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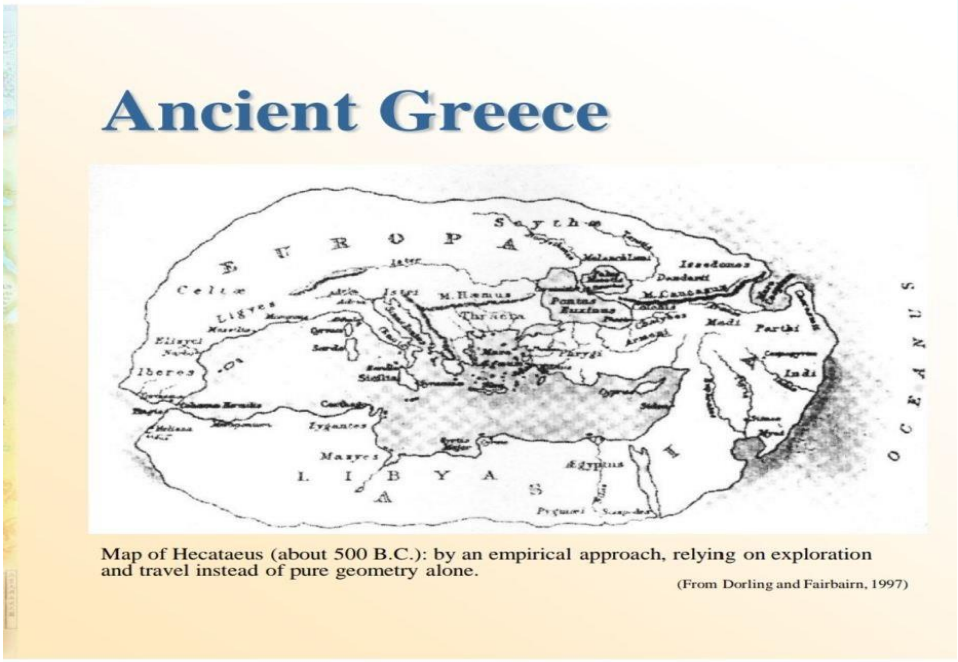
Module V: Cartography and GeoInformatics

1.Development of cartography

- Cartography is defined as the **science and art of making maps** or **graphical representations showing spatial concepts at various scales**.
- Maps convey geographic information about a place and can be useful in **understanding topography, weather, and culture, depending upon the type of map.**
- Early forms of cartography were practiced on **clay tablets and cave walls.**
- Today, maps can show a plethora of information.
- Technology such as **Geographic Information Systems (GIS)** allows maps to be made relatively easily with computers.
- The word cartography is a combination of two words **'carta'** which **means map** and **'graph'** that is something written or represented in the **specified manner, or about a specified subject.**
- Ancient Babylonians 3000 BC to 400 AD
  - ❖ Babylonians
    - ➢ Principles of cartography were understood as early as 2300 BC when they drew maps on clay tablets as well as Egyptian drawings.
    - ➢ UseGreeks immediate are not whole earth engineering & cadastral

- Greeks
  - ➢ Pursued development of geographical knowledge ~600 BC
  - ➢ the Early view of earth as round disk surrounded by ocean
  - ➢ By 4 Century BC scholars accepted the earth was a sphere Proven by **Aristotle‘s six arguments**
  - ➢ Excelled in mathematical calculations & theoretical earth issues



- Egypt
  - ➢ A map made in Ancient Egypt showing the trace of gold workings in Egypt.

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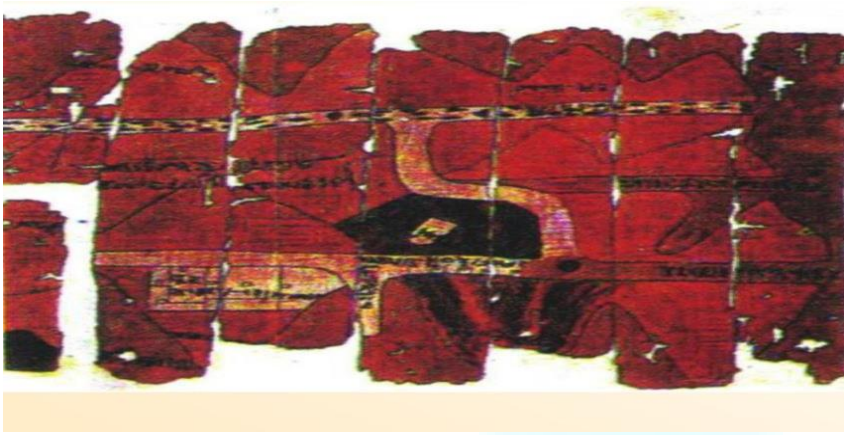
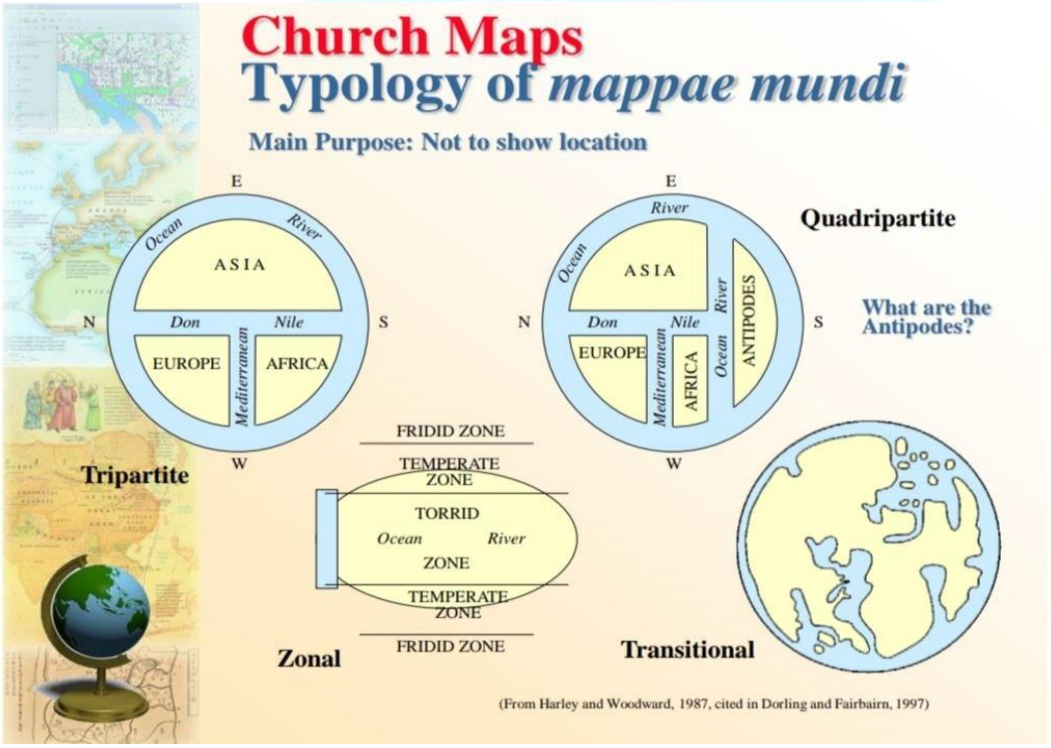
➢ The map, now in Turin, depicts gold workings around the time of **King Seti I (1350 B.C.)**



❖ Romans

➢ Focused on military & administrative needs

➢ Disk shape of world was simple & easy to use



❖ Chinese (develop independently)

➢ Astronomical knowledge

- ➢ Astronomical knowledge existed in Shang **(Dynasty, 11th century B.C.)**
- ➢ Three maps made in Han Dynasty **(2nd century B.C.)** were discovered
- ➢ The earliest magnetic compass made in the West Han Dynasty (**206 B.C. 8 A.D.**)

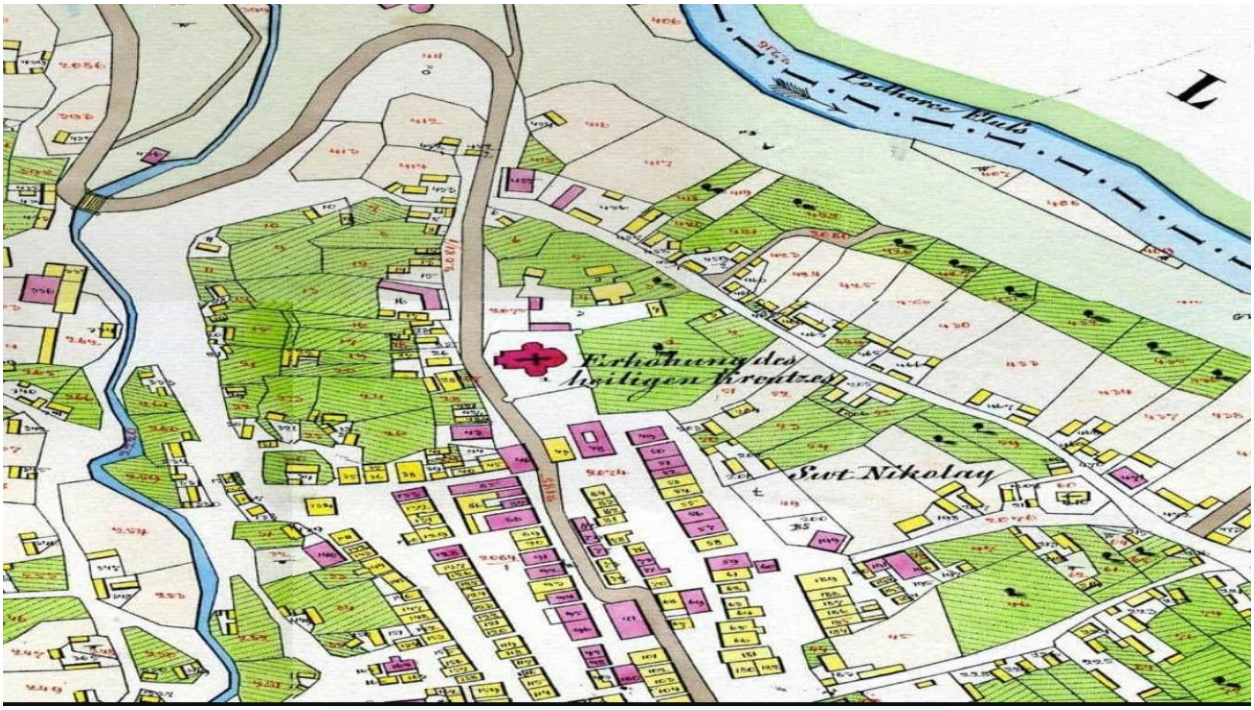
❖ Europe

- ➢ **Aristotle (384-322 B.C.)**: Earth is a sphere
- ➢ **Ptolemy (90-160 A.D.)**: **Geographia**.

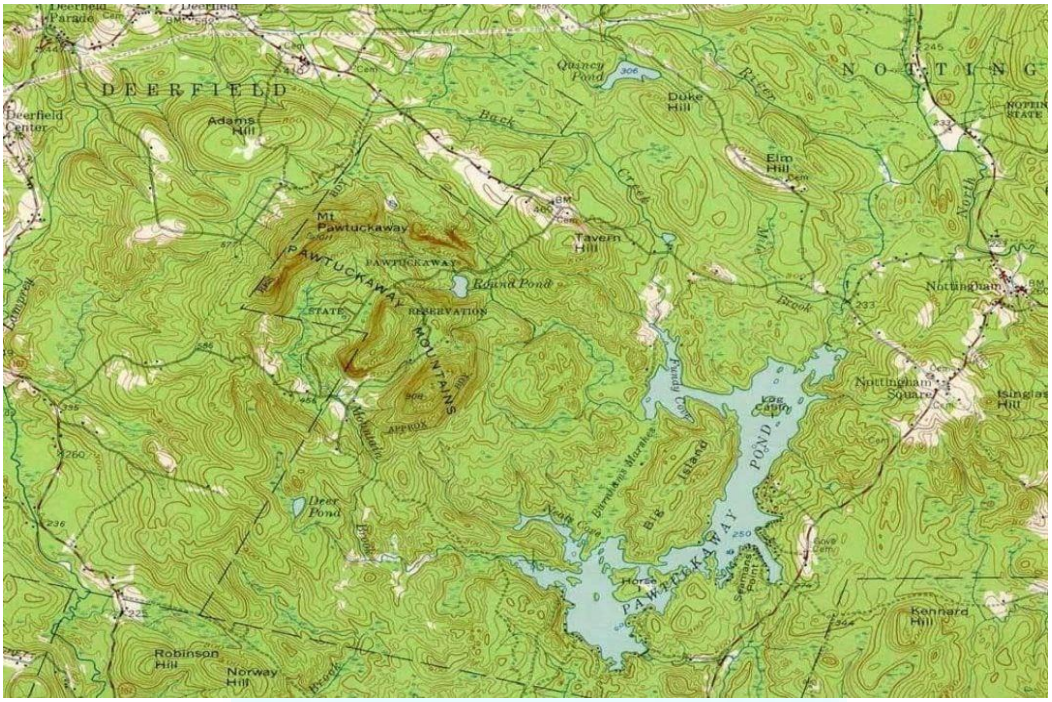
- maps and their classification

❖ Cadastral Maps

- ➢ Cadastral maps are much more detailed.
- ➢ The plans map out individual properties providing details, such as boundary information when houses or land are surveyed, and could be combined to build bigger cadastral maps.
- ➢ Cadastral mapping was among the **earliest types of mapping** where the ancient Egyptians created cadastral records to establish ownership of land just after flooding from the **Nile River.**
- ➢ **“Cadastral”** comes from the **word cadastre,** meaning a **public record, survey, or map of the value, degree, and ownership of land for purposes of taxation**.



- Topographic Maps
  - A topographic map is a lot like a physical map because it indicates different physical landscape features.
  - These maps are different on the other hand because they use contour lines rather than colors showing changes in the land.
  - Contour lines on topographic maps are usually spaced at regular intervals showing elevation changes and the closer the lines are together, the steeper the terrain.
  - These maps can be used for a variety of reasons, from camping, hunting, fishing, and hiking to urban planning, resource managing, and surveying.
  - The nice thing about relief or topographical maps is that they show the true lay of the land, so to speak.
  - That includes streams, valleys, rivers, mountains, hills, and more. They also display important landmarks and roads.



❖ Political Map

- ➢ Political maps are made to show governmental boundaries of nations, states, counties, cities and towns, and might have some physical features such as rivers, streams, and lakes.
- ➢ The characteristic of a political map is a simple to use detailed index
- ➢ Political maps will not indicate any topographic features. It instead focuses just on the national and state borders of a region.
- ➢ They will also add the location of key cities, plus they usually include significant bodies of water, according to the details in the map.
- ➢ Although some physical features show up on political maps, including major mountain ranges, the use of this is to provide geographical reference indicating any physical features.
- ➢ These boundaries and locations are usually based on people instead of the natural world.

- Physical Maps
  - The definition of a physical map is a description of the geographical features of a location.
  - Physical maps can include a lot of identical information available on a political map, however, their main function is to indicate landforms like deserts, mountains, lakes and plains.
  - Their topography style provides a complete picture of the local terrain. A physical map displays the natural landscape characteristics of an area.

- Thematic Map
  - Thematic maps are data maps of a unique topic or for a specific purpose.
  - A thematic map is not the same as a general reference map since these maps don't just show natural features like rivers, cities, political subdivisions, elevation, and highways.
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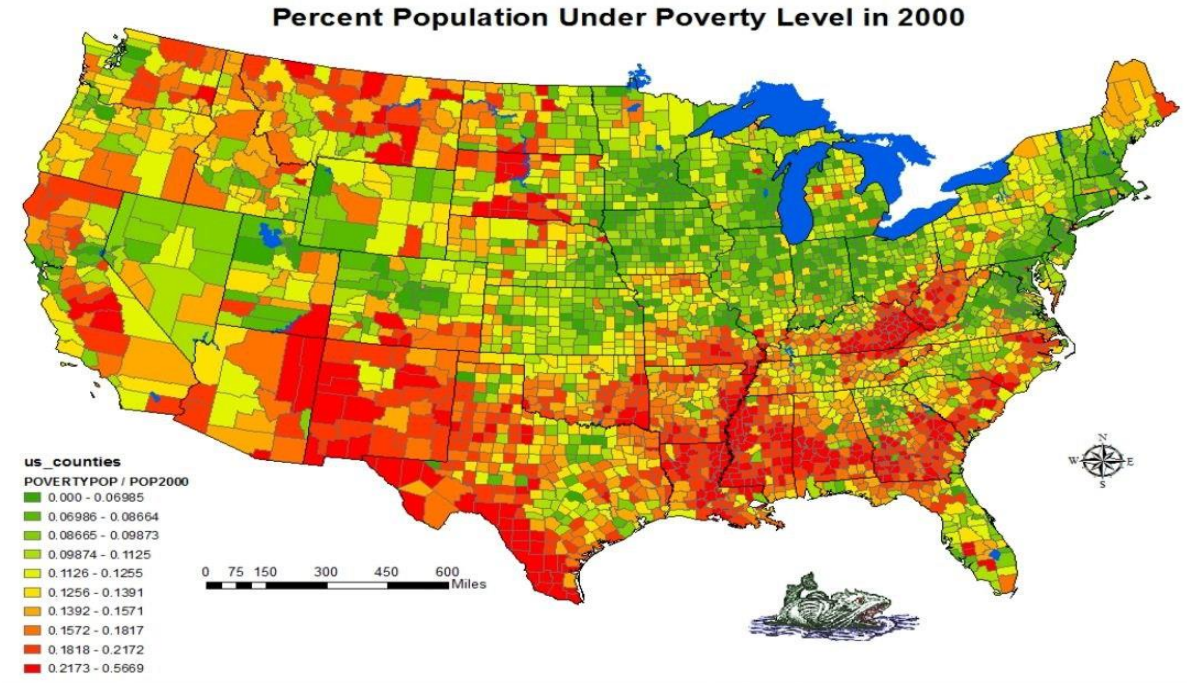
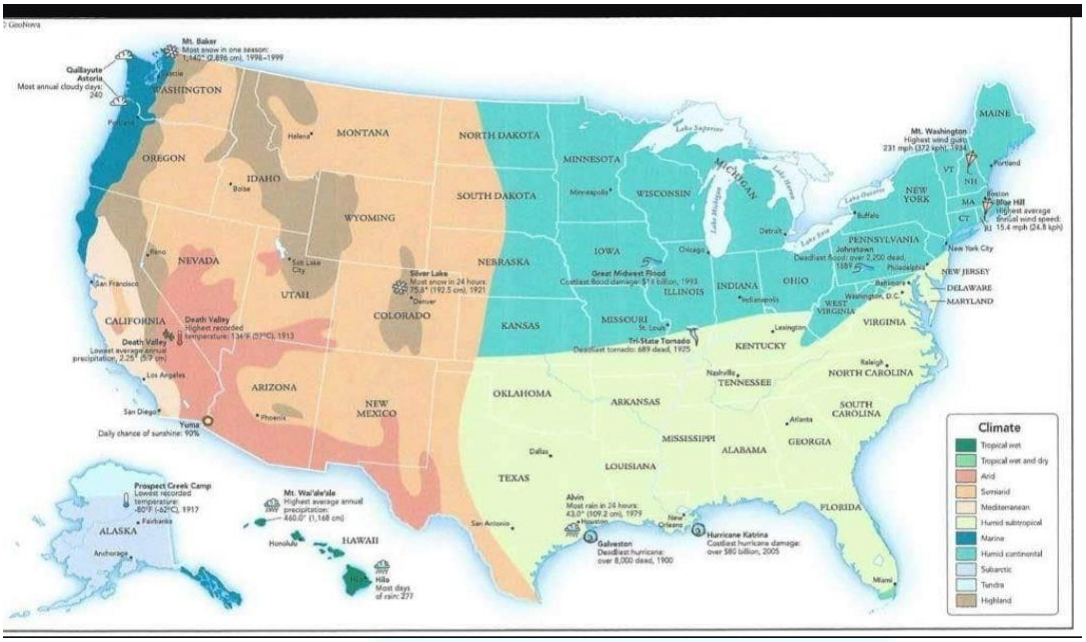
  - If these things are on a thematic map, they are background details and they are used as reference points to improve the map's design.



- Climate Map
  - A climate map shows knowledge about the climate of a region.
  - They are able to display things like the precise climatic zones of an area using the temperature, such as, how much snow an area gets or average amount of cloudy days.
  - These maps normally use colors to point out different climatic areas.

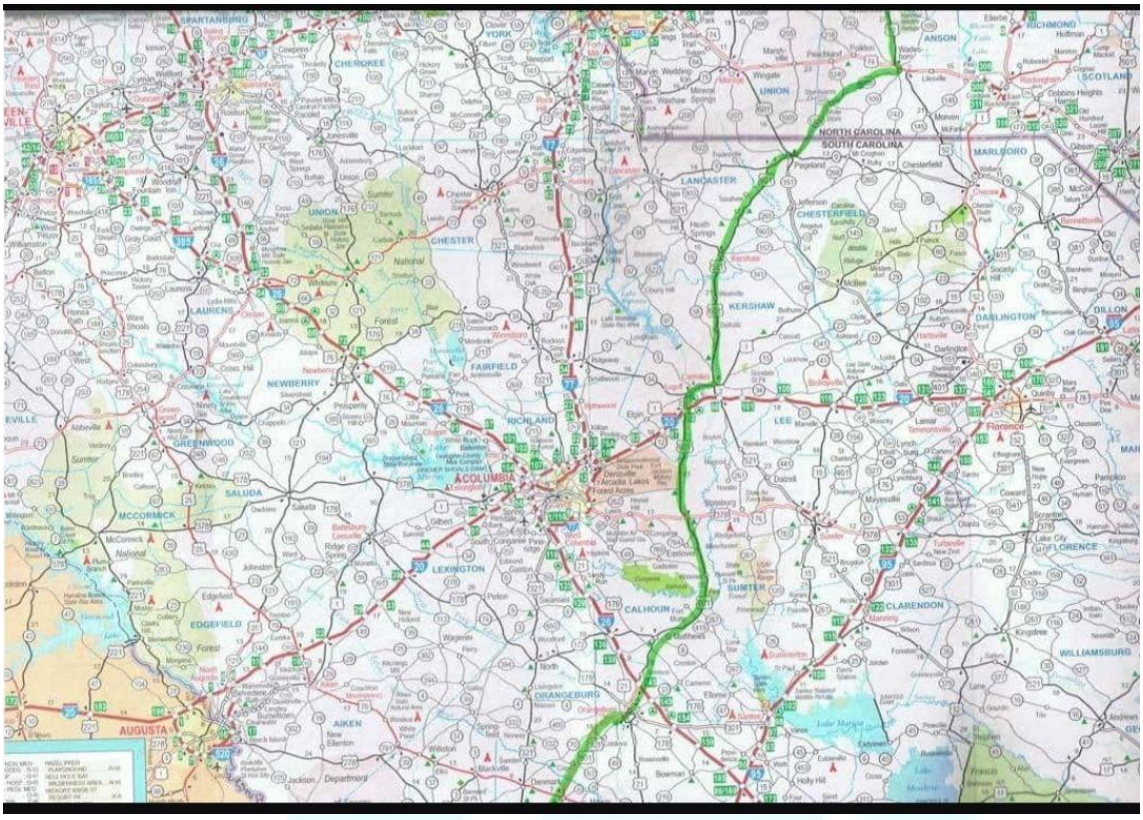


❖ Road Map

➢ A road map or route map is a form of navigational map that primarily displays roads and transport links instead of natural geographical information.

➢ A road map is one of the more popular types of maps. These maps show minor and major highways and roads (based on detail) along with things like airports, city locations, and interesting attractions, such as, parks, campgrounds, and monuments.

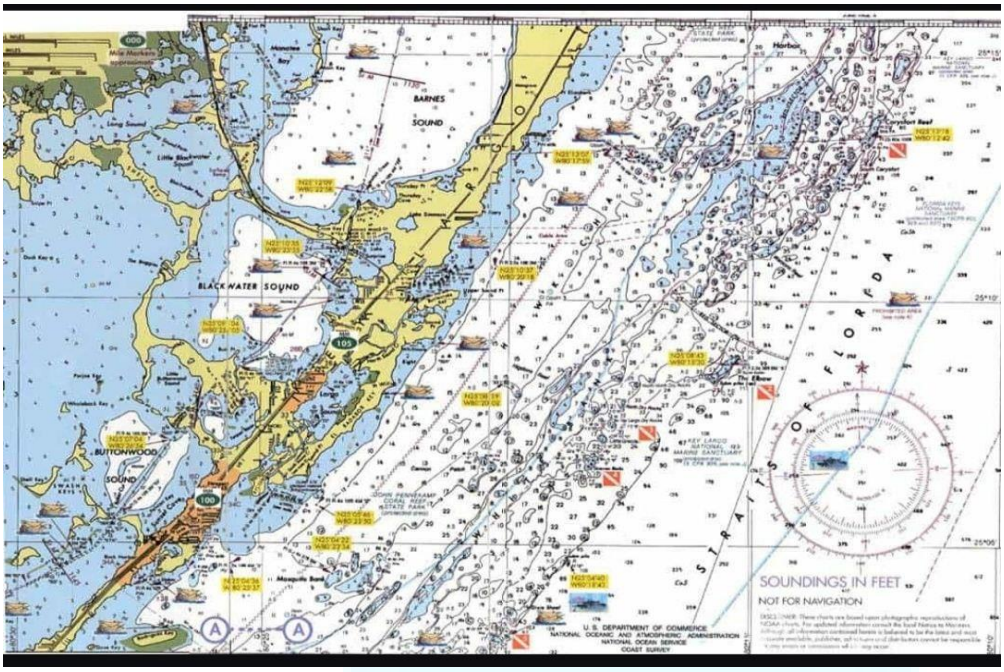
➢ Major highways with a road map are usually red and bigger than other roads, while minor roads can be a lighter color and a smaller line



- ❖ General Reference Map
  - ➢ Imagine a regular map, where towns and cities are named, major transportation routes are included together with natural features like lakes and rivers, and you'll be thinking of a general reference map.
  - ➢ These are the basic maps which are perfect for helping you get to your destination. They are easily read and include street and tourist maps.
  - ➢ The maps display the boundaries, names and different identifiers of ordinary regional areas, along with major cultural and physical features, for example roads, railroads, coastlines, rivers and lakes.

❖ Navigational Chart Map

- ➢ It’s a map that shows the layout of the shoreline and seafloor.
- ➢ Navigational charts are priceless tools helping you make your way around, no matter whether you’re on the ocean or in the air.
- ➢ Maps for the ocean are usually known as charts, and the same is true for air navigation mapping.
- ➢ These charts often include information that’s essential to avoiding accidents in and around the water like submerged rocks, as well as providing additional navigational aids.



- Map Elements
  - ❖ Different elements of a map play an important role in describing map details. Numbered here are descriptions of cartographic elements commonly found on map layouts.
  - ❖ These essential features of a map are found on almost every map around us. They are- **title, direction, legend(symbols), north areas, distance(scale), labels, grids and index, citation** – which make it easier for people like us to understand the basic components of maps.
    - ➢ **Title**
      - ➔ One of the essential elements of Maps usually draws attention by its dominant size.
      - ➔ It should be in a **larger font** and **should match the needs of the theme of the audience.**
      - ➔ Should be an answer to **“What? Where? When?”.**
      - ➔ The Map Title should reflect the purpose of the map clearly to the viewer.
      - ➔ It usually includes the map theme and the geographic location.

- ➔ It should be **larger than other text on the map**.
- ➔ You want people to immediately see the text and understand what it is that they're looking at. So feature the **title prominently in your map layout.**

➢ **Legend**

- ➔ The Legend lists all the **unknown or unique map symbols used on the map and what they depict.**
- ➔ However, this is still **a key element for map reading.**
- ➔ All the symbols should appear exactly as it appears on the map.
- ➔ **Without the legend, it is hard to understand the symbols used on a map**.
- ➔ A legend should consist of examples of the symbols on the map with the labels containing the text.
- ➔ Generally, Legend on the map follows the order as a point, line, and polygon.
- ➔ So you want to make sure that all of the entries into your legends are clearly labeled.
- ➔ **If the symbol does not appear on the map then it should not appear on the legend**.

➢ **Map Scale**

- ➔ Map Scale Provides the **important information to the viewer or the map users regarding linear relations on the map**.
- ➔ The reader must be able to determine the relationship between a unit of measure on the map and a unit of measure in the real world.
- ➔ A scale can be indicated as **numerical (for example 1:50,000)** or **graphical.** Therefore a scale showing a **1:50,000 scale means that every 1 paper map unit represents 50,000 real-world units.**

➢ **North Arrow**

➔ According to the Cartographic rules, each map should have a north arrow.

➔ By convention, **North is always towards the top of the Page**.

➔ North Arrow is used to **show the Orientation**.

➔ This allows the user to **determine the direction of the map**.

➔ Historically these have been pretty complicated when you're talking about doing a compass rose or something like that from a few hundred years ago.

➔ North is at the top of the map that sort of cartographic convention that we put north of the top of the map but that does not have to be the case there may be some circumstances where you're deliberately not putting north at the top of the map but unless you have a very good reason to do otherwise you should follow cartographic convention and have the North arrow at the top of the map.

➢ **Border and Neat Lines**

➔ Both are optional, **borders define where the map area exactly stops.**

➔ Borders are the **thickest lines on the map and closest to map edges**. **Neat lines are finer lines than borders.**

➔ The map needs to have a border or neat line; this is also sometimes called a **map frame.**

➔ This is very important to make sure that you are crisping off the edges of your map, many times if you don't have a border around your entire page the map looks unfinished or the map looks incomplete.

➢ **Credits**

➔ Map Credits include the **map data source**: especially on the thematic map, the name of author i.e: Cartographer, map

creation or publication dates, the name of the map projection used and other explanatory material.

➔ **Map Creation Date is useful and important in those maps, which are related to current affairs or weather.**

➔ Just put the name of the cartographer or in the event that you happen to be for an agency you could probably put the name of the agency that was responsible for the production of the map.

➢ **Labels**

➔ Labels are important parts of a map.

➔ They are used to provide descriptive and important information onto or next to the features on the map.

➔ **Labels on the map need to be placed with purpose**.

➔ They should not overlap because they become unreadable.

- Map Projections
  - ❖ A map projection is one of many methods used to represent the **3-dimensional surface of the earth or other round body on a 2-dimensional plane in cartography (mapmaking).**
  - ❖ Map projection is the **method of transferring the graticule of latitude and longitude on a plane surface.**
  - ❖ It can also be defined as the **transformation of a spherical network of parallels and meridians on a plane surface.**
  - ❖ Classification of Map Projections
    - ➢ **Method of construction**
      - ➔ **Perspective Projections:** These projections are made with the help of shadow cast from an illuminated globe onto a developable surface.
      - ➔ **Non Perspective Projections:** A developable surface is only assumed to be covering the globe and the construction of projections is done using mathematical calculations.

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➢ Development surface used

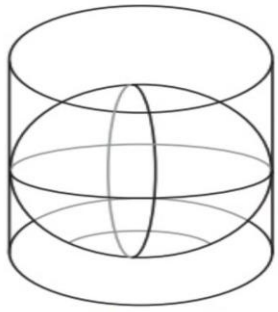
➔ Cylindrical Projection

★ It can be visualized as a **cylinder wrapped around the globe.**

★ The **longitudes (meridians)** and **latitudes (parallels)** appear as straight lines.

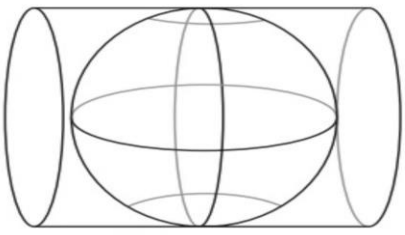
★ Length of the equator on the cylinder is equal to the length of the equator, therefore, it is suitable for showing equatorial regions.

1. **Normal:** when a cylinder has a line of tangency to the equator. It includes Equirectangular Projection, the Mercator projection, Lambert's Cylindrical Equal Area, Gall's Stereographic Cylindrical, and Miller cylindrical projection



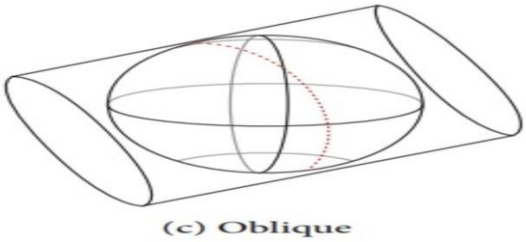
(a) Normal

2. **Transverse:** when the cylinder has line of tangency to the meridian. It includes the Cassini Projection, Transverse Mercator, Transverse cylindrical Equal Area Projection, and Modified Transverse Mercator.



b) Transverse

3. **Oblique:** when a cylinder has a line of tangency to another point on the globe. It only consists of the Oblique Mercator projection.



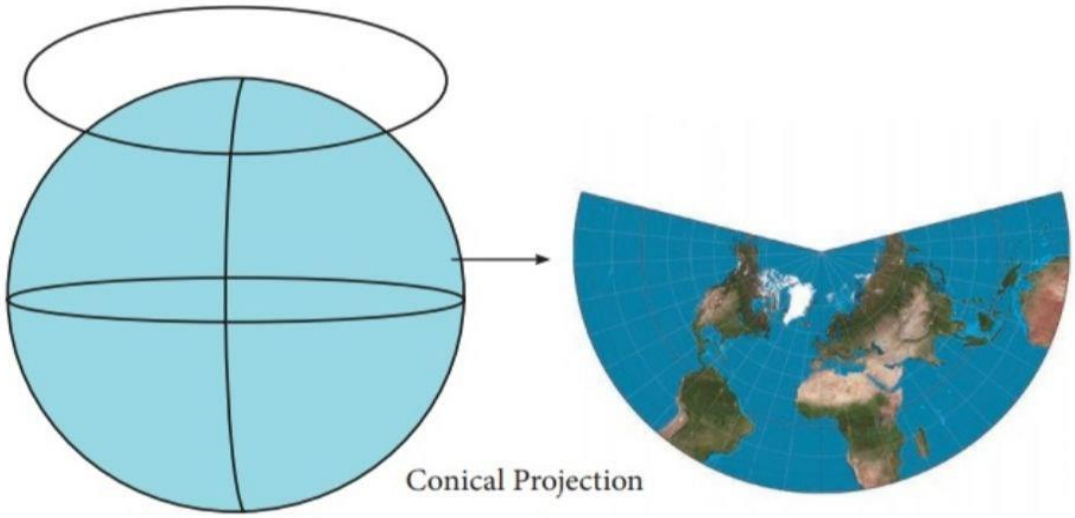
➔ Conical Projection

★ It can be visualized as a cone placed on the globe, tangent to it at some parallel.

★ After projecting the graticule onto the cone, the cone is cut along one of the meridians and unfolded. Parallels appear as arcs with a pole and meridians as straight lines that converge to the same point.

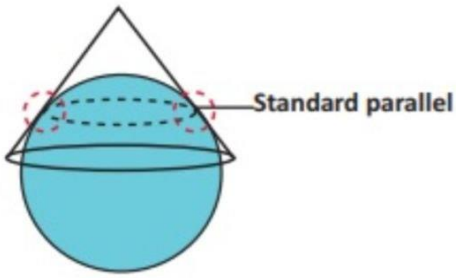
★ It can represent only one hemisphere, at a time, the northern or southern hemisphere.

★ It is suitable for representing middle latitudes.

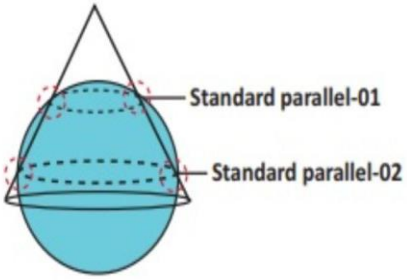


★ Conical projection is divided into two. They are

1. **Tangent:** when the cone is tangent to only one of the parallel.



2. **Secant:** when the cone is not big enough to cover the curvature of earth, it intersects the earth twice at two parallels.

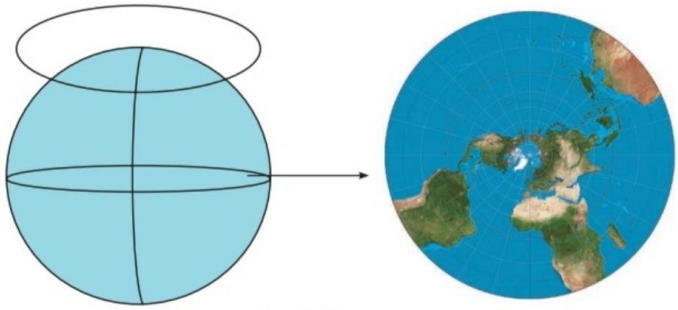


➔ **<u>Azimuthal /Zenithal Projection</u>**

★ It can be visualized as a flat sheet of paper tangent to any point on the globe

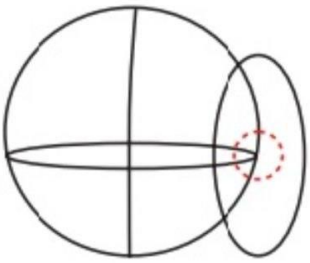
★ The sheet will have the tangent point as the center of the circular map, where meridians passing through the center are straight lines and the parallels are seen as concentric circles.

★ Suitable for showing polar areas

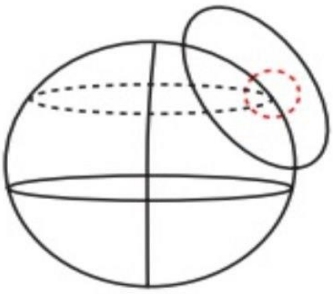


Zenithal Projections

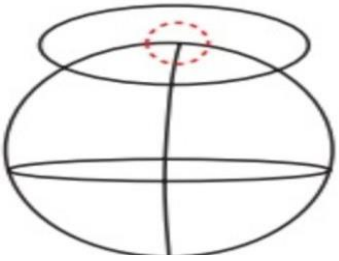
1. **Equatorial zenithal:** When the plane is tangent to a point on the equator.



2. **Oblique zenithal:** when the plane is tangent to a point between a pole and the equator.



3. **Polar zenithal:** when the plane is tangent to one of the poles.



➢ Projection properties

➔ **Equal area projection:** It is also known as **homolographic projections.** The areas of different parts of earth are correctly represented by such projections.

➔ **True shape projection:** It is also known as **orthomorphic projections.** The shapes of different parts of earth are correctly represented on these projections.

➔ **True scale or equidistant projections:** Projections that maintain correct scale are called **true scale projections.** However, no projection can maintain the correct scale throughout. Correct scale can only be maintained along some parallels or meridians.

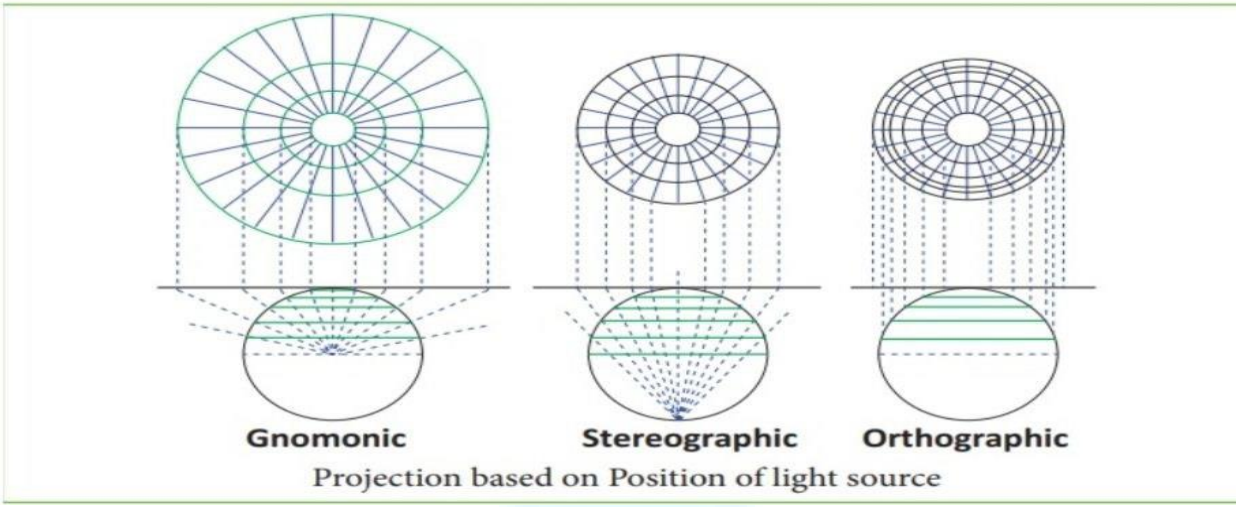
➢ Position of light source

➔ Placing light sources illuminating the globe at different positions results in the development of different projections. These projections are

★ **Gnomonic projection:** when the source of light is placed at the center of the globe

★ **Stereographic Projection:** when the source of light is placed at the periphery of the globe, diametrically opposite to the point at which a developable surface touches the globe.

★ **Orthographic Projection:** when the source of light is placed at infinity from the globe opposite to the point at which the developable surface touches the globe.



- SOI topographic map design
  - ❖ Topographical maps, also known as **general purpose maps,** are drawn at relatively large scales.
  - ❖ These maps show important natural and cultural features such as relief, vegetation, water bodies, cultivated land, settlements, and transportation networks, etc.
  - ❖ These maps are prepared and published by the National Mapping Organization of each country.
  - ❖ **Survey of India** prepares the topographical maps in India for the entire country.
  - ❖ India and Adjacent Countries Series: Topographical maps under India and Adjacent Countries Series were prepared by the Survey of India till the coming into existence of **Delhi Survey Conference in 1937**

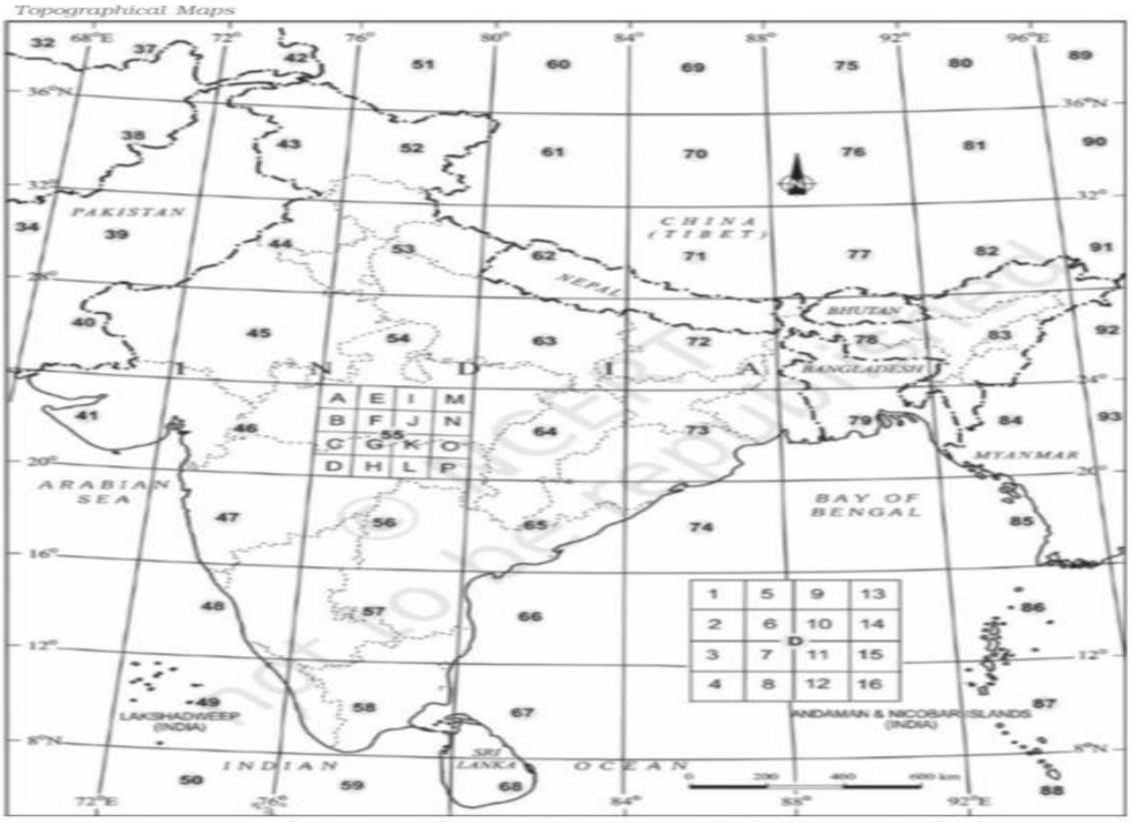
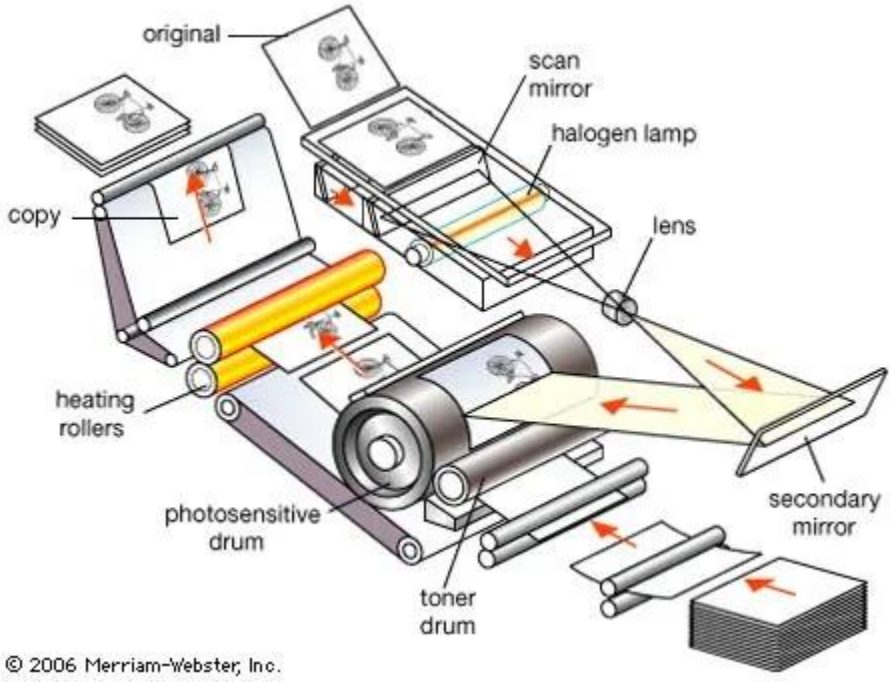


Figure 5.1 Reference Map of Topographical Sheets Published by Survey of India

- Map reproduction
  - ❖ Map reproduction refers to the **physical printing of a map using inks on paper or the electronic duplication of a map in digital form.**
  - ❖ Map reproduction methods
    - ➢ Methods for few copies
      - ➔ **Xerography**
        - ★ Most commonly used method for small scale map
        - ★ **Xeros and Graphos** mean **"Dry writing".**
        - ★ **Xerography or electrophotography is a dry photocopying technique.**

- ★ Process for producing copies of text or graphic material by the use of light, heat, chemicals, or electrostatic charges.
- ★ No chemical reactions is an electrostatic process that involves photoconductivity and surface electrification
- ★ The process was invented in the **1930s by U.S. physicist Chester F. Carlson (1906–1968)** and **developed in the 1940s and ’50s by Xerox Corp.**
- ★ The **first commercially successful xerographic copier was introduced in 1959**.
- ★ **Working:**
  1. Light passing through or reflected from a document reaches a selenium-coated drum surface onto which negatively charged particles of ink (toner) are sprayed, forming an image of the document on the drum.
  2. As a sheet of paper is passed close to the drum, a positive electric charge under the sheet attracts the negatively charged ink particles, transferring the image to the copy paper.
  3. Heat briefly applied fuses the ink particles to the paper.



➢ Methods for many copies

➔ Relief Printing

★ relief printing, in **art printmaking,**

★ a process consisting of cutting or etching a printing surface in such a way that all that remains of the original surface is the design to be printed.

★ **Examples** of relief-printing processes include **woodcut, anastatic printing (also called relief etching), linocut, and metal cut.**

➔ Intaglio printing

★ Intaglio printing is the **opposite of relief printing**.

★ in that the printing is done from ink that is below the surface of the plate.

★ The design is cut, scratched, or etched into the printing surface or plate, which can be copper, zinc, aluminum, magnesium, plastics, or even coated paper.

➔ Lithography

★ Lithography (from Ancient Greek lithos **'stone',** and graphein **'to write')** is a planographic method of printing originally based on the immiscibility of **oil and water.**

★ It was invented in **1796 by the German author and actor Alois Senefelder** and was initially used mostly for musical scores and maps.

★ Lithography can be used to print text or images onto paper or other suitable material.

- Thematic maps

❖ Thematic maps emphasize spatial variation of one or a small number of geographic distributions

- These distributions may be physical phenomena such as climate or human characteristics such as population density and health issues.
- Thematic maps are used to display geographical concepts such as density, distribution, relative magnitudes, gradients, spatial relationships and movements.
- In **1854, John Snow, a doctor from London created the first thematic map** used for problem analysis when he mapped cholera's spread throughout the city.
- Purposes of Thematic Maps
  - They provide specific information about particular locations.
  - They provide general information about spatial patterns.
  - They can be used to compare patterns on two or more maps.
- Requirements for Making a Thematic Map
  - State/District level data about the selected theme.
  - Outline map of the study area along with administrative boundaries.
  - Physical map of the region. For example, a physiographic map for population distribution and a relief and drainage map for constructing transportation maps.
- Rules for Making Thematic Maps
  - The drawing of the thematic maps must be carefully planned. The final map should properly reflect the following components:
    - Name of the area
    - Title of the subject-matter
    - Source of the data and year
    - Indication of symbols, signs, colors, shades, etc.
    - Scale
  - The selection of a suitable method to be used for thematic mapping.
- <u>Classification of Thematic Maps based on Method of Construction</u>

➢ The thematic maps are, generally, classified into

➔ **quantitative maps**

★ The quantitative maps are drawn to show the variations within the data.

★ For example, maps depicting areas receiving more than 200 cm, 100 to 200 cm, 50 to 100 cm and less than 50 cm of rainfall are referred to as **quantitative maps**. These maps are **also called statistical maps**

★ **Dot maps**

1. The dot maps are drawn to show the distribution of phenomena such as **population, cattle, types of crops, etc.**
2. The dots of the same size as per the chosen scale are marked over the given administrative units to highlight the patterns of distributions.
3. Requirement
   A. An administrative map of the given area showing state/district/block boundaries.
   B. Statistical data on selected themes for the chosen administrative units, i.e., total population, cattle, etc.
   C. Selection of a scale to determine the value of a dot.
   D. Physiographic map of the region, especially relief and drainage maps.

4. Precaution
   A. The lines, demarcating the boundaries of various administrative units, should not be very thick and bold.
   B. All dots should be of same size

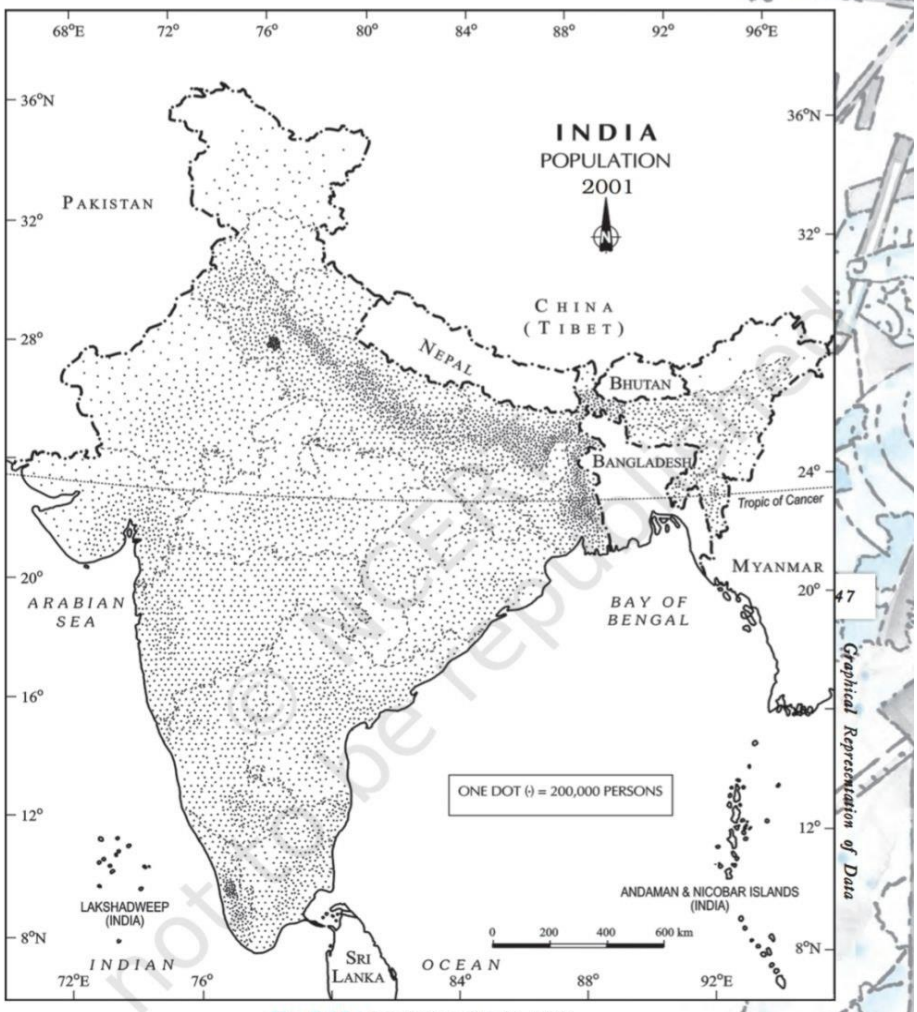


Fig. 3.13 : Population of India, 2001

★ Choropleth Map

1. The choropleth maps are also drawn to depict the data characteristics as they are related to the administrative units.
2. These maps are used to represent the density of population, literacy/growth rates, sex ratio, etc.
3. Requirement for drawing Choropleth Map
   A. A map of the area depicting different administrative units.
   B. Appropriate statistical data according to administrative units.

4. Steps to be followed
   A. Arrange the data in ascending or descending order.
   B. Group the data into 5 categories to represent very high, high, medium, low and very low concentrations.
   C. The interval between the categories may be identified on the following formulae i.e., Range/5 and Range = maximum value – minimum value.
   D. Patterns, shades or color to be used to depict the chosen categories should be marked in an increasing or decreasing order.

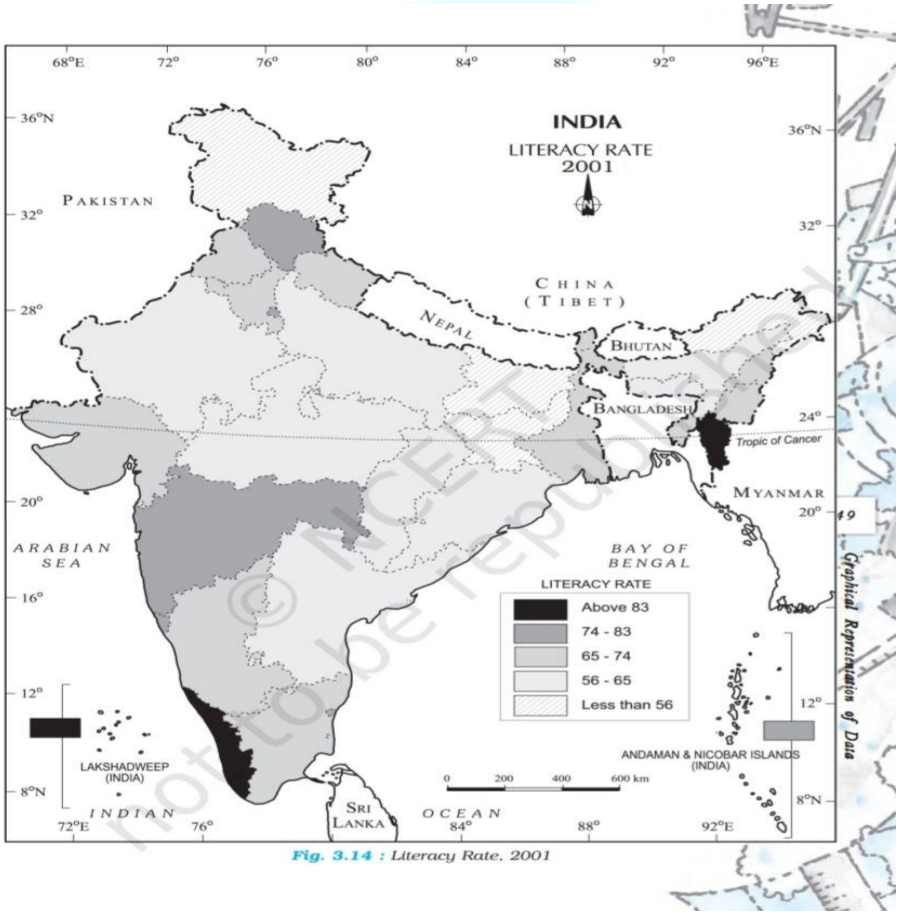


Fig. 3.14 : Literacy Rate, 2001

★ **Isopleth Map**

1. These geographical facts may be represented by drawing the lines of equal values on a map.
2. All such maps are termed the Isopleth Map.

3. The word Isopleth is derived from Iso meaning equal and pleth means lines.
4. Thus, **an imaginary line, which joins the places of equal values, is referred as Isopleth.**
5. isopleths include **Isotherm (equal temperature), Isobar (equal pressure), Isohyets (equal rainfall), Isonephs (equal cloudiness), Isohels (equal sunshine), contours (equal heights), Isobaths (equal depths), Isohaline (equal salinity), etc.**
6. Requirement
   A. Base line map depicting point location of different places.
   B. Appropriate data of temperature, pressure, rainfall, etc. over a definite period of time.
   C. Drawing instrument specially French Curve, etc
7. Rules to be observed
   A. An equal interval of values be selected.
   B. Interval of 5, 10, or 20 is supposed to be ideal.
   C. The value of Isopleth should be written along the line on either side or in the middle by breaking the line.

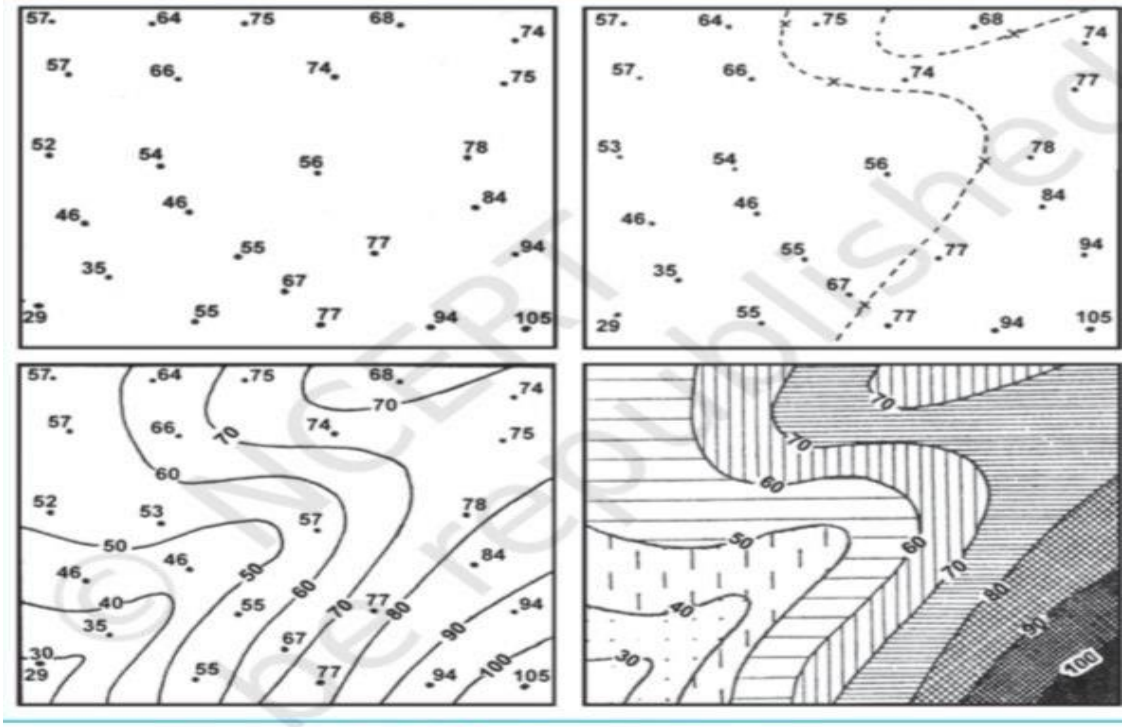


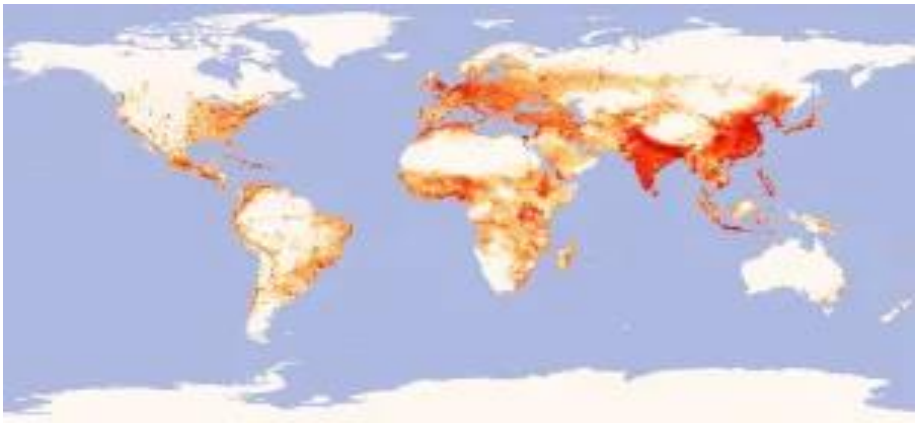
Fig. 3.15 : Drawing of Isopleths

➔ **non-quantitative maps**

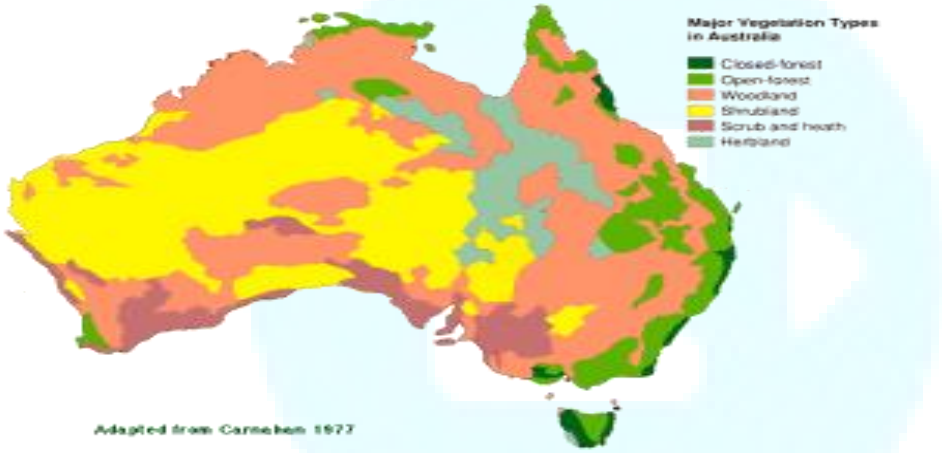
★ The non-quantitative maps, on the other hand, depict the **non-measurable characteristics** in the distribution of given information, such as a map showing high and low rainfall-receiving areas.

★ These maps are also called qualitative maps.

- Special purpose Maps
  - ❖ Special purpose map display information on a specific topic
  - ❖ Special Purpose maps can be about any topic.
  - ❖ In a special purpose map information is not cluttered; rather it is focused on one subject whereas a standard map has tons of information on it.
  - ❖ Types of Special Purpose Maps
    - ➢ **Population Density Map:** Population Density maps show the population dense area.



➢ **Vegetation Map:** Vegetation maps display different types of vegetation. Normally remote sensing is used to create this type of map



➢ **Land Cover Map:** Land Cover map shows different features present in the area. It might have road structure, city footprints, vegetation and more. Remote sensing is heavily used to produce these types of maps.

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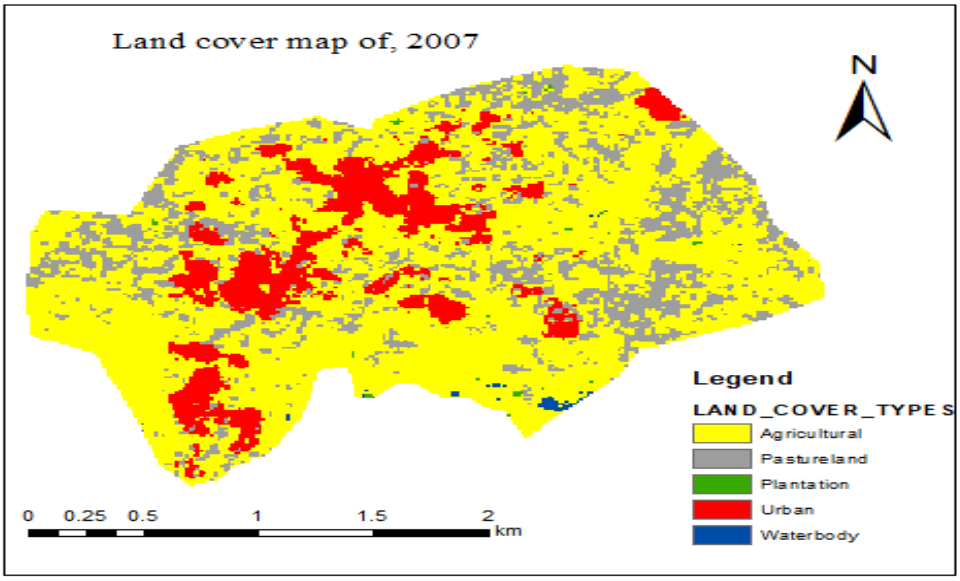
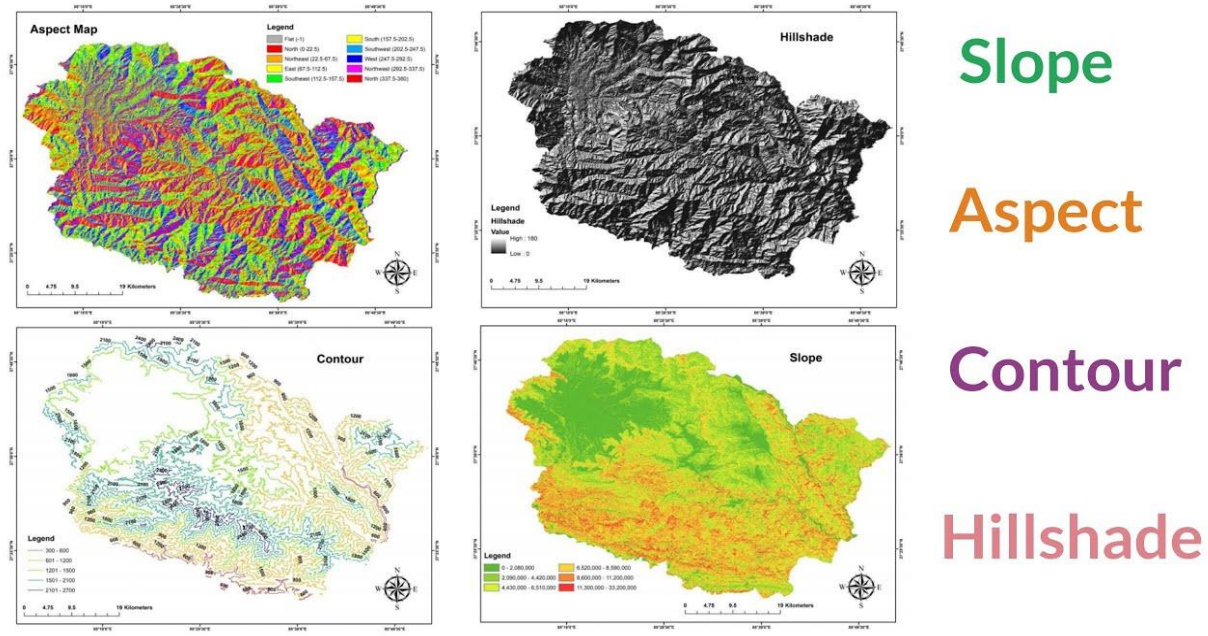
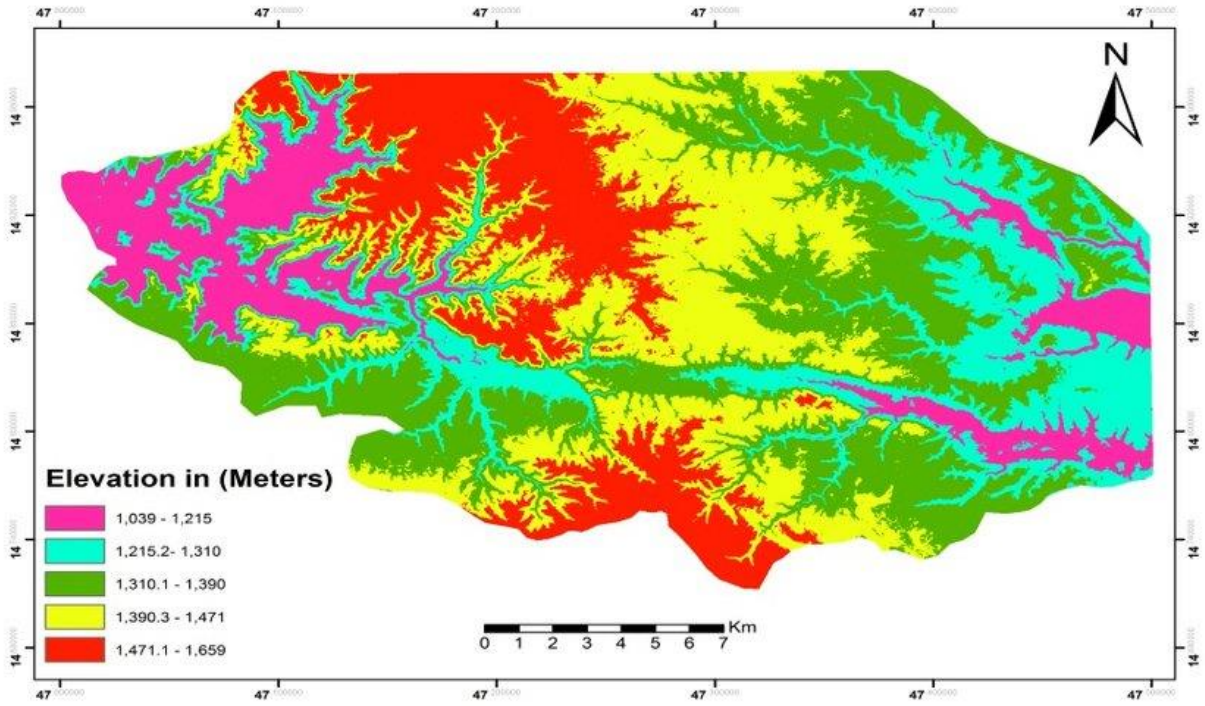


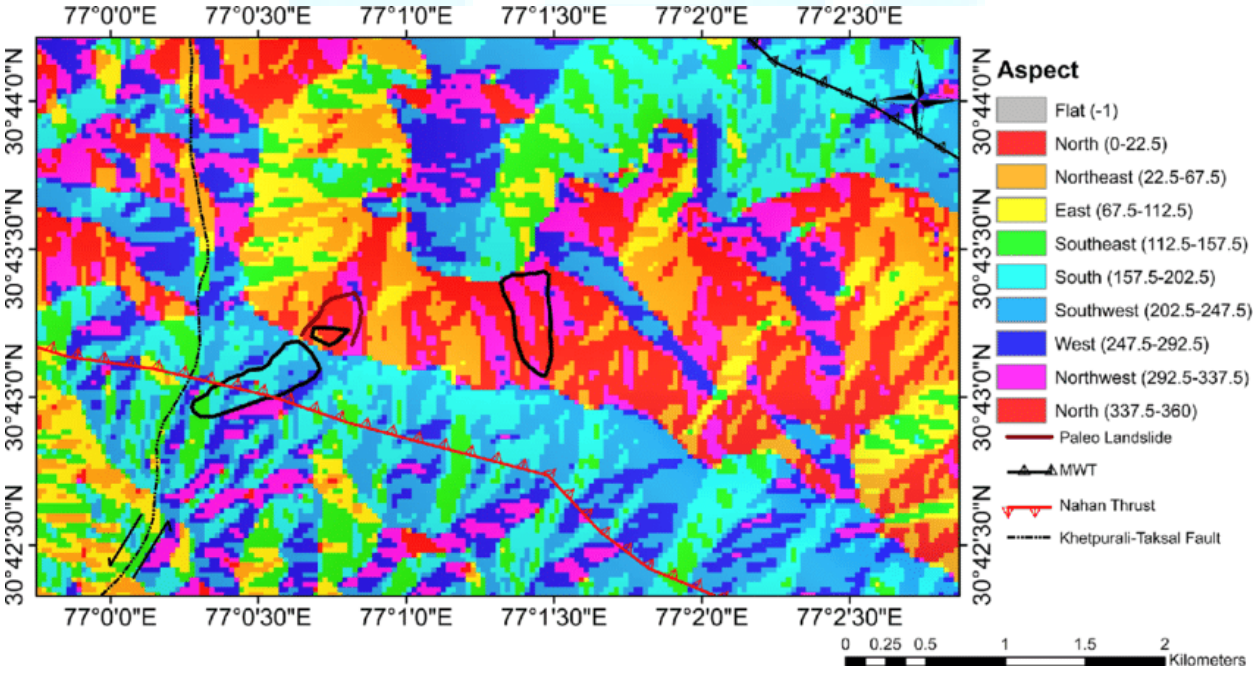
➢ **Slope Map:** GIS tools are normally used to create this type of map where the map displays the sloppiness of the area. Slope value is shown in percentage or in angle.



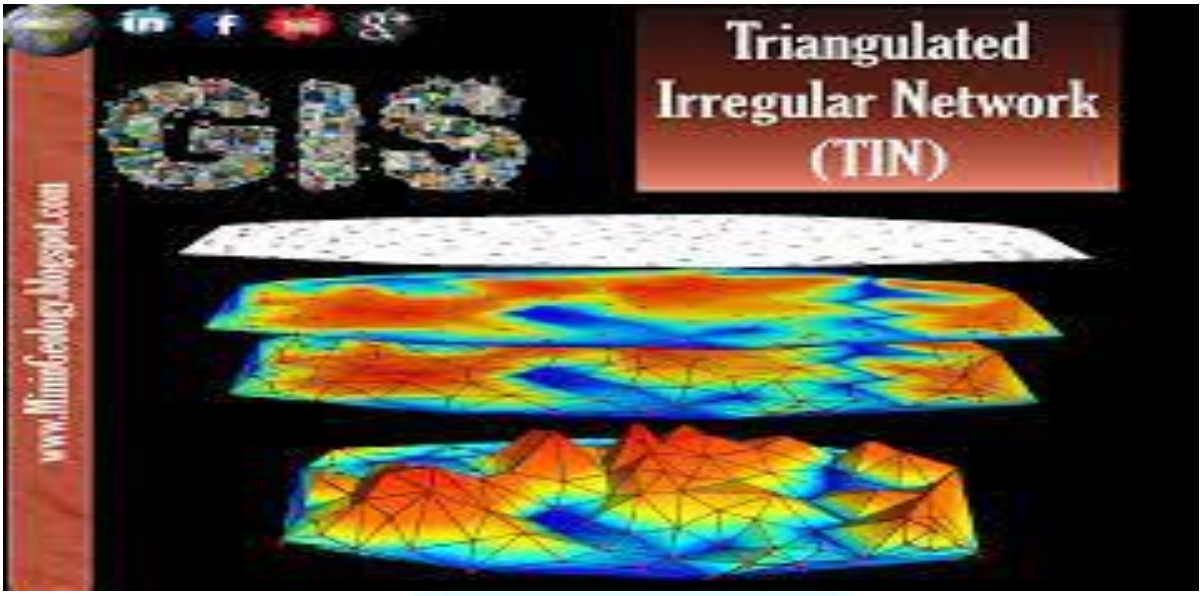
➢ **DEM Map:** Digital Elevation Model map which is in a raster format that has the Z value or height information



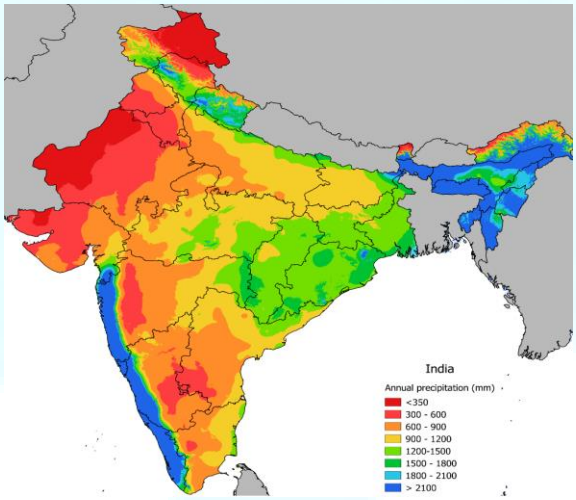
➢ **Aspect Map:** Aspect map shows the direction that topographic slope faces. Normally they are measured in degrees from the north.



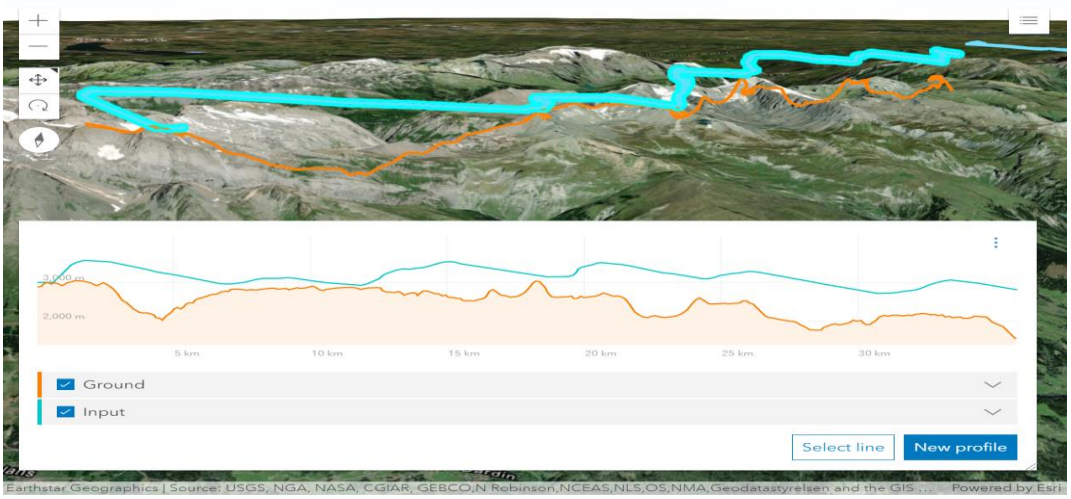
➢ **TIN Map:** Triangulated Irregular Network, which displays the elevation values using non overlapping triangles.



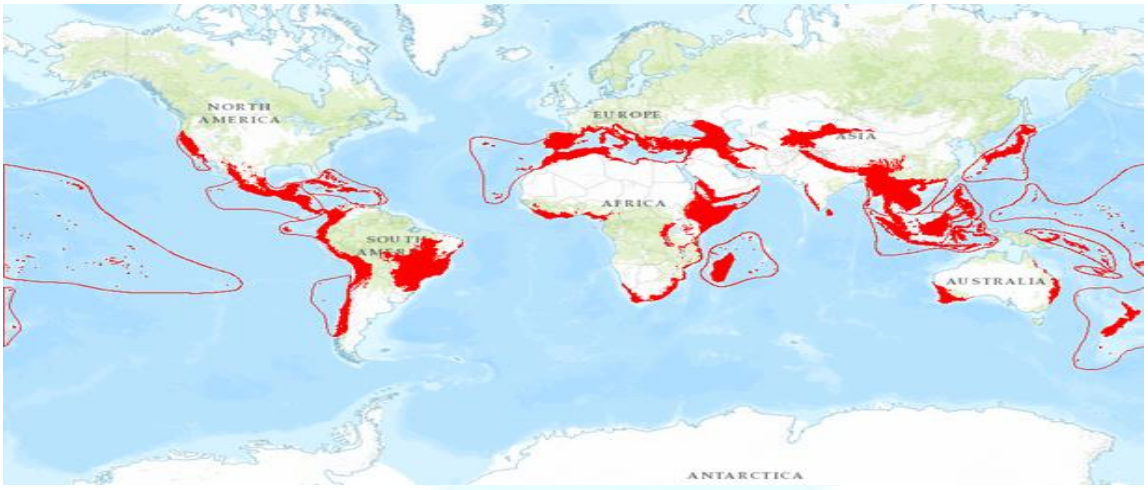
➢ **Precipitation Map**: It shows the amount of the rainfall in the area.



➢ **Elevation Profile Map:** Elevation Profile map shows the change in the z values with respect to distance.



➢ **Hot Spot Map:** Hot Spot map shows the density value in the particular area. For example it might be used by crime analyst to show the major crime area.



➢ **Watershed Map:** It displays the area of the land that divides waters flowing to different rivers, basins, or seas.

- Automation in cartography
  - ❖ Automated cartography is the process by which maps are produced with the help of computers.
  - ❖ **“Map production”** includes map compilation, or “assembling and fitting together the geographical data you will include in your map”,
  - ❖ Map production also involves map construction in which the map is placed on the page or multiple related maps are placed on multiple pages, and associated elements like graphs or tables are added to the pagemor pages.
  - ❖ A **“workflow”** is a process and/or procedure in which certain tasks are completed
  - ❖ **“Automated map production workflows”** are machine-driven processes that result in the completion of tasks that relate to the compilation, construction, or output of a map product.