TVET CERTIFICATE IV in LAND SURVEYING

Elementary Cartography

LSVEC401

Perform Elementary Cartography

Competence

Credits: 6

Learning hours: 60

Sector: Construction and building services

Sub-sector: Land Surveying

Module Note Issue date: July, 2020

Purpose statement

This is a core module which describes the performance outcomes, skills, knowledge and attitudes required to perform elementary cartography.

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Learning Unit 1: Identify maps.

LO 1.1: Proper identification of map types according to their functions

- Content/Topic 1: Description of map

Definition

- ✓ **Cartography** is defined as the art, science and technology of map making. It involves data collection, evaluation, compilation, design, construction and reproduction of maps.
- ✓ **A map** is a graphical representation of natural and artificial features on plane surface (2D) and at a specific scale of surface/part of the earth or whole earth. The features are positioned as accurately as possible usually relative to a coordinate reference system.

The above process combines metrics, graphics and techniques & technology Metrics: framework of maps, control, projections, transformations, reference systems, scales, accuracy of maps and standards. Graphics: representation, design of maps, symbolization Techniques & Technology: enable construction, production and reproduction

Characteristics of map:

- All maps are concerned with two primary elements
- ∇ locations and attributes
- All maps are reductions of reality
- ∇ Scale
- All maps are transformations of space
- ∇ Map projections and coordinate systems
- All maps are abstractions of reality
- ∇ Generalization and its components
- All maps use signs and symbolism
- ∇ cartographic symbolization
- ✓ **Applications/ Importance of maps**: Maps are one of the most important tools researchers, cartographers, tourists, students and others can use to examine the entire earth or a specific part of it. In simple words maps are pictures of the earth's surface. They can be used as general reference to show landforms, political boundaries, water bodies, and the positions of cities.

- Content/Topic 2: Identification of types of map

- ✓ Political Maps

"Political maps" are among the most widely used reference maps. They are mounted on the walls of classrooms throughout the world. They show the geographic boundaries between governmental units such as countries, states, and counties. They show roads, cities and major water features such as oceans, rivers and lakes.

Political maps help people understand the geography of the world. They are usually the first type of map that students are introduced to in school. They are also known as “reference maps” because people refer to them again and again as they have questions.

- ✓ **Physical Maps**

A physical map is one that documents landscape features of a place. These maps generally show things like mountains, rivers, and lakes. Bodies of water are commonly shown in blue. Mountains and elevation changes are sometimes shown with different colors and shades to show elevation. On physical maps, greens usually indicate lower elevations while browns usually indicate higher elevations.

Physical maps are designed to show the natural landscape features of Earth. They are best known for showing topography, either by colors or as shaded relief. Physical maps often have a green to brown to gray color scheme for showing the elevation of the land. Darker greens are used for near-sea-level elevations, with the color grading into tans and browns as elevations increase. The color gradient often terminates in shades of gray for the highest elevations.

Rivers, lakes, seas and oceans are usually shown in blue, often with a light blue color for the shallowest areas and darkening in a gradient or by intervals for areas of deeper water. Glaciers and ice caps are shown in white colors.

Physical maps usually show the most important political boundaries, such as state and country boundaries. Major cities and major roads are often shown. This cultural information is not the focus of a physical map, but it is often included for geographic reference and to increase the utility of the map for many users.

- ✓ **Topographic Maps**

A topographic map is similar to a physical map in that it shows different physical landscape features. Unlike physical maps, though, this type of map uses contour lines instead of colors to show changes in the landscape.Topographic maps also show other important natural features such as lakes, rivers and streams. Their locations are determined by topography, making them important natural elements of topographic maps.

Topographic maps are frequently used by hunters, hikers, skiers, and others seeking outdoor recreation. They are also essential tools of the trade for geologists, surveyors, engineers, construction workers, landscape planners, architects, biologists and many other professions - especially people in the military.

Climate Maps

A climate map shows information about the climate of an area. These maps can show things like the specific climatic zones of an area based on the temperature, the amount of snow an area receives, or the average number of cloudy days. These maps normally use colors to show different climatic areas.

This climate map for Australia uses colors to show differences between the temperate area of Victoria and the desert region in the center of the continent.

Land use/ Land cover

Land use land cover (LULC) map of an area provide information to help users to understand the current landscape. Remote sensing has been widely applied for mapping LULC over a variety of spatiotemporal scales. LULC maps derived from high-spatial resolution imagery provide fine detailed information but the cost is expensive.

Contour map

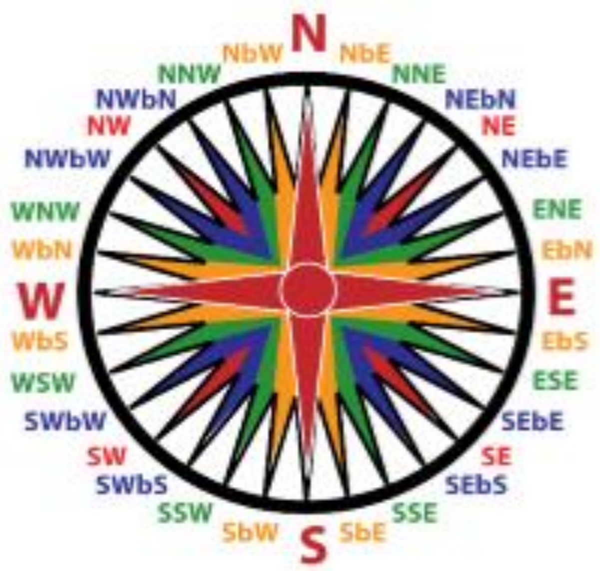
Contour map is a *topographic map* on which the shape of the land surface is shown by *contour lines*, the relative spacing of the *lines* indicating the relative slope of the surface.

LO 1.2 Identify map elements

- Content/Topic 1: Description of key map element

The elements used in your map, and their location and style, will vary depending upon the audience and message.

- ✓ **Title:** A good map should tell you what it is about; explains Purpose of the Map… the What, Where, When, etc.
- ✓ **Orientation:** which direction north is;



- ✓ **Map face:**
- ✓ **Date:**when the map was made or updated
- ✓ **Author:** who made the map
- ✓ **Legend:** what the symbols mean
- ✓ **Scale:**the relationship between the "Real World" and the map.
- ✓ **Index:**where to find selected places on the map;
- ✓ **Grid:**how to find places on the map;
- ✓ **Credit:**where the map's information comes from (sources);

However, not every map will identify all of this information. The more information provided, the better you will be able to evaluate its content, credibility, and appropriateness for a given purpose or audience.

- Content/Topic 2: Classification of map

Classification of maps

Maps are classified according **to content** (Topographic, thematic), **data source** (Basic, derived), **Scale** (large, medium, small, atlas, plans), **producing agent** (official, commercial), **nature of image** (line, photographic, digital), **colours** (monochrome, multicoloured/chromatic), **function** (administrative, planning, education, travel etc)

a) Classification of maps based on content

i. Topographic maps: designed from data collected directly from terrain; most accurate as far as location/position of features is concerned; represent the horizontal and vertical position of features on earth's surface at a specified scale; represent as much as possible the physical environment-relief, hydrology, drainage vegetation; serve a variety of users; mostly financed by public funds. A grid system, boundaries of political divisions and marginal information are also shown. Topography is the configuration of the surface of the earth including its relief, the position of its streams, cities etc. Topography is divided into hypsography (relief features), hydrography (water and drainage system), culture (manmade features) and vegetation.

ii. Thematic maps: special subject maps; maps specific topics e.g. soil, land use, geology, cadastral, population etc; cover small or large areas; private/publicly produced; portray data using shaded areas (chloropleth), dots (dot density) symbols of different sizes (graduated symbol), lines of equal measurement (isoline) or proportional size of area (cartogram). Also called topical maps because they have a single theme of study.

iii. Special purpose maps: made for specific user/use; charts, land registration maps, engineering maps etc; large scale thematic maps also special purpose maps.

b) Classification of maps based on data source

i. Basic Maps: prepared from original survey data carried out specifically for producing such a map. Usually large scale maps produced from primary data from the field.

ii. Derived maps: small scale map derived from information from existing data

c) Classification based on scale of a map

i. Large scale maps: relatively small ground area is represented on a large map area. Usually preferred for urban areas and other densely/closely developed areas. They can be constructed from actual ground or aerial surveys or a combination of both. Used for planning and other uses-traffic control, police work, town planning etc

ii. Plans: cover a small area at large scale. It is also called a graphic representation without relief. The surface is assumed to be a plane.

iii. Small scale maps: relatively large ground surface is represented on a small map area

Small Scale Maps: Small-scale maps are further divided into the following types:

(a) Wall Maps

(b) Atlas Maps

(a) Wall Maps: These maps are generally drawn on large size paper or on plastic base for use in classrooms or lecture halls. The scale of wall maps is generally smaller than the scale of topographical maps but larger than atlas maps.

(b) Atlas Maps: Atlas maps are very small-scale maps. These maps represent fairly large areas and present highly generalized picture of the physical or culture features.

d) Classification based on producing agent

i. Official maps: maps produced by governments or their agents for the benefit of the public and other government organisations for planning. In most cases, they are non-profit.

ii. Commercial maps: maps produced by commercial/private organisations for the purpose of profit making by selling the maps to the public. They rely heavily on official maps for information and mostly popular themes with public are mapped. Examples include town maps, road maps, tourist maps, travel maps etc.

e) **Classification based on the nature of the image**

i. **Line maps:** drawn images of lines

ii. Photographic: map information is represented by photographs

iii. Digital maps: map information is processed by computers and represented on visual copies e.g. diskettes, tape, CD ROMs.

f) Classification based on colour

i. **Monochrome maps**: a single colour used to draw a map e.g. black & white

ii. Multicoloured/chromatic maps: many colours used on fine graphic image of a map

g) **Classification according to function:** These maps tell the function which these maps are used. Examples are administrative maps, planning maps, education maps, navigation maps, travel maps, propaganda maps, military maps, census maps etc.

i. **Navigation maps/charts:** these are special purpose maps generally designed for navigation or other particular purpose in which essential map information is combined with various other data critical to the intended use.

ii. **Aeronautical maps:** these are used for air navigation. Form a specialised representation of mapped features of the earth/part of the earth produced to show selected terrain, cultural and hydrological features and supplementary information required for air navigation, piloting or air operations.

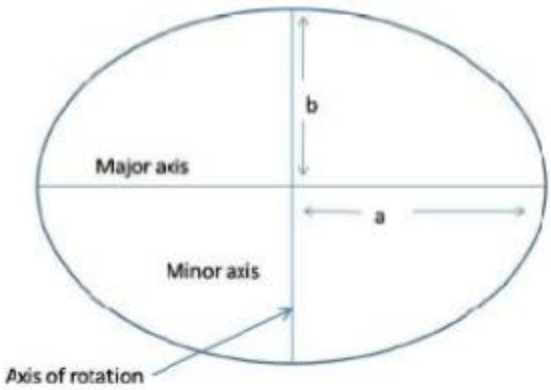
iii. **Nautical charts:** a chart representing depths of water, nature of the sea and coastline, tides and currents in a given area of the sea. Examples include general coastal charts, approach charts, harbour charts, hydrographical charts (generally gives water areas)

Base map: a map/chart showing certain fundamental information used as a base upon which additional data of specialised nature is added

LO 1.3Identify projection system.

- Content/Topic 1:Identification of Earth's Geometry

The earth is an irregular shaped solid figure whose surface does not conform to any exact mathematical shape. The shape and size of the geographic coordinate system's (GCS) surface is defined by a sphere or spheroid`. The earth is best represented by a spheroid but sometimes treated like a sphere to make mathematical computations easier. The assumptions for the earth as a sphere are possible for small scale maps-smaller than 1:5,000,000. At this scale, the differences between a sphere and spheroid are not detectable on the map. For large scale maps, 1:1,000,000 or larger, the spheroid is used to represent the shape of the earth. The sphere is based on a circle while the spheroid (ellipsoid) is based on an ellipse. Rotating the ellipse about its minor axis creates the spheroid.



A spheroid is defined by:

i. **a & b;**

ii. **a & f;**

Where $f=(a-b)/a$ and ranges between 0 and 1

$e^2=(a^2-b^2)/a^2$

a is the semi-major axis; b semi-minor axis; f is flattening; e is eccentricity

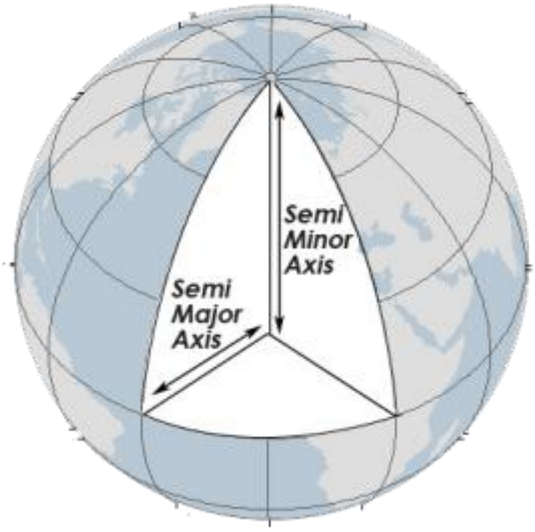
Different surveys of the earth have resulted in many spheroids representing the earth. Generally, a spheroid is chosen to fit one country or a particular area in order to have accurate mapping.

We shall consider the earth to be essentially spherical when reduced in scale so that we can use it as a reference. Mapping the earth without distortions is to map it on a globe. In this case, the distances, angles, areas, azimuths, rhumbs and great circles are retained without distortion. It is only the scale that changes. The disadvantages of the globe are that it is expensive to make; difficult to reproduce; cumbersome to handle; awkward to store; and difficult to measure and draw on it.

What is an Ellipsoid in GIS?

Geodesists have adopted an ellipsoid model to determine latitude and longitude coordinates.

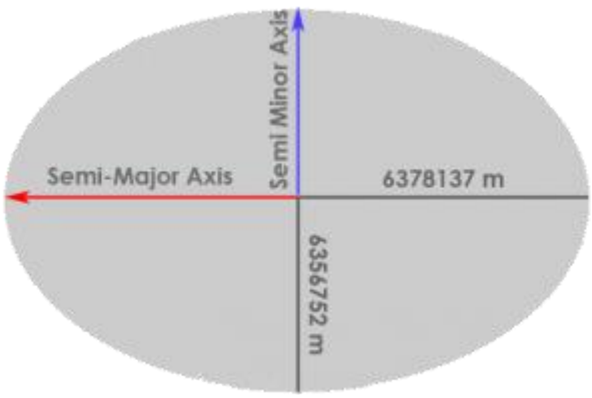
The major axis of an ellipse is the equatorial radius. The minor axis is from the poles to the center.



Reference ellipsoids are primarily used as a surface to specify point coordinates such as latitudes (north/south), longitudes (east/west) and elevations (height).

The most common reference ellipsoid in cartography and surveying is the World Geodetic System (WGS84). The Clarke Ellipsoid of 1866 and was recomputed for the North American Datum of 1927 (NAD27).

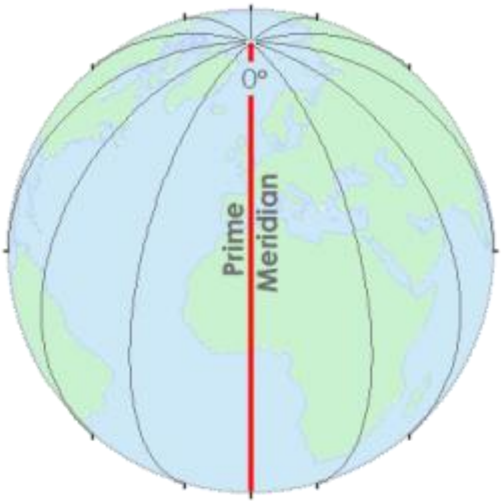
When comparing NAD27 and NAD84, latitude and longitude coordinates can be displaced on the degree of tens of meters (with the same latitude and longitude coordinates).



How Do Horizontal Datum Relate to Ellipsoids?

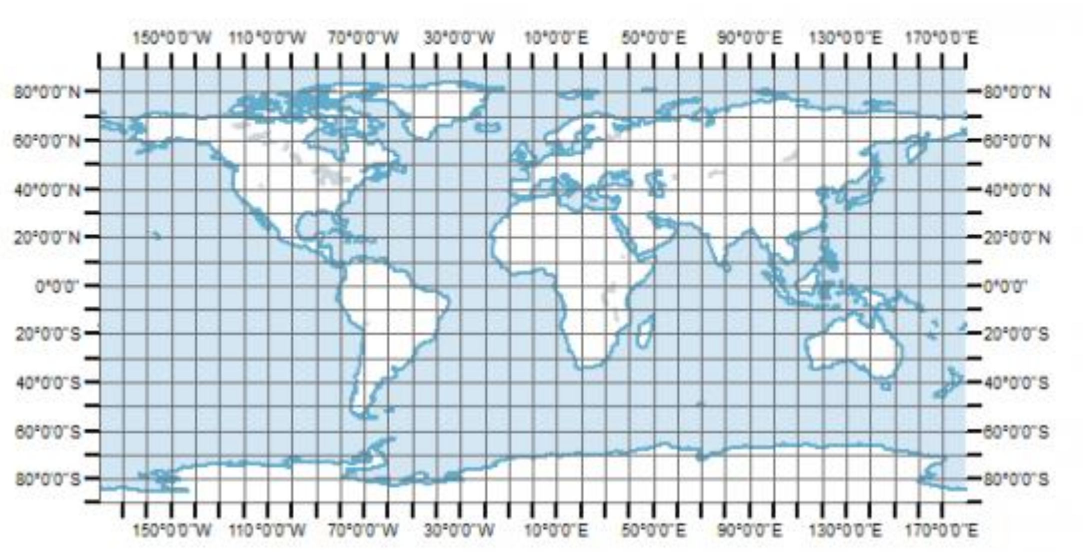
Horizontal datum gives us the capability to measure distances and directions across the surface of the earth. Most **horizontal datum** defines a zero line at the equator from which we measure north and south (latitudes).

There is also a zero line at the **Greenwich Meridian** from which we measure east and west (longitudes).



Together these lines provide a reference for latitude and longitude expressed in decimal degrees. These latitudes and longitude positions (Geographic Coordinate Systems) are based on a spheroid or ellipsoid surfaces that approximate the surface of the earth – a datum.

All coordinates are referenced to a datum such and the ones in the image below:



A datum describes the shape of the Earth in mathematical terms. A datum defines the radius, inverse flattening, semi-major axis and semi-minor axis for an ellipsoid.

Here is the WGS84 datum:

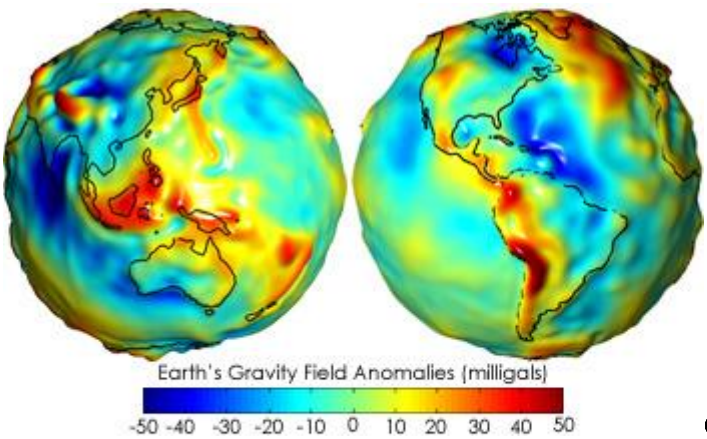
- Semi-major axis: 6,378,137.0 m
- Semi-minor axis: 6,356,752.3 m
- Inverse flattening: 294.978698214

Name	Year	Semi-Major Axis (Equator Radius)	Semi-Minor Axis (Polar Radius)	Users
Clarke	1866	6,378,206.4 m	6,356,583.8 m	North America
International (Hayford) Ellipsoid	1924	6,378,388.0 m	6,356,911.9 m	Most of the World
WGS72	1972	6,378,135.0 m	6,356,750.5 m	NASA
GRS80	1980	6,378,137.0 m	6,356,752.3 m	Worldwide
WGS84	1984	6,378,137.0 m	6,356,752.3 m	Current Worldwide

Fitting the Ellipsoid with the Geoid

A horizontal coordinate system gives us the side-by-side that is our latitude and longitude. On the other hand, a vertical datum is another component of your typical horizontal coordinate system.

We are on a three-dimensional planet which has ups-and-downs in addition to the side-to-side in a horizontal coordinate system on the surface. To handle the ups-and-downs, we have the vertical datum which gives a place to put the zero measurement. Mean sea level is often understood as the basis for our ups-and-downs. This is called the **geoids**.



Geoid (Image courtesy of NASA/JPL)

Vertical datums are lumpy and irregular. This is because of the varying densities in the Earth in different places. There are gravity anomalies such as mountainous areas have more mass.

This means that mean sea level is not as smooth as everyone thinks it is. Geoids are not constant and they differ from place-to-place. Geoids have undulations as you move around on the Earth. The Earth is not as round as we like to pretend it is. We have lumps or undulations on them as they come back to us in the form of a geoid. The geoids put the lumps back into our nice smooth horizontal datum coordinate system.

Ellipsoid height is the most basic version of up-and-down. The ellipsoid uses the size and shape of the **horizontal datum** such as WGS84. It gives a smooth surface without bumps or irregularities. The geoid is complex to describe it mathematically. Therefore, we fit different Ellipsoids to approximate it such as WGS84.

- Content/Topic 2:Identification of map projection's properties.

There is no single map projection that does not have distortions. The map designer selects the most appropriate projection so that there is a measure of control over the unwanted error. Large scale mapping has no distortion problem and therefore the distortions can be ignored. There is no single projection of the globe that can maintain area, distance, shape and direction at the same time.

a) **Equal Area Mapping/equivalence**

This is also called equivalence property of map projection and the area relationships of all parts of the globe are maintained. However, there are linear/distance distortions. The shape and area cannot be maintained at the same time. The intersection of meridians and parallels of latitudes is not at right angles. The property of equivalence is important for general quantitative maps e.g. population density maps

b) Conformal/Orthomorphic mapping

In this projection, angles are preserved around points. Shapes of small areas are also preserved. The meridians and parallels of latitude intersect at right angles and the scale is same in all directions about appoint but may change from point to point. Shapes and areas of large areas like continents are distorted.

These types of projections are used where distance measurements and directions are critical e.g. navigation charts, topographic maps, cadastral maps.

c) Equidistance mapping

In these types of projections, the great circle distances are preserved. The limitations of this property are that distances are only held true from one point to all other points or from a few points to others. The scale is uniform along the lines whose distances are true.

d) Azimuthal mapping

This property preserves directions form one central point to all other points. The quality of azimuthal is not exclusive and can occur with equivalence, conformity and equidistance.

- Content /Topic3: Identification of projection Surfaces

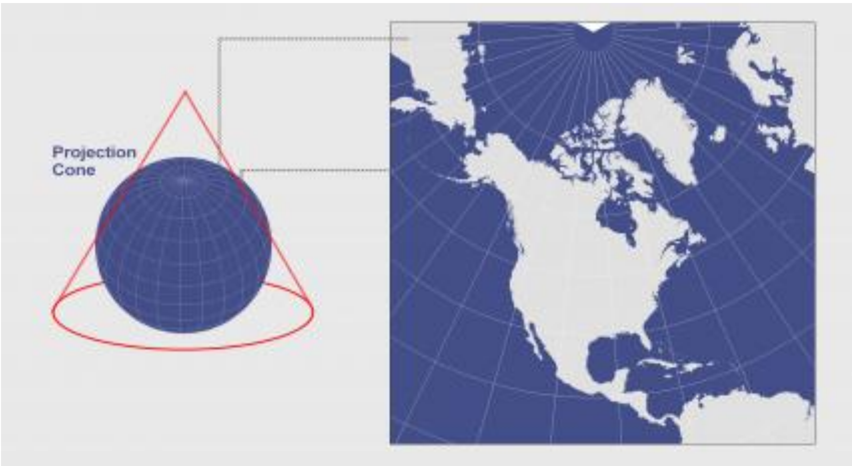
3 Types of Map Projection surfaces

Map projections take developable surface such as cylinders, cones and planes and flatten it in a two-dimensional plane. Each surface is mathematically rendered based on those geometric shapes.

CONIC PROJECTIONS: When you place a cone on the Earth and unwrap it, this results in a conic projection. For example, Albers Equal Area Conic and the Lambert Conformal Conic projections are conic projections. Both of these map projections are well-suited for mapping long east-west regions because distortion is constant along common parallels.

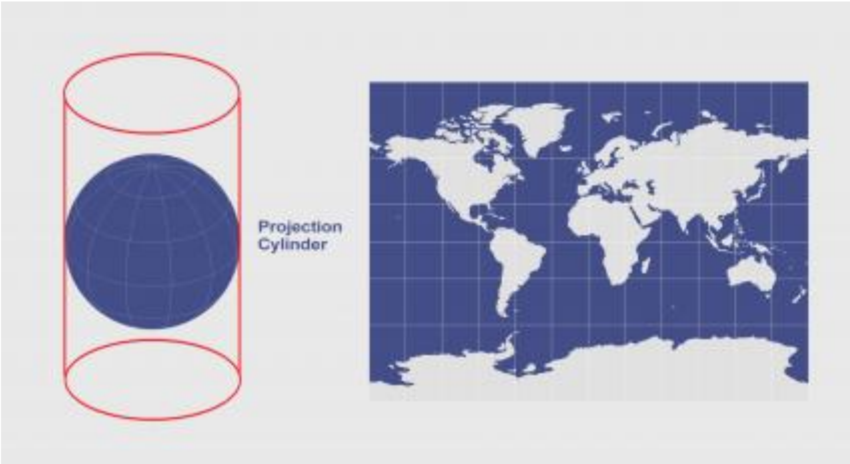
But they struggle at projecting the whole planet. While area is distorted, scale is mostly preserved.

For **conic map projections**, distance at the bottom of the image suffers with the most distortion.

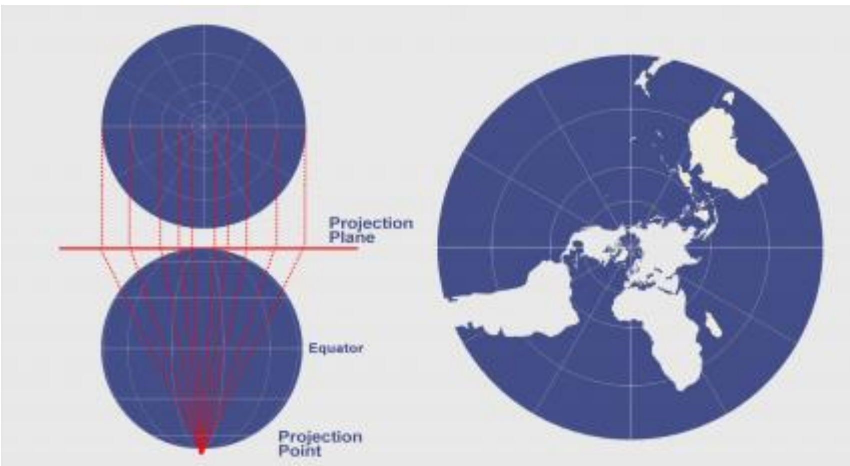


CYLINDRICAL PROJECTIONS: When you place a cylinder around a globe and unravel it, you get the cylindrical projection. Strangely enough, you see **cylindrical map projections** like the Mercator and Miller for wall maps even though it inflates the Arctic.

But it makes sense why navigators and even Google Maps use the Mercator projections – it's all because of the unique properties of cylinders and north always facing up. You can place it in a vertical, horizontal or oblique position such as the **State Plane Coordinate System**. Each one has their own use in mapping the world.



PLANARPROJECTIONS: also known as an azimuthal projection or a zenithal projection. An azimuthal or planar projection is a projection of the globe onto a plane. In polar aspect, an azimuthal projection maps to a plane tangent to the Earth at one of the poles, with meridians projected as straight lines radiating from the pole, and parallels shown as complete circles centered at the pole. Azimuthal projections (especially the orthographic) can have equatorial or oblique aspects. The projection is centered on a point that is either on the surface, at the center of the Earth, at the antipode, some distance beyond the Earth, or at infinity. Most azimuthal projections are not suitable for displaying the entire Earth in one view, but give a sense of the globe. The following figure illustrates azimuthal projection, diagramming it on the left, with an example on the right (orthographic projection, polar aspect).:.



Some widely used azimuthal projections are:

- ➢ Equidistant azimuthal projection
- ➢ Gnomonic projection

- Lambert equal-area azimuthal projection
- Orthographic projection
- Stereographic projection
- Universal polar stereographic projection

All the map projections can differ according to 3 varieties of alignment. The normal case is when the axis of symmetry of the projection surface is equal to the rotational axis. The transverse case is when the axis of symmetry of the projection surface is perpendicular to the rotational axis. The oblique case is when the axis of symmetry of the projection is about 45° degree to the rotational axis.

In the above-mentioned examples of widely used projections of each type, the expressions equidistant, conform and equivalent is coming up. An equidistant map means you have a correct representation of distance on the plane. A conform map is a map with correct angles (important for example for navigation maps). Equivalency means you have a correct representation of areas. (important for example general quantitative maps e.g. population density maps. These three criteria are not satisfied in the same time in a map. That's why it is necessary to know, for which reason you use the map, so that you can focus on the relevant criteria.

- Content /Topic4: Classification of map projections

Map projections are classified based on:

(i) Nature of projection surface defined as geometric figure-planar, conic, cylindrical

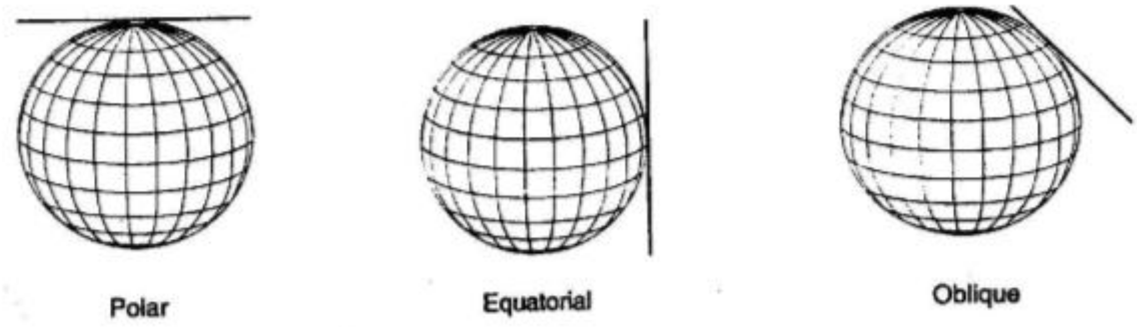
(ii) Coincidence or contact of the projection surface with datum surface-tangent, secant, polysuperficial

(iii) Position or alignment of the projection surface in relation to the datum surface-normal, transverse, oblique

Classification based on projection surface

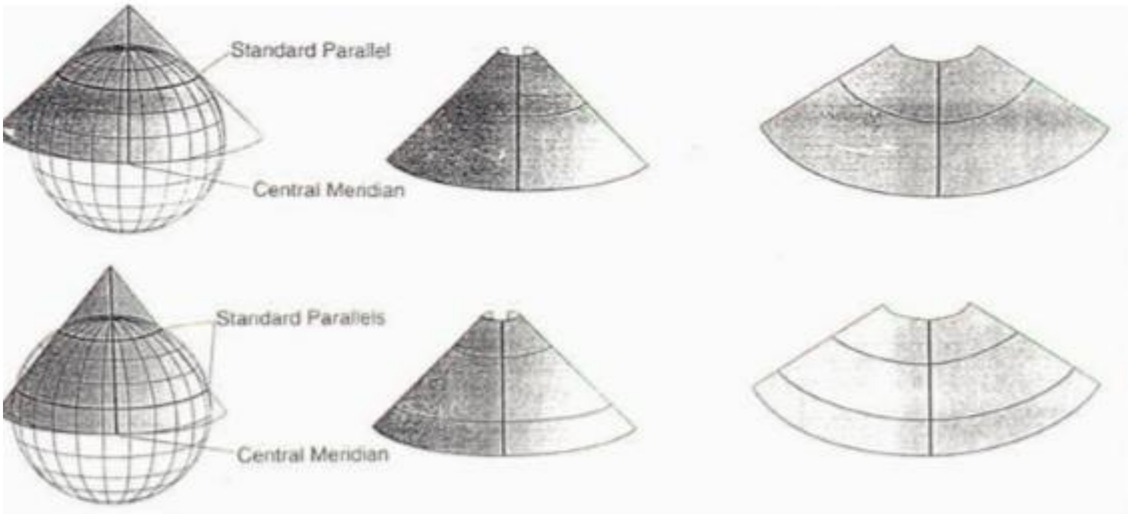
a. Planar/Azimuthal/Zenithal

In this projection, the image of the spherical globe is projected on to a map plane which is tangent to or touches the globe at a single point. The plane is the simplest but has the disadvantage of having only a point as contact between it and the datum surface.



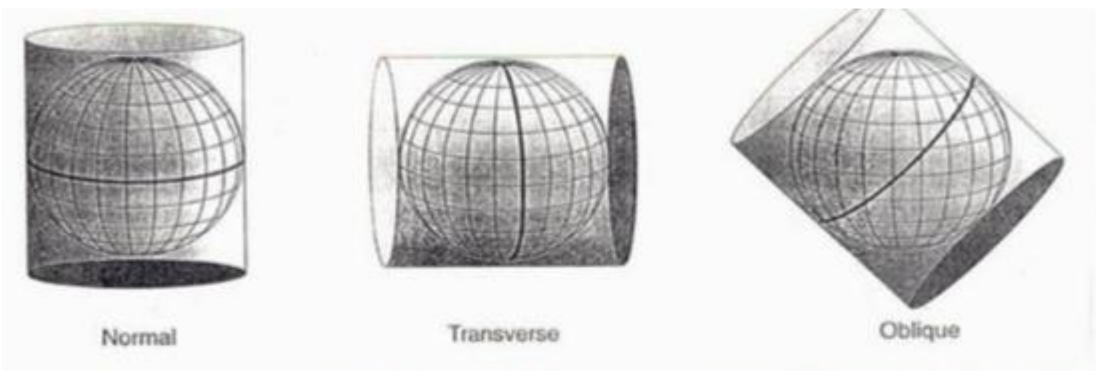
b. Conical

The spherical globe is projected on to a cone which touches along one line or cuts through the globe along two lines usually parallels of latitude. The cone is then unfolded to create a flat map.



c. Cylindrical

The image of the spherical globe is projected on to a cylinder which may be tangent along one line or cuts through along two lines usually parallels of latitude.



Classification based on coincidence/contact

This refers to the nature of contact between the projection surface and the datum. The three varieties are:

a. Tangent resulting to a point for a plane or line of contact for cone or cylinder

b. Secant resulting in a line of contact for a plane or two lines for cone or cylinder

c. Polysuperficial: These are series of successive projection surfaces. The cone and cylinder provide a larger area of contact and are developable into a plane. The contact points are points of least distortion.

Classification based on alignment/position of projection surface in relation to the datum surface

The alignment of the projection surface can be further divided into three varieties. These are:

a. Normal The normal case results when the axis of symmetry of the projection surface coincides with the rotational axis of the datum.

b. Transverse The transverse case occurs when the axis of symmetry of the projection surface is perpendicular to the rotational axis of the datum.

c. Oblique The other cases of orientation result to the oblique case

- Content/Topic 5: Description the commonly used of map projections

a) The Globe:

The globe, as represented by Orthographic projection—equatorial aspect has the following properties: true directions; true distances; true shapes and true areas. The great circles-shortest distance between any two points on the surface of the Earth can be found quickly and easily along a great circle. The short comings of the globe include:

• Even the largest globe has a very small scale and shows relatively little detail.

• Costly to reproduce and update.

• Difficult to carry around.

• Bulky to store.

On the globe:

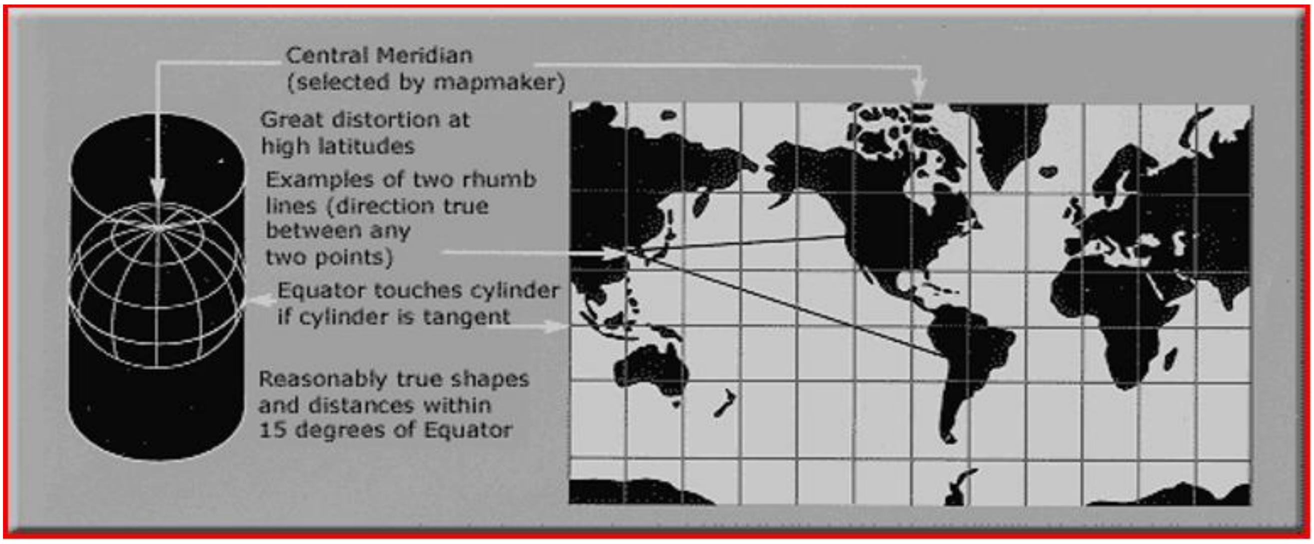
- Parallels are parallel and spaced equally on meridians.
- Meridians and other arcs of great circles are straight lines (if looked at perpendicularly to the Earth's surface). Meridians converge toward the poles and diverge toward the Equator.
- Meridians are equally spaced on the parallels, but their distances a part decreases from the Equator to the poles. At the Equator, meridians are spaced the same as parallels. Meridians at 60° are half as far apart as parallels.
- Parallels and meridians cross at right angles.
- The area of the surface bounded by any two parallels and any two meridians (a given distance apart) is the same anywhere between the same two parallels.
- The scale factor at each point is the same in any direction.

b) Conformal Projections Maps to be used for analyzing, guiding or recording motion and angular relationships require the use of conformal projections. Examples of such maps are navigation charts, charts of meteorologists and general class of topographic maps. There are four conformal projections in common use: **the Mercator, the transverse Mercator, Lambert's conformal conic with two standard parallels and the stereographic azimuthal.**

The Mercator projection

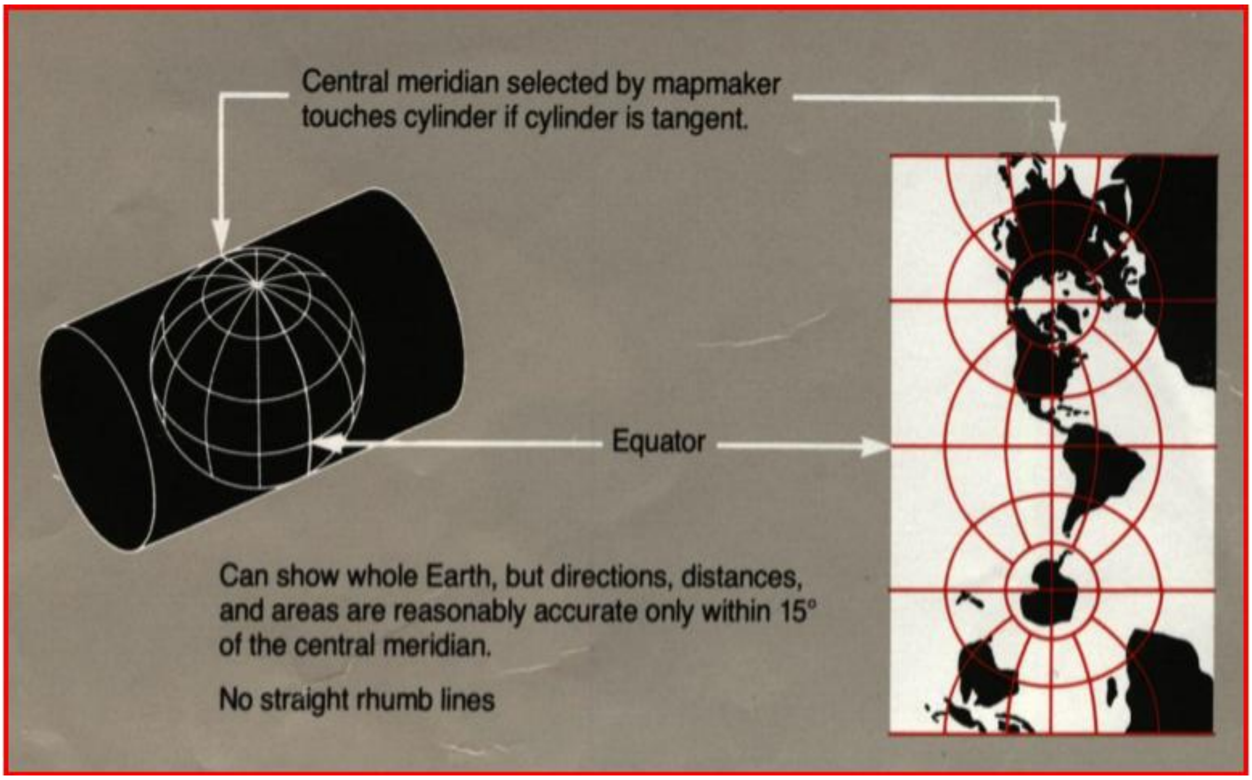
- The best-known map projection is named for its inventor, Gerardus Mercator, who developed it in 1569.
- The Mercator projection is a cylindrical projection that was developed for navigation purposes. The Mercator projection was used for its portrayal of direction and shape, so it was helpful to the sailors of that time.
- The straight lines crossing at right angles of this map projection make it useful for navigation, but it distorts the size of areas away from the equator. Polar areas appear to have a larger

scale than areas near the center. (Note Greenland). Over small areas the shapes of objects will be preserved, however, so this projection is conformal



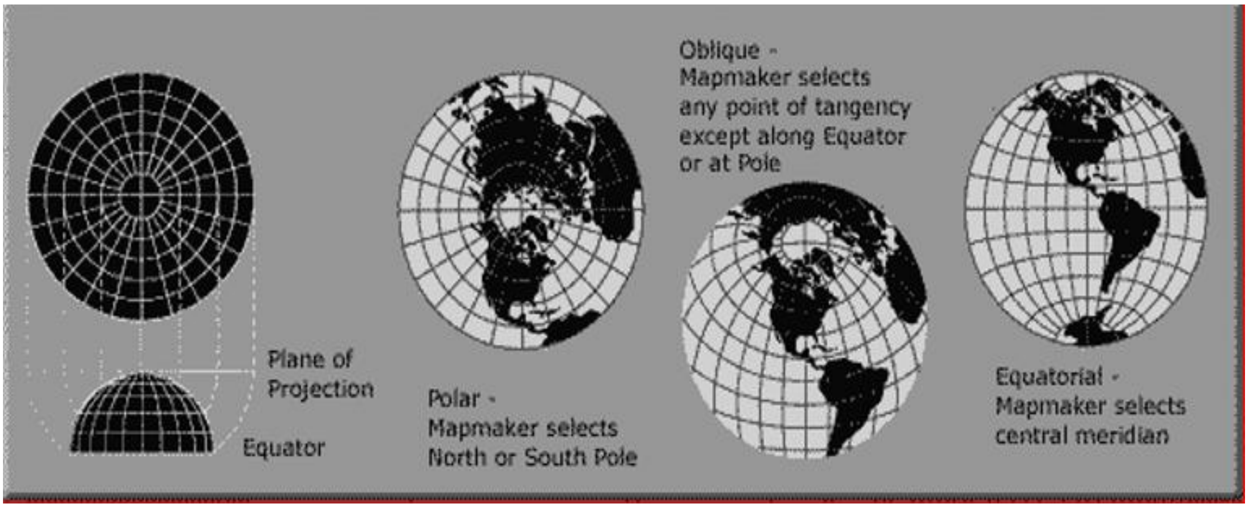
Transverse Mercator

- The Transverse Mercator projection is a cylindrical projection often used to portray areas with larger north south than east-west extent.
- Distortion of scale, distance, direction and area increase away from the central meridian.
- Since the earth is spherical and the equator is like any other great circle, we can rotate Mercator's projection (or the sphere) 90o so that the standard line becomes a meridian (a great circle) that takes place of the equator. When this is done, the projection is called transverse Mercator. It is conformal but it does not have the attribute that all rhumbs are straight lines. Since scale exaggeration increases away from the standard meridian, this projection is useful for only a small zone along the central meridian. In the secant case, of the transverse Mercator, lines of equal scale difference are small circles parallel to the central meridian. Thus the earth is often represented by a series of narrow east-west but long north-south strips, each strip on a single secant case transverse Mercator map projection. Transverse Mercator has been widely used for topographic maps and as a base for the Universal Transverse Mercator (UTM) plane coordinate system.



Conformal Stereographic

This projection falls in the azimuthal group. The distortion is arranged symmetrically around the center point. This is an advantage when the shape of the area to be represented is more or less compact.



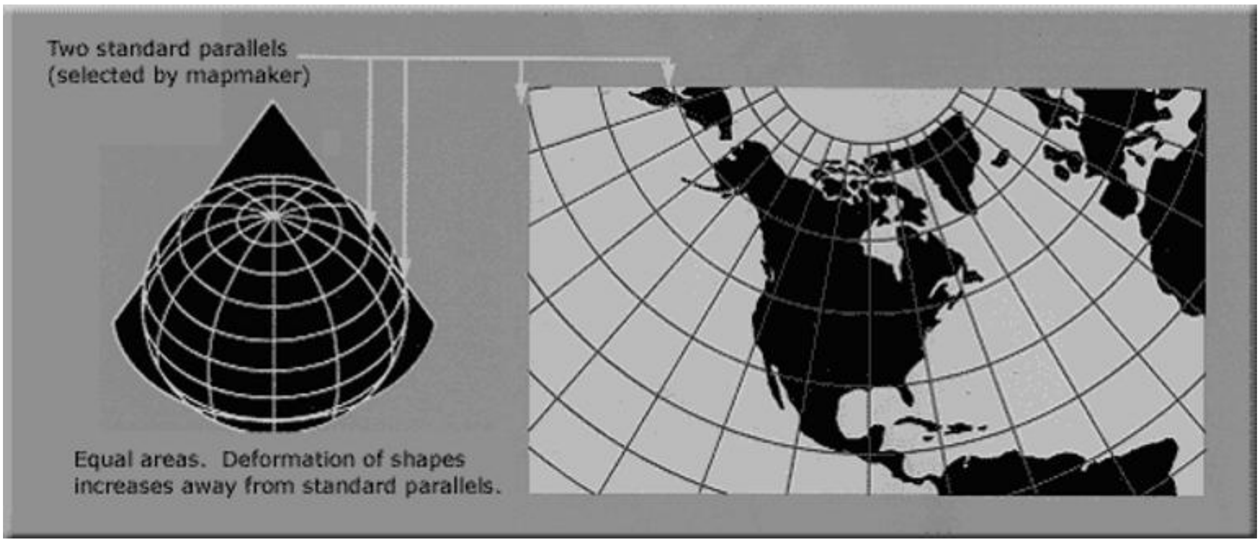
b) Equal Area Projections These projections are used mostly for maps of instruction and for small scale general reference maps. Many of our impression of the regions/continents have been acquired subconsciously. Because non equal area projections have been used for instructional and small scale general reference maps, many people have developed erroneous conceptions of regions' comparative sizes e.g. many people believe that Africa is smaller than North America when in reality Africa is 6 million sq. km larger. These false impressions come from educators use of projections not well suited to the task. The smaller the region to be represented, the less significant is the choice of an equal area projection. The choice of equal area map projections depends on:

• The size of the region involved

• The distribution of angular deformation.

Albers' Equal Area Projection

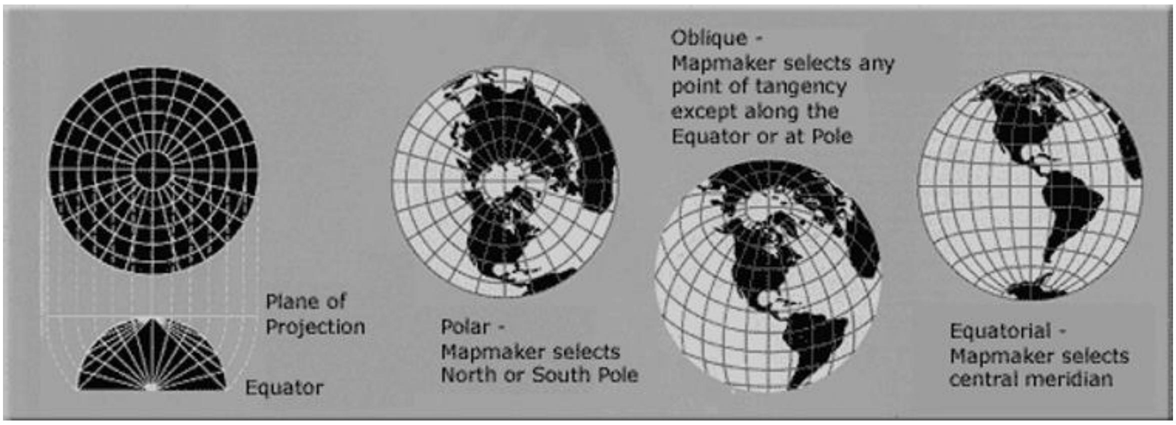
- The Albers Equal Area Conic map projection was developed by Heinrich Christian Albers in 1805.
- This projection uses two standard parallels. No distortion occurs along the two standard parallels, and parallels gradually decrease in spacing away from the central parallel.
- Scale and shape are not preserved, but directions are reasonably accurate in limited regions.
- This projection is useful for mapping areas that are mainly east-west in extent and that require equal-area representation like the regions of Europe, the United States, Alaska, and Hawaii...



Lambert Azimuthal Equal Area

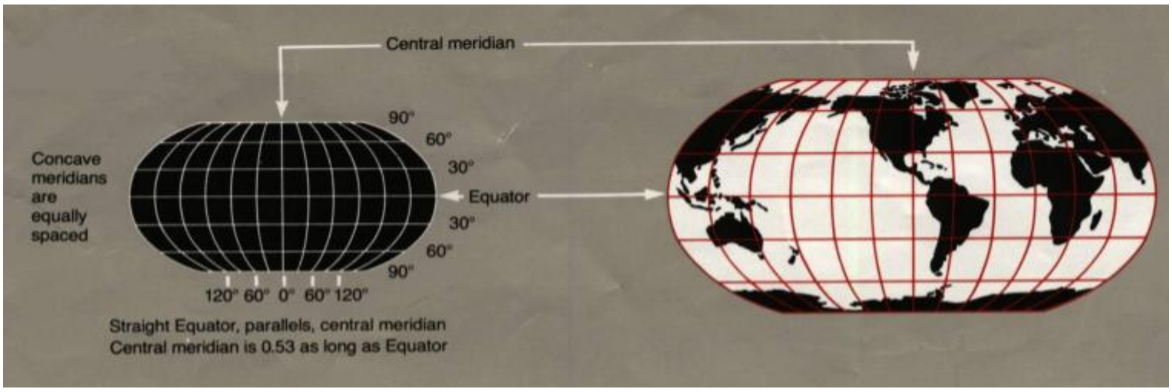
- The Lambert Azimuthal Equal Area map projection was developed by Johann Lambert in 1772.
- This equal-area projection is useful when mapping large ocean areas.

- Directions are true only from the center point. Scale decreases away from the center point, as distortion of shapes increases.
- Distances are true along the equator and other parallels.



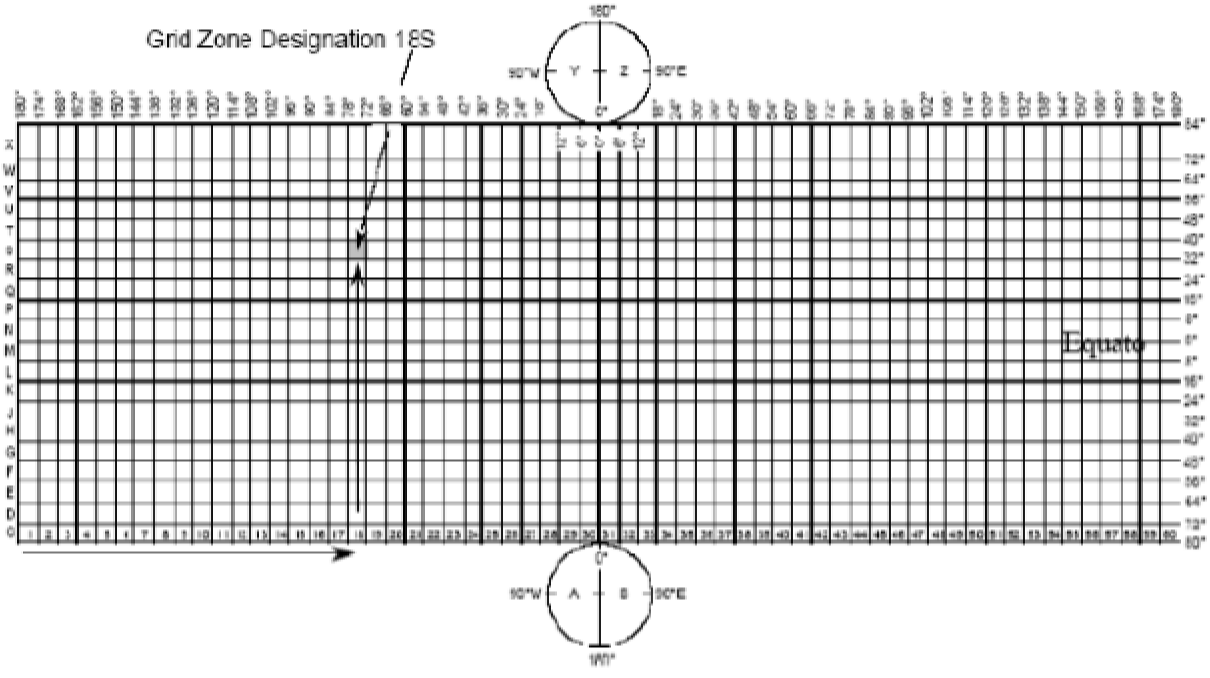
Robinson's projection

- The Robinson projection was a compromise projection developed by Arthur Robinson, a leading educator in cartography.
- The Robinson projection is considered a pseudo cylindrical projection.
- This projection shows the whole earth uninterrupted with reasonable shapes. It departs somewhat from equal area in order to provide better shapes in the middle- and low-latitude regions.
- The Robinson projection was used by Rand McNally, the National Geographic Society, and others.



The Universal Transverse Mercator (UTM) The UTM grid system has been widely adopted for topographic maps, satellite imagery, natural resources databases and other applications that require precise positioning. It was first adopted by US Army in 1947 for large scale maps worldwide. In the UTM grid system, the area of earth between latitude 84°N to 80°S is divided into north-south columns 6° of longitude wide. These columns are called zones.

They are numbered from 1 to 60 eastward, beginning at the 180th meridian. Each column is divided into east-west bands/belts of 8° of latitude. These belts are lettered from the South Pole using C through X (O and I omitted). Row X is 12° latitude extending from 72°N to 84°N to cover all land areas in the northern hemisphere



Greenwich Meridian

Each quadrilateral is assigned a number-letter combination. For example, 18S denotes a quadrilateral 6° in longitude, between 78°W and 72°W, and 8° in latitude, between 32°N and 40°N. The meridian halfway between the two boundary meridians for each zone is designated as the central meridian and a cylindrical projection (transverse Mercator) is done for each zone. The central meridian for zone 1 is at 177° W. The scale of central meridian is reduced by 0.9996 to minimize scale variation in zone resulting in accuracy variation of approximately 1 part in 2,500. The origin of the coordinates within a particular grid zone is set at the equator (0m North) for northern hemisphere and at 10,000,000m south of equator for southern hemisphere for the Y/N values. For X/E, the origin is set at 500,000m west of central meridian. Thus there are no negative values within zone, and central meridian is at 500,000m east...

Universal Polar Stereographic (UPS) Grid System

In order to cover the polar areas (south of 80°S latitude and north of 84°N latitude) with coordinate grid as accurate as the UTM system, the UPS is used. Each circular polar zone is divided in half by the line representing the 0° and 180° meridian. In the north polar zone, the west half is designated grid zone Y, the east half as grid zone Z. In the south polar zone, the west longitude half is designated A, the east half B. In the polar areas, the false northings and false eastings of the poles are given the value 2,000,000 meters in both zones. The 2,000,000 meter easting coincides with the 0°-180° meridian line. The 2,000,000 meter northing coincides with the 90°E-90°W meridian line. Grid north is parallel to true north along the 0° meridian and, therefore, also to true south along the 180° meridian.

LO 1.4 Identify coordinate system.

- <u>Content/Topic 1:Identification of reference System</u>

What is a Coordinate Reference System?

A reference ellipsoid is the mathematical model of the shape of the Earth with the major axis along the equatorial radius. A geographic coordinate system uses longitude and latitude expressed in decimal degrees. For example, WGS 1984 and NAD 1983 are the most common datum today. Before 1983, NAD27 was the most common datum.

Cartographers write spherical coordinates (latitudes and longitudes) in degrees-minutes-seconds (DMS) and decimal degrees. For degrees-minutes-seconds, minutes range from 0 to 60. For example, the geographic coordinate expressed in degrees-minutes-seconds for New York City is:

- Latitude: 40 degrees, 42 minutes, 51 seconds N
- Longitude: 74 degrees, 0 minutes, 21 seconds W

You can also express geographic coordinates in decimal degrees. It’s just another way to represent that same location in a different format. For example, here is New York City in decimal degrees:

- Latitude: 40.714
- Longitude: -74.006

Map Coordinate Systems

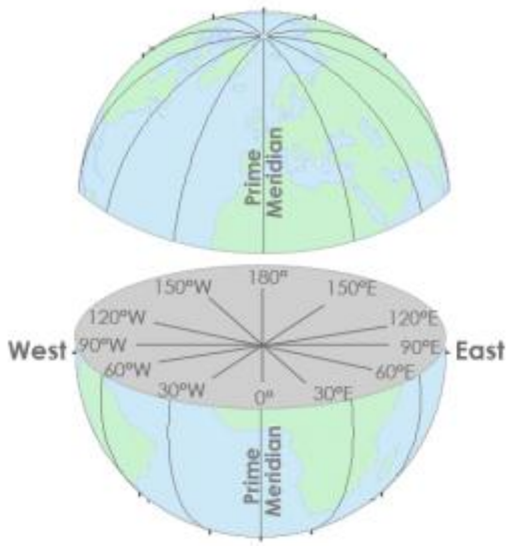
You can give any location on Earth latitude and longitude coordinates.

The field of study that measures the shape and size of the Earth is geodesy. Geodesists use coordinate reference systems such as WGS84, NAD27 and NAD83. In each coordinate system, geodists use mathematics to give each position on Earth a unique coordinate.

- ✓ **Geographic coordinate system**

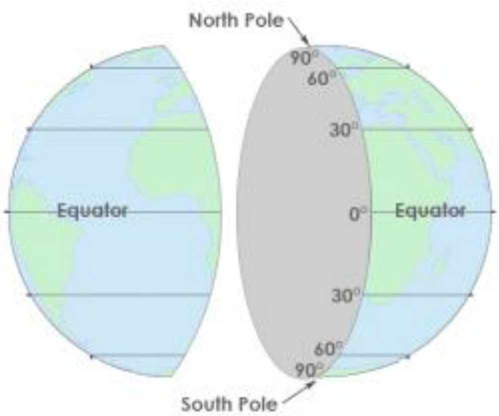
A geographic coordinate system defines two-dimensional coordinates based on the Earth's surface. It has an angular unit of measure, prime meridian and datum (which contains the spheroid).

As shown in the image below, **lines of longitude** have X-coordinates between -180 and +180 degrees.



Longitude Coordinates

And on the other hand, **lines of latitudes** have Y-values that are between -90 and +90 degrees.



Latitude Coordinates

The **equator** is where we measure north and south. For example, everything north of the equator has positive latitude values. Whereas, everything south of the equator has negative latitude values.

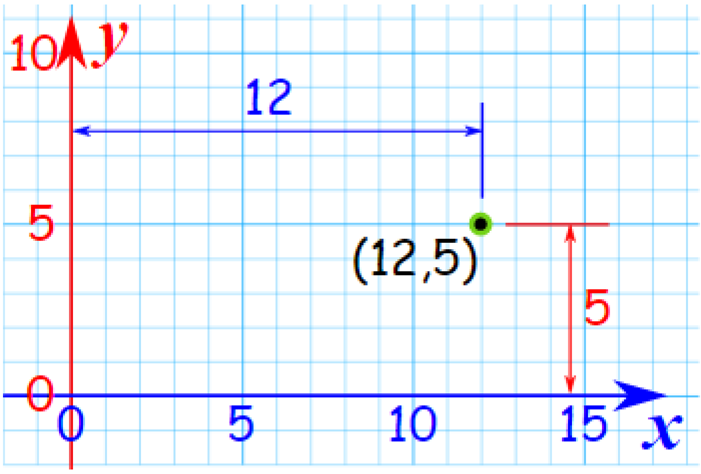
The Greenwich Meridian (or prime meridian) is a zero line of longitude from which we measure east and west. In fact, the zero line passes through the Royal Observatory in Greenwich, England, which is why we call it what it is today. In a geographical coordinate system, the prime meridian is the line that has 0° longitudes.

- ✓ **Grid coordinate system**
  - **Cartesian coordinate system**

They are called *Cartesian* because the idea was developed by the mathematician and philosopher **Rene Descartes** who was also known as ***Cartesius***.

He is also famous for saying *"I think, therefore I am"*.

Using Cartesian Coordinates we mark a point on a graph by **how far along** and **how far up** it is:

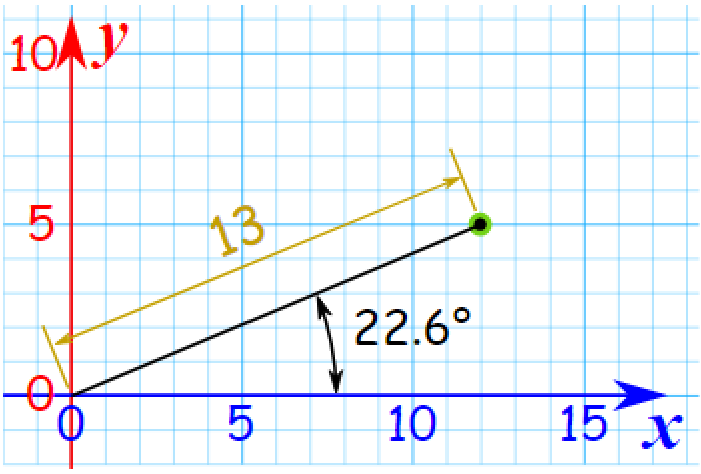


The point **(12, 5)** is 12 units along, and 5 units up.

They are also called **Rectangular Coordinates** because it is like we are forming a rectangle.

- **Polar Coordinates**

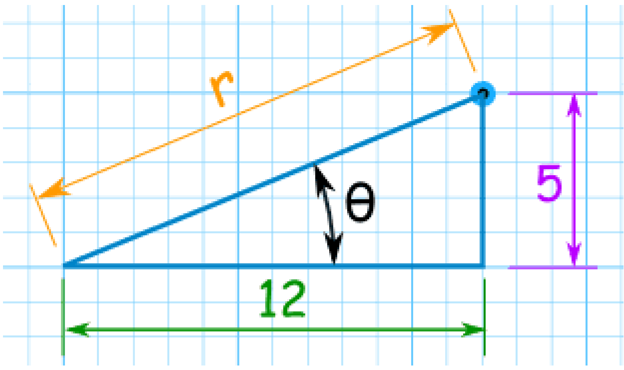
A polar coordinate system, gives the co-ordinates of a point with reference to a point 0 and a half line or ray starting at the point 0. We will look at polar coordinates for points in the (x y)-plane, using the origin (0, 0) and the positive x-axis for reference. A point P in the plane has polar coordinates (r, θ), where r is the distance of the point from the origin and θ is the angle that the ray |OP| makes with the positive x-axis.



To Convert from Cartesian to Polar

When we know a point in Cartesian Coordinates (x, y) and we want it in Polar Coordinates (r,θ) we **solve a right triangle with two known sides**.

Example: What is (12, 5) in Polar Coordinates?



Use Pythagoras Theorem to find the long side (the hypotenuse):

$r^2 = 12^2 + 5^2$

$r = \sqrt{(12^2 + 5^2)}$

$r = \sqrt{(144 + 25)}$

$r = \sqrt{(169)} = \mathbf{13}$

Use the Tangent Function to find the angle:

$\tan(\theta) = 5 / 12$

$\theta = \tan^{-1}(5 / 12) =$ **22.6°** (to one decimal)

Answer: the point (12, 5) is **(13, 22.6°)** in Polar Coordinates.

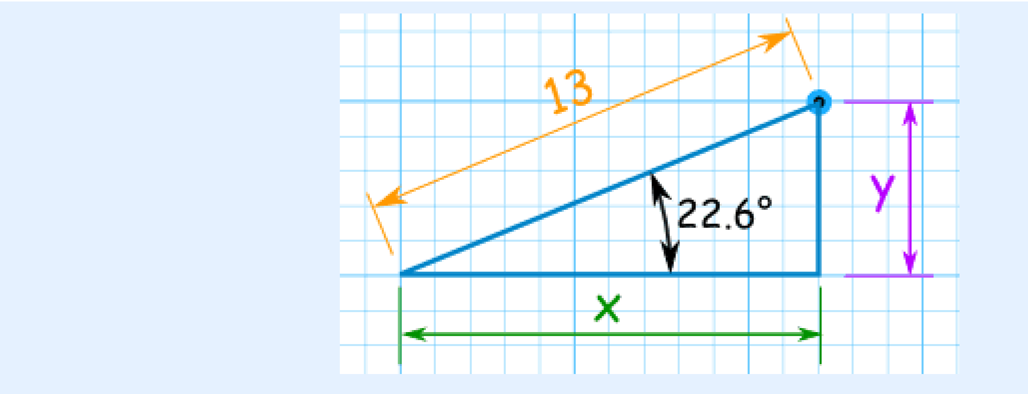
Summary: to convert from Cartesian Coordinates (x, y) to Polar Coordinates (r, θ):

- **$r = \sqrt{(x^2 + y^2)}$**
- **$\theta = \tan^{-1}(y / x)$**

To Convert from Polar to Cartesian

When we know a point in Polar Coordinates (r, *θ*), and we want it in Cartesian Coordinates (x,y) we **solve a right triangle with a known long side and angle**:

Example: What is (13, 22.6°) in Cartesian Coordinates?



Use the Cosine Function for x:	$\cos(22.6°) = x / 13$
Rearranging and solving:	$x = 13 \times \cos(22.6°)$
	$x = 13 \times 0.923$
	x = **12.002...**
Use the Sine Function for y:	$\sin(22.6°) = y / 13$
Rearranging and solving:	$y = 13 \times \sin(22.6°)$
	$y = 13 \times 0.391$
	y = **4.996...**

Answer: the point (13, 22.6°) is *almost exactly* **(12, 5)** in Cartesian

Summary: to convert from Polar Coordinates (r, *θ*) to Cartesian Coordinates (x, y):

- **$x = r \times \cos(\theta)$**
- **$y = r \times \sin(\theta)$**

Learning Unit 2: Perform map symbolization and generalization

LO 2.1 Identify map symbols.

- <u>Content/Topic 1 Identification of graphical symbols:</u>

Graphical symbols

A graphical symbol is any drawn or otherwise constructed image used as a means of representation. Maps are composed of symbols arranged on a flat surface representing arrangement of phenomenon at a particular scale. They give information individually on location and collectively on distribution, structure and relative position. There are many kinds of different symbols but all these are classified into three groups:

1. Points

2. Line

3. Area

For effective communication, the symbols have to be:

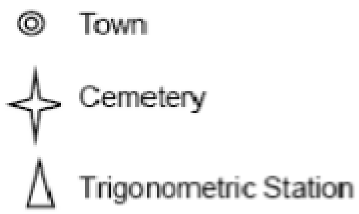
Detectable: large enough to be seen

Discrimination: they have to be of such form that their characteristic can be distinguished

Recognition: the meaning of the symbol should be realized

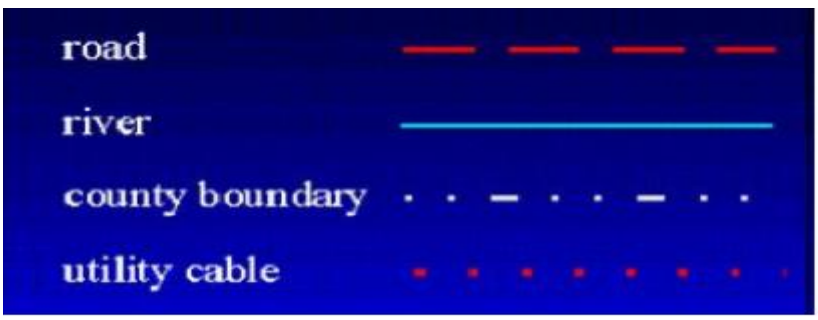
- **Point symbols**

Symbols used to indicate location and identity or other characteristics of features of small territorial extend in relation to a map scale.



- **Line Symbols**

They represent features with linear characteristics. They are linear marks used to represent a variety of geographical features e.g. roads, railways, rivers, canals. They are also used to represent a concept of flow. They also represent absolute values e.g. contour lines, valley boundaries, grid lines, graticule lines. The length of the symbol is important than its width.



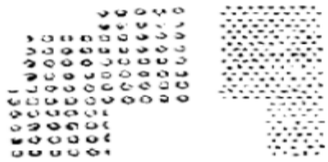
Area Symbols

These are used to represent features of considerable area extent in relation to scale. They indicate a region with a common attribute over the entire area. The area can also be represented without an outline.


MARSH OR SWAMP


TROPICAL GRASS


WOODS


VINEYARD/ORCHARD

- Content/Topic 2 Description ofGround features:

✓ **Relief**: is the difference between its highest and lowest elevation point in an area. Mountains and ridgesare typically the highest elevation points, while valley and other low-lying areas are the lowest. Relief is essential to understanding the topography. Consequently, map makers display different elevation through several methods. Contour lines show elevation change between consecutive lines. The closer the lines are to each other, the steeper the elevation. Colour is also used to show elevation.

✓ **Water bodies/hydrology:**Colour associated with representation of features is blue. Rivers, canals, streams, dams, lakes, seas, oceans etc. for each of these features, different representation is used. Rivers: line-single or double depending on scale. If double line is used, the infill is tint or solid blue. They may be permanent or seasonal, definite or indefinite and they should be differentiated. Use solid outline and pecked/broken outline for permanent and seasonal rivers respectively.

✓ Canals: constructed water features and require regular outline Lakes and large stretches of water: these are area features and are represented by outline of area with infill usually blue tint. Small water features like springs, wells, water holes: at large scale or small scales are represented by geometric symbols with solid infill of blue with letters to identify the particular feature. Coastal features: high water mark (HWM)-this is a line differentiating the open sea and dry land. At high tide we have the HWM and at low tide the low water mark (LWM). These fluctuating marks on topographic maps are represented by the mean water mark. On nautical charts, the LWM is represented. It is represented using a solid blue line or black plus color band reducing seawards.

✓ **Vegetation features:** Green colour is normally used on topographic maps. The basis of classification is (i) floristic species; (ii) structural-woody, herbaceous; (iii) height- bushy plants or woodlands; (iv) density woods, bush, scattered trees (v) economic value of vegetation The limits for natural vegetation are difficult to define because they have no particular species growing in isolation. The dominating characteristics of vegetation are used to classify. In defining limits, adopt the mean position and use mixed symbols. Green or black color is used giving a pictorial kind of representation hence arising to different classes of vegetation and species. There is a defined limit for natural and cultural vegetation because of the regular pattern used in planting-used regular pattern for representation.

- ✓ **Transportation features:**

- ***Roads:*** the width is shown at large scale and centre line at small scale. Differentiate between the type of surface (loose soil, compacted soil, tarmac or hard surface); Accessibility (all weather roads, dry weather roads, public or private roads); Importance/Administrative (international, national, primary feeders, secondary roads, minor roads, tracks and foot paths); Number of lanes/tracks (high ways, single track or multi track). In most cases, roads are represented by single or double lines. Use visual variables to combine the different type of classifications.
- ***Railways:*** are represented using black and the variables to be shown include: (i) gauge (normal or narrow); (ii) Number of tracks (multiple or single); (iii) lines (multiple or single); (iv) size (in double lines, the difference between the two line, in single line, the thickness). Railways are always represented in symbols except on very large scale maps. Additions and multiplicity of symbols are used.

- ✓ **Boundaries:** Different types of boundaries exist: administrative or property boundaries; political or geographical. International boundaries: areas or zones of friction are fixed through various stages of evolution. The description is by major geographical features on the ground surface-difficult to relate to ground surface. Delimitation is an agreement between neighbouring countries as to exact locations of these descriptions. Demarcation is the actual physical marking of the boundary on terrain by building monuments along the boundary at turning points.

  Status of boundaries-depends on nature of agreement and how far the delimitation. Dejure-exists by treaty and agreement and recognized by majority of international bodies. De-facto-enforced, disputed, exist, unrecognized by majority In representing, the map maker does not know the nature of the boundary. Therefore there is no differentiation between de-facto and dejure boundaries. Boundaries are important land features and are given prominence in representation. Location of monuments is shown on map. The use of repeated symbols and color band along boundaries is common.

  Other boundaries:

Administrative-they represent hierarchy in administration. They also define restricted areas (military zone, forests, park reserves, game reserves e.t.c) They are all line features. Color can be used to differentiate the different types of boundaries e.g. for forests and national parks, use green; red for restricted areas

- ✓ **Buildings:** on large scale maps, it may be possible to plot the outline of the building. Where this is possible, the area may be filled in color, tint, line pattern, dots. For small buildings, use black symbols. For small scale maps, buildings may only be represented symbolically. Towns and villages may be represented by area outline. The criteria for representation should be guided by the function, administrative status, population or combination of factors. Special buildings e.g. churches, mosques, hospitals, hostels are represented differently. For large scale, outline may be plotted but for small scale maps most of them are symbolically represented often with descriptive symbols which may be pictorial or connotative in nature.

LO 2.2:Symbolize map.

- Content/Topic 1 Representation of elevation

- ✓ **Spot height:** Spot heights are placed at ruling points such as tops of hills, bottoms of valleys, ridge points and saddle points. Their selection and placing are important and they are sighted to give maximum value in determining the height of the ground where it is not clear from contour or any other information. The accuracy of spot heights depends on the method of survey-the accuracy required for spot heights depend on the scale of the map and the type of ground. Approximate values are often much more useful than no values at all.
- ✓ **Hill shading:**this is the most commonly used technique to indicate slopes, either alone or in conjunction with contours. It does not itself give an indication of the height. It only gives indication of the steepness of the slope and an excellent visual picture of relief without any positive value of height. Basically, hill-shading consists of shading the ‘dark’ side of the hill ‘lighting’ the sunny side to provide contrast.
- ✓ **Contours:** a line joining points of equal height. It is the standard method of relief representation. Contours combine an accurate indication of height with a good indication of shape and are a simple and effective method of showing relief especially when used in conjunction with heighted points. Effectiveness of contours depend to a large extend on the selection of the vertical interval between contours, scale of the map and the nature of the terrain. The best vertical interval is one which enables the hill features and changes of scope to be shown as fully as the scale permits without making the contours so close together as to obscure the map or too close together to be shown separately on steep slopes.

- ✓ **Vertical Interval Related to two factors**: (i) map scale (ii) terrain slopes A map is required to have enough contours to allow appreciation of terrain but not so many that they merge into a continuous mass of lines hence obscure other information. The general guide:

Scale	V.I.
1/10,000	5 or 10
1/25,000	10
1/50,000	20
1/100,000	25
1/250,000	50

On smaller scales, it might be necessary to show 50m and 100m contours and to verify intervals in the high ranges.

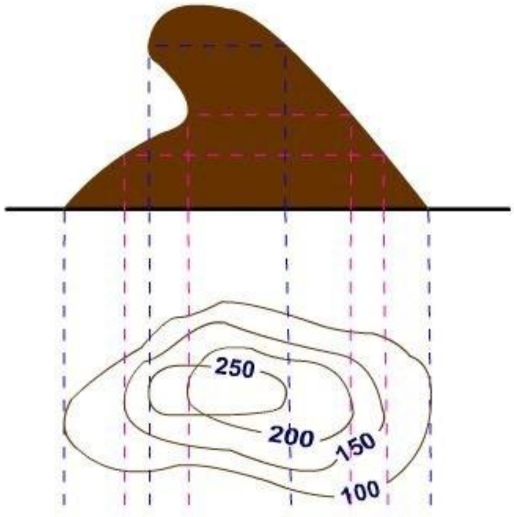
Contour representation

Contours are normally drawn as continuous lines of standard gauge. Every fourth or fifth contour, depending on the V.I. to provide multiples of 10, 50,100, etc, is called an index contour and is shown in a heavier gauge of line. This helps in reading and counting the contours to determine the height. Auxiliary or supplementary contours at an intermediate vertical interval may be used in special circumstances to supplement the standard contours e.g. in flat ground where a small rise within the standard vertical interval may be a significant figure. Auxiliary contours must be clearly distinguished from standard contours and their values must be shown.

Characteristics of contour lines

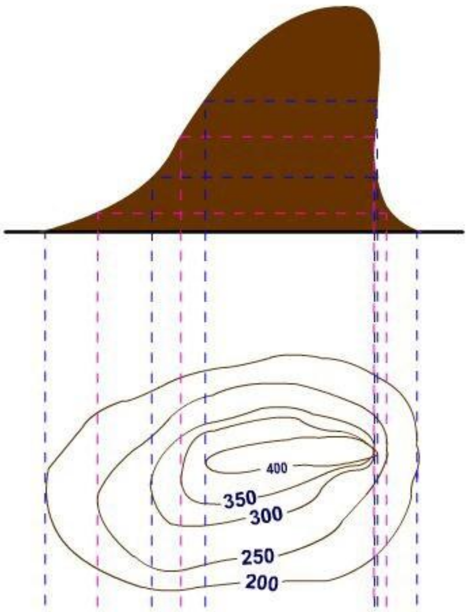
The following characteristic features may be used while plotting or reading a contour plan or topographic map:

- ✓ Two contour lines of different elevations cannot cross each other. If they did the point of intersection would have two different elevations, which is absurd. However, contour lines of different elevations can intersect only in the case of overhanging cliff or cave.



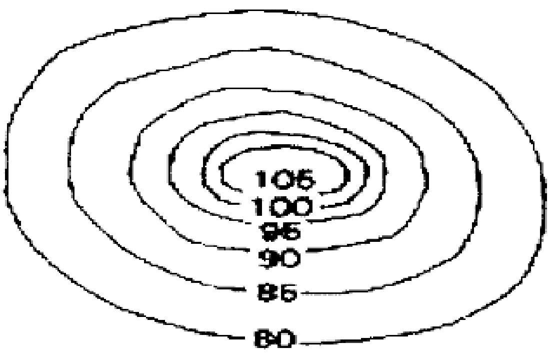
Overhanging cliff and its contour

- ✓ Contour lines generally do not meet or intersect each other. If contour lines are meeting in some portion, it shows existence of a vertical cliff.

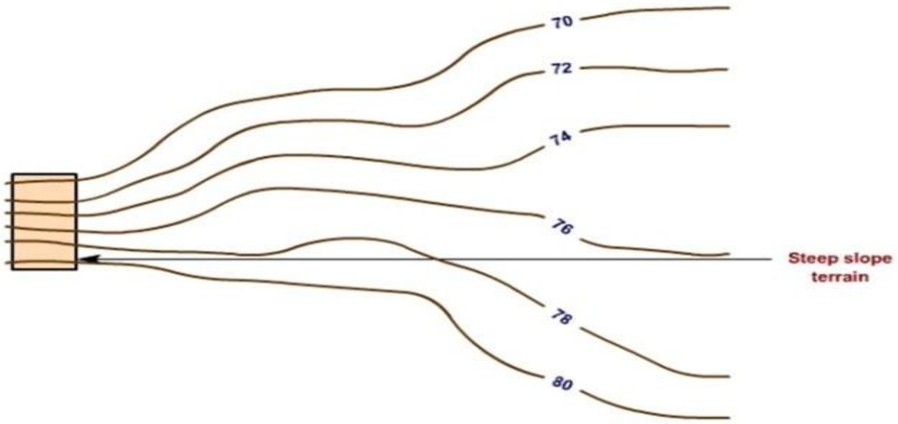


Vertical cliff and its contours

- ✓ The contour lines are closed near the top of hill or high ground and wide apart near the foot. This indicates a very steep slope towards the peak and towards the foot.

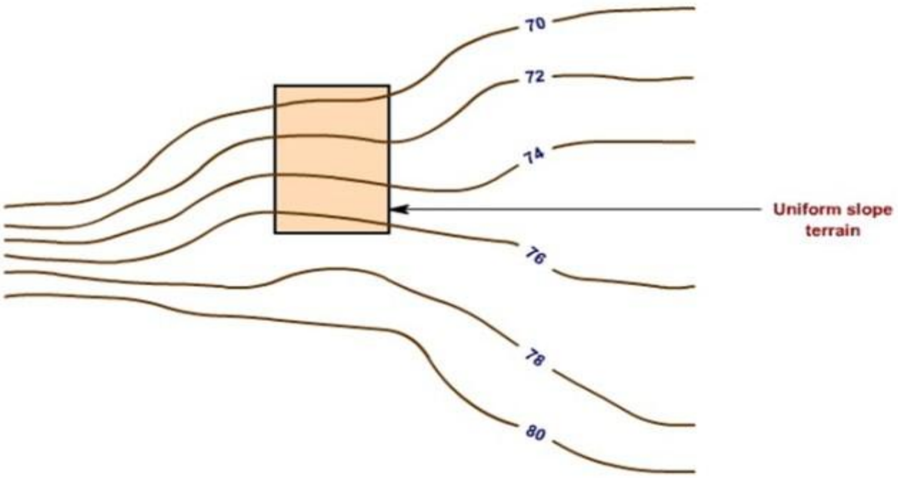


- ✓ Closely spaced contour indicates steep slope ground.



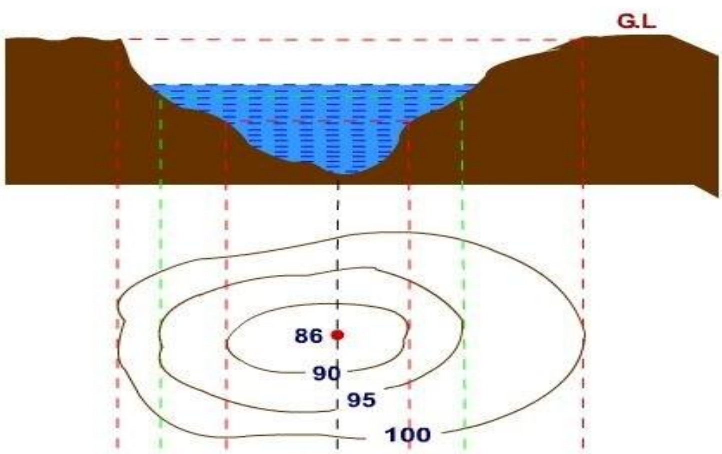
Contours of Terrain having different types of slope

- ✓ Equally spaced contour indicates uniform slope.



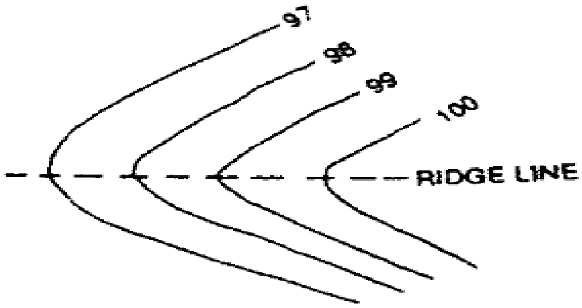
Contours of Terrain having different types of slope

- ✓ Two contour lines having the same elevation cannot unite and continue as one line. Similarly, a single contour cannot split into two lines.
- ✓ Approximately concentric closed contours with decreasing values towards centre indicate a pond.

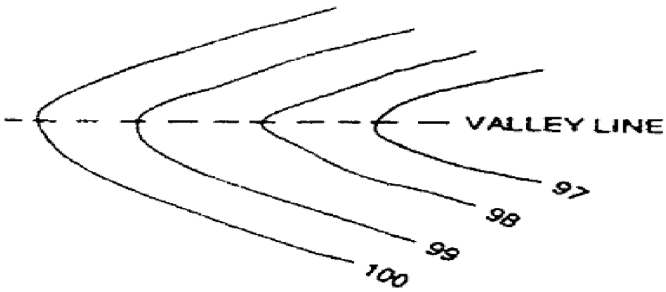


Pond and its contour

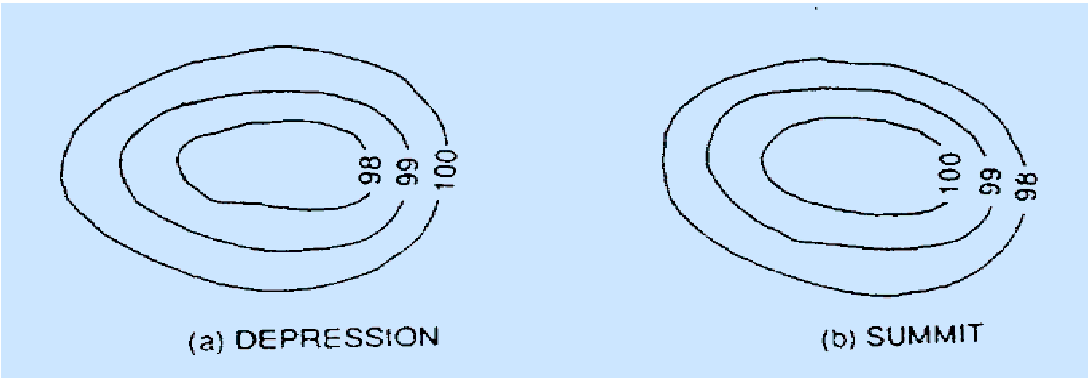
- ✓ Irregular contours signify rough, rugged country. Smooth lines imply more uniformly rolling terrain.
- ✓ A contour cannot branch into two contours of the same elevation.
- ✓ When the higher values are inside the loop, it indicates a ridge line. Contour lines cross ridge lines at right angles.



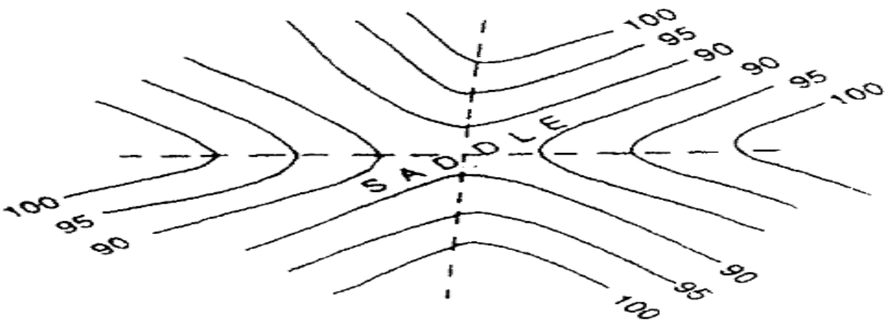
- When the lower values are inside the loop, it indicates a valley line.Contour lines cross valley lines at right angles.



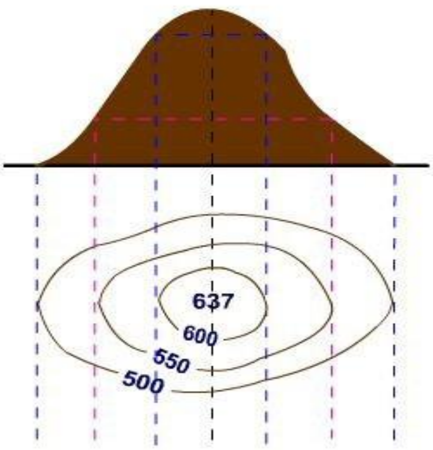
- A series of closed contours always indicates a depression or summit.The lower values being inside the loop indicates a depression and the higher values being inside the loop indicates a summit.



- Depression between summits are called **saddles.**

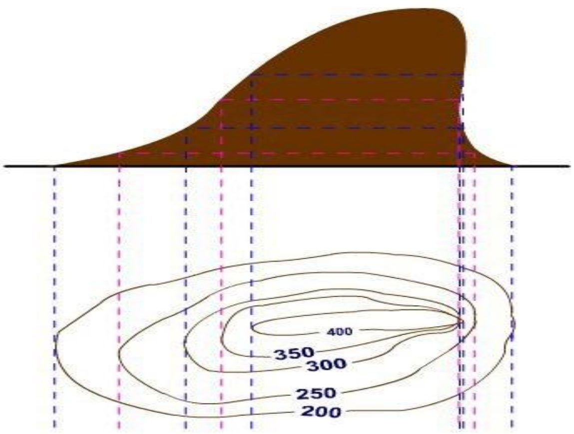


- Concentric closed contours that increase in elevation represent hills. A contour forming a closed loop around lower ground is called a depression contour (Spot elevations and hachure inside the lowest contour and pointing to the bottom of a hole or sink with no outlet make map reading easier.)



Hill and its contour

- Contour lines generally do not meet or intersect each other. If contour lines are meeting in some portion, it shows existence of a vertical cliff.



Vertical cliff and its contours

- <u>Content/Topic 2 Representation of shape</u>

a) **Hachures:** hachure depicts the relief by means of short disconnected lines drawn down the slope in the direction of water flow. The lines are short, thick and close together on steep slopes and are longer, more spaced out and thinner on the gentle slope. Diagram showing hachure this is an artistic method that requires much skill and although it does give a 3D effect to relief, it does not provide any definite height information and has the disadvantage of obscuring all other details. Hachure are not normally used on modern maps except to depict certain details e.g. cuttings, embankments, cliffs, craters and steep slopes. Bottom of valleys and tops of hills are not shown by hachure.

b) Hill shading: this is the most commonly used technique to indicate slopes, either alone or in conjunction with contours. It does not itself give an indication of the height. It only gives indication of the steepness of the slope and an excellent visual picture of relief without any positive value of height. Basically, hill-shading consists of shading the 'dark' side of the hill 'lighting' the sunny side to provide contrast. The darker the shading, the steeper the slope on the shadow side. The light is usually assumed to come from the North-West corner of the map. For some purposes, a good hill shaded map is more descriptive than a contoured map. With addition of spot heights, a reasonable standard of height comparison may be obtained and a clearer picture of relief is shown. It cannot however be substituted for a contoured map. A disadvantage of hill-shading is that it tends to obscure names and details below it and for this reason it has to be more lightly than might otherwise be desired.

c) Layer Shading/Layer Tinting/ Hypsometric Shading: a layer is a uniform tint applied to a ground between defined limits of height above or below a datum e.g. all ground between 50 and 100m. By using different tints for different layers, it is easy to get a clear picture of the variations of height or depth over an area. Layers are normally used in conjunction with contours to assist the user in gaining a quick appreciation of relief. They are occasionally used alone or in conjunction with hill shading to give a general impression of relief in areas where there is insufficient accurate height information for contouring. Although layers are generally considered an extremely useful aid to relief appreciation, they involve considerable additional work in map production and printing. They are therefore normally used on mapping scales of 1/250,000 and smaller. Light colors are usually chosen for the lower elevations while dark colors are used for higher elevations.

LO 2.3: Generalize visual variables.

- Content/Topic 1 Identification of process of map generalization

  - **Introduction of map generalization**
    - ✓ **Cartographic Generalization**

Map generalization is defined as the process of reducing the information content of maps due to scale change, map purpose, intended audience, and/or technical constraints. Generalization methods are used to remove detail that is unnecessary for an application, in order to reduce data volume and speed up operation. One constraint on the amount of generalization is introduced by the scale of the map. The smaller the scale, the more the amount of generalization and vise versa. This is because the amount of space available to show any given feature decreases as scale decreases. Generalization is also strongly influenced by the purpose of which the map was designed. Two maps of a given area may vary significantly in content even if they are of similar scale, depending upon their purpose. If generalization is done properly, the distinguishing characteristic of the mapped features will still be effectively represented.

- ✓ **Generalization Problem**

When a map is reduced in scale, there is a tendency for the clarity of the map to be reduced as well. Features such as roads, rivers, or cities often end up so close together in the reduced-scale map that they end up colliding, coalescing, or becoming tiny in size as to essentially be invisible to the person using the map. Cartographic generalization attempts to resolve this issue by redrawing the map in a different fashion when the scale is reduced, producing a more useable small scale map.

- ✓ **Models of Generalization**

To better understand the complexity of generalization, researchers have attempted to design models of the process. Some efforts have focused on fundamental operations and the relationship among them, whereas others have created complex models.

Robinson et al.'s

Model Arthur Robinson and his colleagues (1978) developed one of the first formal models or frameworks to better understand the generalization process. They separated the process into two major steps: selection (a pre-processing step) and the actual process of generalization. Generalization involves the processes of simplification, classification and symbolization.

- **Processes of map Generalization as title**

- ✓ **Simplification:**

Cartographers also need to simplify the features on a map beyond the tasks of feature type selection and feature classification in order to make a map more intelligible. To continue the previous example, this approach means that the shorelines of the lakes are made less complex at smaller scales. Ideally, enough detail is retained so that the major characteristics of the features are identifiable. A coastline with many bays and headlands, for example, should not be reduced to a smooth curve. Instead, sufficient complexity should be retained so that the nature of the actual coastline can be realized, even though the individual features are not all retained.

- ✓ **Classification:**

Classification is the grouping of things into categories, or classes. By grouping attributes into a few discernible classes, new visual patterns in the data can emerge and the map becomes more legible. In the example above, the highways are classified into those without traffic detectors (gray) and those with traffic detectors (in color) and furthermore, within the latter, into slow (red), intermediate (yellow), and fast (green) travel conditions. There are many kinds of data classification used on maps; we will focus specifically on classification of numerical map data in more detail later on in the chapter. As a preview of some of the things map readers must consider about classification, the example below shows one dataset for the rate of prostate cancer by county in Pennsylvania mapped using a different number of classes. As you can see, different patterns emerge depending upon how many classes the cartographer chooses to visualize. One must be critical when looking at maps because changing the map classification can change what appears to be true. In *How to Lie with Maps*, Mark Monmonier discusses how mapmakers intentionally and unintentionally lie through techniques such as map classification, among others.

✓ **Symbolization:**

In the final process of creating a map, the cartographer symbolizes the selected features on a map. These features can be symbolized in visually realistic ways, such as a river depicted by a winding blue line. But many depictions are much more abstract, such as a circle or star representing a city. Map symbols are constructed from more primitive "**graphic variables,** the elements that make up symbols. Below, we provide a brief overview of these core graphic variables; then we focus on how color in particular is used (or should be used).

- Content/Topic 2: Identification of Scale on map

Cartographic Scale Cartographic scale refers to the relationship between the earth and map distance. Cartographic scale is based on a strict mathematical principle. It expresses the relationship between the map and earth distances. Understanding the relationship between scale and how it influences content of the map is important. Also important to note is that cartographic scale determines the mapped space and the level of geographic detail possible. There are three types of cartographic scales:

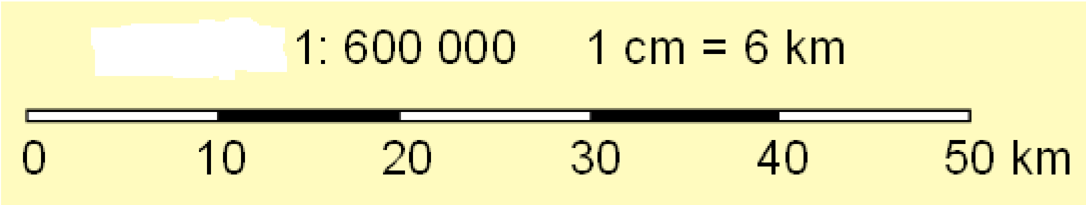
a) Representative Fraction (RF)

It is the simplest and functional way to represent scale. It is unit less and any distance measure may be inserted. Example, 1:24000 means that one distance unit on map represents twenty four thousand units on the ground. However, any enlargement or reduction of original map makes the RF value wrong since it alters the map units without adjusting the earth units.

e.g. 1:50,000 or 1/50,000

b) Graphical Scale

It is a more reliable representation of scale on large scale maps because it promotes direct estimates of distances and is reduced or enlarged a long with the accompanying map. However helpful they might be on large-scale maps, graphical scales should never appear on maps of the world, a continent, or a large country, all of which are drastically distorted in some fashion when features are transferred from a spherical earth to a flat map. Because of the stretching and compression involved in flattening the globe, the distance represented by a one-inch line can vary enormously across a world map, and scale can fluctuate significantly along, say, a six-inch line. Because map scale varies not only from point to point but also with direction, a graphical scale on a small-scale map invites grossly inaccurate estimates.



c) Verbal Statement

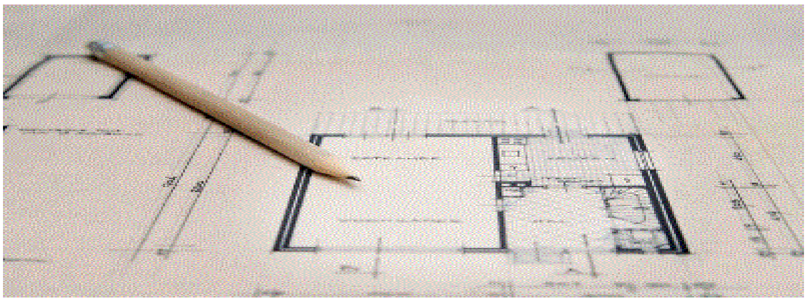
Example: one inch equals one mile reads like a spoken description of the relationship between map distance and earth distance. The statement is invalid if the map is reduced or enlarged.

E.g. one centimetre represents six kilometres

Learning Unit 3: Perform Map layout

LO 3.1. Select tools

- <u>Content/Topic 1: Identification of Plotting tools</u>



pencils, map, drawing, architectural drawing, planning, diagram

✓ Pencils

✓ Colored pencil

✓ **Eraser**: An eraser is an article of stationery that is used for removing fault drawing line or marks from paper or skin (e.g. parchment or vellum).

✓ **Ink pen**is a writing instrument which uses metal nib to apply a water- based ink to paper. The pen draws ink from the reservoir through a feed to the nib and deposits it on paper via a combination of gravity and capillary action.

✓ **Ruler:** A ruler is a stationery item and drafting tool used when drawing lines, as a guide for cutting, and for various other uses. It is available in different shapes and materials, depending on the type of lines the user wishes to draw. Some rulers have measurement gradations and can be used for measuring length. In general, those used for drawing lines and as a cutting guide are referred to as straight edges, and those used for taking measurements, rulers.

- Content/Topic 2: Identification of drawing equipment

✓ **Table:** also known as drawing board or drafting table is a kind of multipurpose desk which can used for any kind of drawing, writing or impromptu sketching on a large sheet of paper or for reading a large format book or other oversized document or for drafting precise.

drawing table, table plans, ...

✓ Calculator

- Content /Topic3: Identification of drawing materials

✓ **Transparent paper** also called tracing paper is the paper that takes pencil well, and from which pencil can be easily erased. Reproductions can be made directly from pencil drawings on drafting vellum .Vellum also Takes pen and ink well .on most papers, ink will bleed (that is spread and absorb into the paper).ink lines on vellum are crisp and solid as it does not absorb ink readily however caution must be taken to not unintentionally smear the ink before it dries.

✓ **Bristol paper** Bristol sheet provides a stiff, strong surface to work on without the need for mounting. The felt sides of the paper (typically the more desirable working side for the artist) are exposed so there are two workable surfaces in one surface

✓ **Graph paper** or grid paper is available in a variety of grid patterns. Most grid media used in interior design has 4 squares per inch. This can represent ¼" scale for drawing purposes. It is used for planning, drawing, rough design sketches, technical sketches, or simply under a sheet of trace as a guide.

LO 3.2: Lay marginal information.

- Content/Topic 1 Arrange Marginal information

Marginal information: Marginal information is the peripheral information on the edge of the map that provides useful information about the map user.

a) Sheet Name: Normally placed at the centre top margin or right corner of lower margin. It is taken from a prominent geographic feature on the map.

b) Map Series: identifies a group of maps covering an area. Usually found at the top right corner and lower left margin and is found in an identification panel of the map. Maps can be a single sheet or a series of sheets covering a single area. When an area is sub divided into other areas and each area mapped on to a map sheet, this is called a series. They have a uniform specification e.g. same scale, single series number.

c) Sheet Number: e.g. 173/2 identifies a particular sheet within a series of maps. Normally sheet number placed at the top right corner of the top margin.

d) Edition Number: each edition of the map carries this number that identifies a particular area version of the map sheet. It gives information on how old or new the map is. The latest carries the highest edition number. The series, sheet number and edition number constitute the sheet identification panel of the map.

e) Area of coverage (series title): refers to the name of geographical area the map series is intended to cover. E.g. East Africa 1/50,000 (Rwanda) "from E. Africa at a scale of 1/50,000 in particular Rwanda. It can also state the subject or type of map

f) Numerical scale: this is a figure that gives you the relationship between map distances and ground distances. It appears on lower ground margin.

g) Graphical scale: on lower margin and next to area of coverage

h) Units of measurement: this mostly appears inform of a statement e.g. elevation in feet or elevation in metres or height in metres.

i) Contour interval: this is specified on lower margin e.g. vertical interval 20m (V.I. 20m)

j) Conventional symbols/legend reference: symbols used on a map series are normally illustrated in their correct sizes, colors and full descriptions. To comprehend and understand the map, it is important to study and interpret the legend box information.

k) Index to adjoining sheets: This appears in form of a box. It shows a map within a map series and has a maximum of eight boxes with the particular map sheet being at the centre.

162/3	**162/4**	**162/5**
173/1	**173/2**	**174/1**
173/3	**173/4**	**174/3**

It helps the map reader to know where a particular area or extended area of interest is by giving their names and sheet numbers.

l) Notes concerning the grid or reference system used: these notes give the grid/graticule, projection used, spheroid, units of measurement. They appear on lower right margin.

Meridian of origin, latitude of origin, scale factor at origin, false coordinates of origin, datum.

m) Instructions on use of grid: this is given on a map to assist users get locations

n) Information on true north, grid north and magnetic north: this is given inform of a diagram.

True North: this is the direction of meridian through centre of map

Magnetic North: this is the direction of north magnetic pole of earth. It is given by half an arrow or full arrow to show compass.

Grid North: this shows the north according to grid

o) Projection, spheroid, geodetic datum, levelling datum: this give information relating to geodetic data- given in the lower margin. Projection gives the system used to transform spherical system into flat/map system. Spheroid is the figure used to draw the map from the earth for easier conversion. The geodetic datum gives the height reference system.

p) Boundaries disclaimer: this is used on maps crossing international boundaries to stop controversies arising out of the map. “This map is not an authority on limitations of boundaries”

q) Publication note: gives name of publishing agent-the institution that makes the maps to public. Located on lower margin.

r) Copy right note: protects the rights of owner

s) Printer’s note: this gives the information about the printer and sometimes the number of copies given. Given on the lower right margin.

Printed by survey of Kenya 500/1/75 reprinted by survey of Kenya 1000/9/81

t) History note: this gives the indication on the stages through which the map has undergone since its first/original production-placed on the bottom left margin.

u) Administrative divisions: give administrative/political divisions found on the map.

v**) Glossary:** abbreviations used are explained in the glossary e.g. traditional words

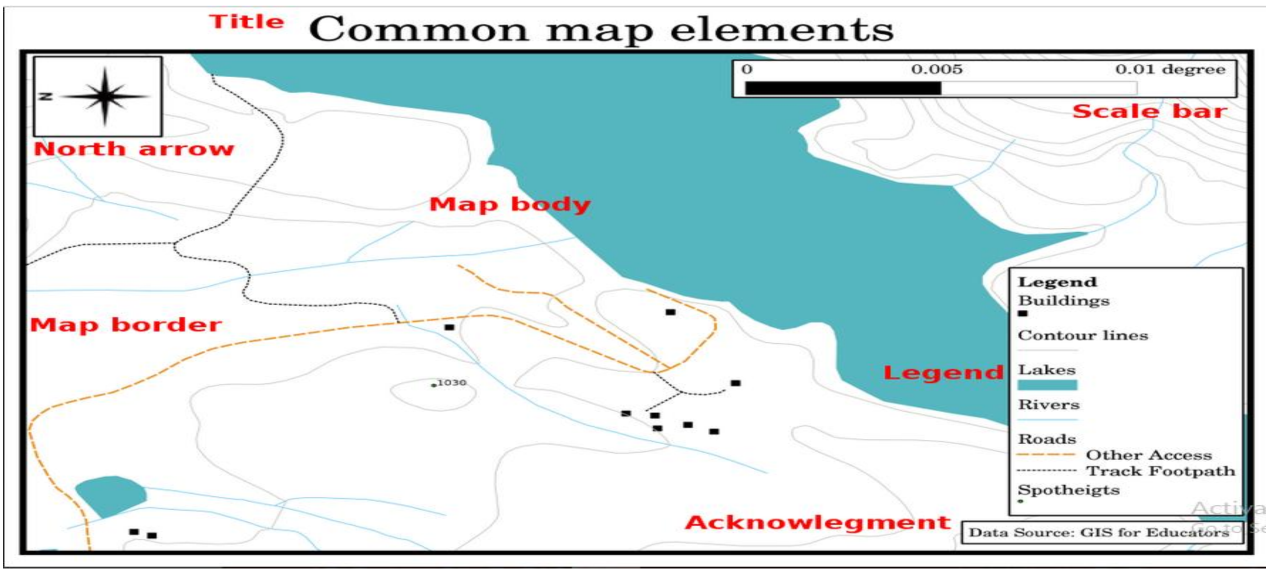
w) Height conversion diagram: applicable where two different units are used. A map reader is given a scale to convert from one measurement to another.

x) Compilation diagram: is given in form of a diagram and indicates the main source of construction data.

LO 3.3: Lay border information.

- Content/Topic 1 Set border information

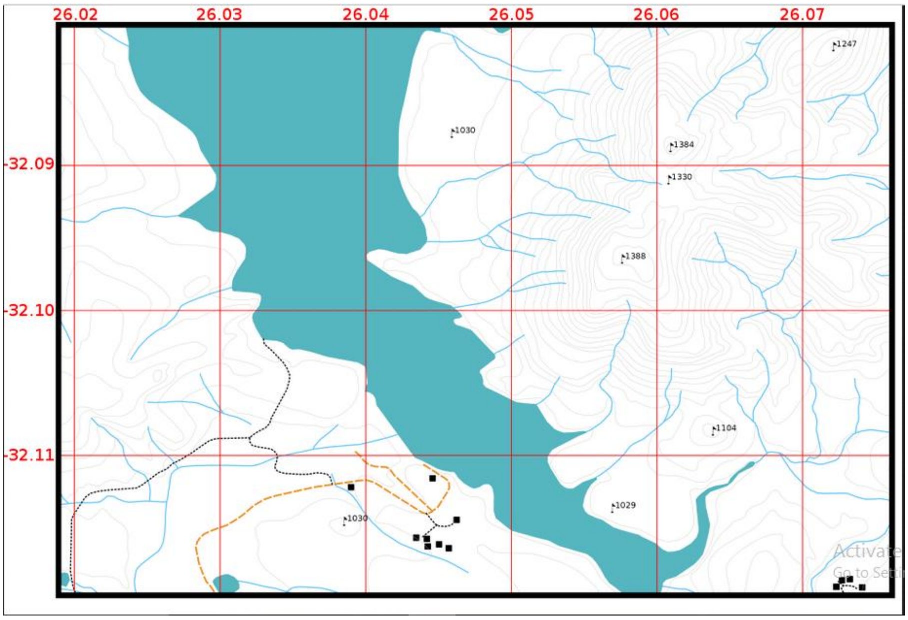
Definition: The map border is a line that defines exactly the edges of the area shown on the map. When printing a map with a graticule (which we describe further down), you often find the coordinate information of the graticule lines along the border lines, as you can see in figure.

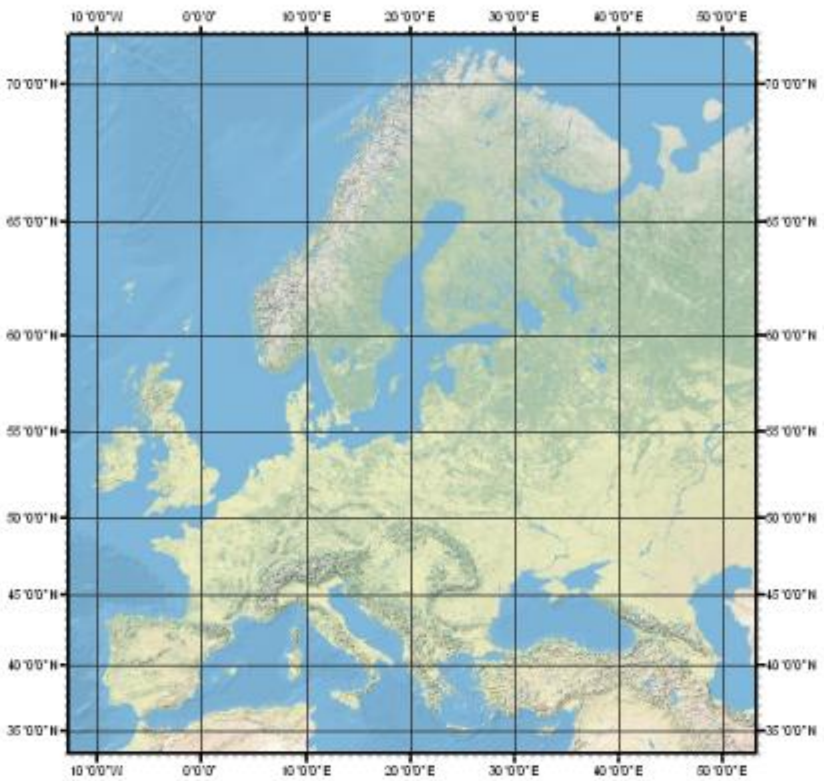


a) Geographical coordinates of the corners of the map e.g. 2^{o}15’, 37^{o}15’

b) Values of graticule lines or ticks after every 5’ e.g. on the left margin $2^{o}15'$, $2^{o}10$

A graticule is a network of lines overlain on a map to make spatial orientation easier for the reader. The lines can be used as a reference. As an example, the lines of a graticule can represent the earth’s parallels of latitude and meridians of longitude. When you want to refer to a special area on a map during your presentation or in a report you could say: ‘the houses close to latitude -32.11 / longitude 26.04 are often exposed to flooding during January and February’ (see in figure)





c) Grid values if a grid reference system is used

d) Destination of roads and railways that go beyond map edge.

Key Map Elements

- ✓ **Title:** A good map should tell you what it is about;
- ✓ **Orientation:** which direction north is;
- ✓ **Date:** when the map was made or updated;
- ✓ **Author:** who made the map;
- ✓ **Legend:** what the symbols mean;
- ✓ **Scale**:how distances on the map relate to distances on the ground;
- ✓ **Index**: where to find selected places on the map;
- ✓ **Grid**: how to find places on the map;
- ✓ **Credits**: where the map's information comes from (sources); however, not every map will identify all of this information. The more information provided, the better you will be able to evaluate its content, credibility, and appropriateness for a given purpose or audience.

References

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3. Robinson, A. M. (1995). *Elements of Cartography.* Sixth Edition. John Wiley & Sons. .

   source, I.