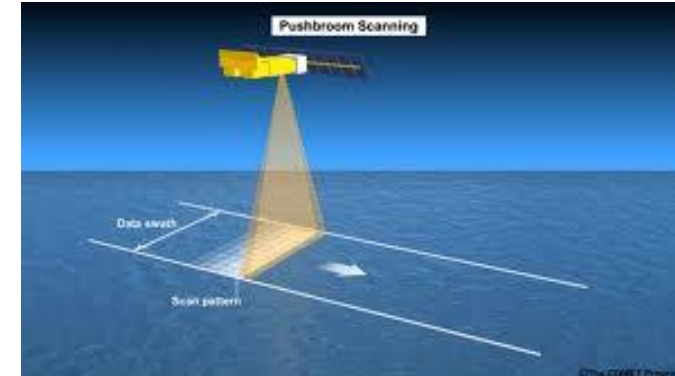
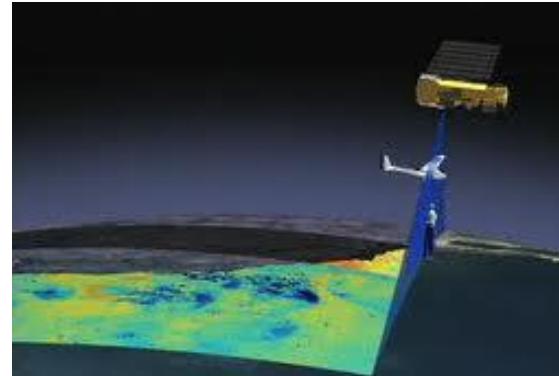


EVNS – 501 Geographical Information System



Dr. S. Jayakumar

Professor

Department of Ecology and Environmental Sciences

Pondicherry University

Puducherry



Content



Co-funded by the
Erasmus+ Programme
of the European Union

- General Information
- Course description
- Course goal
- Course outcome
- Course structure
- Course assessment
- References

1. General Information

Course Code	:	EVNS - 501
Course Title	:	Geographical Information System
Number of Credits	:	4.5 ECTS
Course duration	:	18 Weeks
Level	:	Postgraduate
Course Teacher	:	Prof. S. Jayakumar
Prerequisite	:	Basic understanding on Mathematics (school higher level), English language skill, computer operation (Windows/Mac).

2. Course description

This course provides the fundamentals and basic concepts of Geographical Information System. The basic methods and procedures in Quantum GIS is also taught in the course. The basic operations such as downloading of open source satellite data, geometric correction of topo maps, digitization, head-up interpretation and map composition are also being taught as part of this course.

3. Course goals

The main course objective is to provide a basic understanding on What is GIS and how it can be used to various fields. This course allows the students to acquire hands-on knowledge and skills on GIS software, data handling, spatial analysis.

4. Course outcome

By the end of the course, successful students will:

1. Know the basic concepts and fundamentals of geographic information system
2. Handle GIS software independently
3. Know the different between spatial and non-spatial data, data quality and analysis
4. Approach the environmental problems spatially to find suitable solutions.
5. Handle raster and vector maps and other spatial data to integrate into GIS domain
6. Apply the spatial methods and procedures to find solutions to the environmental problem
7. Be able to identify the root cause for the problem
8. Be able to prepare strategic solution to the environmental problem

5. Course structure

5.a. Course Content

Week -1	Fundamentals of remote sensing
	Components of RS
Week -2	Electromagnetic radiation
	Atmospheric window and effects of atmosphere
	Principles of Scanner and CCD array
Week -3	Types of Sensor and bands
	The pixel
	Spectral reflectance of soil, water and vegetation
Week - 4	Thermal Remote Sensing
	Microwave Remote Sensing
Week - 5	Satellite and Sensors
	Satellite orbits and for different resolution
Week - 6	Digital image processing-mosaicing, histogram equalization
	Image Classification
Week - 7	Air borne and space borne data: Fundamentals of photogrammetry, aerial cameras, planning of aerial photography
Week - 8	Planning of aerial photos and characters of aerial photo
	Types of Aerial photos, Photogrammetry
Week - 9	Elements of aerial photo interpretation
Week - 10	Satellite data availability - Indian space agency - data centre and USGS Earth Explorer

5. Course structure

5.a. Course Content

Week 1	Introduction to GIS
	How does GIS work?
	Components of GIS
Week 2	Cartography and Nature of Maps - 1
	Cartography and Nature of Maps - 2
	Essential Map elements
Week 3	Coordinate system and projection
	Attribute data and Thematic Mapping
Week 4	Vector data model
	Creating thematic map
Week 5	Data classification
Week 6	Arc Node topology
	Polygon arc topology

Week 7	Introduction to QGIS
Week 8	GIS terms and definitions - 1
	GIS terms and definitions - 2
Week 9	Topology and Shape files
	Selection methods in GIS
Week 10	Generalization Problem
Week 11	Overlay methods
Week 12	Raster data model 1
Week 13	Raster data model 2
Week 14	Raster data analysis 1
	Raster data analysis 2
Week 15	QGIS Elements - 1
	QGIS Elements - 2
Week 16	Grass GIS Elements

5. Course structure

5.b. Mode of delivery



In-Class teaching



Google Classroom

On-line teaching

Students will get enrolled in
Google classroom
And online classes will be
conducted if covid -19 conditions
do not permit to conduct off-line
classes

5. Course structure

5.c. In-class discussion

The in-class discussion will focus on how to approach environmental problems spatially and distinguish the factors responsible for the problems

5.d. In-class assignments & field assignment

Understanding various national and international environmental issues in urban and rural areas, preparedness for field study, data quality standards, various methods and procedures available

5.e. Reading and discussion of assigned papers for seminars

Understanding the environmental problem, debate the novel approach in the methodology, need for such studies, data and tools utilized.

5.f. Group project presentation

Ability to make presentation, effective communication, critical interpretation of data, response to audience

6. Course Assessment

Type of assessment	Percentage of Marks
In-class discussion	5
Assignment	5
Seminars	10
Group projects	10
Internal assessment test (MCQ types)	10
Final assessment	60
Total	100

7. References

- Chang, KT, 2017, Introduction to Geographic Information Systems, McGraw Hill Education 4th Edition.
- Robinson, AH, Morrison, JL, Muehrcke, PC, Kimerling, AJ, Guptill, SC, 2009, Elements of Cartography, 6th Edition, Wiley Publication.
- Husain, M, 2014, Evolution of Geographical Thought, Rawat Publishing house.
- Hands-On Geospatial Analysis with R and QGIS
<https://www.packtpub.com/application-development/hands-geospatial-analysis-r-and-qgis> Author: Shammunul Islam Date: November 2018
- QGIS Tutorials and Tips, downloadable from <https://www.qgistutorials.com/en/>

1. What is Geographical Information System?

...a system of computer hardware and software and procedures used by people to collect, manage, manipulate, analyze, and display data with spatial characteristics to produce information about *locations* or *places*.

A computer system consisting of hardware and software that utilizes relational database technology and a topological data structure to allow the integration of raster and vector spatial data with tabular information for display, edit, query, analysis, combination, creation, maintenance, and management of geographic data sets in an environment that is customizable to meet the application needs of the users forming a powerful network of information that facilitates the sharing of data for better decision-making.

2. How does GIS work?

Geographic **I**nformation **S**ystem links locational (spatial) database (tabular) information and enables a person to visualize patterns, relationships, and trends.



+

St./cont.	Name	Conting.	Planned	Address
1764	Richard Mads	01_01	5623	1767 Mile St.
525	Chaz McGinnis	01_01	5354	1765 Mile St.
1017	Nancy Audge	01_01	4875	1763 Mile St.
5689	Patricia Saker	01_01	4726	1761 Mile St.
6503	Bill Rodbeck	01_01	5002	1759 Mile St.
3211	Richard King	01_01	4623	1757 Mile St.
384	Sam Lewis	01_01	5023	1755 Mile St.

=



This process gives an entirely new prospective to data analysis that cannot be seen in a table or list format.

3. What is the need for GIS?

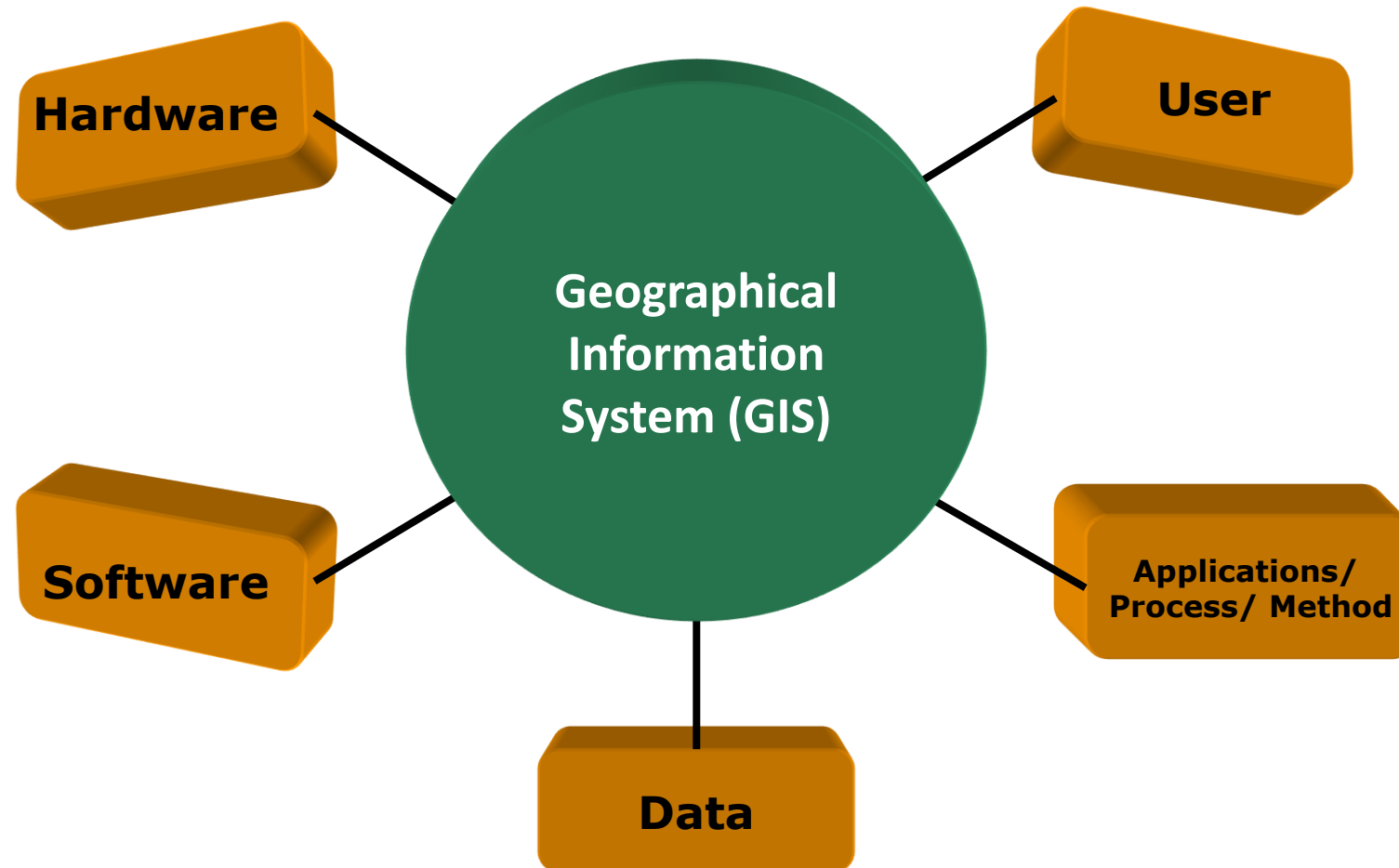
GIS can give solutions to all our spatial problems

What can we do with GIS?

GIS technology helps to answer:

- Location (Where is it...)
- Condition (What is it...)
- Trend (What has changed...)
- Pattern (What is the pattern...)
- Routing (Which is the 'best' way ...)
- Modeling (What if...)

4. Components of a GIS



4. Components of GIS

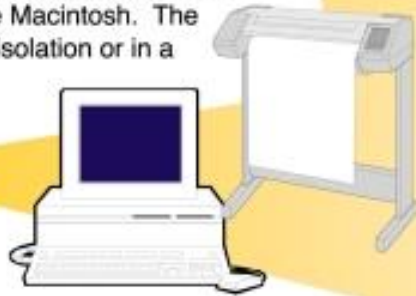
1. Hardware

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

HARDWARE

The hardware is the computer and peripherals on which the GIS operates. Today, this could be a centralized computer server running the UNIX or Windows NT operating systems, a desktop PC, or an Apple Macintosh. The computer may operate in isolation or in a networked configuration.

- **Computers**
- **Networks**
- **Peripheral Devices**
 - **Printers**
 - **Plotters**
 - **Digitizers**





4. Components of GIS

2. Software

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

- Tools for the input and manipulation of geographic information
- A database management system (DBMS)
- Tools that support geographic *query*, analysis, and visualization
- A graphical user interface (GUI) for easy access to tools



Commercial		Open Source	
<ul style="list-style-type: none"> • ESRI ArcINFO, ArcView, ArcGIS • Erdas Imagine • MapInfo • Genamap • ILWIS (Academic) • Microimages TNT • Manifold 		<ul style="list-style-type: none"> • GRASS • QGIS • JUMP • GeoTools • FGIS • GMT • OGR 	

4. Components of GIS

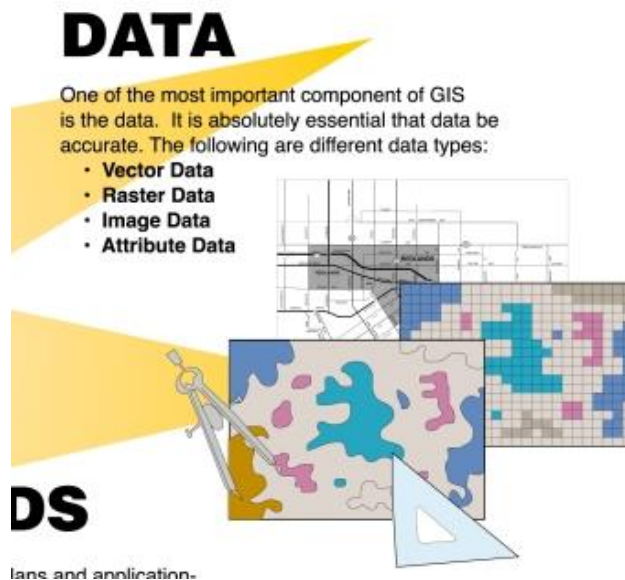
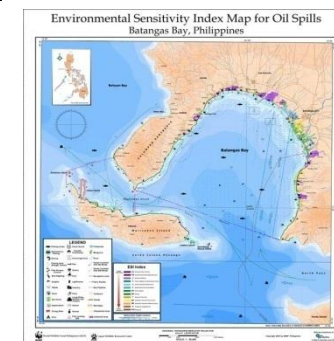
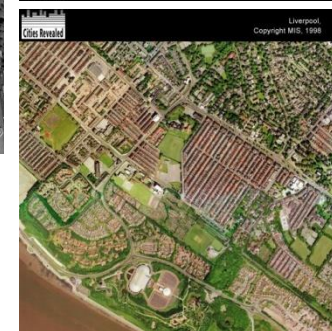
3. Data

Possibly the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organizations to organize and maintain their data, to manage spatial data.

DATA

One of the most important component of GIS is the data. It is absolutely essential that data be accurate. The following are different data types:

- Vector Data
- Raster Data
- Image Data
- Attribute Data

4. Components of GIS

4. Application/Process/Method

It includes the experts and step-by-step procedure to carry out the GIS application

5. User

The end user of GIS application (Govt, NGOs, Companies, etc.)

5. Cartography

- Cartography is the **art, science, and technology** of making maps
- A Map is a geographic representation of a portion of the Earth's surface drawn to scale as seen from above.
- It uses **colors, symbols and labels** to represent features found on the ground.
- A spatial model of the real world, but differentiated from it by: **abstraction, focus, simplification, symbolization scale, projection, and purpose**

6. What is a Map?

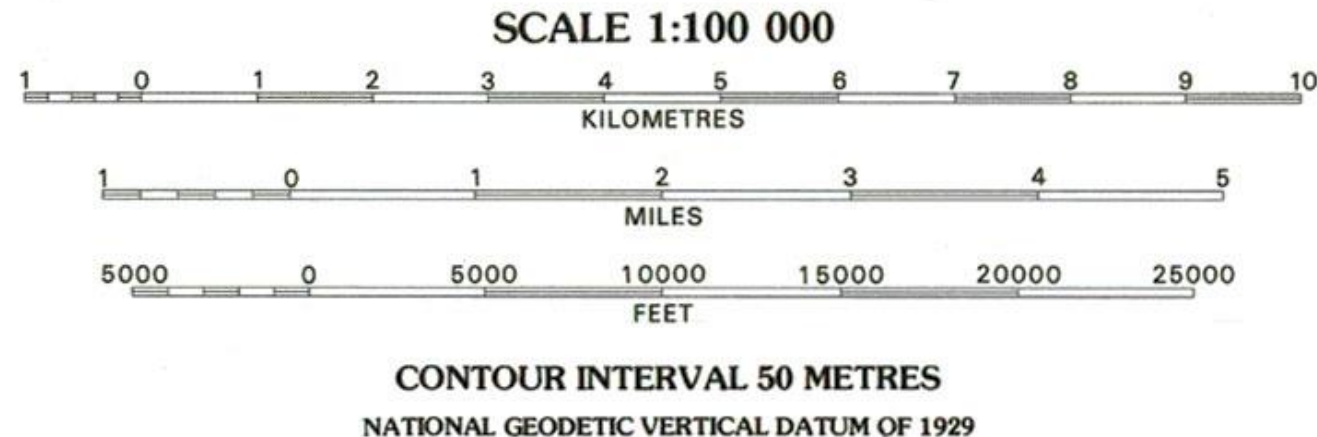
- Map is a visual representation of an entire area or a part of an area, typically represented on a flat surface.
- An abstracted information
- Advantages
 - Measurements
 - Direction
 - Location

7. The Nature of Maps

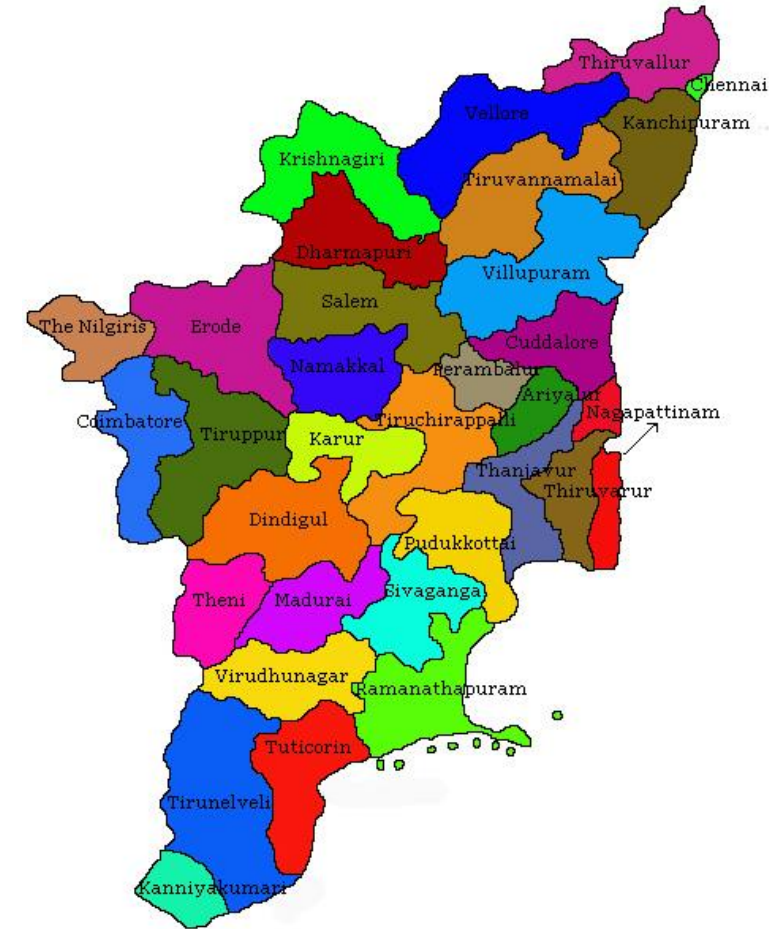
- Maps are an abstracted representation
- Maps simplify the truth that is being represented
- The model of the Earth being represented in a map can rarely be complete
- Maps are used as means of communication
- Every map has the goal to convey a message

8. Scale of Map

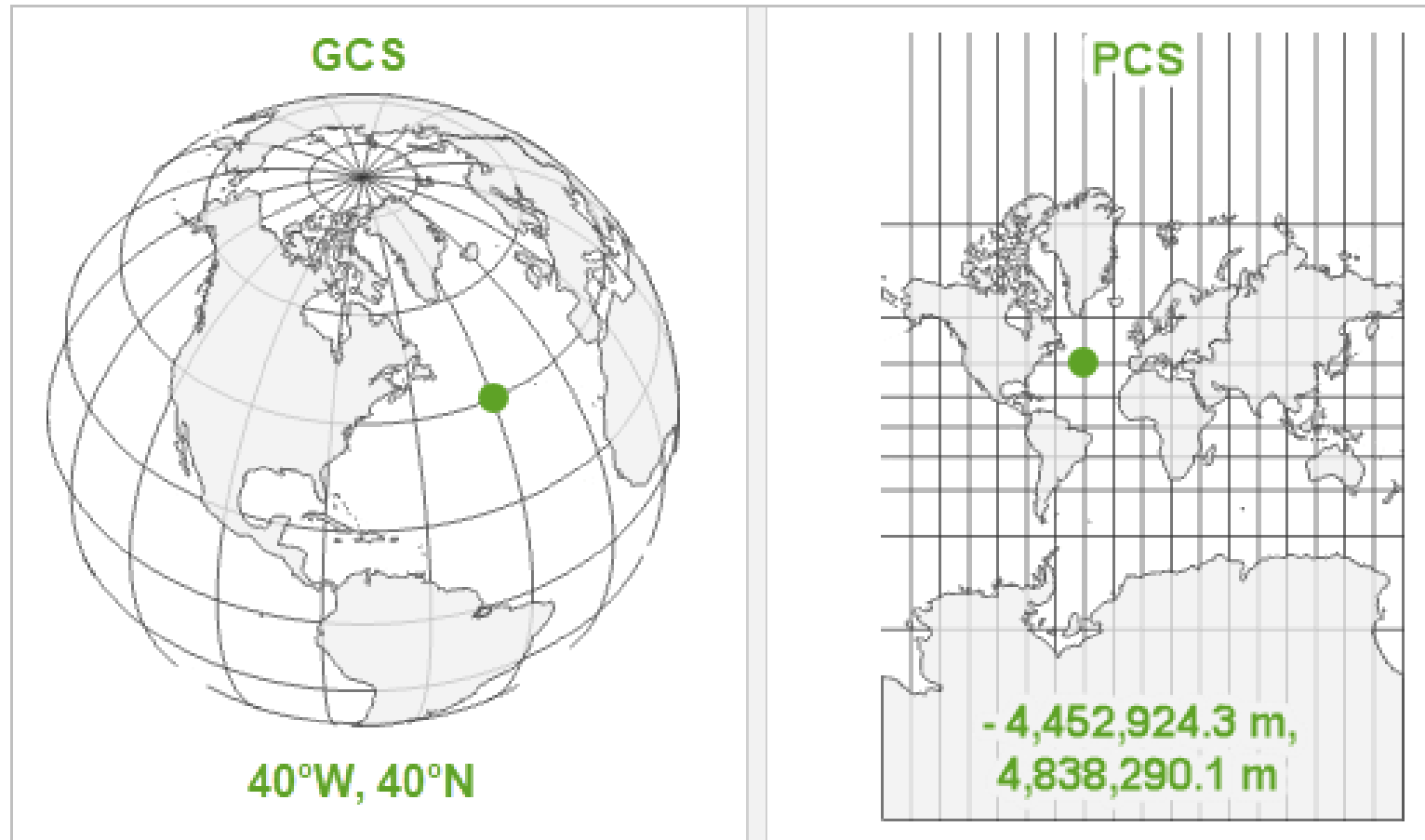
The proportion which, a distance between two points on a map bears to the distance between the corresponding points on the actual ground



9. Large scale and Small scale maps

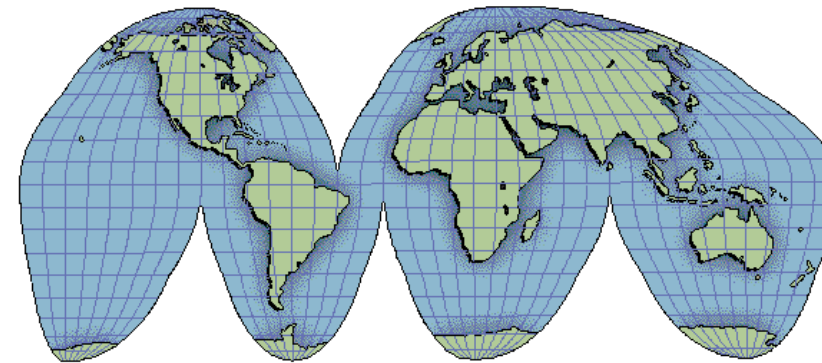
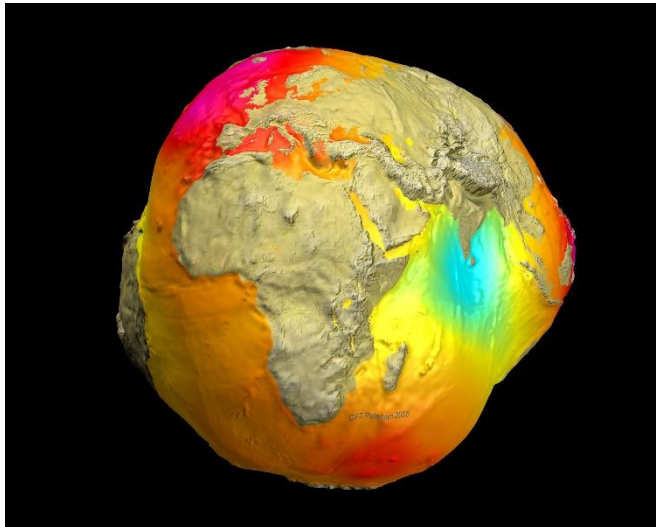


10. Coordinate System



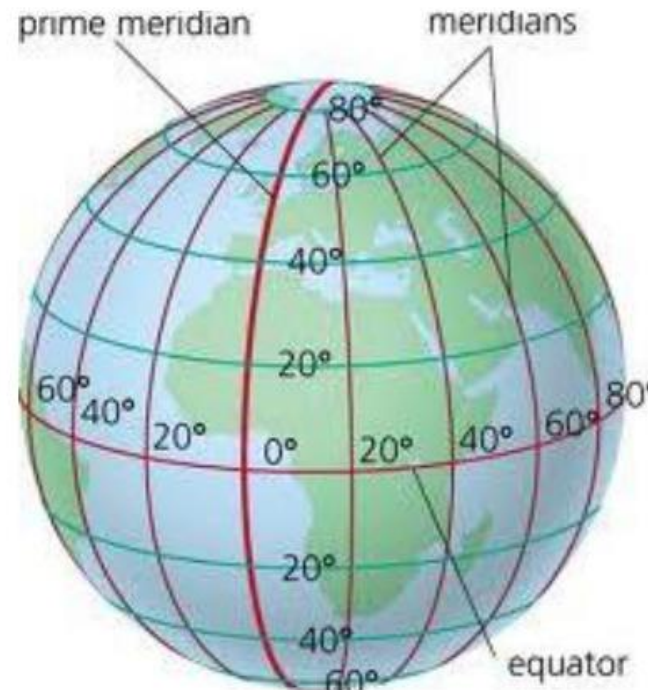
10. Map Projection

A mathematical model that transforms the locations of features on the earth's surface to locations on a two-dimensional surface.



10. Map Projection

Latitude and Longitude



Exercise

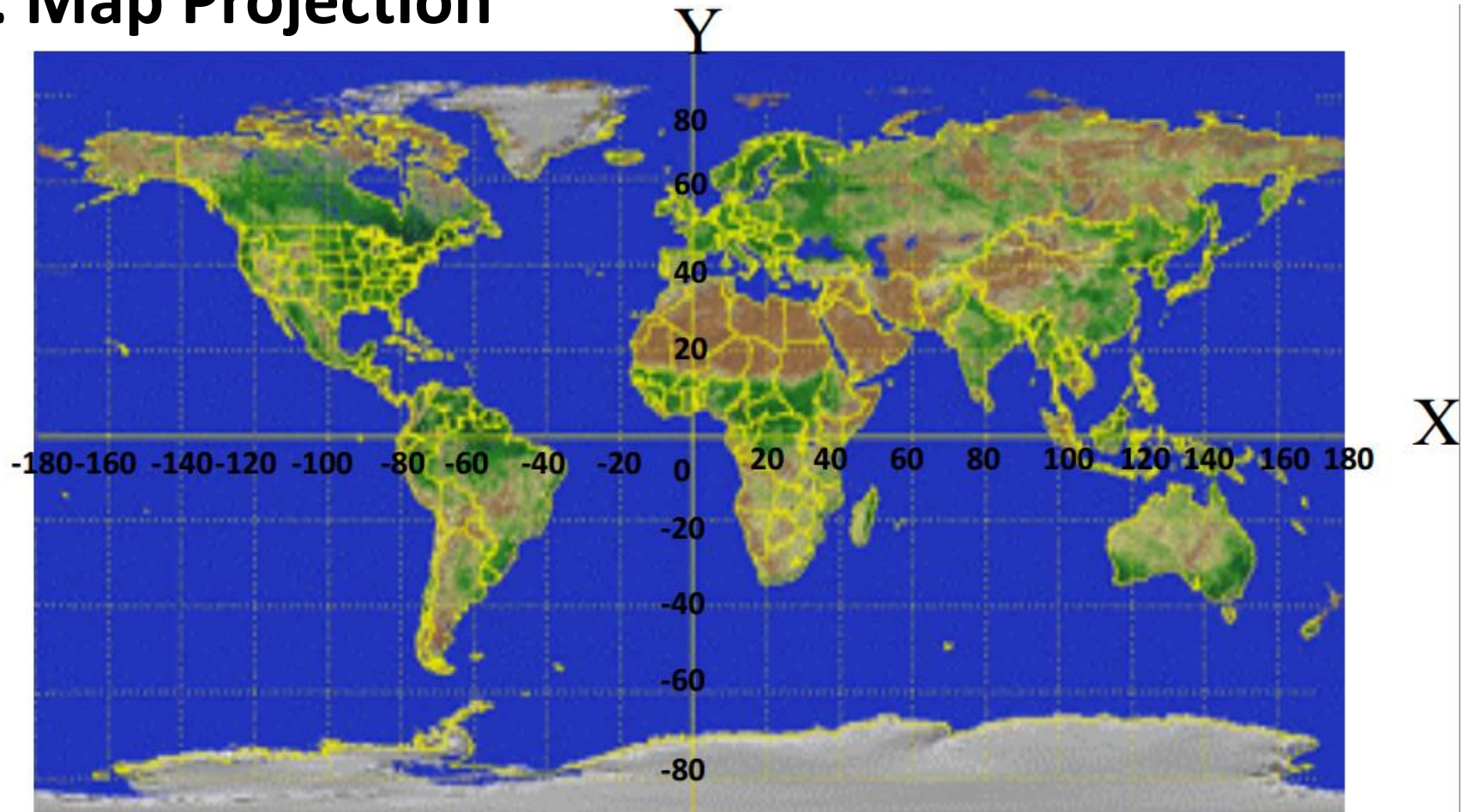
In which quarter these
Lat/Long are located

	Lat	Long
➤	43°	21°
➤	78°	-111°
➤	-4°	23°
➤	-15°	-29°

Latitude - distance from the equator along the Y axis

Longitude - distance from the prime meridian along the X axis.

10. Map Projection



X - Equator.

Y - Prime Meridian

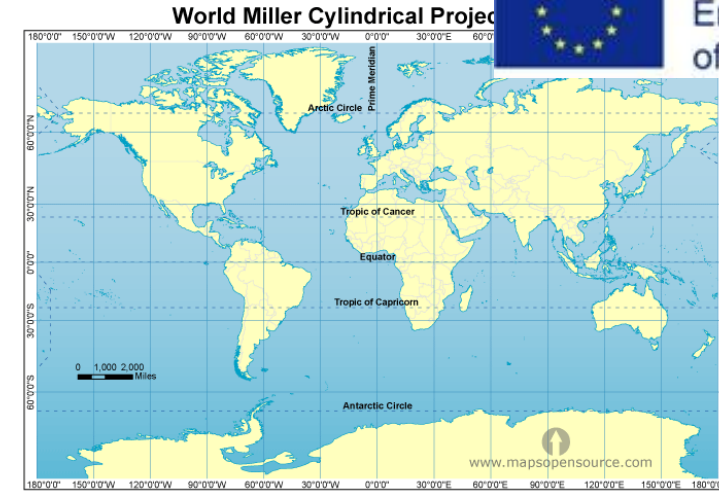
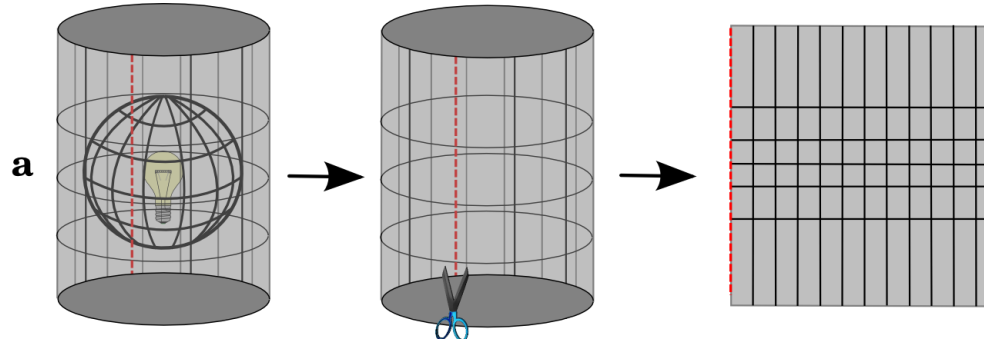
Lat/Long are the coordinate of point on earth.

10. Map Projection

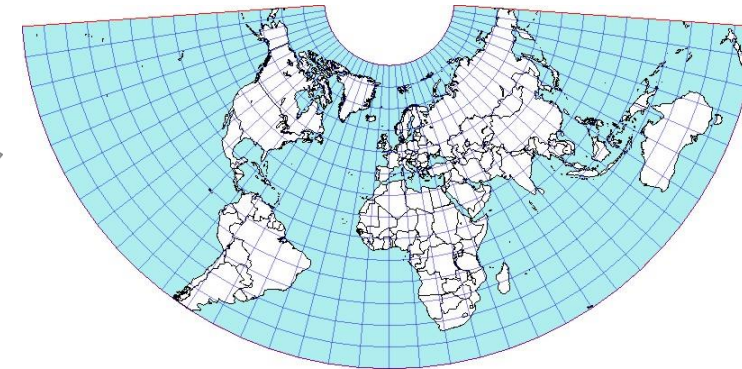
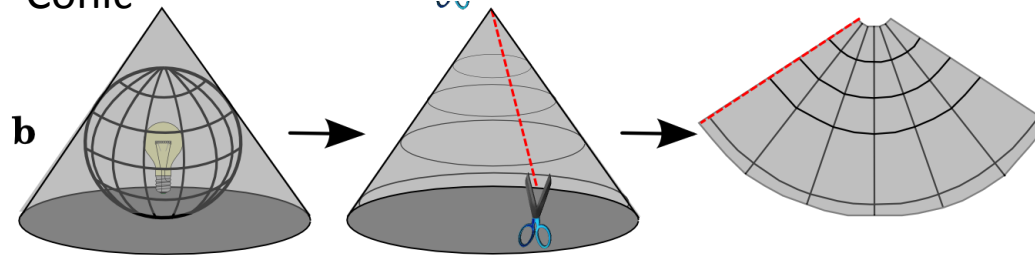
Projections

- Goal: translate places on the Earth (3D) to Cartesian coordinates (2D)
- The systematic transformation of points on the Earth's surface to corresponding points on a plane surface.
 - Map projections always introduce some type of distortion
 - selection of a projection is done to minimize distortion for the particular application

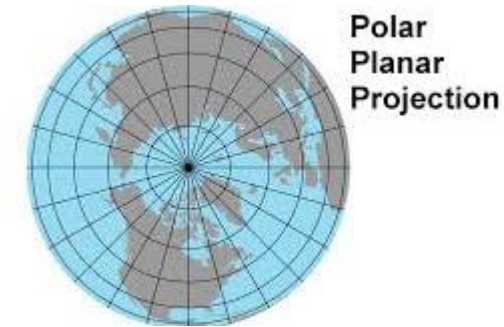
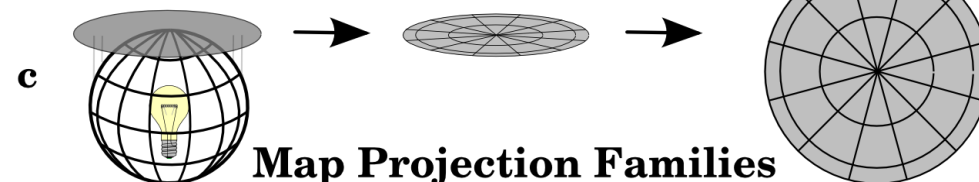
Cylindrical



Conic



Azimuthal



Map Projection Families

11. Essential Map Elements –Map Design and Layout

Primary Elements

- Title (What, Where, When)
- Subtitle



11. Essential Map Elements –Map Design and Layout

Primary Elements

- Legend

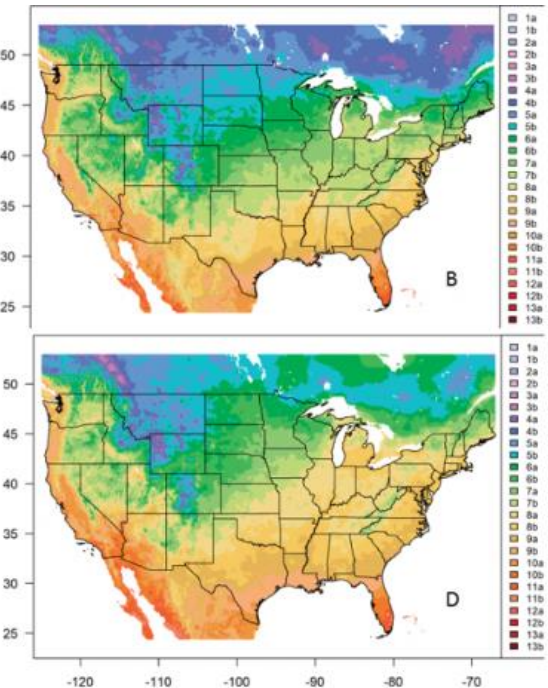
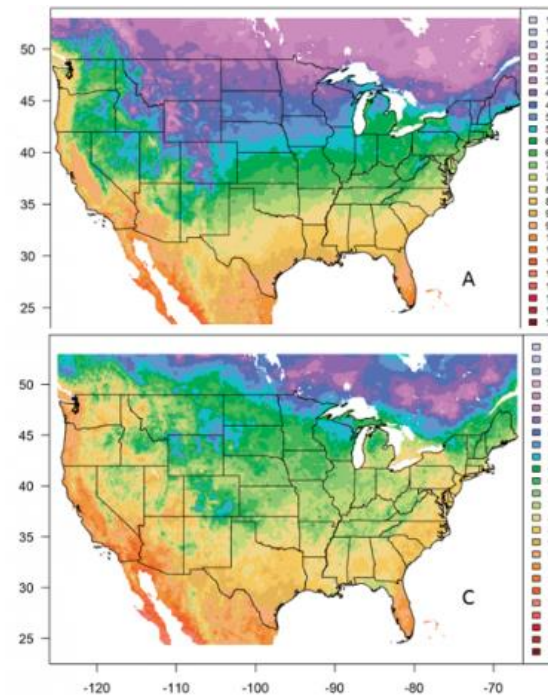
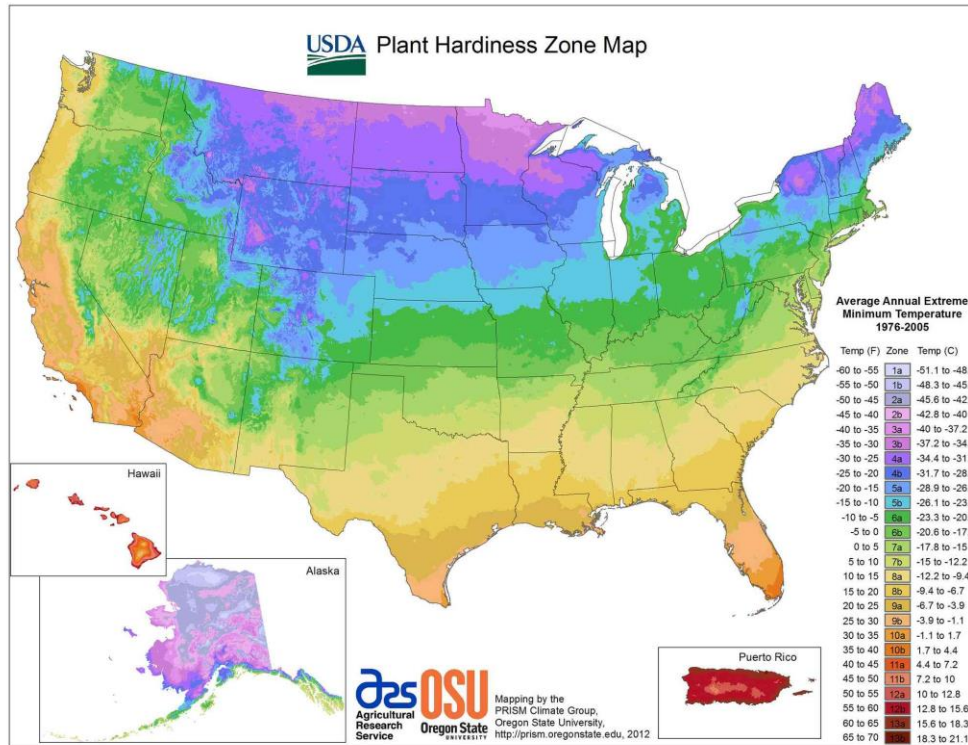
LEGEND

(Note: Not all symbols are visible on all maps.)

<p>Road Designation</p> <ul style="list-style-type: none"> ○ Interstate □ U.S. Highway ○ State Highway □ Numbered County Road 	<p>Road Features</p> <ul style="list-style-type: none"> ———— Paved, Named Secondary Road ———— Paved Major Road ———— U.S. or State Highway ———— Interstate - - - - - Gravel or Dirt, Named Road - - - - - Gravel or Dirt, Major Road Paved, Private Road or Driveway Gravel or Dirt, Private Road or Driveway Road mapped from other sources, Unverified ——+—— Railroad 	<p>Miscellaneous Facilities</p> <ul style="list-style-type: none"> ☠ Cemetery ⛪ Church ⚖ Courthouse or City/Town Hall 🚒 Fire Department 🏥 Hospital ★ Police or Sherriff's Department ✉ Post Office 🎓 School
<p>Text Features</p> <ul style="list-style-type: none"> 99 Highway Mile Markers 100 Interstate Exit Numbers 16000 Intersection Address ? Unverified Location of Address 15490 Verified Location of Address • 15490 Verified Location of Address HILLTOP Subd, MHPk, Apt 	<p>Boundaries and Regions</p> <ul style="list-style-type: none"> ———— County Boundary ■ Incorporated City or Town <small>(Lake Tuscaloosa included in City of Tuscaloosa)</small> ■ State Parks and National Forests ———— Township and Range Lines Section Lines 	<p>Miscellaneous Symbols</p> <ul style="list-style-type: none"> 🏠 Apartment Building ⚓ Boat Launch 📡 Communication Tower 🔥 Fire Hydrant ⛑ Gas Well 🚪 Gate ⛳ Golf Course 📍 Landmark 🚁 Lifesaver Helicopter Pad ⚡ Power Substation 🌊 Water Tower

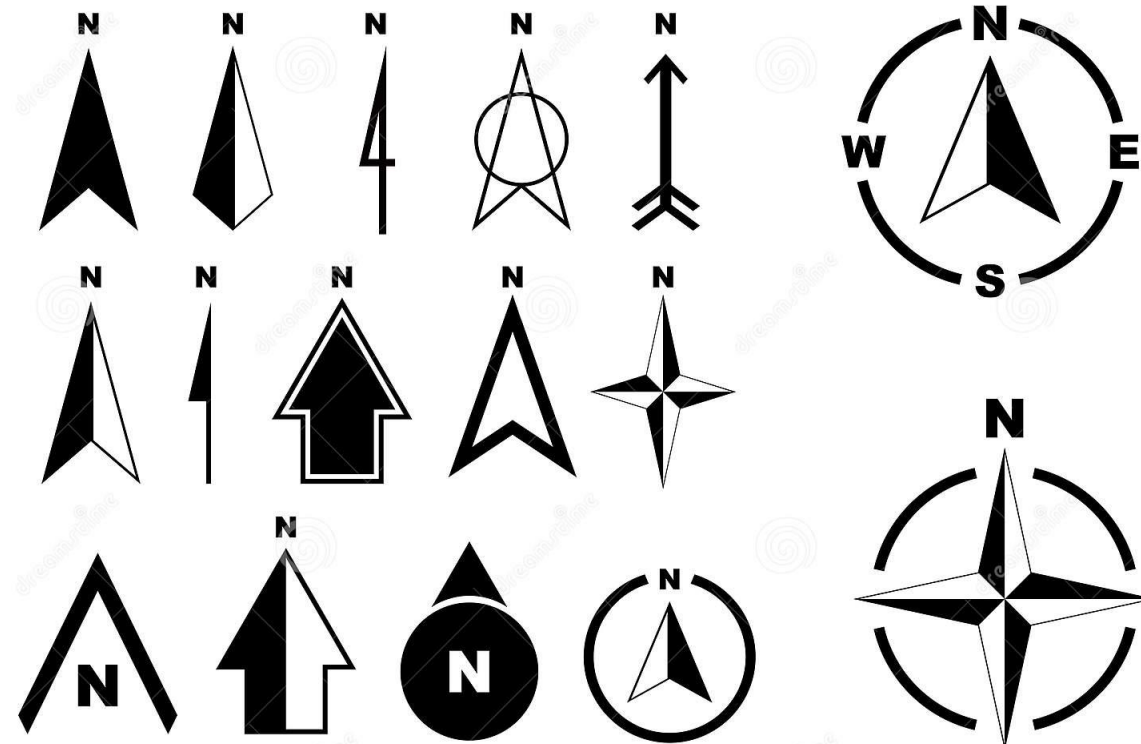
11. Essential Map Elements –Map Design and Layout

Primary Elements - Maps



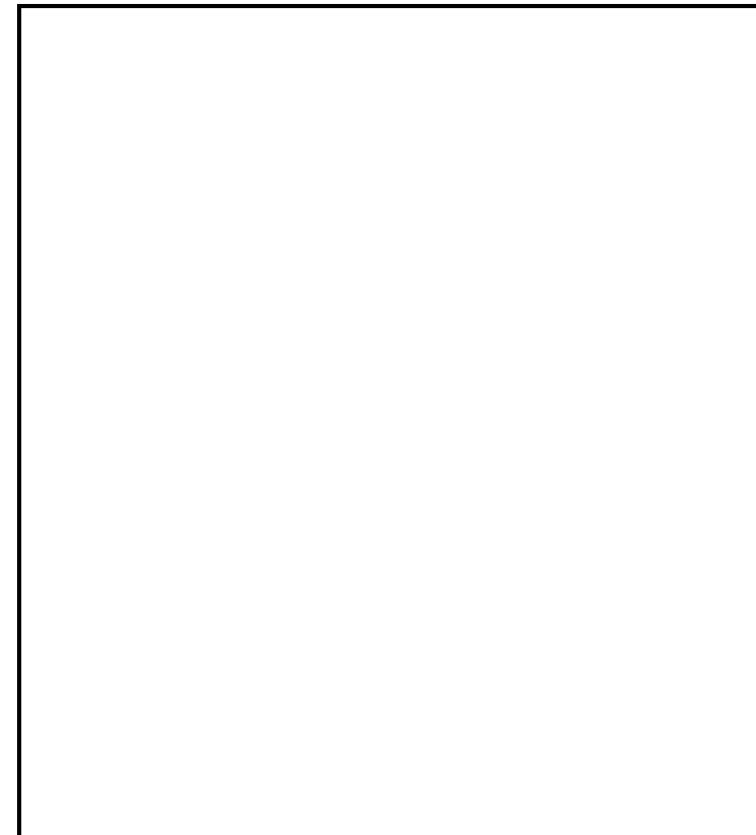
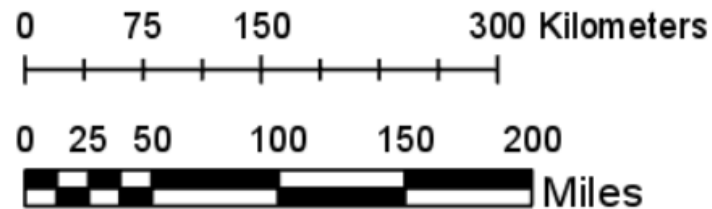
11. Essential Map Elements –Map Design and Layout

Primary Elements - Maps



11. Essential Map Elements –Map Design and Layout

Primary Elements – Date, Authorship, Scale bar, Page border



11. Essential Map Elements – Map Design and Layout

Secondary Elements – Neat line, Graticules

