Geographic Information System (GIS)

Dr. Eman Omar

Outlines

- What is GIS?
- What can GIS do?
- GIS applications
- Components of GIS
- What is special about GIS?
- GIS and geographic questions

What is GIS?

- An information system that is designed to work with geographically referenced data

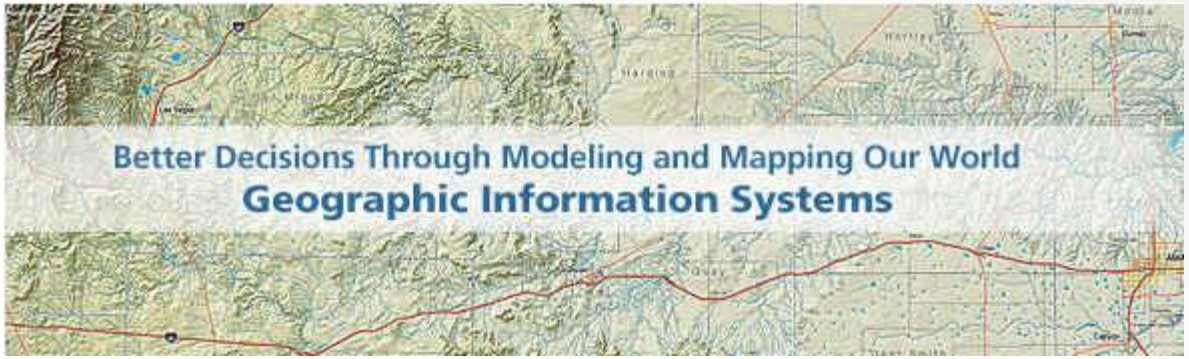


Image from esri.com

- Information system: hardware, software, database
- Geographically referenced data: coordinate system

What is GIS?

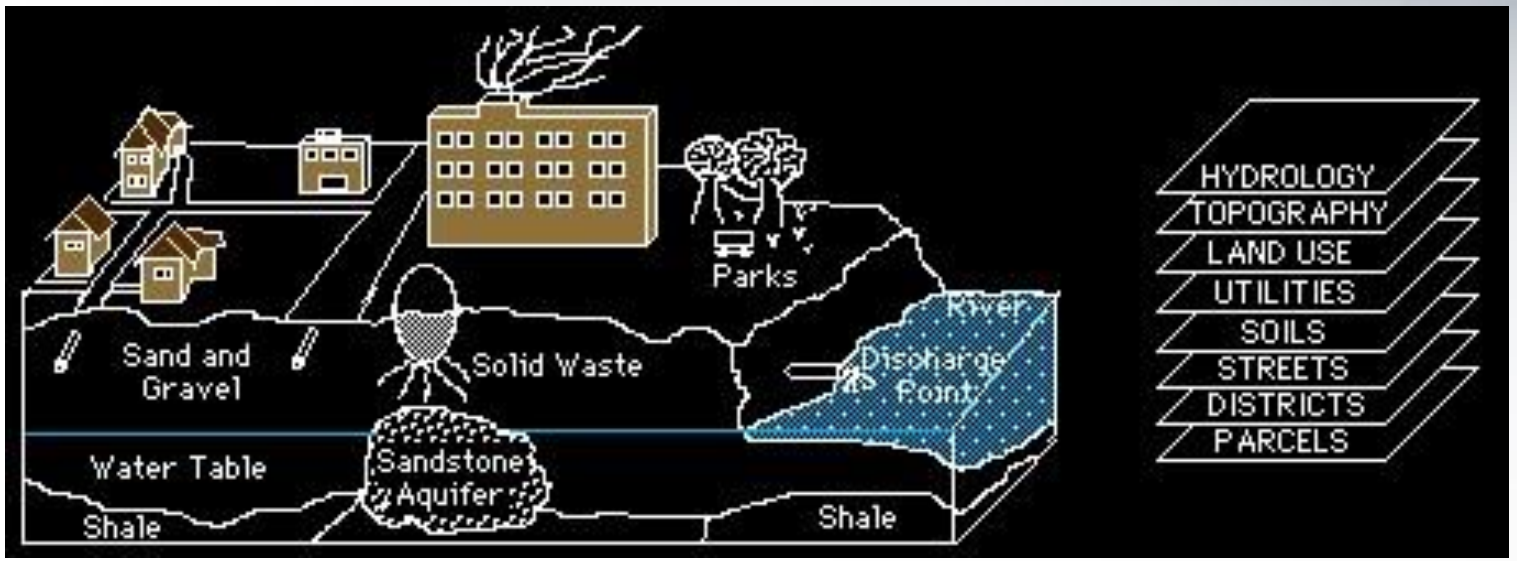
- Is any information system that have the ability to:
  1. Collect, store, retrieve information based on its spatial location.
  2. Identify locations within a targeted environment which meet specific criteria.
  3. Explore relationship among datasets within that environment.
  4. Analyse the related data spatially and make decisions about the environment.
  5. Display the selected data in graphic or non-graphic form.

What is GIS?

Different views

- **Functionalities view**
  - A system for capturing, storing, retrieving, manipulating, analyzing, and displaying data which are spatially referenced to the Earth
- **Information system view**
  - Geographic Information System (GIS) is a kind of Information System (IS) designed to work with geographically referenced data
- **Database view**
  - A database system with specific capabilities for spatially-referenced data, as well as a set of operations for working [analysis] with the data
- **Disciplinary view**
  - GIS as a multidisciplinary science: GIS is an integrated multidisciplinary science consisting of the following traditional disciplines.

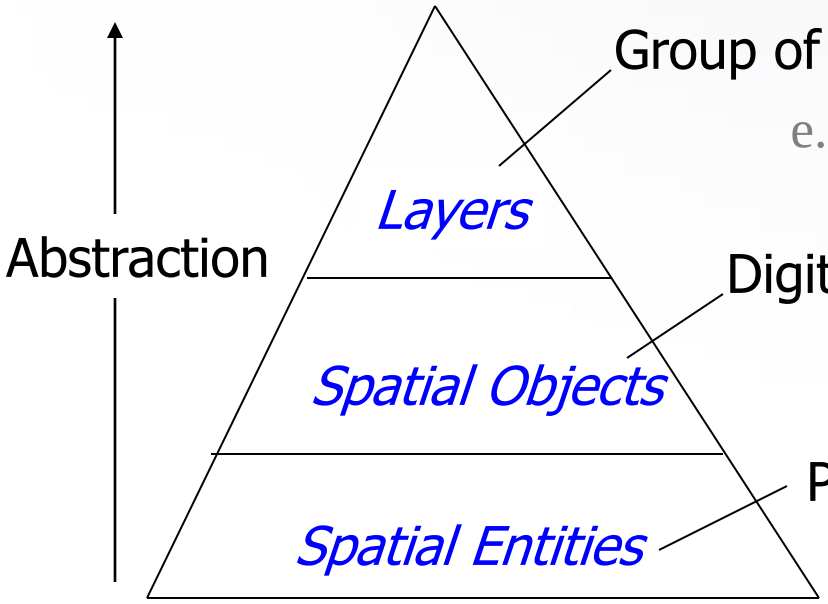
Themes are organized spatially



- GIS organizes the information about place by layers

Themes are put into a computer

Modeling the phenomenon…



Group of spatial objects with related entity type

e.g. city layer, SARS layer, Tornado layer

Digital Representation of Spatial Entities

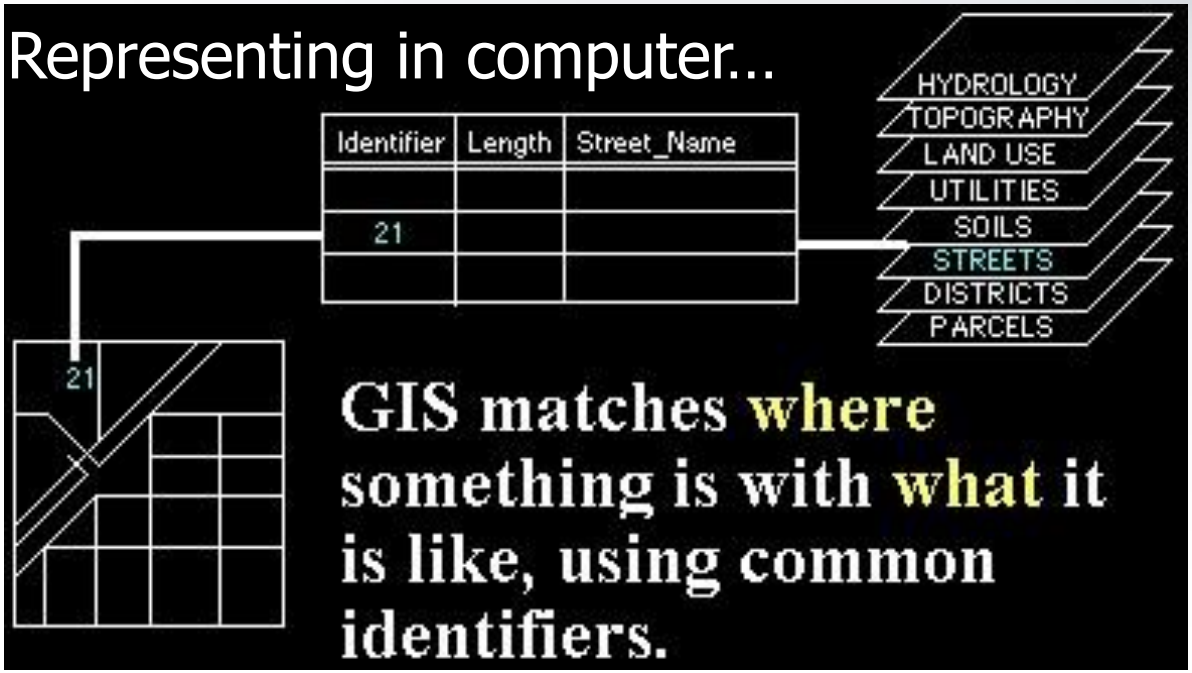
e.g. point, line, polygon

Phenomenon of interest in the real world

e.g. urban growth, Tornado movement
SARS spread, crime, consumer behavior

Putting the geography into a computer…

Link between where and what



- In most of GIS, *spatial objects* are linked to *attributes*
- What about the link between where and when?

Why use Computer Based GIS Systems

- Can process and integrate spatial data with attribute data from different data sources in a single analysis with high speed compared to manual methods.

Components of geographic data

1. The phenomenon being reported such as temp, elevation and so on, also called attribute.
2. The spatial location of the phenomenon such as coordinates.
3. Time (change over time)

- Geo-referenced data (Geographic data): spatial data that related to locations on the earth surface.

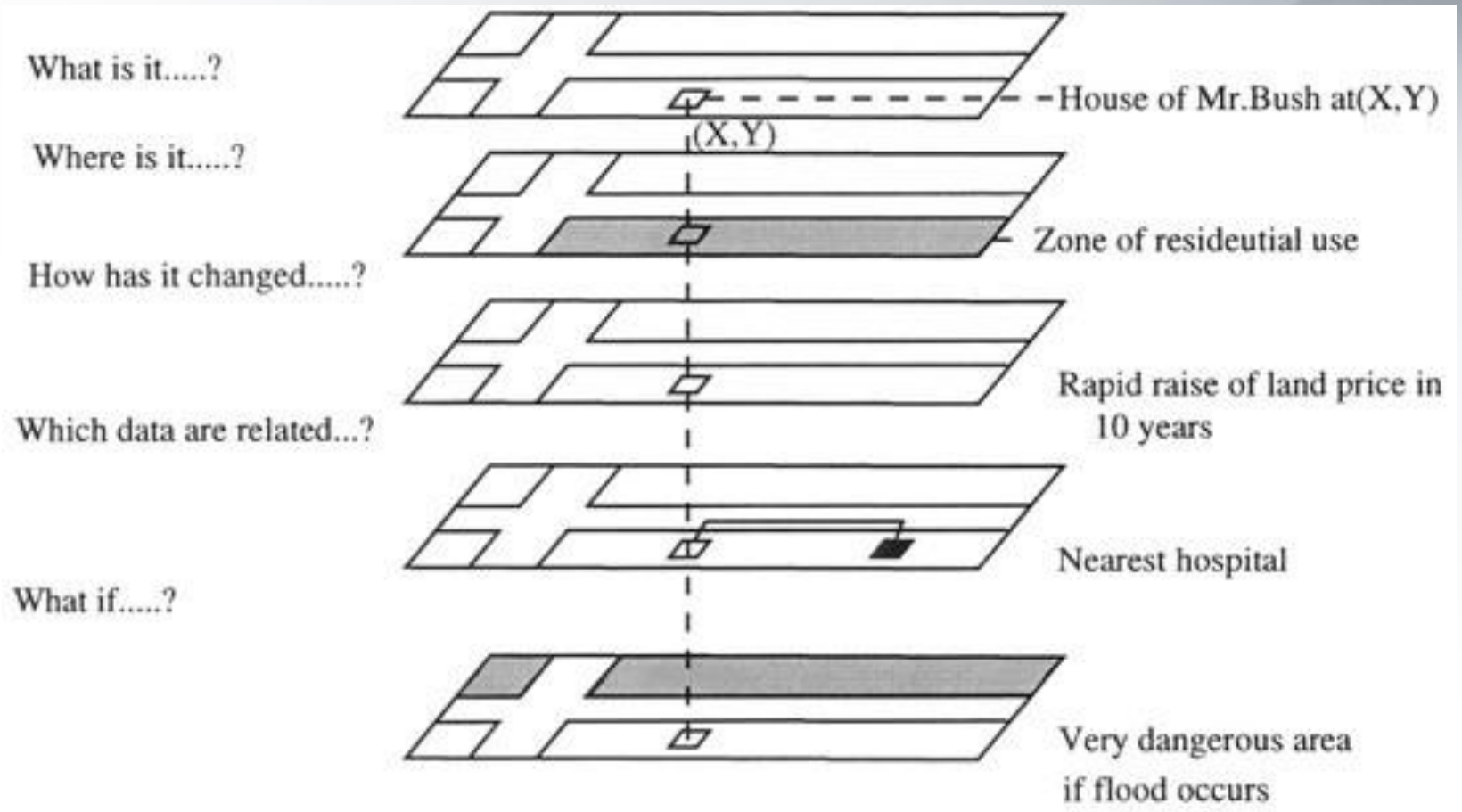
GIS Components

- Data:
  - sensors, Maps, Records
- Hardware:
  - Computer, scanner, GPS
- Software:
  - QGIS, ArcGIS
- Apps/Methods:
  - Route finder
- People:
  - User, analyst, data manger

Spatial Component

- Almost everything that happens, happens somewhere.
  - Estimates are that 80% of all data has a spatial component.
- Knowing where something happens is of critical importance to our daily life and others
- Data from most sciences can be analyzed “spatially”.

Spatial Query



Components of GIS: hardware

- Equipment needed to support the many activities of GIS ranging from data collection to data analysis
- Data acquisition: surveying equipments, GPS receiver, remote sensing equipments, digitizer, scanner
- Data compilation/analysis: workstation
- Data publishing: web-server, mobile computing device

Components of GIS: software

- The definition of GIS by functionalities:

A system for capturing, storing, retrieving, manipulating, analyzing, and displaying data which are spatially referenced to the Earth

- So GIS software provides those functionalities

Components of GIS: data

- Core of GIS
- Kinds of geographic data are extensive
  - Satellite image
  - Maps
  - Table
- Metadata: data about data, documents characteristics of data
- Accounts for 70-80% of GIS projects in the early stage
- Impact of internet is huge; geographic data is increasingly accessible to the general public

What is special about GIS?

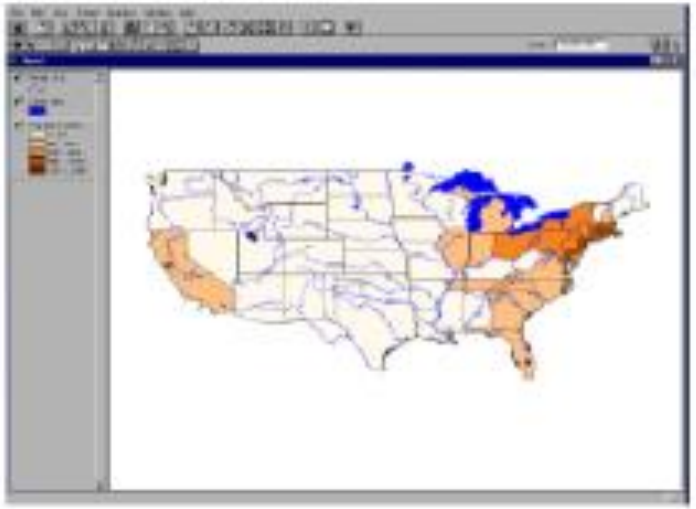
Integration

- Most problems exist in a geographic context. GIS puts various themes together.

What is special about GIS?

Visualization

Database (sequential processing)



Thematic Map (parallel processing)

- I

"A map is worth a thousand word"

Capabilities of GIS

1. Cartographic capabilities: such as digitizing, graphic display, interactive graphic display and plotting.
2. Data Management capabilities: data storage and retrieval.
3. Analytical capabilities: geo-spatial data analysis.

Maps and Map Scale

Maps are a way of communicating and visualising geo-referenced information.

Map Scale: is the ratio (proportion)between measurements on the map and corresponding measurements on the ground.

The map is a model of the reality.

Ways of Representing Map Scale

- Representative Fraction: The ratio between the map and the ground. For example 1:100000 or 1/100000 is interpreted as one map unit is equivalent to 100000 units on the ground. Use the same measurement units inches, Kilometres.
- Verbal Statement: express the scale verbally such as “one inch to sixteen miles”
- Graphical Bar: Is the most commonly used visual representation of scale.

Calculating the ground Distance

- Sm = Dm/Dg

Where,

Sm is the Map Scale.

Dm is the distance on map.

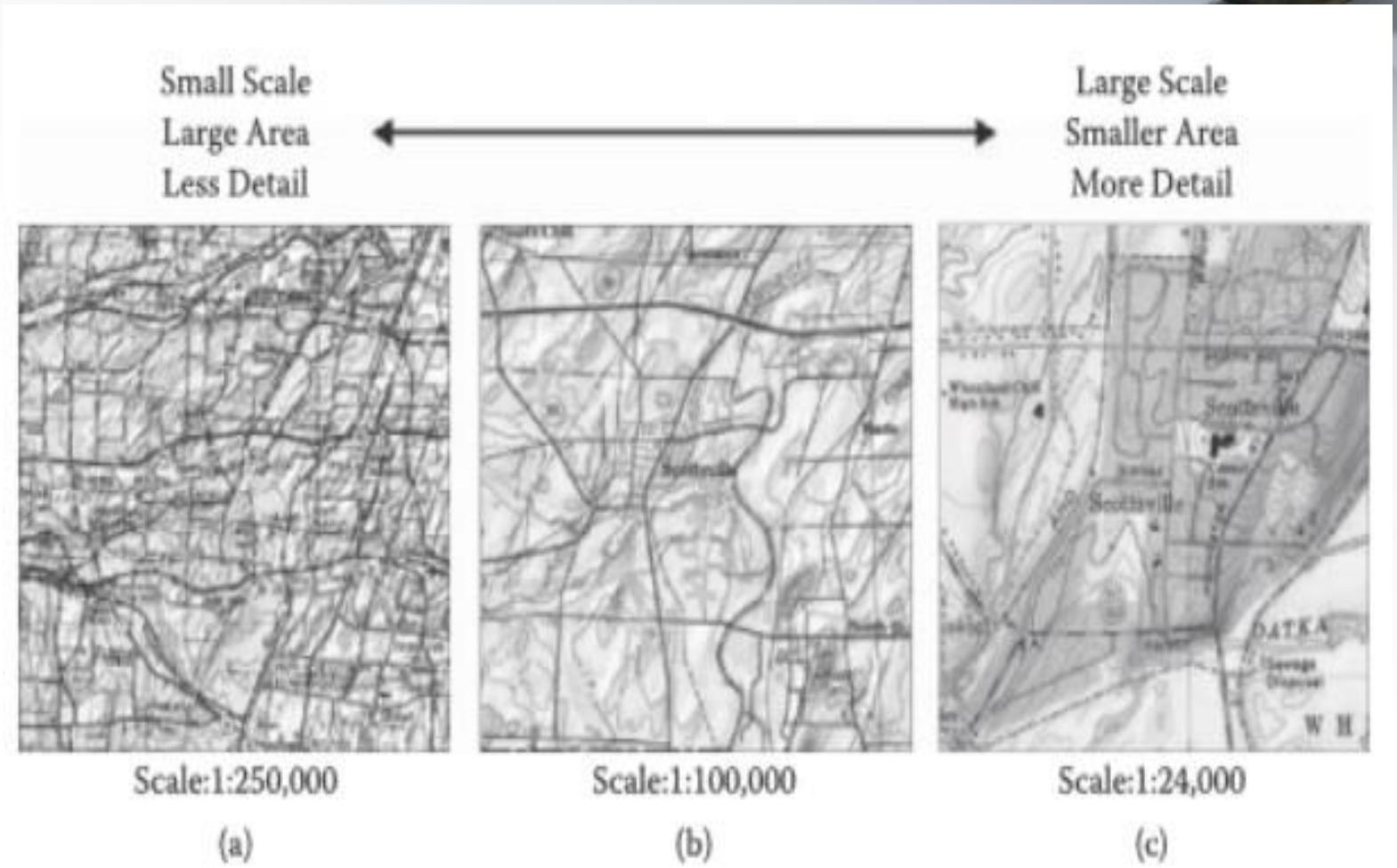
Dg is the distance on the ground.

Large vs. Small Scale Maps

Small-Scale maps show larger areas with less details.

Large-Scale maps: show smaller areas with more details.

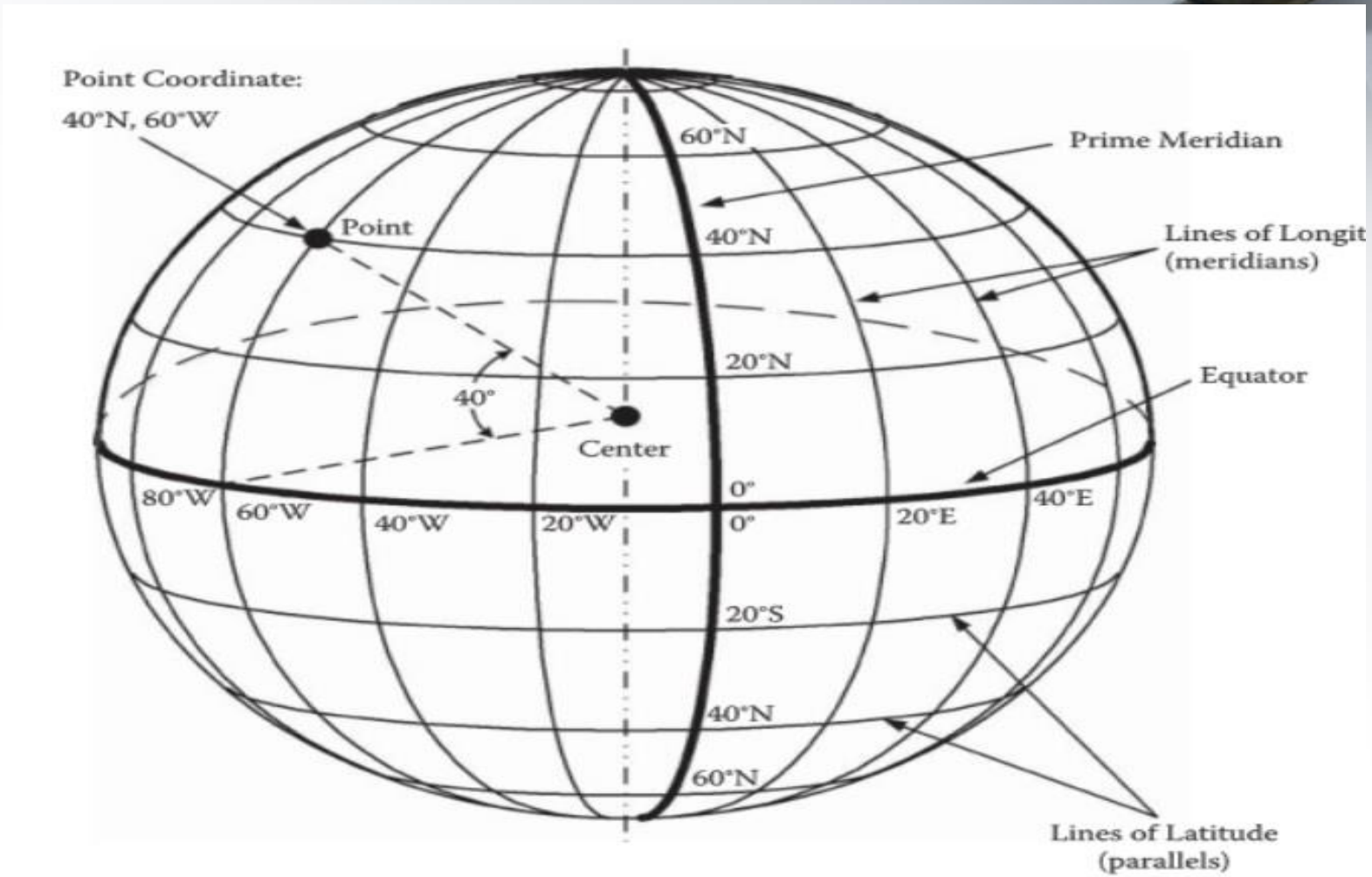
Map Scale cont.



Coordinate Systems.

- Geographical Referencing on the earth surface can take many forms such as zip codes, addresses and Latitude and Longitude.
- Lat and Long are spherical coordinates and the basis for generating other 2-D map projections such as UTM.

Coordinate Systems cont.



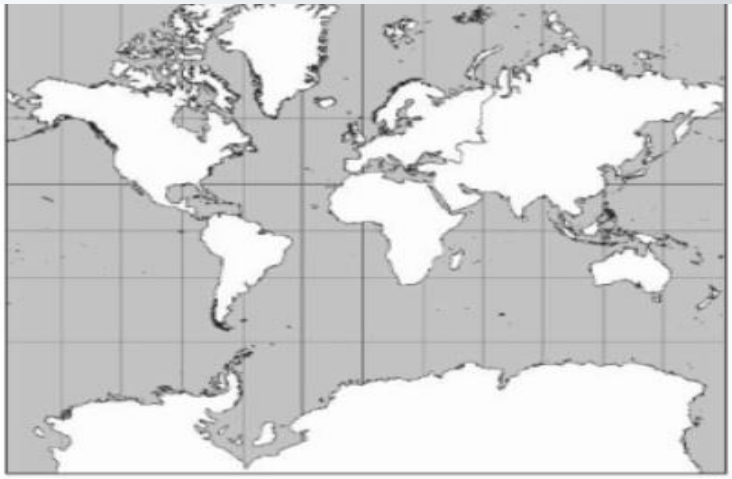
Map Projection

Is a method of representing the earth's three-dimensional surface(Sphere) into a two-dimensional surface.

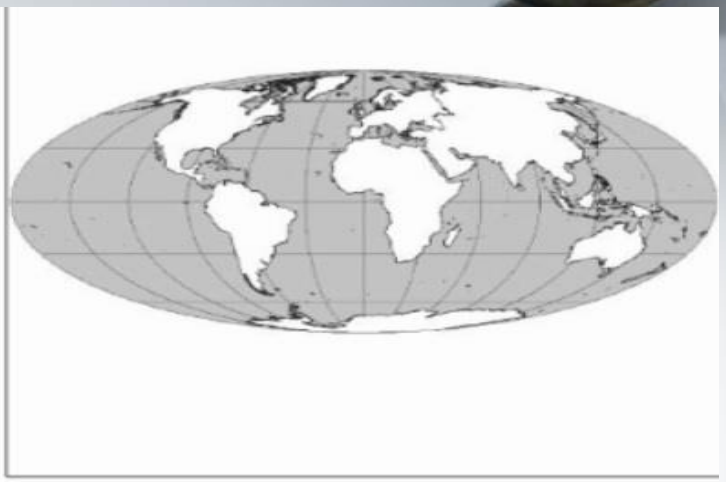
But we should note that:

1. Projections are mathematical transformations.
2. Scale is true only in certain places.
3. There are many projections.
4. All map projections distort. (lose some details)
5. Some types are better for some applications and for some areas.

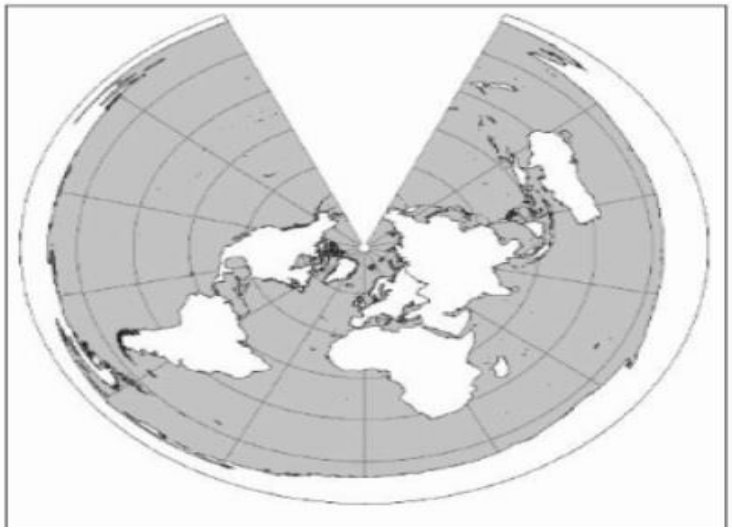
Map Projection cont.

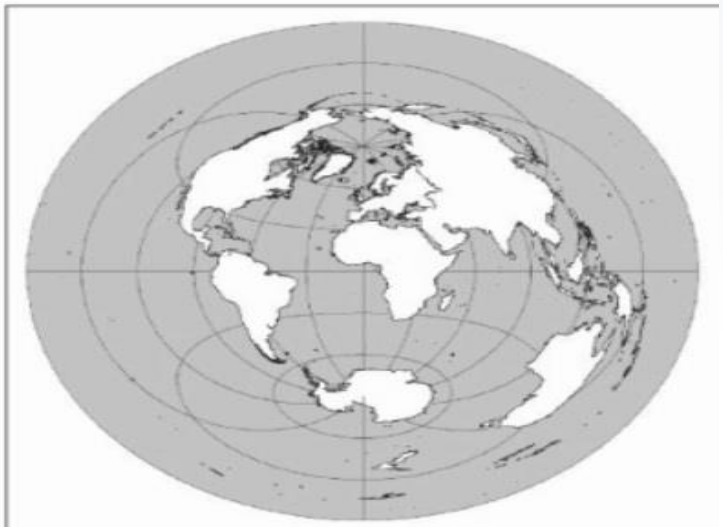


Conformal (Mercator)



Equal Area (Mollweide)





Applications of GIS

- Renewable resources (water, air, soil, forest).
- Business Applications.
- Election administration.
- Infrastructure Management (security, gas, electricity).
- Maps and data publishing.
- Exploration of Gas, oil, minerals.
- Public health and safety.
- Real estate Management.
- Surveying and Mapping.
- Transportation and Logistics.

Applications of GIS cont.

- Urban and regional planning.
- Education and Research.

Relevant Sciences and technologies

- Computer Science.
- Information Management Technology.
- Cartography.
- Geodesy, Photogrammetry and Remote sensing.
- Data Communication.

Review

- Fundamentals of GIS

1. Introduction
2. Definitions
3. Components of Geo-data.
4. GIS Components.
5. Capabilities of GIS.
6. Maps and Map Scale.
7. Map Projection and Coordinate Systems.
8. Applications of GIS.
9. Relevant Sciences and Technologies.

GIS Software and Data sources

- QGIS

Is an open source GIS.

- OpenStreetMap (OSM)

Is Volunteered Geographical Information (VGI) data source, mapping the world.

Thank You

Questions ??