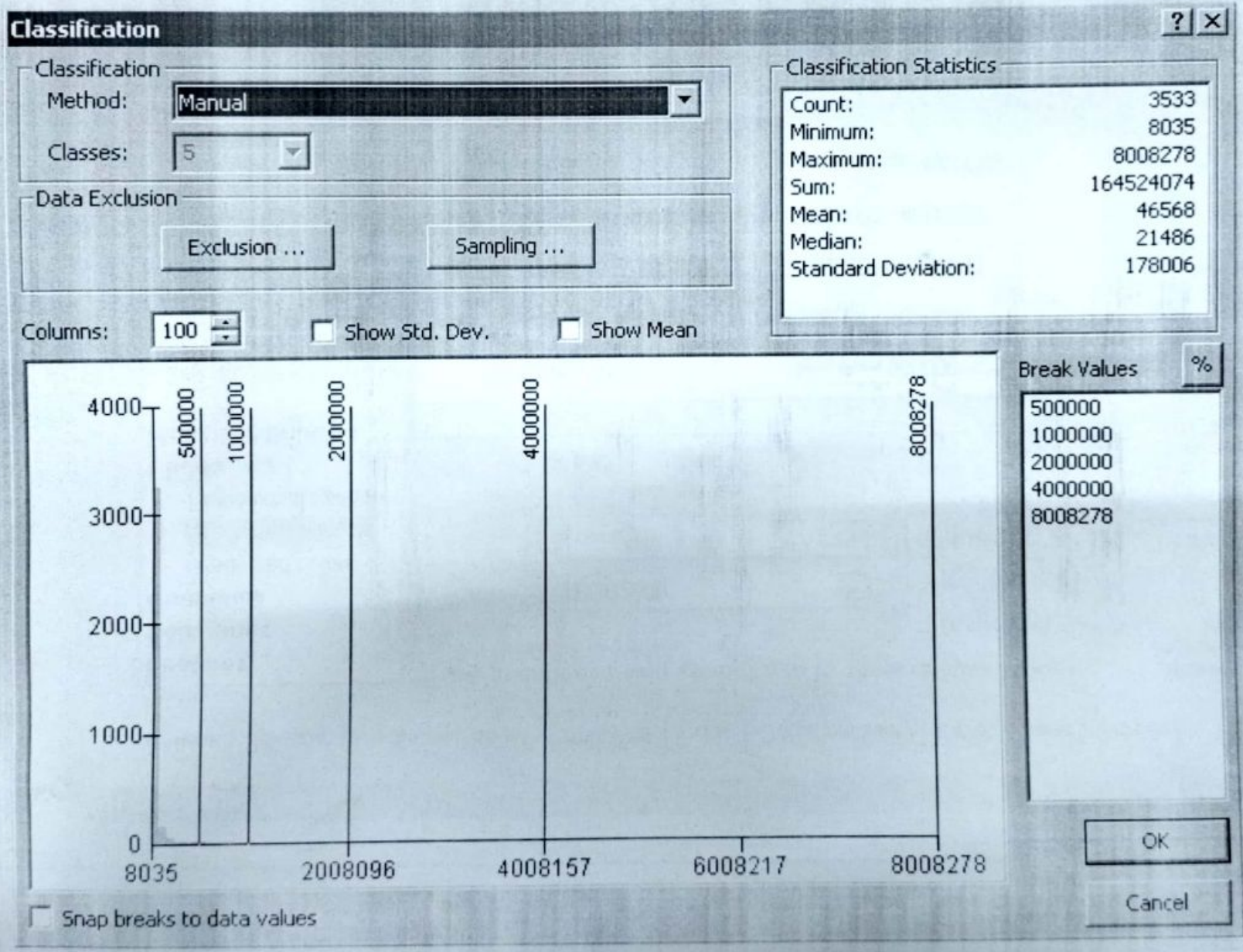
Choropleth Maps

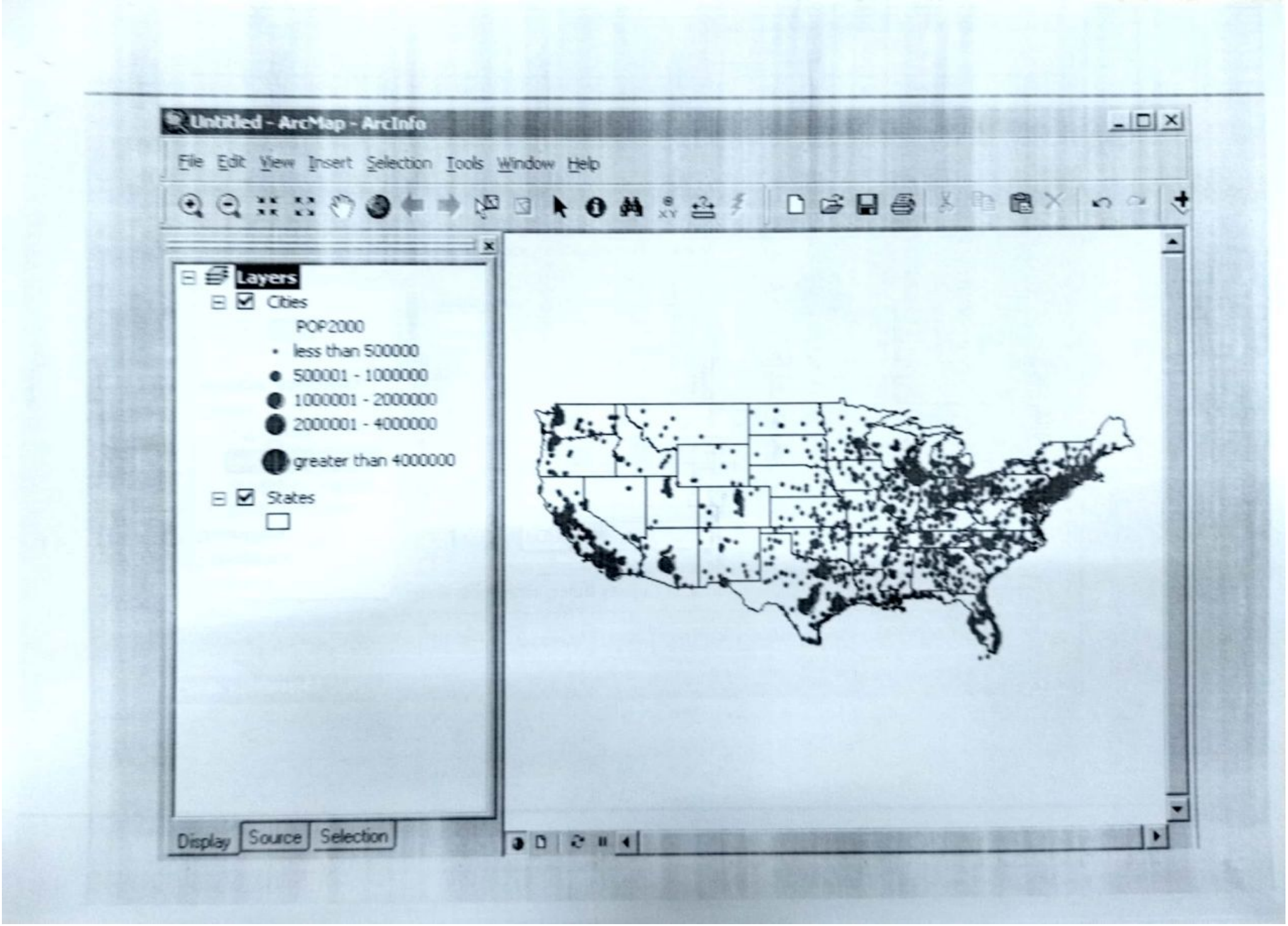
- uses ranges or graduated colours to map data for administrative areas
- Derived from the Greek words *choros* = space and *pleth* = value
- Shading is used to denote an increase or decrease in a value
- Should technically only plot standardised values (e.g. percentages, ratios) or the maps may be misleading

Graduated Symbols

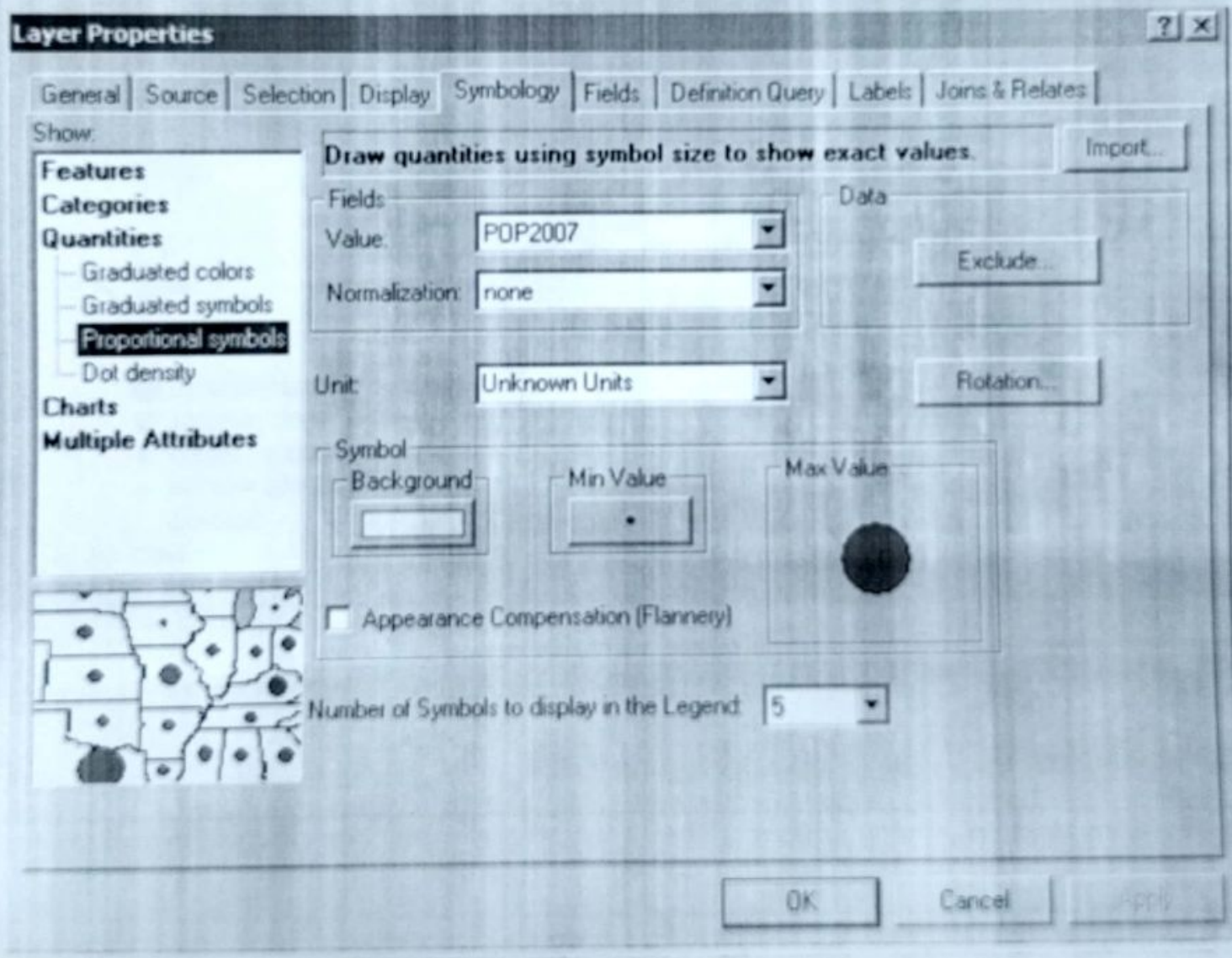


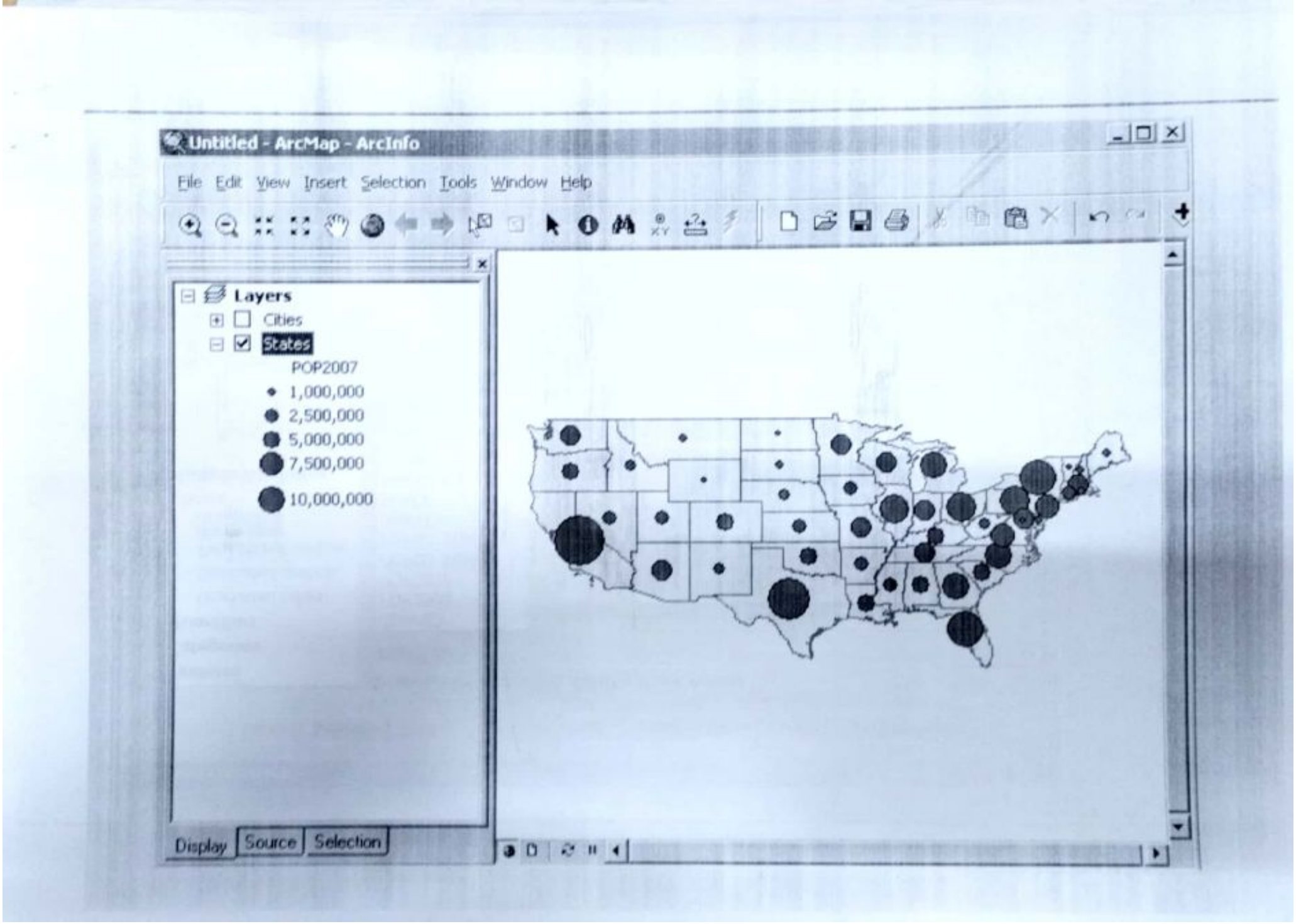
Manually Adjusting Categories



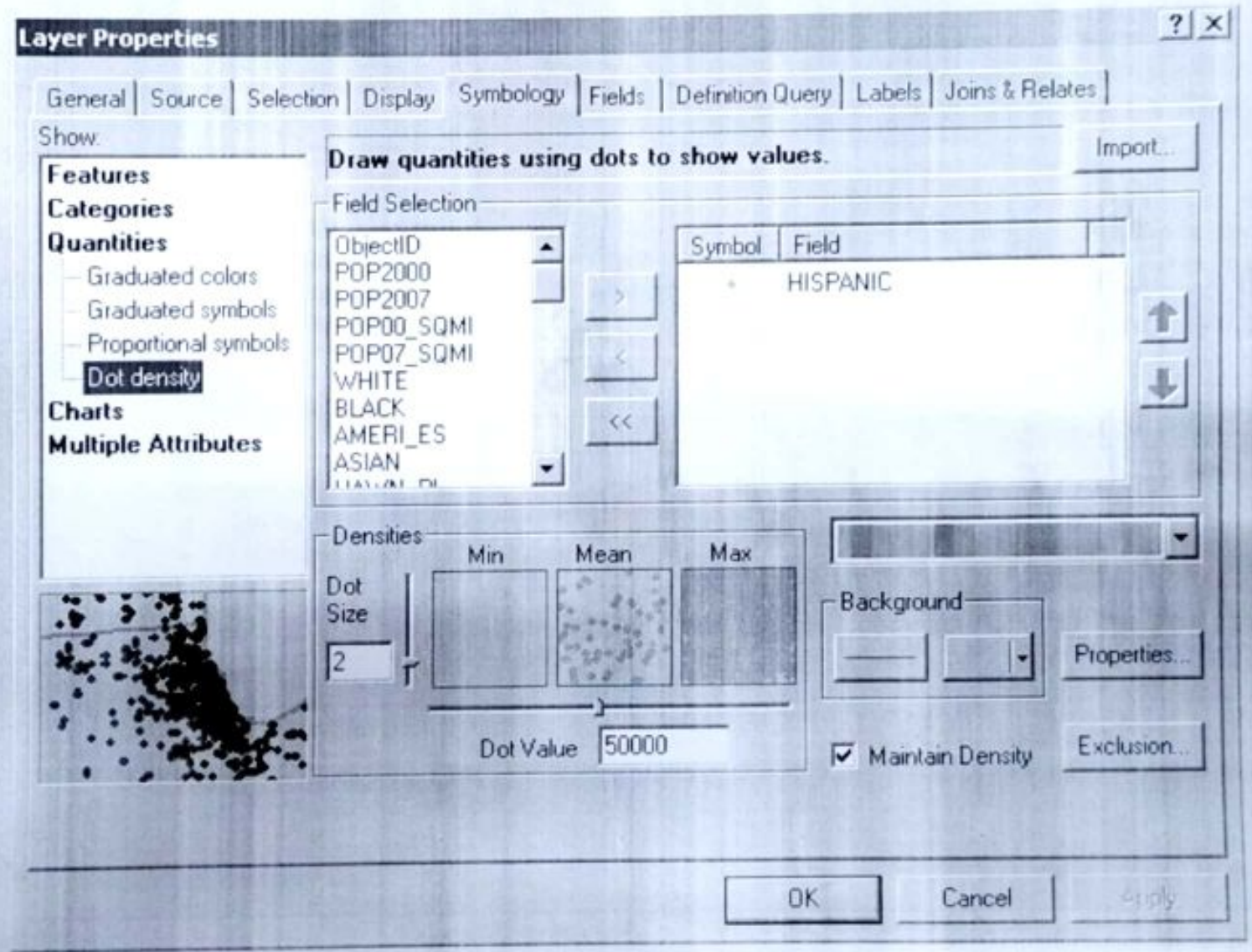


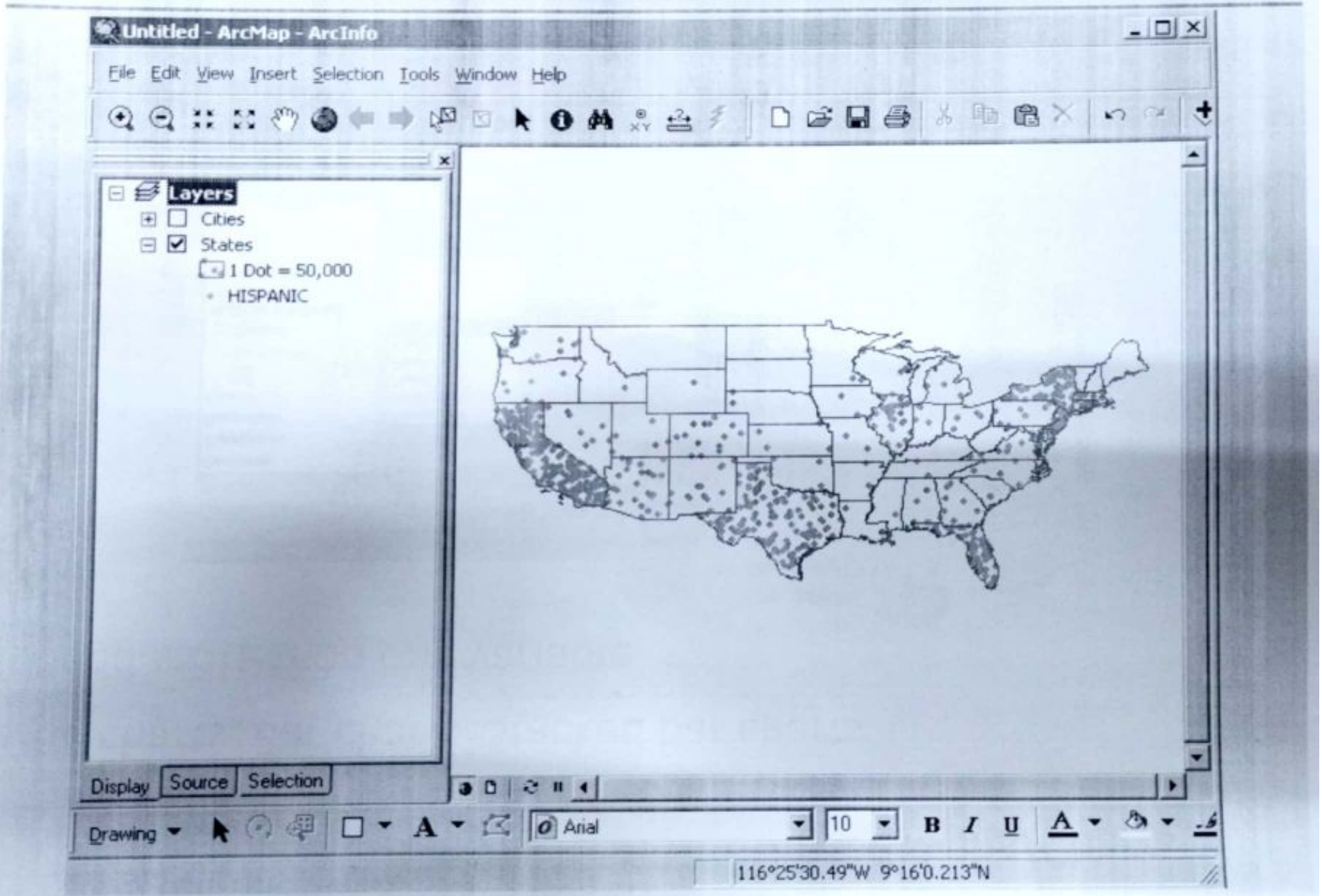
Proportional Symbols





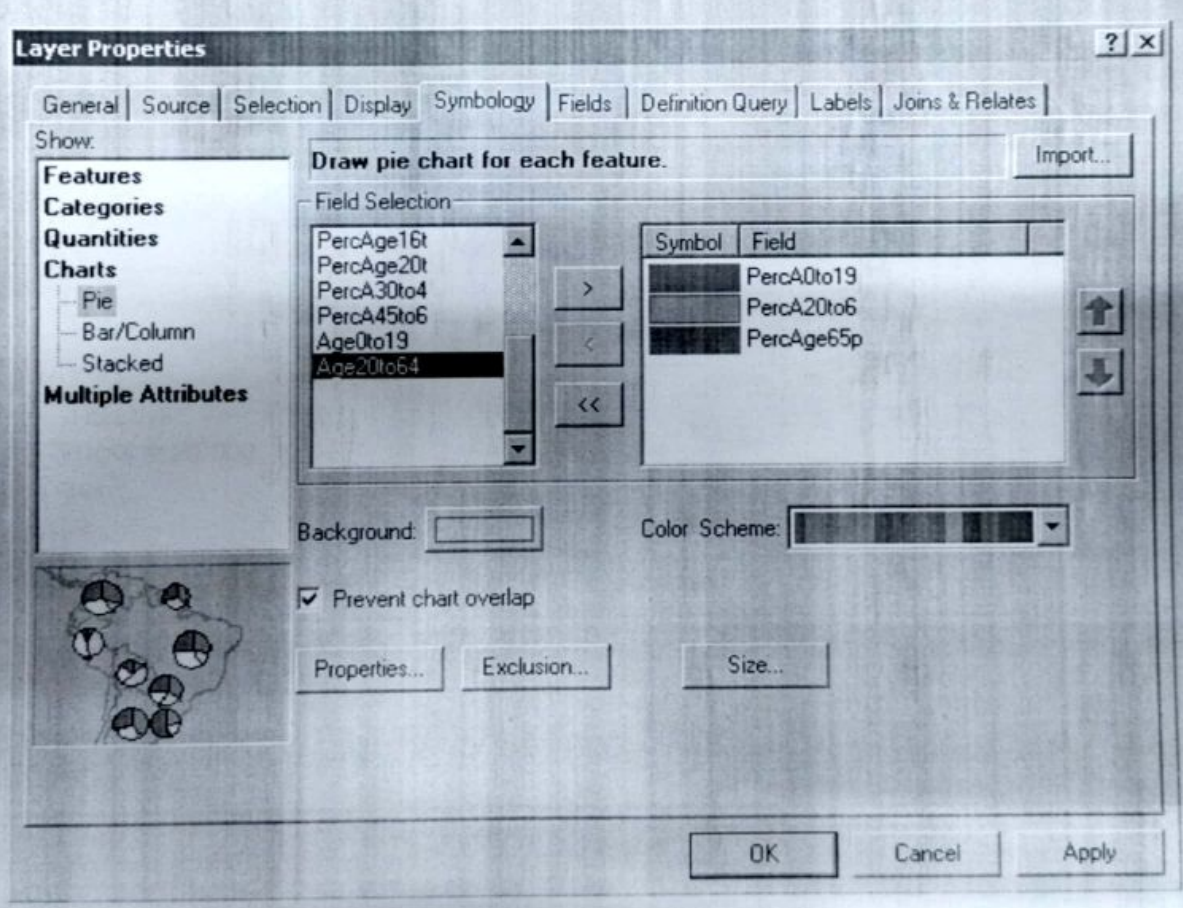
Dot Density

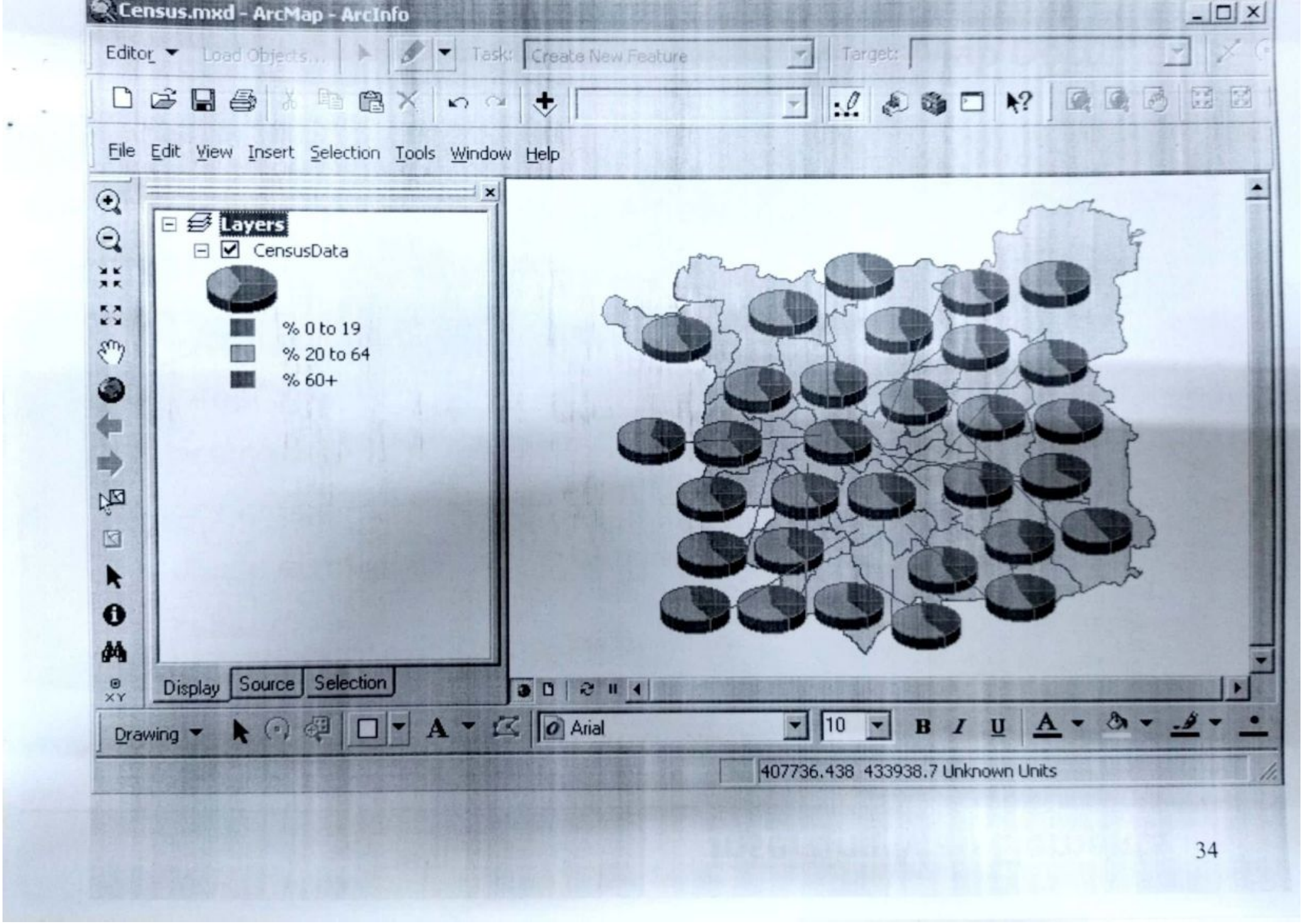




Graphs/Charts

- Pie charts, Bar charts, Stacked bar charts
- Need more than one variable





Inserting Map Elements

- ArcMap makes it easy to add……
  - Titles
  - Legends
  - North arrows
  - Scale bars
  - Scale text
  - Label text
  - Pictures

Map Documents

- When you are working, you load different maps, change symbology, create some new maps, etc.
- You can save your work as a Map Document (.mxd)
- You can then click on the .mxd file and it will load ArcMap and all your files
- The .mxd DOES NOT contain the data
- It is a pointer to the data + all your settings
- Can use absolute or relative pathnames (specify in File → Document Properties)

Saving Layer Properties

- Save layer properties for repeated use
- Data is not saved with the properties
- Can save this as an .mxd but do not always work in the same map document
- Definition file (.lyr) that defines the properties that you have set for that layer (e.g. symbols, labels, joins, etc.)
- Can load a combination of different layer files without creating each map from scratch

Global Positioning System (GPS), Fundamental concepts, and the GPS satellite system

PROF. DR. ALTAF ALI SIYAL

OBJECTIVES

- Understand the Geographical Coordinate System
- Understand fundamental Concepts of GPS and how GPS basically works
- Describe common error sources
- Understand the GPS Satellite System

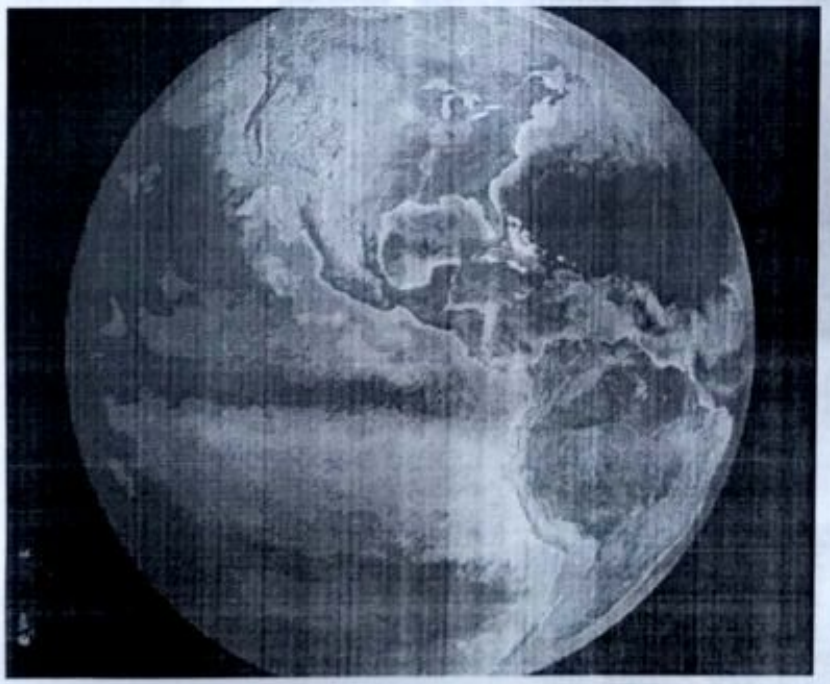
CONCEPT OF POSITIONING SYSTEM

- Positioning system is being used since humans have inhabited the planet Earth.
- A coordinate system is a method for identifying the location of a point on the earth.
- Each of these numbers indicates the distance between the point and some fixed reference point, called the origin.
- Global Positioning System is the acquisition of real time location information from a series of satellites in Earth s orbit.
- To understand GPS, you need to learn about Earth's Geography and the role of Satellites.

EARTH'S GEOGRAPHY

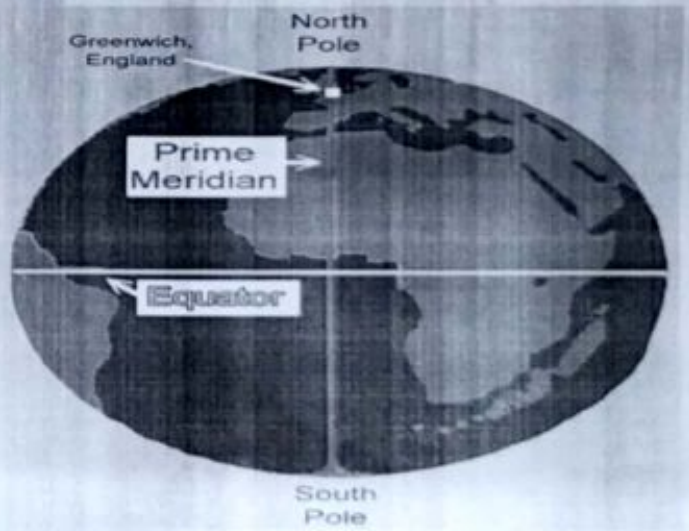
EQUATOR

- It is a circle of latitude, about 40,075 km in circumference, that divides Earth into the Northern and Southern hemispheres.
- It is an imaginary line located at 0 degrees latitude, halfway between the North and South poles.



PRIME MERIDIAN:

- It is a geographical reference line that passes through the Royal Observatory, Greenwich, England, at which longitude is defined to be 0°.
- The line itself divided the eastern and western hemispheres of the Earth



Positions on Globe: Lines of Reference

Figure: 1

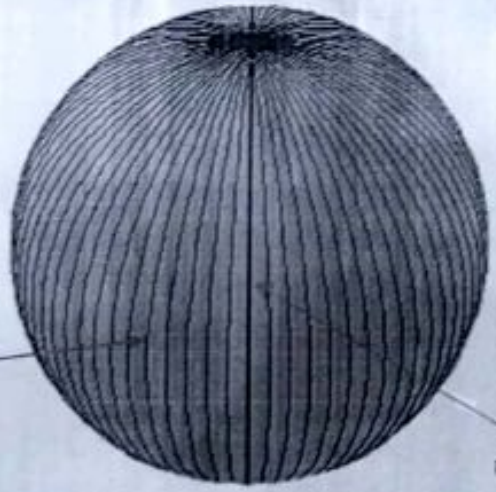


Figure: 2

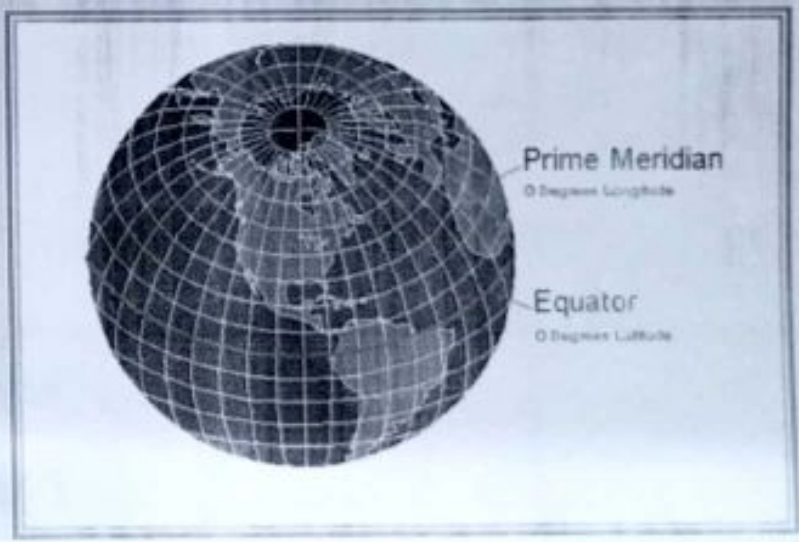
Figure: 3

Positions on Globe

- Measured by Geographical Coordinates (angles) rather than Cartesian Coordinates
- Locations are represented by ***Latitudes*** and ***Longitudes***

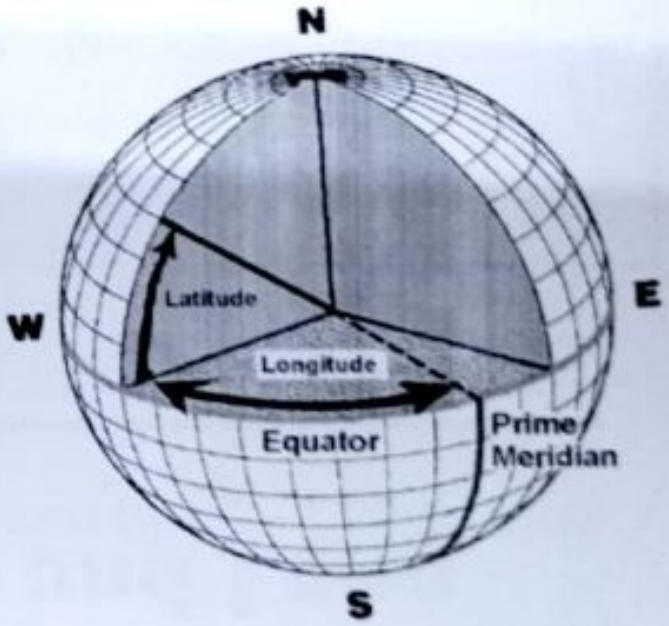
- ***Latitudes*** (Y) and ***Longitudes*** (X) are ***angles***

- ***Equator*** is the ***reference plane*** used to define latitude
- ***Prime Meridian*** is used to define longitude

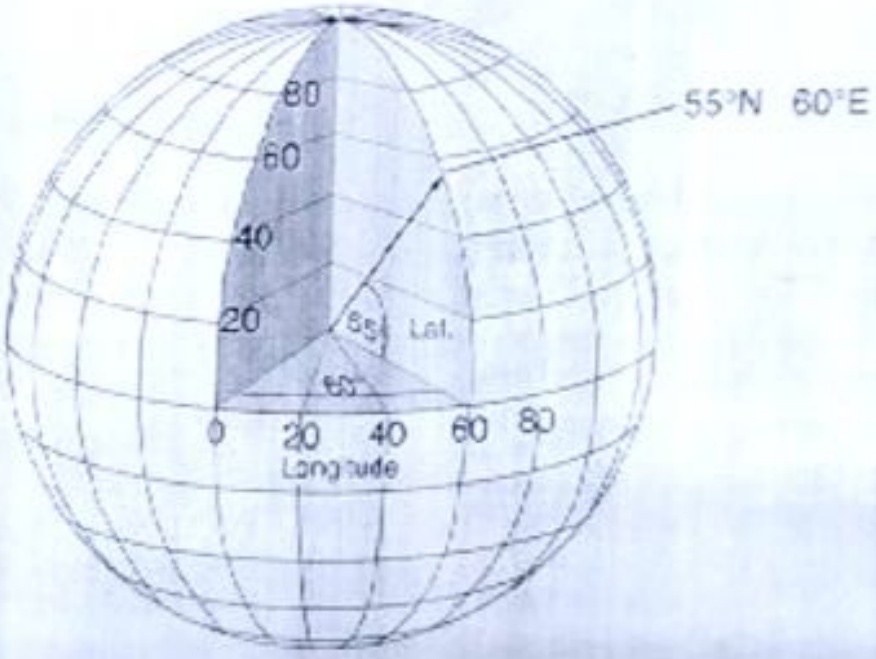


Latitude and Longitude

- The *Latitude* is measured as the number of degrees from the ***Equator***
- The *Longitude* is measured as the number of degrees from the ***Prime Meridian***
- The lines of constant latitude and longitude form a pattern called the *Graticule*



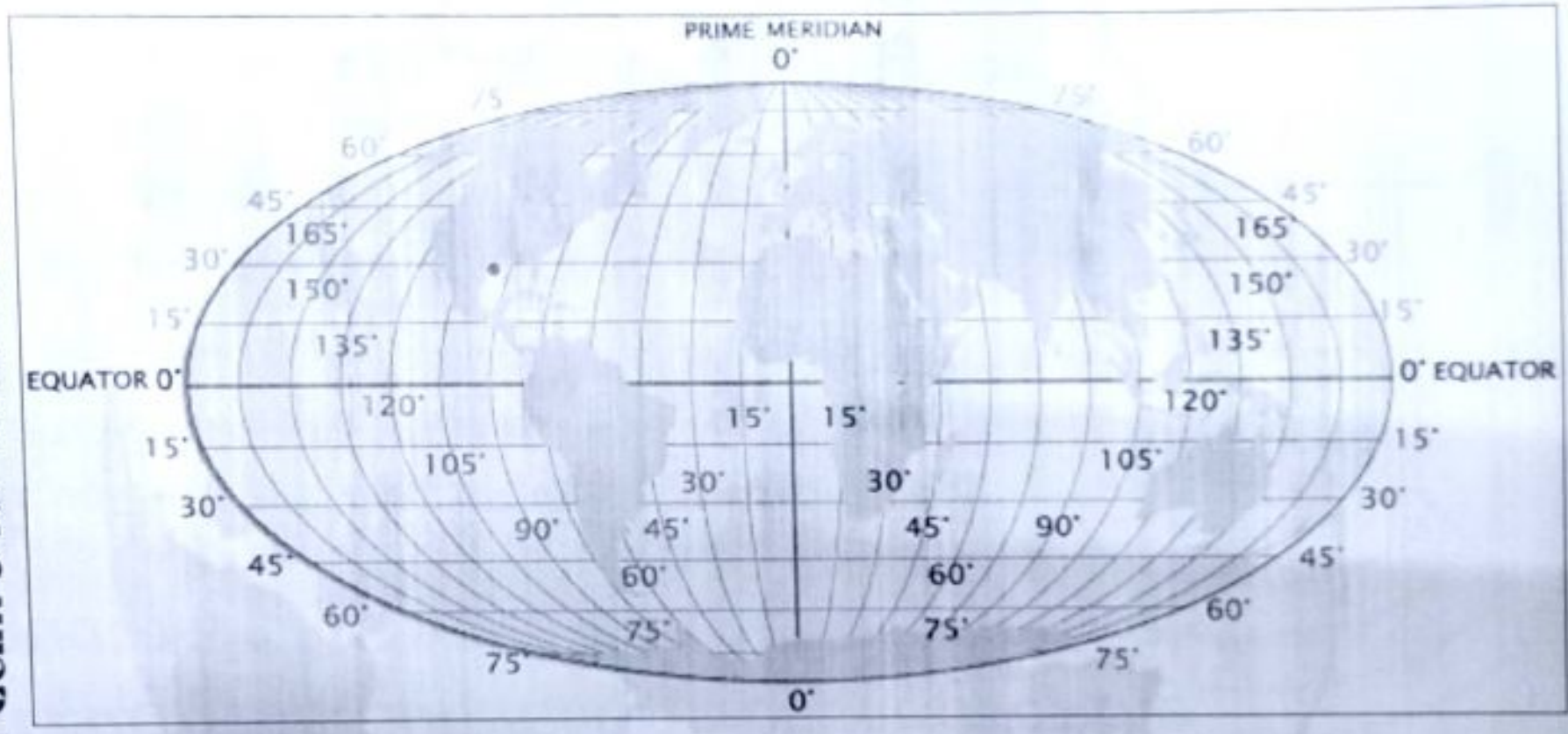
Example: Measuring Lat and Long



Example: In figure

60° E (longitude), 55° N (latitude)

Geographic Coordinate System (GCS)

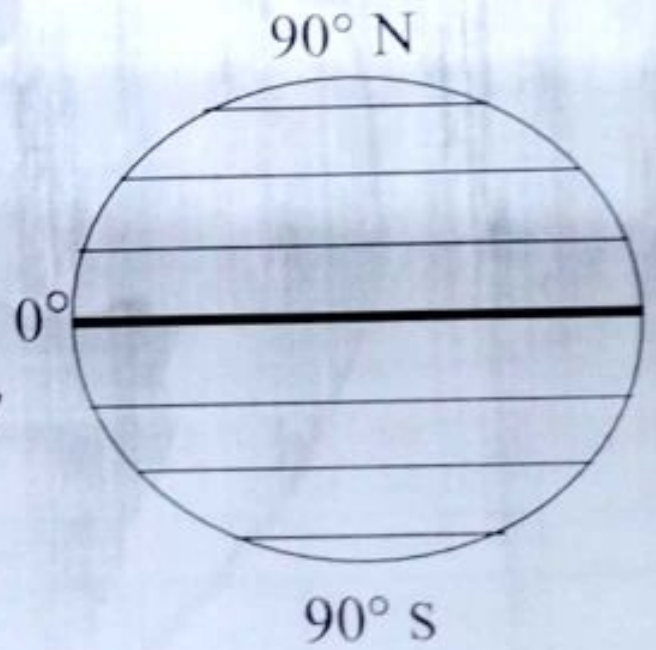


- GCS uses a three-dimensional spherical surface to define locations on the earth.
- Latitude and Longitude are angles denoted by (°, ', ")

Latitude

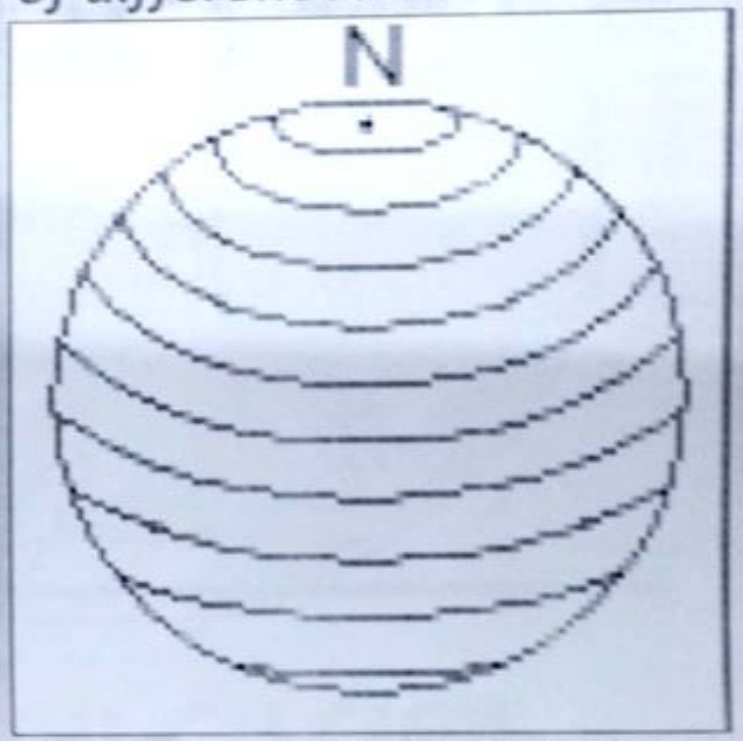
"Latitude is the angular distance of any point on Earth measured north or south of the Equator in degrees, minutes and seconds"

- *At poles* (North and South Poles) latitudes are *90° North* and *90° South*
- At *equator* latitude is *0°*
- The equator divides the globe into *Northern* and *Southern Hemispheres*
- *Each degree* of latitude is approximately *69 miles (111 km)* (variation because Earth is not a perfect sphere)



Lines of Equal Latitudes

- Lines of constant latitude are called parallels of latitude (horizontal lines)
- Parallel lines at an *equal distance*
- On Globe lines of latitude are *circles of different radii*
- *Equator* is the *longest circle* with *zero latitude* also called *'Great Circle'* (24,901.55 miles or 40,075.16 kilometers)
- Other lines of latitudes are called *'Small Circles'*
- *At poles* the circles *shrink to a point*
- Circle of Equator is *divided* into *360 degrees*



In figure, lines of Latitude or Parallels

Some Important Small Circles

- **Tropic of Cancer**
  - At 23.5°N of Equator and runs through Mexico, Egypt, Saudi Arabia, India and southern China.
- **Tropic of Capricorn**
  - At 23.5°S of Equator and runs through Chile, Southern Brazil, South Africa and Australia.
- **Arctic and Antarctic Circles**
  - At 66° 33′ 39″ N and 66° 33′ 39″ S respectively

U.S.-Pakistan Centre for Advanced Studies in Water

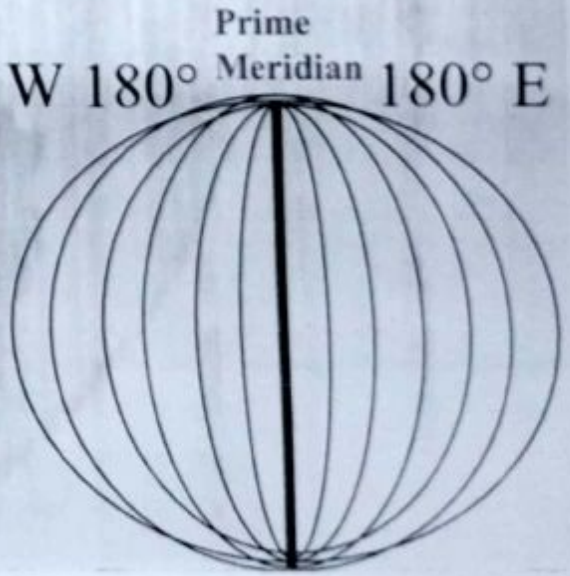
Map of the World

U.S.-Pakistan Centre for Advanced Studies in Water

Longitude

"Longitude is the angular distance of any point on Earth measured east or west of the prime meridian in degrees, minutes and seconds"

- Measured from *0° to 180° east* and *180° west* (or -180°)
- The *meridian at 0°* is called *Prime Meridian* located at Greenwich, UK
- Both 180-degree longitudes (east and west) share the same line, in the middle of the Pacific Ocean where they form the *International Date Line*
- 1 degree of Longitude=
  - **69.17 mi (111.32 km) at Equator**
  - **48.99 mi at 45N/S**
  - **0.0 mi at 90N/S**



Longitude & Time

- The earth turns/rotates 360 degrees in 24 hours:
  15 degrees = 1 hour

- If you know the time in Greenwich when it is local noon at your location one can find your longitude relative to Greenwich

- What will be time in Quetta located at Longitude 67° E when time in Greenwich is 11 am?

U.S.-Pakistan Centre for Advanced Studies in Water

Prime Meridian

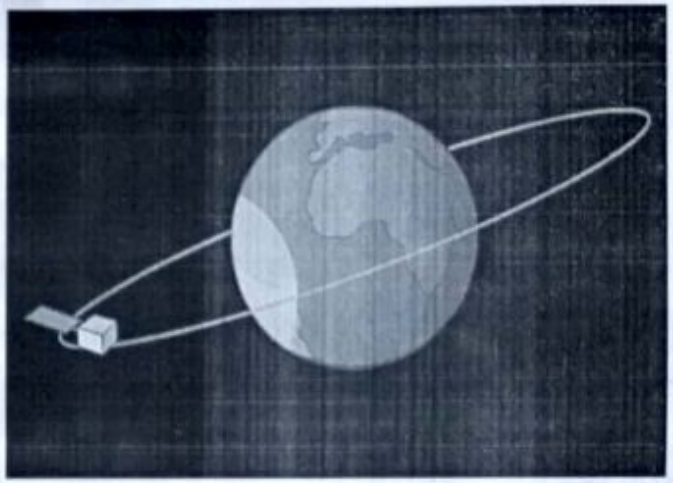
- Royal Astronomical Observatory in Greenwich, England

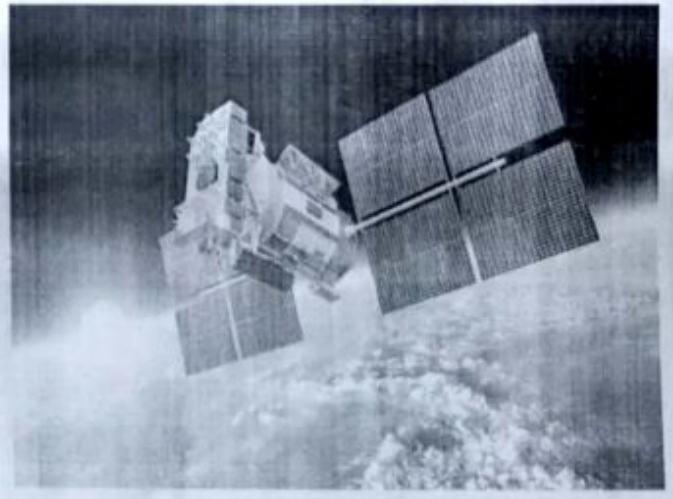
GPS

- The **Global Positioning System** (**GPS**) is a space-based satellite navigation system that provides location and time information:
  - in all weather conditions,
  - anywhere on the globe
  - on or near the Earth where there is an unobstructed line of sight to three or more **GPS** satellites

SATELLITES

- ✓ A satellite is an object in space that orbits or circles around a bigger object.
- ✓ There are two kinds of satellites:
  - ✓ **Natural**
  - ✓ **Artificial**
- ✓ The first artificial satellite was Sputnik, a Russian beach-ball-size space probe that lifted off on Oct. 4, 1957.
- ✓ A satellite in orbit has to operate continuously over its entire life span.
- ✓ About 6,600 satellites have been launched. Around 3,600 are still in orbits.
- ✓ Satellites make us safer, provide modern conveniences, and broadcast entertainment.



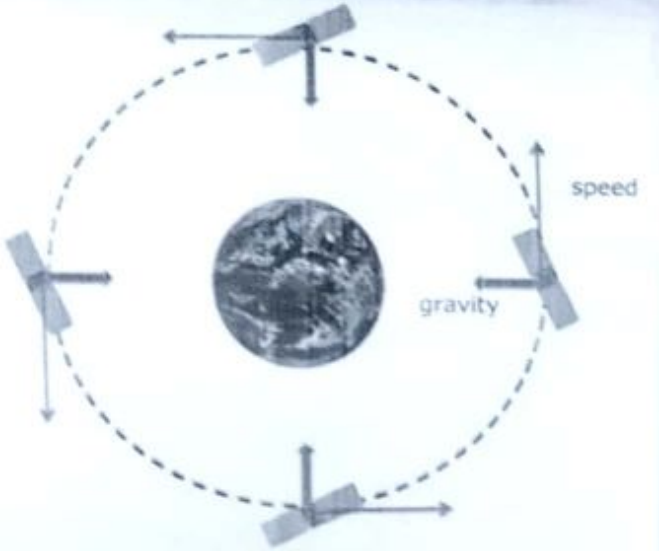


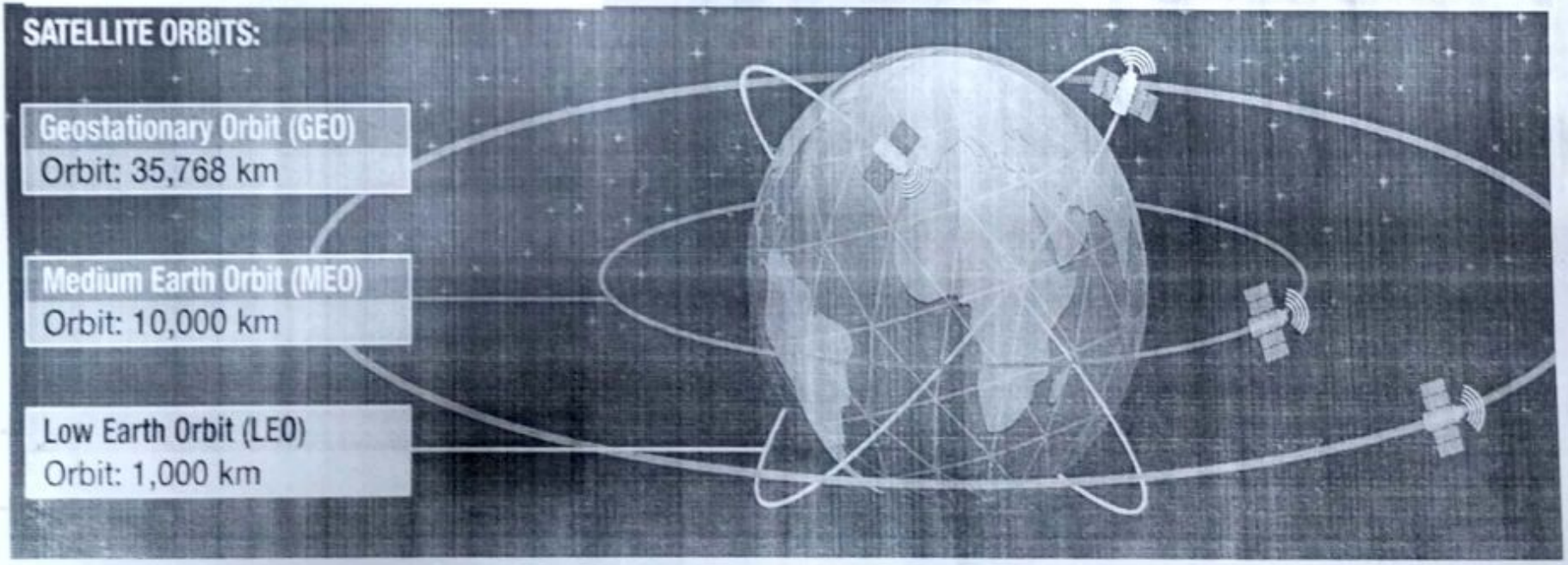
SATELLITES

How are Satellites launched and orbit into the Space?

- Satellites & spacecraft are launched into space by putting them on rockets carrying tons of propellants.
- The propellants give the rocket enough energy to boost away from Earth's surface.
- A satellite orbits Earth when its momentum is balanced by the pull of Earth's gravity.
- The International Space Station orbits about 402 km above the Earth and travels at a speed of about 27600.25 km per hour.

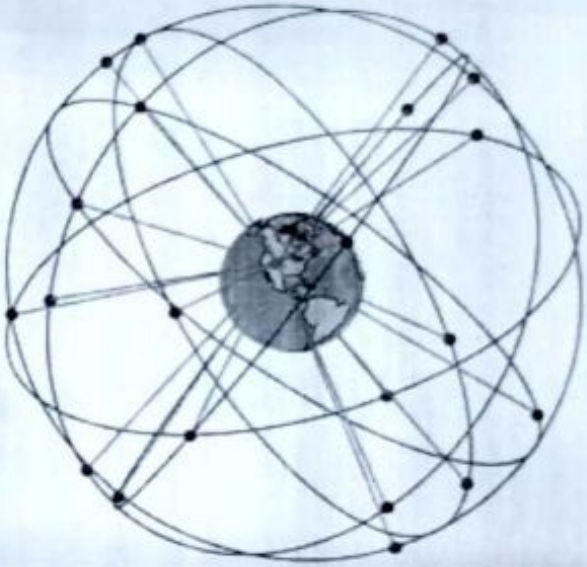
SATELLITES





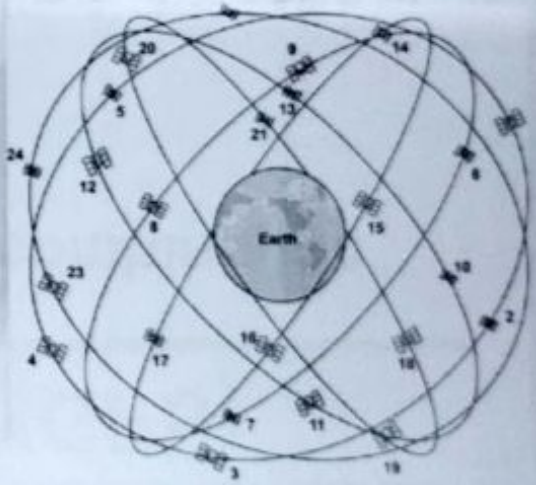
GLOBAL POSITIONING SYSTEM (GPS)

- The GPS is a satellite-based navigation system made up of a network of more than **24** (currently 32) satellites placed into six orbit by the U.S. Department of Defense (DoD).



- The first GPS satellite (**NAVSTAR 1**) was launched in 1978 and full constellation was achieved in 1994.

- They last about 10 years and replacements are constantly being built and launched into orbit.



- GPS was originally intended for military applications, but in the 1980s, the system was available for civilian use.

- GPS works in any weather conditions, anywhere in the world, 24 hours a day.

GLOBAL POSITIONING SYSTEM (GPS)

- Two dozen GPS satellites working in combination are known as a satellite constellation
- This constellation is currently controlled by the United States Air Force 50th Space Wing
- It costs about $750 million to operate and maintain the system per year
- Mainly used for navigation, map-making and surveying

WHERE GPS IS USED

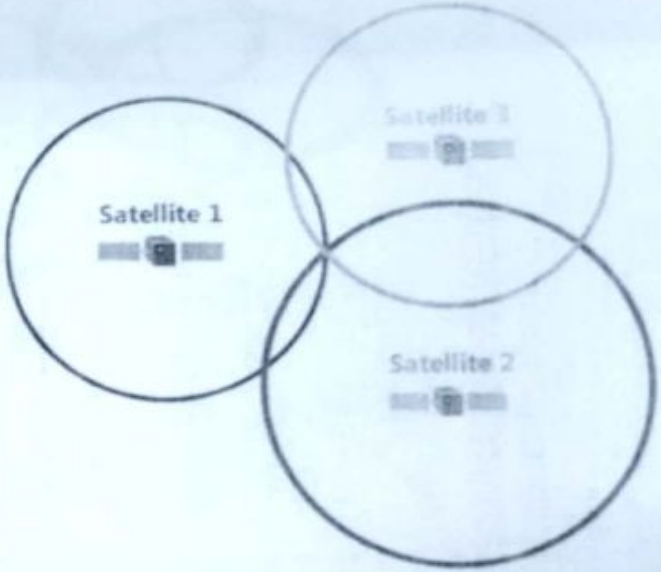
Military.
Search and rescue.
Disaster relief.
Mapping, Surveying, Geology
Marine navigation.
Remote controlled vehicle and robot guidance.
Satellite positioning and tracking.
Shipping.
Hiking, climbing, biking
Agriculture
Aviation

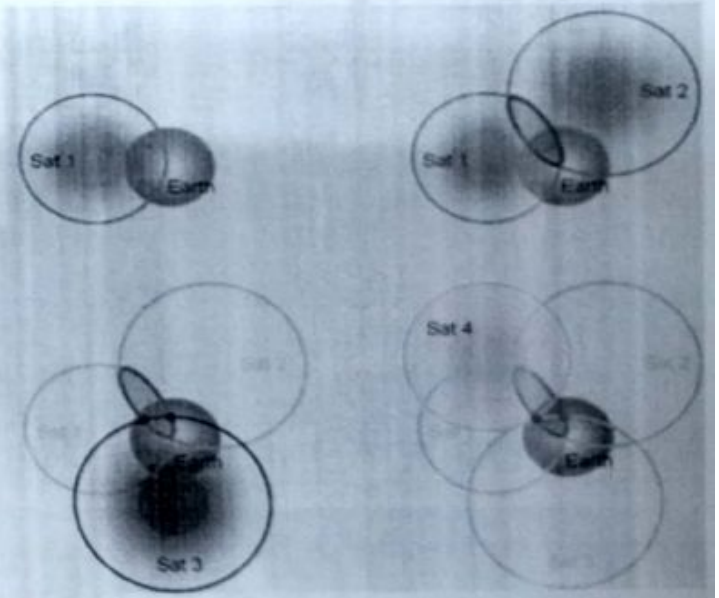
- Who can use It?

  - Everyone!
  - Merchant, Navy, Coast Guard vessels
  - Commercial Airliners, Civil Pilots
  - Surveyors
  - Commercial Truckers
  - Hikers, Mountain Climbers, Backpackers
  - Cars now being equipped
  - Communications and Imaging Satellites
  - Space-to-Space Navigation
  - Any system requiring accurate timing

GLOBAL POSITIONING SYSTEM (GPS)

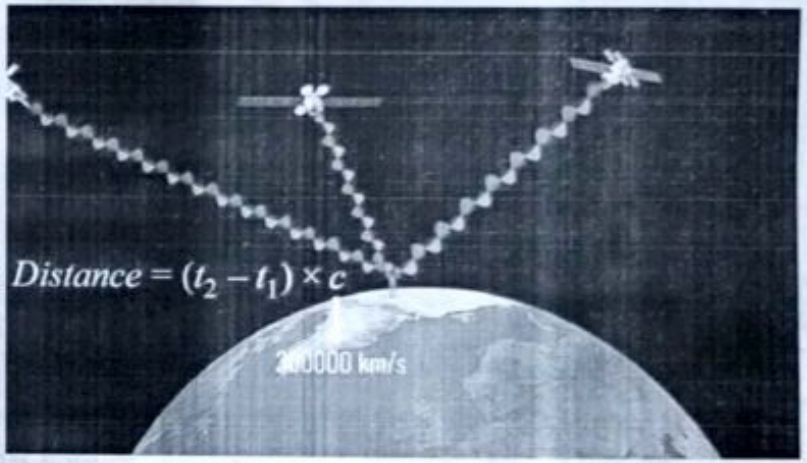
- GPS is a radio navigation system. It uses radio waves between satellites and a receiver inside your phone to provide location and time information using **trilateration.**
- The Satellites fly in medium Earth orbit (MEO) at an altitude of about 12,000 miles and at speeds of roughly 7,000 miles per hour (2 complete orbits in less than 24 hours)
- To achieve global coverage for GPS, 24 satellites are required. Currently 32 in the orbit.
- Using 24 GPS satellites ensures that at least 4 satellites are within line-of-sight of any location on Earth at all times.

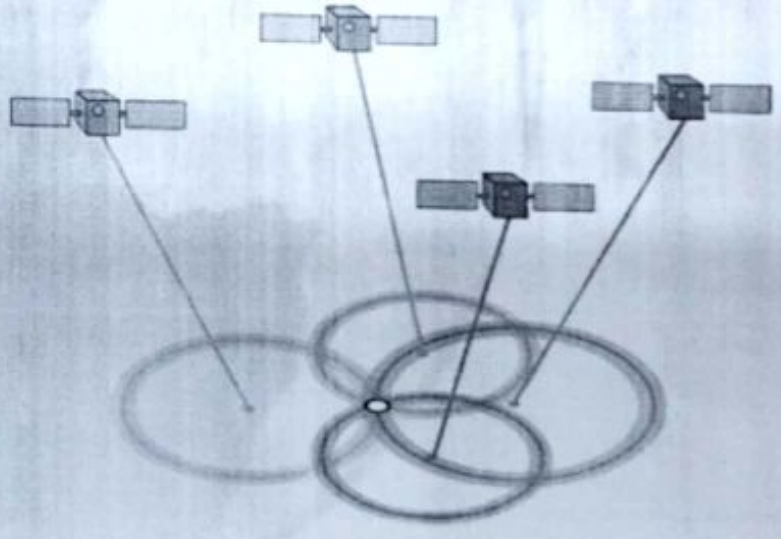




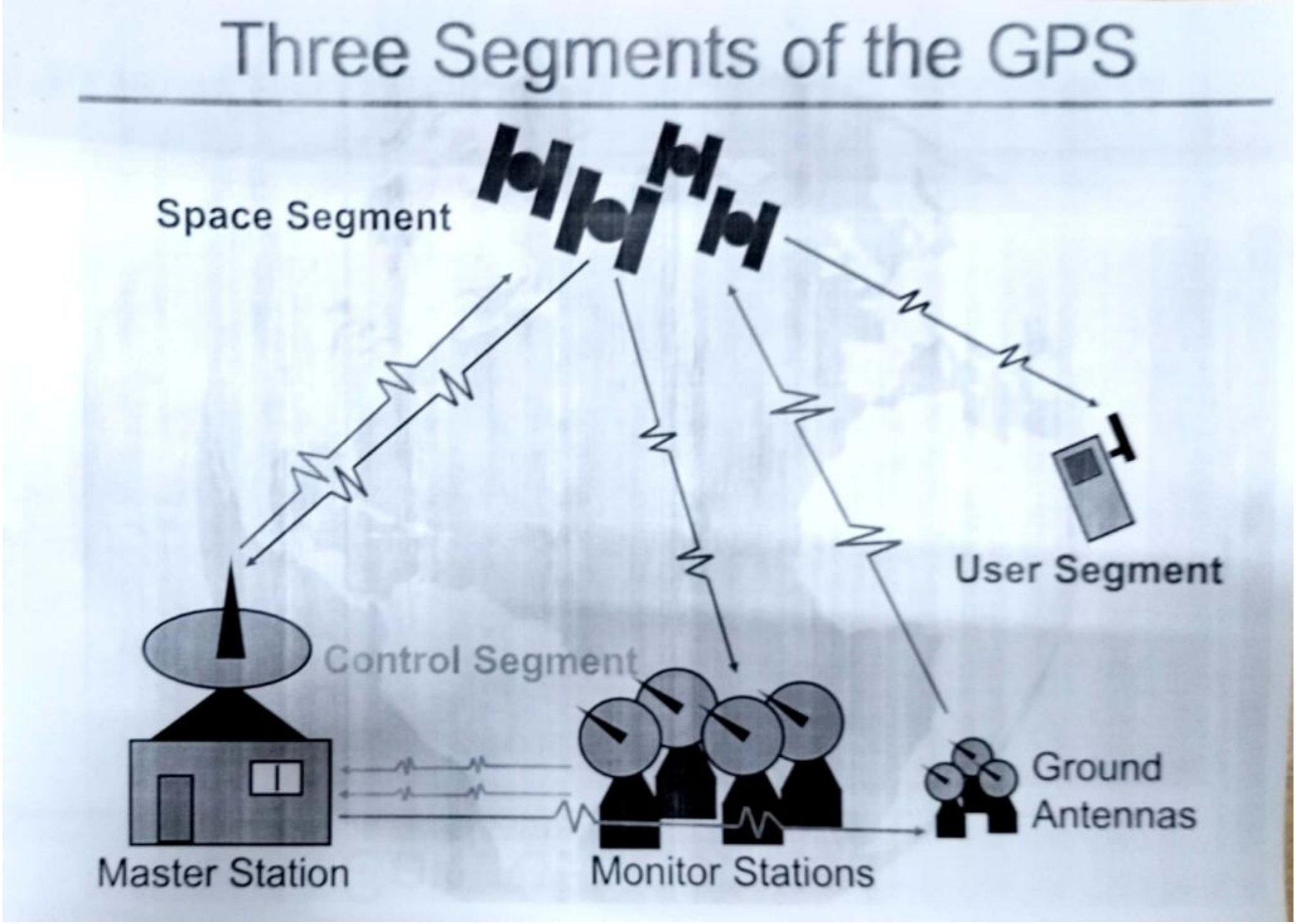
GLOBAL POSITIONING SYSTEM (GPS)

- ✓ GPS satellites carry atomic clocks that provide extremely accurate time and constantly transmits radio signals using a unique identifying code.
- ✓ Receivers work on crystal clocks – Atomic clock in smart phones is impractical
- ✓ Time offset is the difference b/w actual time and time measured by smart phone.

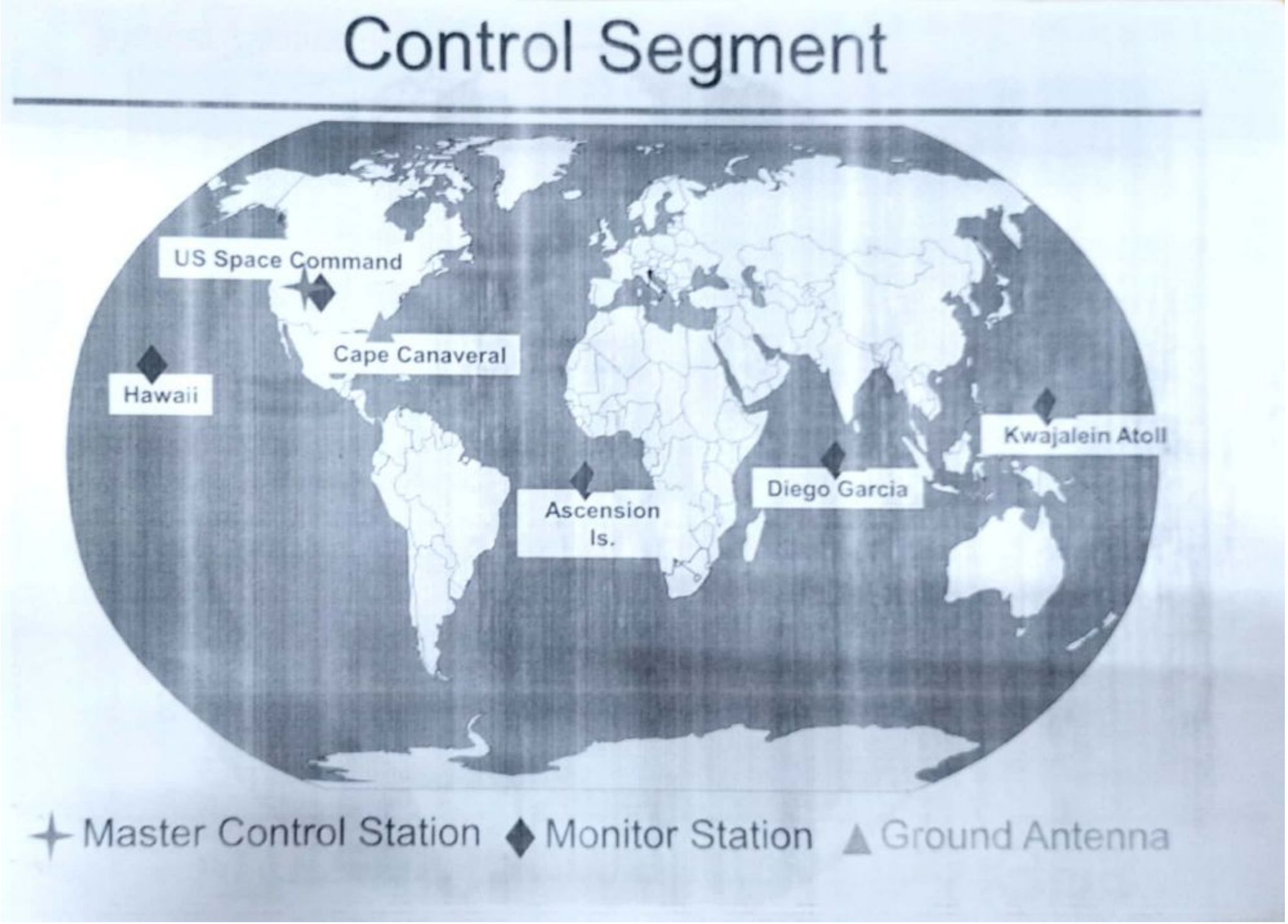




Three Segments of the GPS



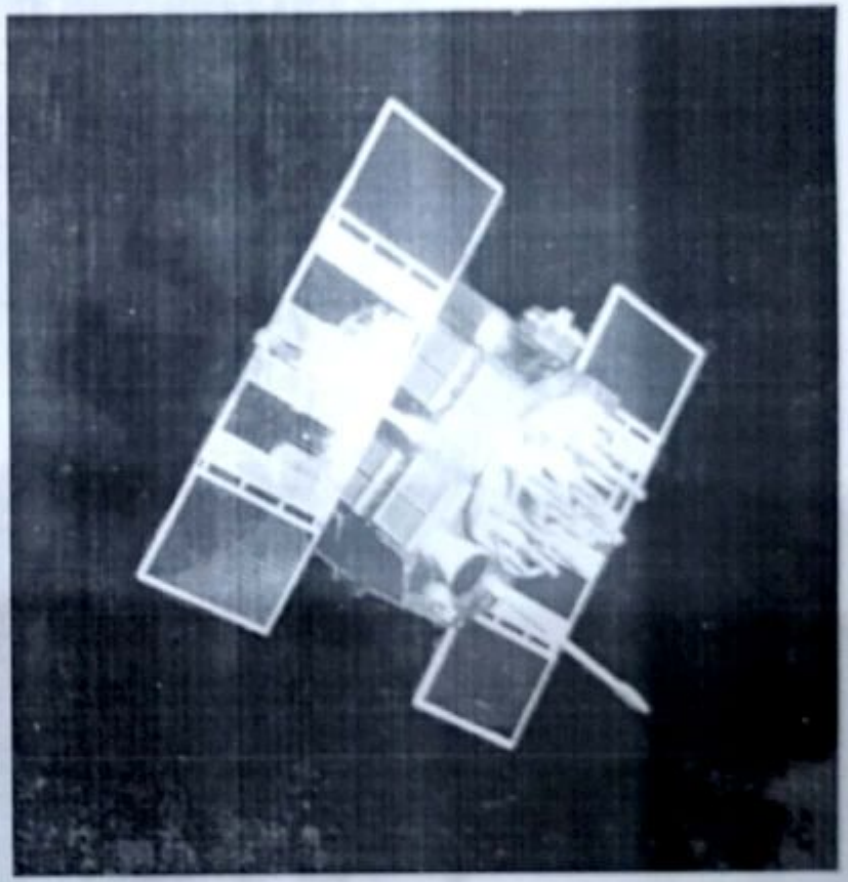
Control Segment



Components of the System

Space segment

- 24 satellite
- Six orbital planes
  - Inclined 55° with respect to equator to cover the polar regions
  - Orbits separated by 60°
- 20,200 km elevation above Earth
- Orbital period of 11 hr 55 min
- Five to eight satellites visible from any point on Earth
- Design life—10 years
- Four atomic clocks



Space Segment

- Powered by solar cells, the satellites continuously orient themselves to point their solar panels toward the sun and their antenna toward the earth.
- Orbital planes are centered on the Earth
- 8-10 satellites are spare satellites to be used in case of failure of any satellite already in use

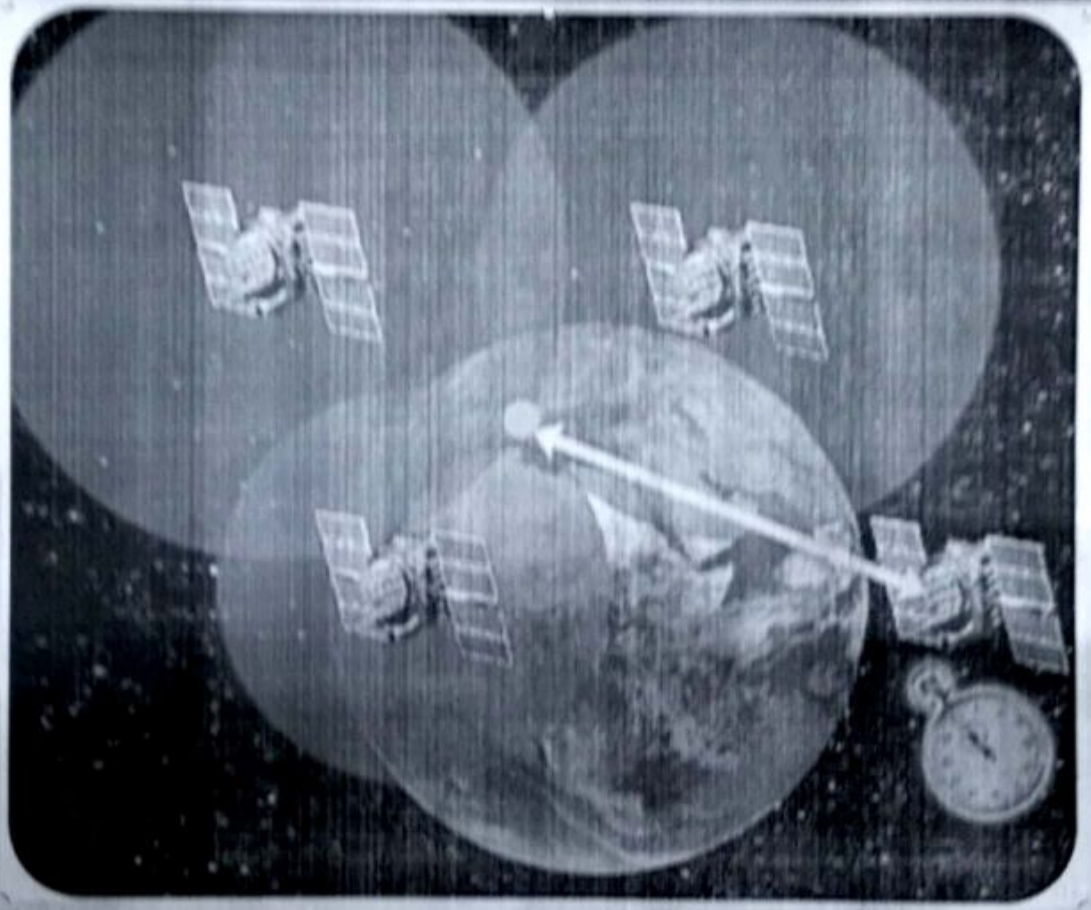
Operation Overview

A GPS receiver can tell its own position by using the position data of itself, and compares that data with 3 or more GPS satellites.

To get the distance to each satellite, the GPS transmits a signal to each satellite.

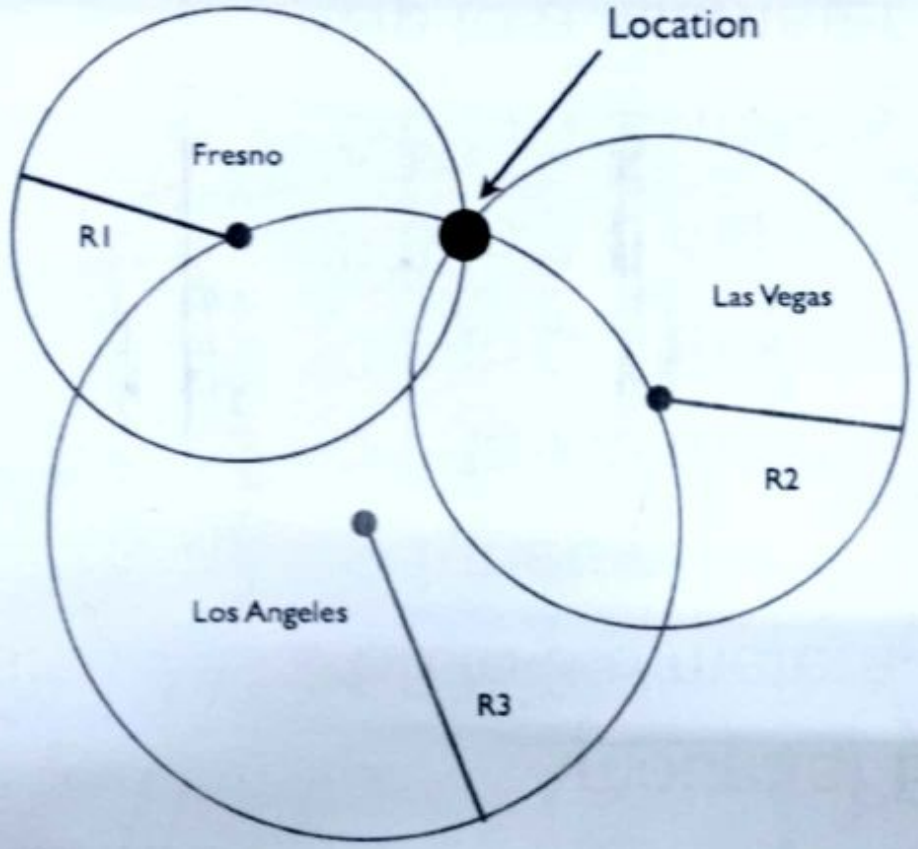
- The signal travels at a known speed.
- The system measures the time delay between the signal transmission and signal reception of the GPS signal.
- The signals carry information about the satellite's location.
- Determines the position of, and distance to, at least three satellites, to reduce error.
- The receiver computes position using trilateration.

Trilateration



In geometry, **trilateration** is the process of determining absolute or relative locations of points by measurement of distances, using the geometry of circles and spheres

Trilateration



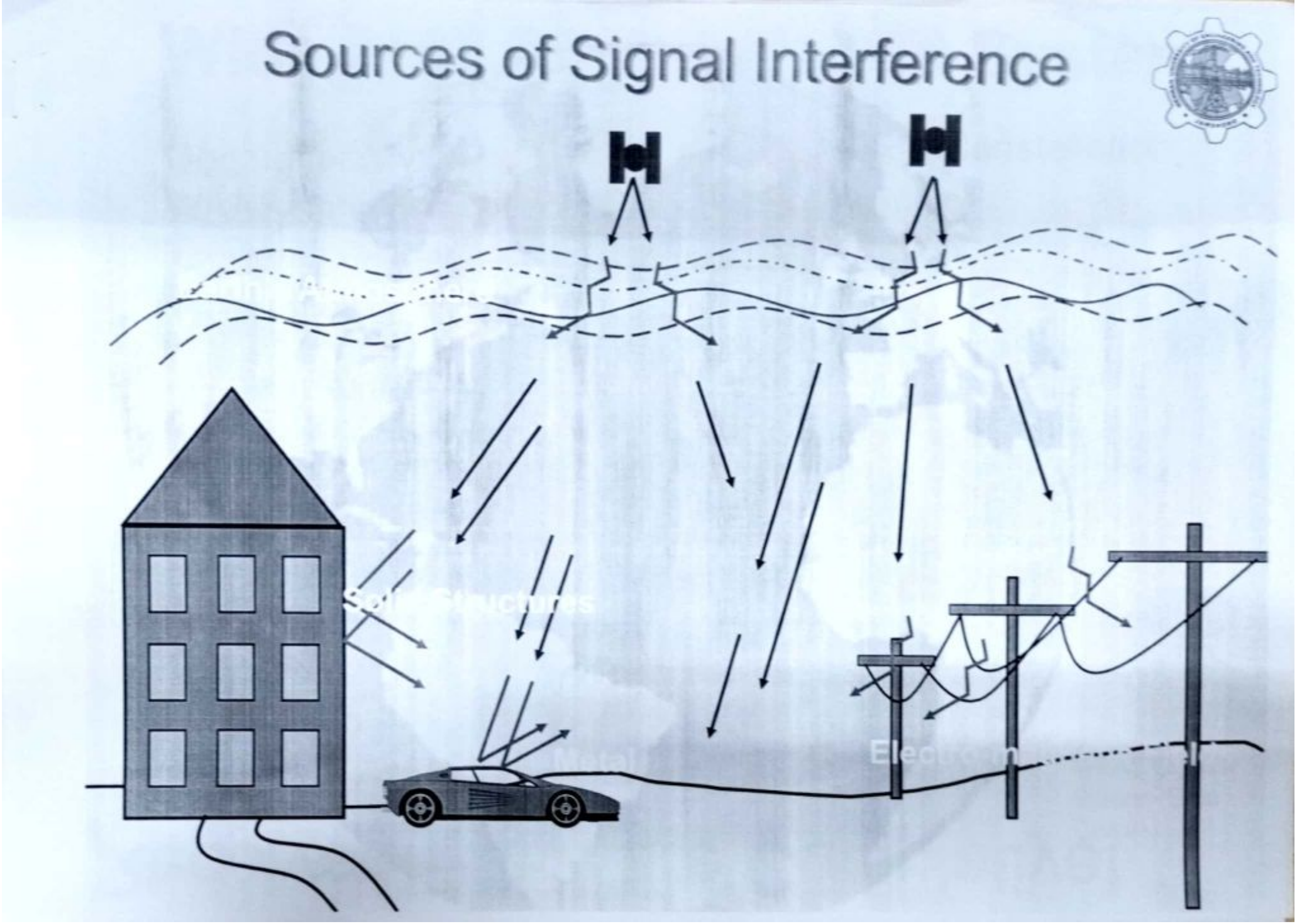
A demonstration of trilateration.
If a user knows his distance (R1, R2, R3) from three transmission towers in Los Angeles, Fresno, and Las Vegas, he can calculate his location

Sources of GPS Error

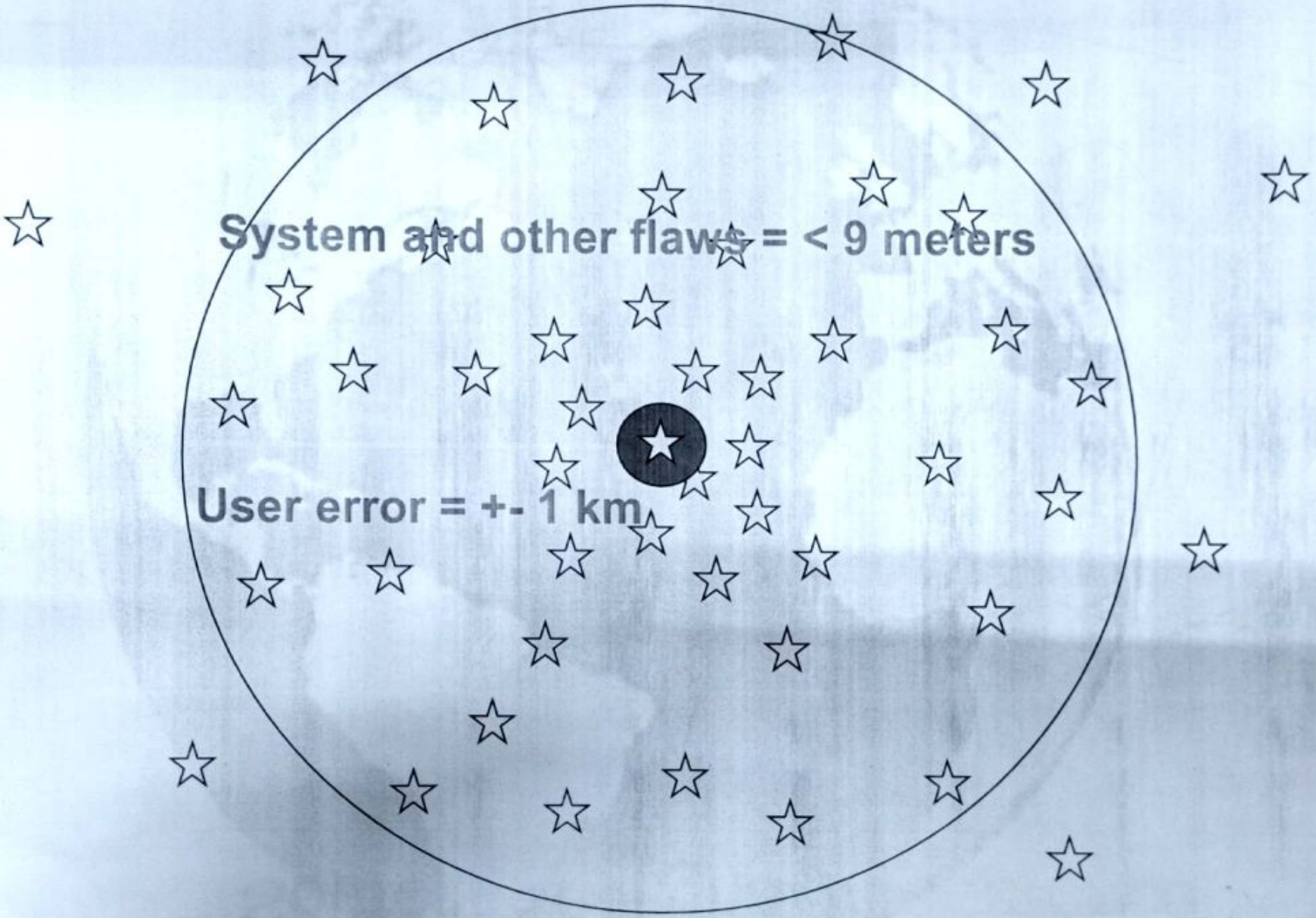
Source	Amount of Error
Satellite clocks:	1.5 to 3.6 meters
Orbital errors:	< 1 meter
Ionosphere:	5.0 to 7.0 meters
Troposphere:	0.5 to 0.7 meters
Receiver noise:	0.3 to 1.5 meters
Multipath:	0.6 to 1.2 meters
User error:	Up to a kilometer or more

Errors are cumulative.

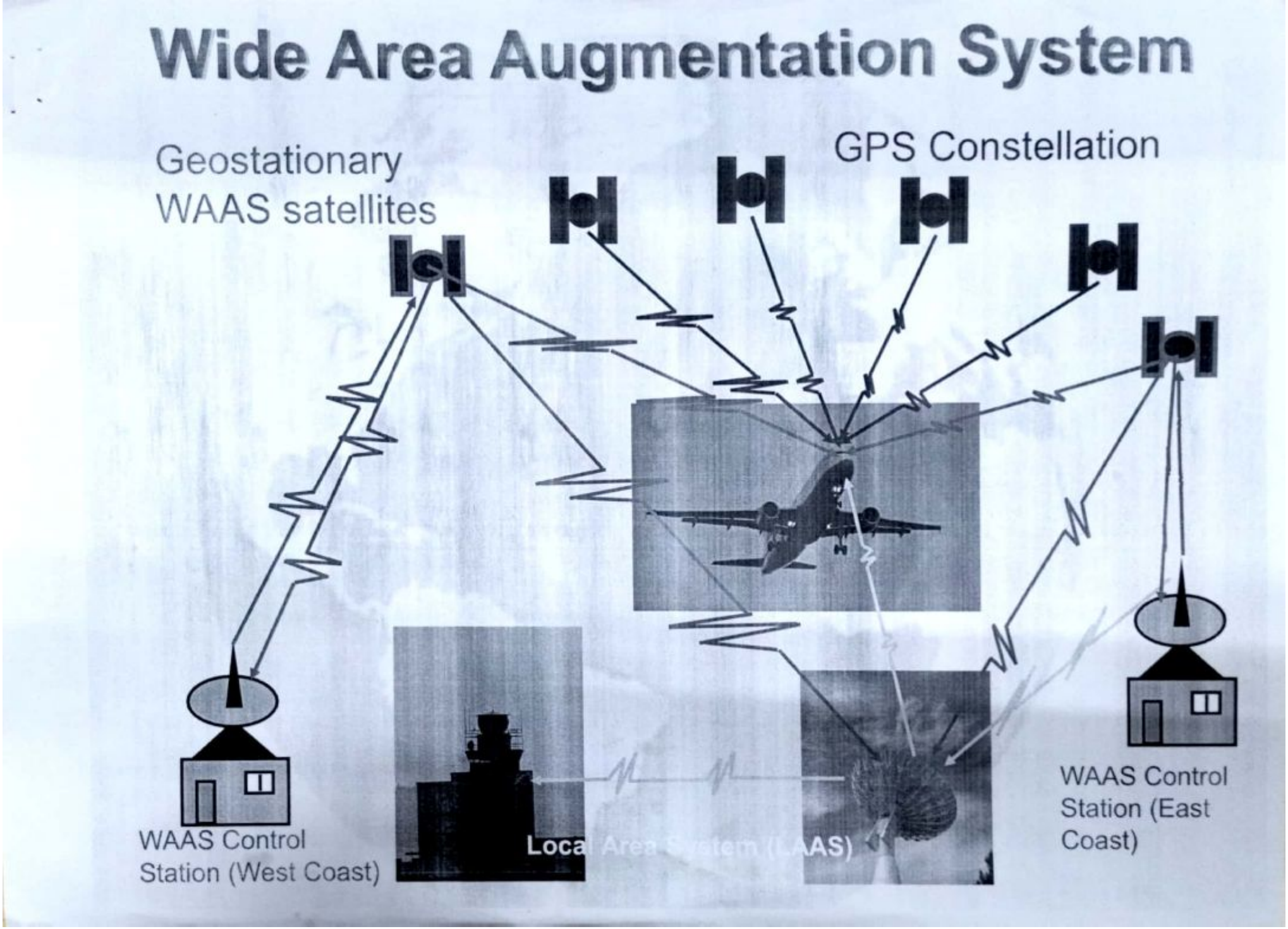
Sources of Signal Interference



Receiver Errors are Cumulative!



Wide Area Augmentation System



QUESTION ?