



TYBA

SEMESTER - V (CBCS)

GEOGRAPHY PAPER - VI

**TOOLS AND TECHNIQUES IN
GEOGRAPHY FOR SPATIAL
ANALYSIS-I
(PRACTICAL GEOGRAPHY)**

SUBJECT CODE : UAGEO503

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TYBA SEM –V
PAPER NO VI
TOOLS AND TECHNIQUES IN GEOGRAPHY FOR
SPATIAL ANALYSIS-I
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| Unit -I | Map Projections |
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MAP PROJECTIONS

After going through this chapter you will be able to understand the following features:

Unit Structure

- 1.1 Objectives
- 1.2 Introduction
- 1.3 Subject discussion
- 1.4 Concept of Map Projections
- 1.5 Need for Map Projections
- 1.6 Classification and suitability of Map Projections
- 1.7 Construction and properties Map Projections
- 1.8 Graphical methods of drafting selected projections
- 1.9 The different types of projection
 - 1.9.1 Zenithal polar equal area
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 - 1.9.5 Cylindrical equal area
 - 1.9.6 Cylindrical equidistant
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- 1.13 Technical words and their meaning
- 1.14 Task
- 1.15 References for further study

1.0 OBJECTIVES

- By the end of this unit you will be able to:
- Discuss the Concept of Map Projections
- Understand the Need for Map Projections
- Learn the Classification and suitability of Map Projections
- Understand the Construction and properties of Map Projections
- Learn Graphical methods of drafting selected projections
- Learn Zenithal polar equal area
- Learn Zenithal equidistant
- Learn Conical one standard parallel
- Learn Conical two standard parallel
- Learn Cylindrical equal area
- Learn Cylindrical equidistant

1.2. INTRODUCTION

In this unit we will study Projections its concept, need, classification and suitability, construction and properties. We will learn about Graphical methods of drafting selected projections such as Zenithal polar equal area, Zenithal equidistant, Conical one standard parallel, Conical two standard parallel, Cylindrical equal area, Cylindrical equidistant in the latter part of this unit.

1.3. SUBJECT-DISCUSSION

A reduced model of the Earth that may be a globe or a map is essential for any study in geography. But neither of the two is perfect, as a globe is seldom practical, and flat maps are never free from errors. Maps are important and indispensable tools to geographers that help them understand important things about the surface of the Earth in a visual way. It is a two dimensional description of a specific area of land. Maps describe in a visual or graphic format certain key features of the territory being examined. A map projection is a systematic transformation of the latitudes and longitudes of locations from the surface of a sphere or an ellipsoid into locations on a plane. Maps cannot be created without map projections. All map projections necessarily distort the surface in some fashion.

1.4. CONCEPT OF MAP PROJECTIONS

A map projection is a mathematical formula used to transfer all or part of the curved surface of the earth onto the flat surface of a map.

1.5. NEED OF MAP PROJECTIONS

We know that the shape of the Earth is an oblate spheroid or an ellipsoid. A globe is a scaled-down model of the Earth. Even though globes are capable of representing the size, shape, distance and directions of the Earth's features with reasonable accuracy, they are not suitable for many applications. They are hard to transport and store, not suitable for use at large scales, and expensive to produce. Moreover, measuring terrain properties is difficult on a curved surface and it is quite impossible to view large portions of the Earth at once. Nevertheless maps do not suffer from these shortcomings. They are more practical in most applications if compared to globes.

So to portray a curved plane that is the globe on a 2 dimensional plane or a map we need to construct a "projection" to alter the curved space and make it flat. Hence to give an accurate view of the Earth in a 2D sense, we need to project the Earth on to a reference point.

1.6. CLASSIFICATION AND SUITABILITY OF MAP PROJECTIONS

Down the ages cartographers have developed innumerable map projections among them three large families of map projections and several smaller ones have been acknowledged. These are based on the types of geometric shapes that are used to transfer features from a sphere to a plane. It may be said that Map projections are based on developable surfaces, and the three traditional families consist of cylinders, cones, and planes. Now the question arises that which developable surface should be used for a projection. It depends on what region is to be mapped, its geographical extent, and the geometric properties that areas, boundaries, and routes need to have, given the purpose of the map.

Now we have come to know that three classes of map projections are cylindrical, conical and azimuthal. The earth's surface projected on a map wrapped around the globe as a cylinder produces the cylindrical map projection. Projected on a map formed into a cone gives a conical map projection. When projected on a planar map it produces azimuthal or zenithal map projections.

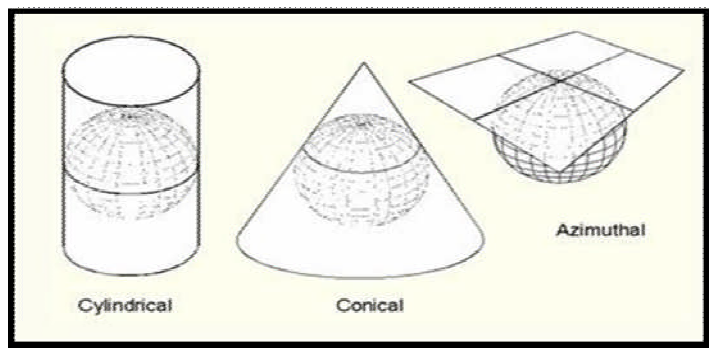


Fig showing Three classes of map projections: cylindrical, conical and azimuthal.

1.7. CONSTRUCTION AND PROPERTIES OF MAP PROJECTIONS

- ❖ The construction of a map projection involves three steps:
 - Selection of a model for the shape of the earth or planetary body (usually choosing between a sphere or ellipsoid)
 - Transformation of geographic coordinates (longitude and latitude) to plane coordinates (eastings and northings or x, y)
 - Reduction of the scale
- ❖ Map projection properties:

The five essential map projection properties are shape, distance, direction, scale, and area. These map projection properties come into being when there is conversion from a three-dimensional object, such as the earth, to a two-dimensional representation, such as a flat paper map. Of them area and shape are considered major properties and are mutually exclusive, that is if area is held to its true form on a map, shape must be distorted, and vice versa. But distance and direction are minor properties that may coexist with any of the other projection properties. Nevertheless, distance and direction cannot be true everywhere on a map. A map can never show all the map projection properties, true direction, true distance, true area, and true shape at the same time. It may exhibit one or more map projection properties in one attempt.

Whenever we create a flat map of a three-dimensional object such as earth distortions occur. But it is not constant across the map. It is observed that distortion may take different forms in different parts of the map like it is usually less near the points or lines of intersection where the developable surface intersects the globe.

Different families of map projections aim to preserve at least one of the map projection properties. It is discussed below:

- The equal area map projection, aims to preserve the area relationships of all parts of the globe and here the meridians and parallels are not at right angles to each other. Moreover, distance distortion is usually present on equal area map projection, as well as shape is often skewed. However it is useful for general quantitative thematic maps.
- The Conformal map projections, also known as orthomorphic map projection, preserve angles around points, and shape of small areas. In Conformal map projections meridians intersect parallels at right angles, areas are distorted significantly in small scales, and shapes of large regions may be severely distorted.
- The Mercator projection is a conformal map projection that preserves shape.
- The equidistant map projection aims to preserve great circle distances meaning a distance can be held true from one point to all other points, or from a few select points, to others, but not from all points to all other points. Identifying marks of the equidistant map projection are that they are neither conformal nor equal area, and look less distorted. Equidistant map projections are useful for general purpose maps and Atlas maps.
- The azimuthal map projection, also known as the true direction map projection, preserves direction from one point to all other points in the map. Azimuthal map projection is most useful for preserving direction two or one from the point, often used for navigation.

1.8. GRAPHICAL METHODS OF DRAFTING SELECTED PROJECTIONS

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. As we know that, the earth on which we live is not flat. It is geoid in shape like a sphere. A globe is the best model of the earth. Due to this property of the globe, the shape and sizes of the continents and oceans are accurately shown on it. It also shows the directions and distances very accurately. The globe is divided into various segments by the lines of latitude and longitude. The horizontal lines represent the parallels of latitude and the vertical lines represent the meridians of the longitude. The network of parallels and meridians is called graticule. This network facilitates drawing of maps. Drawing of the graticule on a flat surface is called projection.

But a globe has many limitations. It is expensive. It can neither be carried everywhere easily nor can a minor detail be shown on it. Besides, on the globe the meridians are semi-circles and the parallels are circles. When they are transferred on a plane surface, they become intersecting straight lines or curved lines.

1.9 THE DIFFERENT TYPES OF PROJECTION USE ARE AS FOLLOWS

1.9.1 Zenithal Polar Equal Area Projection

In this projection, a 2-dimensional plane of projection touches the generating globe at either of the poles. The meridians are straight lines drawn at true azimuth apart radiating from the pole. At any point the product of the two principal scales is unity. The parallels are spaced with varying radii in such a way that area on the projection exactly conforms to the area on the earth's surface.

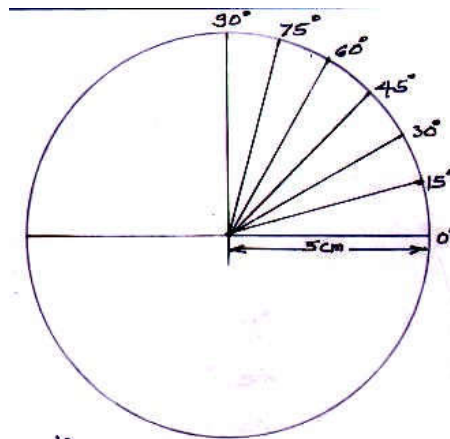
Zenithal Polar Equal Area Projection -

Draw Zenithal Polar Equal Area Projection with the help of following details.

Radius of the globe = 5cm. Latitudinal distance (interval) = 15°
Longitudinal interval = 30°

Draw projection for northern hemisphere.

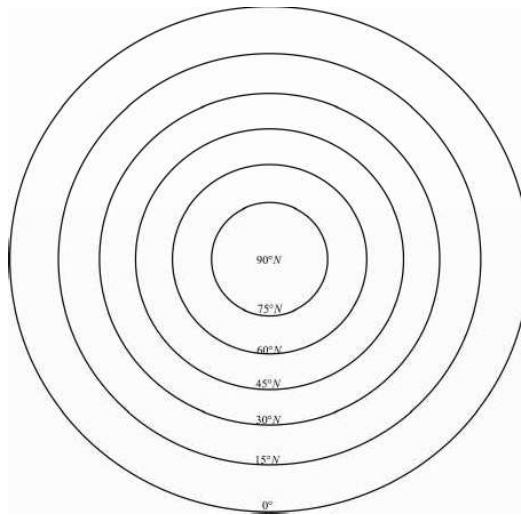
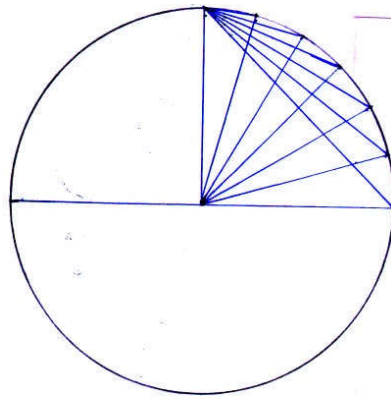
- 1) Draw circle of 5cm radius to represent Earth
- 2) Latitudinal interval is 15° & so draw several lines at the interval of 15° from Equator to Pole.



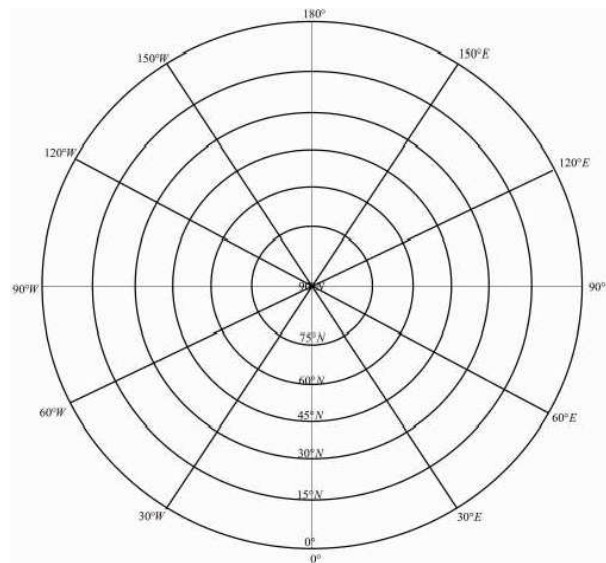
Draw lines connecting $90^\circ N$. To equator (0°), 15° , 30° , 45° , 60° & 75° as shown in the diagram. Take these distances as radius & draw concentric circles to represent latitudes.

N

90°



3) Longitudinal interval is 30° & so draw straight vertical line at the center of concentric circles. Keep protractor near to this line & take angles at an interval of 30° - i.e. $0^\circ, 30^\circ, 60^\circ, 90^\circ, 120^\circ, 150^\circ, 180^\circ$



- 4) Give numbers to all longitudes.

Properties:-

- 1) The parallels are concentric circles. The pole is a point forming the centre of this projection.
- 2) The meridians are straight lines radiating from the pole. They are spaced correctly at true angular interval i.e. the azimuths are true in this projection.
- 3) The meridians intersect the parallels at right angle.
- 4) The scale along the parallels increases away from the centre of the projection.
- 5) The distance between the parallels goes on decreasing away from the centre of the projection. It means there is a decrease in the scale along the meridians towards the margin of the projection. The decrease in the scale along the meridians is in the same proportion in which there is increase in the scale along the parallels away from the centre of the projection with the result that the projection is equal area.
- 6) Shapes are more and more distorted away from the centre of the projection because the scale along the meridians is too small and that along the parallels is too large. The shape is compressed along the meridians but stretched along the parallels.
- 7) The shape of the central area of the projection is represented in a satisfactory way for here the shapes are very slightly distorted.
- 8) Shapes are distorted away from the centre of the projection, hence only the central part of the projection can be presented in a satisfactory way.

Advantages:-

- 1) It is used for preparing political and distribution maps of Polar Regions. (Shapes of the countries in the central part are preserved).
- 2) Used for the general purpose maps of large areas in the northern hemisphere.

Disadvantages:-

- 1) Shapes of objects are distorted more and more as you proceed from the centre of the map outward.
- 2) Distances are not accurately represented except along the one or two base parallels (latitudes).

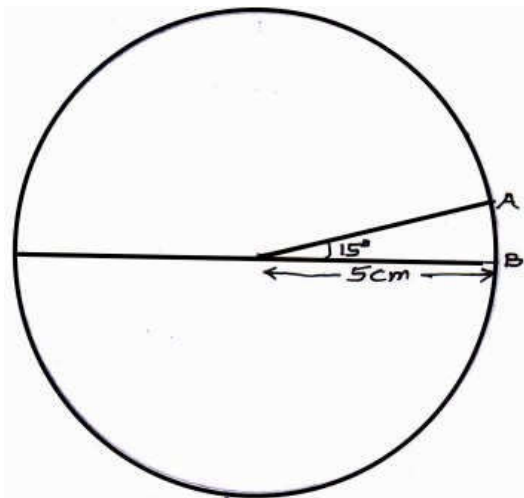
1.9.2 Zenithal Polar Equi-Distant Projection

In this projection, a 2 dimensional plane of projection touches the generating globe at either of the poles. The radial scale along a meridian

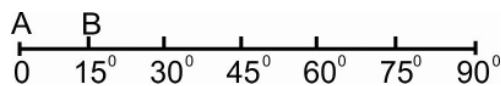
is truly maintained so that parallels are equi- distant on the meridians. True azimuth at the pole is preserved in spacing circles while meridians are straight lines radiating from the poles.

Draw Zenithal Polar Equidistance projection -

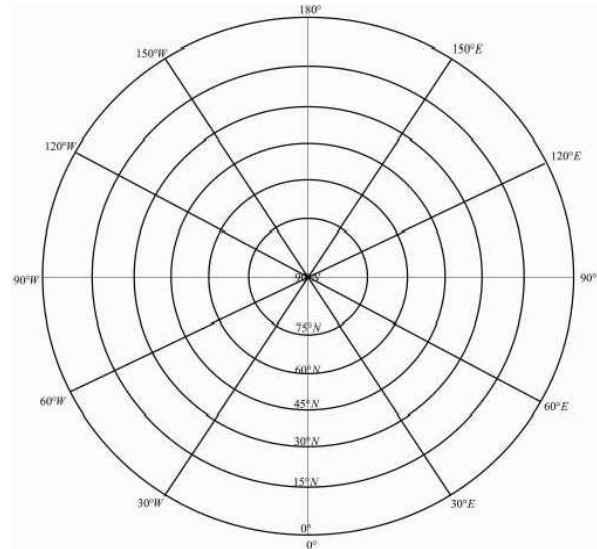
- 1) Radius of the globe = 5cm
 - 2) Latitudinal interval = 15°
 - 3) Longitudinal interval = 30°
 - 4) Extent - Northern Hemisphere.
- 1) Draw circle of 5cm radius Latitudinal interval is 15° . hence draw line at the interval of 15° .



2) To draw latitudes at an interval of 15° draw straight line & mark six divisions of an interval of A - B to represent $0^{\circ}, 15^{\circ}, 30^{\circ}, 45^{\circ}, 60^{\circ}, 75^{\circ}$ & 90° .



3) Take these distances as radius & draw concentric circles to represent parallels of latitudes.



4) Draw longitudes at an interval of 30° . Give number to all parallels of latitudes & meridian of longitude.

Properties:-

- 1) The parallels are concentric circles. The pole is a point forming centre of the projection.
- 2) The meridians are straight lines radiating from the pole and space correctly at true angular interval i.e. azimuths are true in this projections.
- 3) The meridians intersect the parallels at right angles.
- 4) Since the spacing between the parallels represents true distance the scale along the meridian is correct.
- 5) The scale along the parallels increases away from the centre of this projection.
- 6) The areas are exaggerated and shapes distorted exaggeration and distortion increasing away from the centre of the projection.
- 7) The projection is neither equal- area nor orthomorphic.
- 8) Shape being greatly distorted away from the centre of the projection, it is only a small area in the central part of the projection that can be represented in a satisfactory way. The area lying between the pole and 60 degree parallel is shown satisfactorily.

Advantages:-

- 1) This projection is commonly used for preparing maps of polar areas used for general purposes.

2) Since the scale along the meridians is correct, narrow strips running along the meridians are shown fairly correctly.

Disadvantages:-

- 1) The distortion increases away from the equator.
- 2) This projection is not orthomorphic. So the shape of countries is not same as on the globe.

1.9.3 Conical one standard parallel

A conical projection is one, which is drawn by projecting the image of the graticule of a globe on a developable cone, which touches the globe along a parallel of latitude called the standard parallel. As the cone touches the globe located along AB, the position of this parallel on the globe coinciding with that on the cone is taken as the standard parallel. The length of other parallels on either side of this parallel are distorted.

Conical one standard parallel projection 1) $R = 3.2\text{cm}$

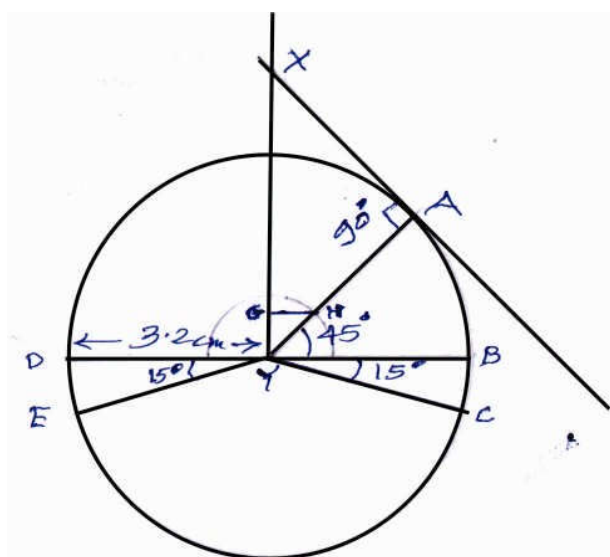
- 2) Standard Parallel = $45^\circ N$.
- 3) Latitudinal interval = 15°
- 4) Longitudinal interval = 15°
- 5) Extent - Longitudinal - $75^\circ E$ to $75^\circ W$.

Answer -

Draw circle of 3.2 cm.

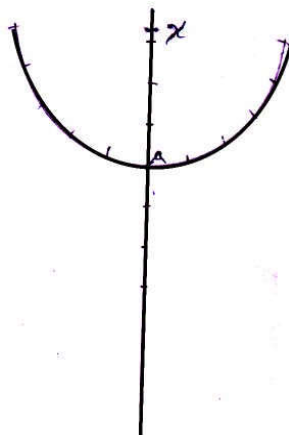
Draw angles of 90° $45^\circ N$.

Draw XA line perpendicular to the line of 45° .



Draw angles of 15° BYC and DYE for Latitudinal & longitudinal intervals. Take a distance / measurement DE on the compass & draw semi circle at Y. The line of semicircle will intersect line of 45° . From this point draw line perpendicular to XY line. This distance GH is for our longitudinal interval of 15° (at 45° N)

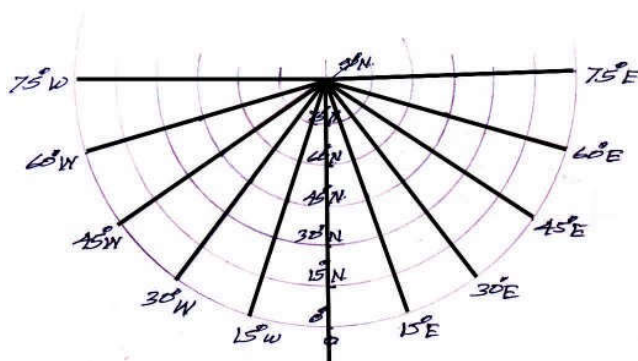
Draw straight line for drawing final projection. Mark point X Take a distance / radius XA on the compass and draw semicircle.



A is at 45° N. Our extent is from 0° to 90° N. Sol take a distance of BC on the compass & mark divisions of 15° to the north and south of 45° N. (3 - 3 divisions) Take a distance of GH on the compass & mark 5 divisions on either sides of XA line on 45° N. (Standard parallel) for longitudes.

Draw curves from X for all markings on XA line to represent latitudes.

Draw straight lines from markings on 45° N. line to point X to represent Latitudes.



Properties:-

- 1) The parallels are concentric arcs of circles. The pole is represented by an arc.
- 2) The meridians are straight lines.
- 3) The meridians intersect the parallel at right angle.

- 4) The distance between any two parallels on these projections is true. Thus scale along all the meridians is correct.
- 5) The distance between the meridians decreases towards the poles, i.e. the meridians are closer to each other towards the poles.
- 6) The scale is correct along the standard parallel but very large along other parallels, the exaggeration increases away from the standard parallels. Thus areas lying adjacent to the standard parallels are fairly correct on these projections.
- 7) This projection is neither equal-area nor orthomorphic.
- 8) The scale along the meridians is true. But it goes on increasing along the parallels away from the standard parallel. Therefore, away from the standard parallel, areas are exaggerated and their shapes distorted. It is suitable only for a narrow strip of lands lying adjacent to the standard parallel.

Advantages:-

- 1) This projection is commonly used for showing areas of mid-latitudes with limited latitudinal and larger longitudinal extent.
- 2) A long narrow strip of land running parallel to the standard parallel and having east-west stretch is correctly shown on this projection.
- 3) Direction along standard parallel is used to show railways, roads, narrow river valleys and international boundaries.
- 4) This projection is suitable for showing the Canadian Pacific Railways, Trans-Siberian Railways, international boundaries between USA and Canada and the Narmada Valley.

Disadvantages:-

- 1) It is not suitable for a world map due to extreme distortions in the hemisphere opposite the one in which the standard parallel is selected.
- 2) Even within the hemisphere, it is not suitable for representing larger areas as the distortion along the pole and near the equator is larger.

1.9.4 Conical Two Standard Parallel

In this projection, a simple right circular cone is taken as the projection plane. Two circles of the cone correspond to two different parallels on the generating globe and form an ordinary cone independent of the globe. These are the standard parallels which are so selected as to cover two-thirds of the latitudinal extent of the area to be mapped. The parallels appear as concentric arcs of circle while meridians appear as straight lines converging at the vertex of the cone.

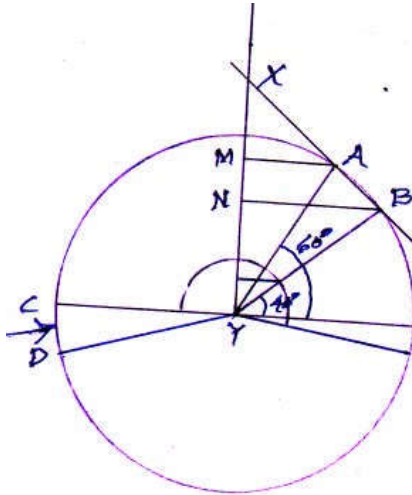
Conical Two Standard Parallel Projection -

R = 3.2cm Standard Parallels - 40°N 10°, Longitudinal interval = 15° 60°N.
Lat interval =

Extent - Lon - 90°E to 90°W -

Lat - 0° to 90°N

Draw globe with a radius of 3.2cm.



Draw XY perpendicular line and AY, BY lines at an angles 60° & 40° respectively. Join AB points & extend line upto the perpendicular line, to get X point.

Draw lines AM and BN perpendicular to XY line from points A & B. In order to find out distance between A & B we can use following formula

$$AB = 2\pi R \times 20^\circ \rightarrow (60^\circ - 40^\circ)$$

$$360^\circ$$

$$\pi = 3.14 \quad R = 3.2 \text{ cm}$$

$$AB = 2\pi R \times \frac{1}{18}$$

$$18$$

$$= 1 \times 3.14 \times 3.2 \times \frac{1}{9}$$

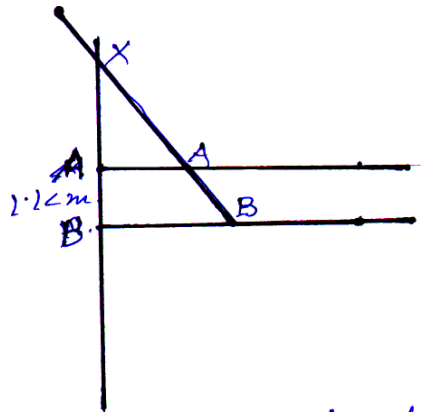
$$9$$

$$= \frac{3.14 \times 3.2}{9}$$

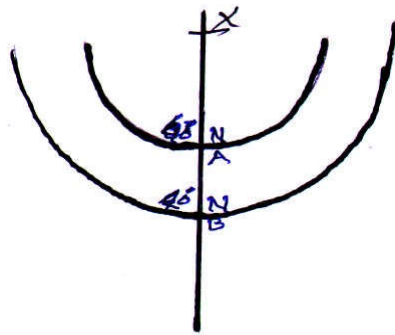
$$9$$

$$= 1.1 \text{ cm}$$

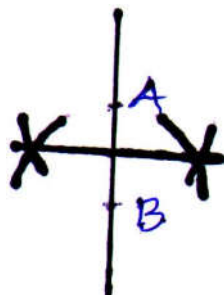
Draw straight vertical line take a distance of 1.1 cm.



Draw lines perpendicular from A & B take measurement MA & NB on these lines to get points M & N. Join M, N points & extend line to get X point. Take XA distance on the compass & draw semicircle to represent standard parallel 60° & take XB distance on the compass & draw semicircle to represent 40° N.

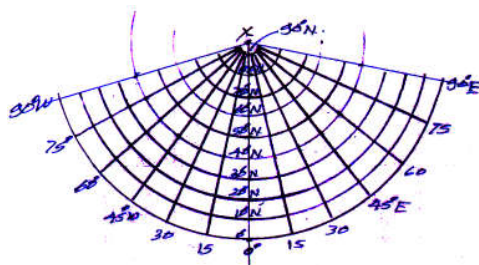


Take distance A-B = 1.1 cm on straight line & draw curves on either side with measurement of radius as 1.0 cm.



We get two equal divisions of AB (latitudinal interval of 10°). Mark these divisions of 10° on the vertical line to represent latitudes from 0° to 90° N. (Use strip of paper)

Draw semi circle at Y with radius equal to CD. This semicircle will intersect YB line (40°N) draw line perpendicular to XY line from this point. (This procedure is same as conical one standard. Parallel projection) Complete projection & give names to all latitudes & longitudes.



Conical Two Standard parallels projections.

Properties

- 1) The parallels are concentric arcs of circles. The pole is represented by an arc.
- 2) The meridians are straight lines.
- 3) The meridians intersect the parallels at right angles.
- 4) The meridians are correctly divided for spacing the parallels. The scale along all the meridians is, therefore, correct.
- 5) The scale is correct along the standard parallels and relatively large along all other parallels. This projection is therefore, suitable for an area which has small extent in latitude only. In such a case those standard parallels are chosen which are quite close to each other. We thus eliminated to some extent the inaccuracy caused due to different scales of the parallels lying between the standards parallels and outside the standard parallels.
- 6) A belt of an area having very small latitudinal extent but great longitudinal extent can be shown quite satisfactorily on this projection.
- 7) This projection is neither equal-area nor orthomorphic.
- 8) The scale being either too large or too small along the parallels other than the standard parallels are far away from the standard parallels are not accurately represented on this projection. Therefore, for better representation, an area should be of small latitudinal extent.

Advantages:-

- 1) This projection is used for general purpose of maps.
- 2) A long narrow strip of land running in the east-west direction is shown fairly correctly on this projection. The Canadian pacific Railway, Trans-Siberian Railway and international boundary between U.S.A

and Canada can be shown fairly accurately on this projection, the accuracy being more than it is in the case of conical projection with one standard parallel.

- 3) The projection is quite satisfactory for showing small countries having small latitudinal extent.

Disadvantages:-

- 1) Being neither equal-area nor orthomorphic this projection is not used for a specific purpose.
- 2) It is not used for displaying large areas because distortion became greater and greater the further we move from the lines where the cone intersects the globe.

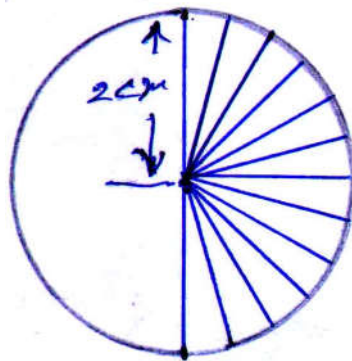
1.9.5 Cylindrical Equal Area Projection

The cylindrical equal area projection, also known as the Lambert's projection, has been derived by projecting the surface of the globe with parallel rays on a cylinder touching it at the equator. Both the parallels and meridians are projected as straight lines intersecting one another at right angles. The pole is shown with a parallel equal to the equator; hence, the shape of the area gets highly distorted at the higher latitude.

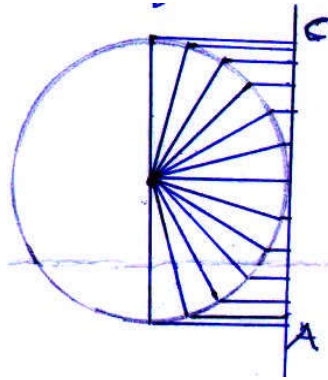
$$R = 2\text{cm}$$

Lat interval = 15° Lon interval = 30° Extent = Entire world.

- 1) Draw circle with a radius of 2cm to represent globe. Mark divisions of 15° (Latitudinal interval)



- 2) Draw perpendicular line at equator and transfer all markings for latitudes from the curved surface of globe to straight line.



3) Our longitudinal extent is the entire world. Hence the total length of circumference of globe can be calculated using formula

$$= 2\pi R$$

$$\pi = 3.14$$

$$= 2\pi R$$

$$R = 2cm$$

$$= 2 \times 3.14 \times 2$$

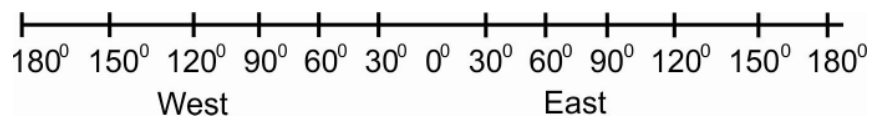
$$= 12.56cm$$

$$= 12.6cm$$

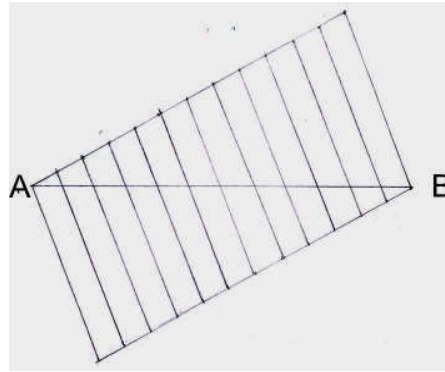
4) Rough diagram of our projection.



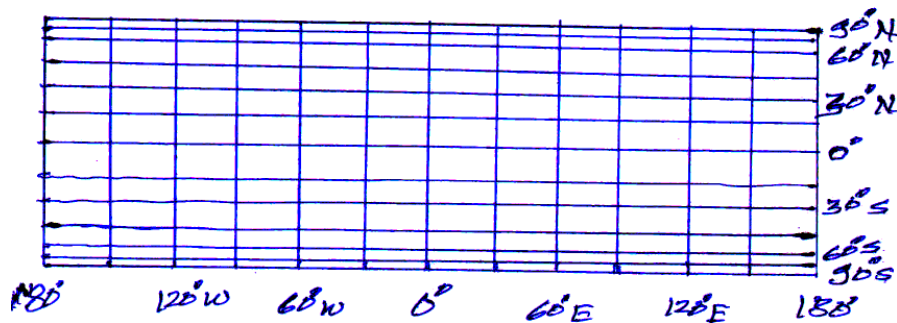
5) Our longitudinal interval is 30° . We can draw rough diagram to know total number of divisions (Total 12 divisions).



6) Divide line of 12.6cm into 12 equal parts as shown in cylindrical equidistant projection



7) Draw rectangle of 12.6cm X 4cm and transfer divisions from AC line (latitudes) and from AB line (longitudes) to get cylindrical equal area projection.



Properties

- 1) All the parallels are of the same length and every one of them is equal to the length of equator.
- 2) The Length of equator on this projection is equal to the length of the equator on the globe. Therefore, the scale along the equator is correct. The parallels are longer than the corresponding parallels on the globe. For an example, 30 degree parallel, 60 degree parallel and 80 degree parallel on this projection are 1.154 times, 2.000 times, and 5.758 times longer than the corresponding parallel on the globe respectively. A pole which is the point on the globe is equal to the length of the equator on this projection. The scale along the parallels is, therefore, exaggerated, the exaggeration increasing away from the equator.
- 3) All the meridians are of the same length and the length of each meridian is equal to the length of the diameter of the globe but their lengths between the parallels go on decreasing towards the poles. Thus, the meridians on this projection are shorter in the length than the corresponding meridians on the globe. Their lengths have been shortened in the same ratio in which the parallels are made longer with the result that area of a strip lying between any two parallels on this projection is equal to the area between the corresponding parallels on the globe. Thus, equal-

area property is maintained over the entire projection. Therefore, this projection is an equal-area and useful for showing distribution of products.

4) In the polar area, the parallels are markedly stretched in the east-west direction and the meridians are shortened greatly in the north-south direction. Consequently the countries are stretched in the east-west direction and compressed in the north-south direction. Thus, there is increased distortion in the shapes of the countries towards the poles. The distortion in the shapes of tropical countries is almost negligible.

5) Parallels and meridians are straight lines.

6) The meridians intersect the parallels at right angles.

7) The distances between the parallels go on decreasing towards the poles but the distances between the meridians remain the same.

Advantages

1) This projection is used for showing tropical countries.

2) Being an equal-area projection, it is drawn mainly for showing the world distribution of tropical products such as rubber, coconut, rice, cotton, groundnut, etc.

Disadvantages

1) Distortion increases as we move towards the pole.

2) The projection is non-orthomorphic.

3.) Equality of area is maintained at the cost of distortion in shape.

1.9.6 Cylindrical Equi-Distant Projection

This projection is very simple to construct because it forms a grid of equal rectangles. Because of its simple calculations, its usage was more common in the past. In this projection, the Polar Regions are less distorted in scale and area

Draw cylindrical Equi-distance Projection.

1) Radius of the reduced globe = 3.2cm.

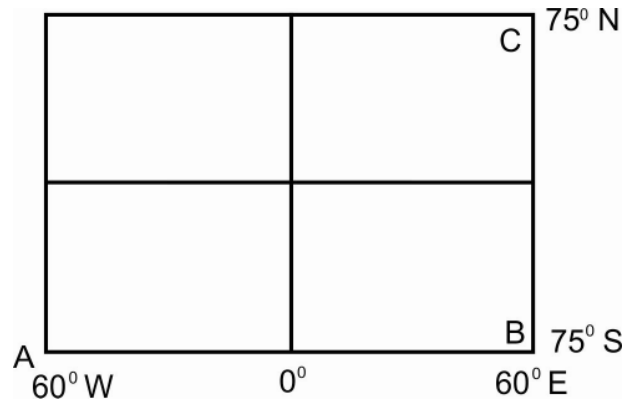
2) Latitudinal interval = 15°

3) Longitudinal interval = 30°

4) Extent - Latitudinal - 75° N Latitude to 75° S Latitude Longitudinal extent 60° W to 60° E

Procedure -

1) Draw rough diagram for understanding extent of the map.



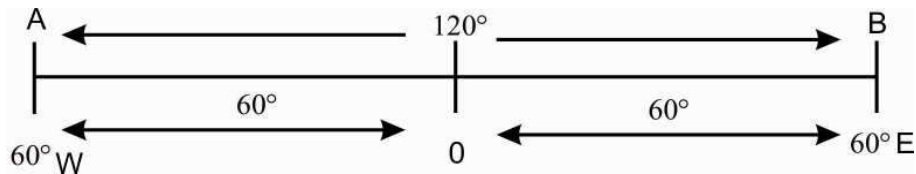
3) For latitudinal extent find out measurement of distance B-C & for longitudinal extent A-B.

$$R = 3.2 \text{ cm}$$

$$= 2\pi R$$

$$\pi = 3.14$$

$$AB = 2\pi R \times \frac{120}{360}$$



Distance AB covers angular distance of 120° on the earth's surface.

$$AB = 2\pi R \times \frac{120}{360}$$

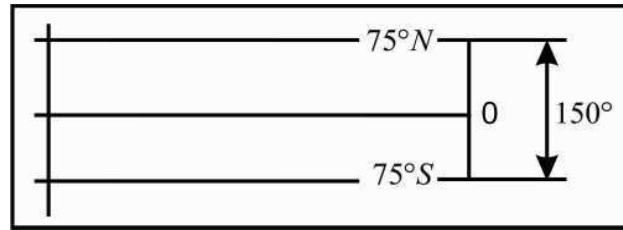
$$= 2 \times 3.14 \times 3.2 \times \frac{1}{3}$$

$$= \frac{2 \times 3.14 \times 3.2}{3}$$

$$= \frac{20.096}{3}$$

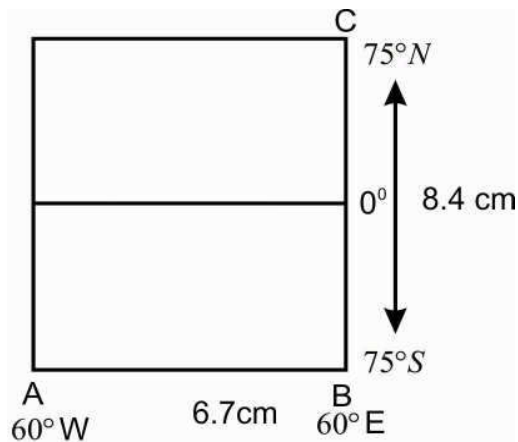
$$= 6.7 \text{ cm}$$

$$BC = 2\pi R \times \frac{150}{360}$$

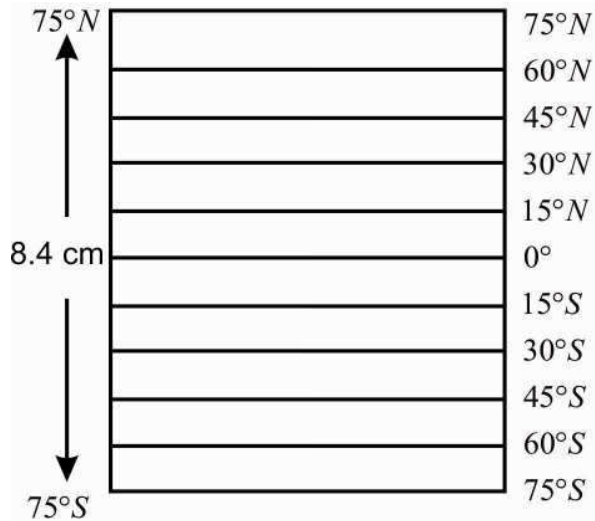


$$\begin{aligned}
 &= 2 \times 3.14 \times 3.2 \times \frac{150}{360} \\
 &= 1 \times 3.14 \times 3.2 \times \frac{5}{6} \\
 &= \frac{3.14 \times 3.2 \times 5}{6} \\
 &= \frac{50.24}{6} \\
 &= 8.37 \text{ cm } BC = 8.4 \text{ cm}
 \end{aligned}$$

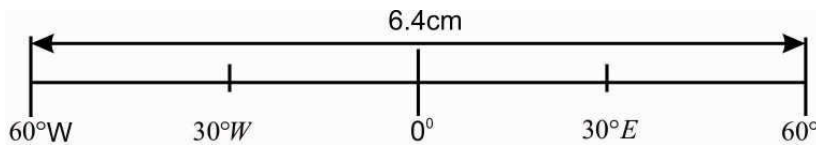
4) Latitudinal extent BC = 6.4cm Longitudinal extent AB =6.7cm.
Draw rectangle of 8.4× 6.7cm



5) Our latitudinal interval is 15°. Let us draw rough diagram



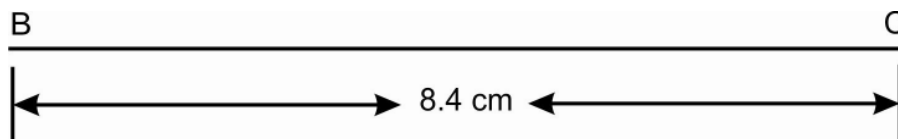
Latitudinal extent $75^{\circ}N$ to $75^{\circ}S$. (10 Parts) Our Longitudinal interval is 30°



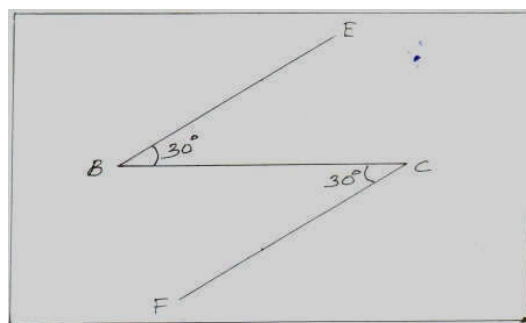
Longitudinal extent $60^{\circ}W$ to $60^{\circ}E$ (4 parts)

6) In order to mark divisions for latitudes, draw line of 8.4cm and diide it into 10 equal parts. Similarly for longitudes, draw line of 6.4cm & divide it into 4 equal parts.

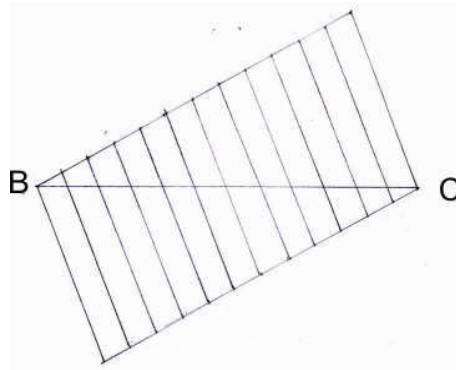
7) Longitudinal extent $75^{\circ}N$ to $75^{\circ}S$ Draw line of 8.4cm.



Draw lines / angles at 30° at B & C as shown in the diagam.



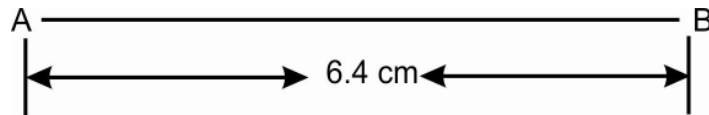
Mark 10 divisions of one cm each on BE and CF lines.



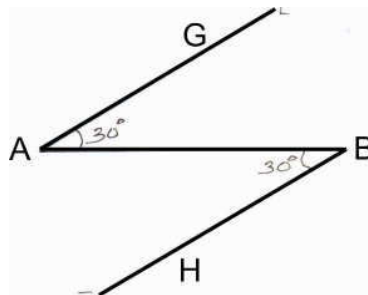
Join these divisions to get 10 equal parts of BC.

8) Latitudinal extent - 60° W to 60° .

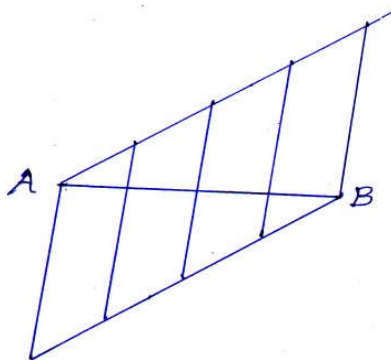
Draw line of 6.4 cm



Draw line / angles at 30° at A & B as shown in the diagram.

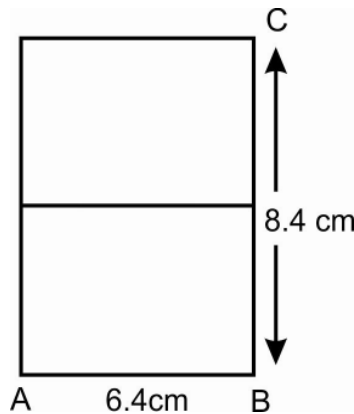


Mark 4 divisions of 2cm each on A,G and BH lines.



Join these divisions to get 4 equal parts of AB.

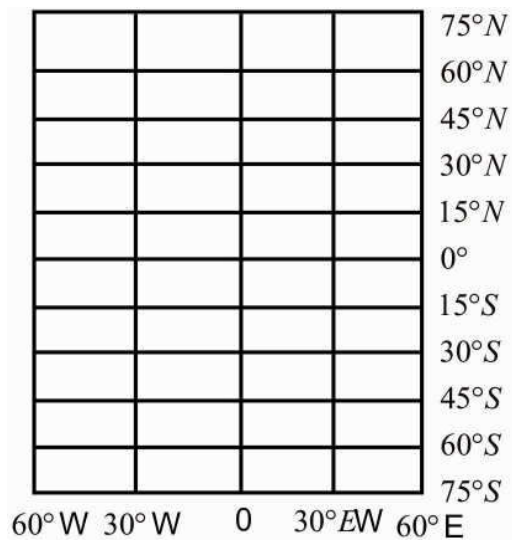
9) Draw rectangle of 8.4cm x 6.4 cm.



Now transfer four equal divisions on AB line & ten equal divisions on BC line with the help of strip of paper.

Keep paper strip attached to line BC in (7) mark ten divisions on paper. Now transfer paper to our final diagram and transfer all divisions on BC line in final diagram.

Similarly transfer four equal divisions on AB line.



Cylindrical equi-distance projection.

Properties :

- 1) Parallels and meridians are straight lines.
- 2) The meridians intersect the parallels at right angles.
- 3) The distances between the parallels and those between the meridians remain the same throughout the projection.

- 4) All the parallels are of the same length and every one of them is equal to the length of equator.
- 5) The Length of equator on this projection is equal to the length of the equator on the globe. Therefore, the scale along the equator is correct. The parallels are longer than the corresponding parallels on the globe. For an example, 30 degree parallel, 60 degree parallel and 80 degree parallel on this projection are 1.154 times, 2.000 times, and 5.758 times longer than the corresponding parallel on the globe respectively. A pole which is the point on the globe is equal to the length of the equator on this projection. Therefore the scale along the parallels is exaggerated and the exaggeration increases away from the equator.
- 6) Shapes are more and more distorted away from the centre of the projection because the scale along the meridians is too small and that along the parallels too large. The shapes are compressed along the meridians but stretched along the parallels.
- 7) The shapes of the central areas of the projection are represented in a satisfactory way for the shapes are distorted here but very slightly.
- 8) Shapes being distorted away from the centre of the projection, it is only the central part of the projection that can be represented in a satisfactory way.
- 9) Generally, the area lying between a pole and 45 degree parallel can be shown on this projection satisfactorily.

Advantages :

- 1) It is used for preparing political and distribution maps of polar region. (shapes of the countries in the central part are preserved).
- 2) Used for the general purpose maps of large areas in the Northern Hemisphere.

Disadvantages:-

- 1) The distortion increases away from the equator.
- 2) This projection is not orthomorphic. The shape of countries is not same as on the globe.

1.10 SUMMARY:

After going through the chapter we have come to know that map projection is a mathematical formula used to transfer all or part of the curved surface of the earth onto the flat surface of a map. Earth is represented as a sphere and the process of flattening the earth causes distortions in one or more of the following spatial properties such as: a. Distance, b. Area, c. Shape, d. Direction. We have also learnt that no projection is capable of preserving all these properties. Hence all flat maps are distorted to some extent. There are many different map

projections and each is distinguished by its suitability for representing a particular portion and amount of the earth's surface. Some map projections minimize distortion in one property at the expense of another, while others strive to balance the overall distortion. Cartographers decide which properties are most important and choose a projection that suits their needs. We have studied different types of projection such as Zenithal polar equal area, Zenithal equidistant, Conical one standard parallel, Conical two standard parallel, Cylindrical equal area and Cylindrical equidistant.

1.11 CHECK YOUR PROGRESS/ EXERCISE

1. *True false*

- a. A globe is a scaled down model of the Earth.
- b. To portray a conical plane on a 2 dimensional plane or a map we need to construct a "projection" to alter the curved space and make it flat.
- c. The earth's surface projected on a map wrapped around the globe as a cone produces the cylindrical map projection.
- d. In Zenithal Polar Equal Area Projection the parallel are concentric circles and the pole is a point forming the centre of this projection.
- e. Conical one standard parallel projection is commonly used for showing areas of low-latitudes with larger latitudinal and limited longitudinal extent.

2. *Fill in the blanks*

- a. A long narrow strip of land running in the east-west direction is shown fairly correctly on _____ projection.
- b. In _____ Projection all the parallels are of the same length and every one of them is equal to the length of equator.
- c. In Cylindrical Equal Area Projection all the _____ are of the same length and the length of each meridian is equal to the length of the diameter of the globe but their lengths between the parallels go on _____ towards the poles.
- d. In Cylindrical Equi-Distant Projection Parallels and meridians are _____ lines and the meridians intersect the parallels at _____ angles.
- e. In Conical Two Standard Parallel the pole is represented by an _____.

3. *Multiple choice question*

- a. The equal area map projection
 - i. aims to preserve the area relationships of all parts of the globe and here the meridians and parallels are not at right angles to each other
 - ii. preserves shape.

- iii. preserves angles around points, and shape of small areas.
- b. The globe is divided into various segments
 - i. by rivers and mountains.
 - ii. by the lines of latitude and longitude.
 - iii. by roads and rail lines.
- c. The network of parallels and meridians is called
 - i. projection.
 - ii. drainage network.
 - iii. graticule.
- d. In Zenithal Polar Equal Area Projection
 - i. The meridians intersect the parallels at right angles.
 - ii. The scale along the meridians is true.
 - iii. a 2 dimensional plane of projection touches the generating globe at either of the poles.
- e. In Conical one standard parallel
 - i. the scale is correct along the standard parallel but very large along other parallels.
 - ii. the parallel are concentric circles.
 - iii. the scale along the parallels increases away from the centre of the projection.

4. Answers the following Questions

1. What is a map projection?
2. What is the need of map projection?
3. What do you understand by classification and suitability of Map Projections?
4. What are the properties of Zenithal Polar Equi-Distant Projection? State its advantages.
5. State the properties of Conical Two Standard Parallel and its disadvantages.
6. Compare the advantages and disadvantages of Cylindricalequal area and Cylindrical equidistant projections.

7. Write short notes on:
- Equal area map projection
 - Conformal map projections
 - Mercator projection
 - Equidistant map projection

1.12. ANSWERS TO THE SELF LEARNING QUESTIONS

- 1.a.true
- 1.b.false, To portray a curved plane on a 2 dimensional plane or a map we need to construct a "projection" to alter the curved space and make it flat.
- 1.c.false, The earth's surface projected on a map wrapped around the globe as a cylinder produces the cylindrical map projection.
- 1.d.true
- 1.e.false, Conical one standard parallel projection is commonly used for showing areas of mid-latitudes with limited latitudinal and larger longitudinal extent.
- 2.a. Conical Two Standard Parallel
- 2.b. Cylindrical Equal Area
- 2.c. meridians , decreasing
- 2.d. straight, right
- 2.e. arc
- 3.a. i.
- 3.b. ii
- 3.c. iii
- 3.d. iii
- 3.e. i.

1.13. TECHNICAL WORDS

1. **Projection:** a systematic presentation of intersecting coordinate lines on a flat surface upon which features from a curved surface (as of the earth or the celestial sphere) may be mapped such as an equal-area map projection.

2. **Grticule:** a network of lines representing meridians and parallels, on which a map or plan can be represented.
3. **Globe-** it is a three-dimensional, spherical, scale model of Earth

1.14. TASK

1. In a chart define map projection and write down the properties of Zenithal polar equal area, Zenithal equidistant, Conical one standard parallel, Conical two standard parallel, Cylindrical equal area and Cylindrical equidistant projections.

1.15. REFERENCES FOR FURTHER STUDY

- Kellaway, G.P., 1979: Map Projections, B.I. Publications, New Delhi
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- Monkhouse, F.J. and Wilkinson, H.R. 1980: Maps and Diagrams, B.I. Publications Private Limited, New Delhi. 36
- Robinson, A.H., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J. and Guptill, S.C. 1995: Elements of Cartography, John Wiley and Sons, New York.
- Singh, R.L. and Singh, R.P.B. 1992: Elements of practical Geography.
- Steers, J.A. 1954: An Introduction to the Study of Map Projections, University of London Press, London.
- Oxford dictionary



MAP-BASIC

After going through this chapter you will be able to understand the following features:

Unit Structure

- 2.1. Objectives
- 2.2. Introduction
- 2.3. Subject discussion
- 2.4. Concept of Map
- 2.5. Basic components of the map
- 2.6. Types of maps
- 2.7. Methods of enlargement and reduction of maps
- 2.8. Location
 - 2.8.1. Four-figure grid references
 - 2.8.2. Six-figure grid references
- 2.9. Distance
- 2.10. Directions
- 2.11. Area calculation (graphical and strip method)
- 2.12. Summary
- 2.13. Check your Progress/Exercise
- 2.14. Answers to the self-learning questions
- 2.15. Technical words and their meaning
- 2.16. Task
- 2.17. References for further study

2.1 OBJECTIVES

By the end of this unit you will be able to:

- Understand the concept of map
- Learn basic components of map

- Discuss types of maps
- Evaluate methods of enlargement and reduction of maps
- Learn location of map
- Learn distance of map
- Learn directions of map
- Learn area calculation (graphical and strip method) of map

2.2 INTRODUCTION

In this unit named Map-Basic, we will study about the concept and the distinguishing characteristics of Maps. There will be a discussion on basic components of map and the types. Methods of enlargement and reduction of maps is very important. We will learn that in this unit. We will also learn location, distance and directions of map. Area calculation of map both graphical and strip method will be discussed in the latter part of this unit.

2.3 SUBJECT-DISCUSSION

Map is a two-dimensional form of the three dimensional earth that represent geography and culture. Since time immemorial people have been making pictures of places that were different than maps today. The earliest maps were carved on rocks. Those illustrations show beliefs and rituals connected with wider cosmologies. Down the ages, with the nations' expansion, the need for maps became more evident. People need maps now to make a very large area look small and understandable. Hence, maps are the primary tools by which spatial relationships are visualized. So Maps are considered as important documents. There are several key elements that should be included each time a map is created in order to help the reader to understand the communications of that map and to document the source of the geographic information used.

Maps have important parts and the acronym DOGSTAILS makes it easy to remember. These are described below.

- Date or D states When the map was made
- Orientation or O states the Directions (north arrow)
- Grid or G Locates places on the map
- Scale, S, states what the map distance is
- Title or T describes What, where, and when
- Author or A states Who made the map
- Index or I answers Map address of places

- Legend or L describes what the symbols mean
- Sources or S states Basis for map information

2.4 CONCEPT OF MAP

A Map is the representation of the earth's pattern as a whole or a part of it, or the heaven on a plane surface with conventional signs, drawn to a scale and projection so that each and every point on its corresponds to the actual terrestrial or celestial position. The

work of a map is to illustrate specific and detailed feature of a particular area, there are many kinds of map; static, two-dimensional, three-dimensional, dynamic and even interactive. Maps attempt to represent various things like political boundaries, physical features, roads, topography, population, climates, natural resources and economic activities.

2.5 BASIC COMPONENTS OF MAP

Maps may contain a variety of elements or components they are as follows

- 1) Base Map
- 2) Projection
- 3) Title
- 4) Scale
- 5) Compass rose - Direction
- 6) Conventional signs & symbols
- 7) Lettering in the map
- 8) Legend (or key)
- 9) Date

Without these five components, the map would not be a productive map for use.

- 1) **Base Map** - Base map is the map drawn accurately & is obtained from the authentic source. e.g. Govt. publication etc.
- 2) **Projection** - There are many different types of projections. Each projection has specific characteristics & hence we select base map drawn on suitable projection as per our requirement. e.g. equal area projection is used to show distribution of geographical features.
- 3) **Title** – The title of a map tells the reader what they are looking at. It could be a simple name of a country. The title should clearly explain what the cartographer is trying to show.

- 4) **Scale** – the scale on the map allows the reader to see the size and the distance of the features on the map.
- 5) **Compass rose-Direction** – the compass rose on the map orients the reader with the cardinal directions of the map. North direction is marked on the map. Cardinal directions are East, West, North, South.
- 6) **Conventional signs & symbols** - Map is a generalized picture of the earth's surface. Signs & symbols are used to represent distribution in symbolic form e.g. church or CG means campingground etc. signs & symbols help us to understand geographical features.
- 7) **Lettering in the map** - Lettering helps us in reading details given in the map. Large size old letters are used to represent title or large areas like continents or oceans. Small size letters are used for small villages.

Upright letters are used for land features and slant letters are used for water bodies like rivers, sea or oceans.

- 8) **Legend** – a map legend, or key, helps the reader interpret what is on the map. The key should explain every feature or symbol on the map.
- 9) **Date** – every map must have a date. This tells the reader when the map was created. Without a date the reader would not know the relevance of the map.

There are various ways by which the earth is mapped.

- 1) By actual survey with the help of the instruments like chain, prismatic compass, plane table, theodolite etc.
- 2) By photographs.
- 3) By freehand sketches and diagrams.
- 4) By computer.
- 5) By satellite and remote sensing methods.

2.6 TYPES OF MAPS

A map is the representation of the earth surface or a part of it or some other celestial body such as sun, moon, stars or planets on a flat surface i.e. a plane surface. The representation is drawn to a specific scale and map projection and shows distinctive aspects of the surface such as relief features, routes, settlements etc.

❖ Maps may be classified with respect to:

- 1) Scale
- 2) Purpose or content

2.6.1 Classification of Maps based on scale

- a) **Cadastral Maps** – Cadastral maps are drawn to register the ownership of landed property by demarcating the boundaries of fields and buildings etc. they are prepared specially by government to realize revenue and tax.
- b) **Topographical Maps** – Topographical maps are prepared on a large scale. They show general surface features detail comprising both natural landscape and cultural landscape. They do not show plot or boundaries of the building but topographic forms like relief and drainage, swamp and forests, villages and towns and means of communication on them. In India 1: 50,000 scale maps are generally prepared.
- c) **Wall maps** – They are used in classrooms. In these maps, the world as a whole or in hemisphere is distinctly represented. They may also be prepared for a continent or country, large or small, according to need.
- d) **Chorographical or atlas maps** – These maps are drawn on a very small scale and give more or less highly generalized picture regarding the physical, climate and economic conditions of different regions of the earth. These maps show only important peaks, important rivers, chief towns, railway lines, etc.

2.6.2 Maps based on purpose or contents

- a) **Astronomical Maps** – These maps shows heavenly body or heavenly feature.
- b) **Geological Maps** – They show the rocks that from the crust of the earth and their mode of occurrence and their deposition. A correlation of these maps with the corresponding relief maps reveals the causes and evolution of landforms.
- c) **Orographic or Relief Maps** – Maps showing the surface forms is termed as ore-graphic or relief maps. They show the bulges and depressions found over the surface. The level of land, its slope and drainage are well marked on it.
- d) **Weather and climate Maps** – They show the average condition of temperature, pressure, wind and precipitation over a short period, which range from a day to a season. Map showing daily weather conditions are termed as daily weather maps while those showing the average of weather conditions over 10 years or more are called climatic maps.
- e) **Political Maps** – Show boundaries between different states or boundaries between different political units within a country.
- f) **Historical Maps** – Maps showing historical events are called historical maps.

- g) **Social Maps** – Social organism tribes and races their languages, religions, etc. are depicted on social maps.
- h) **Population Maps** – It denotes distribution of man over an area.
- i) **Economic Maps** – Maps displaying the distribution of important centers of agricultural, minerals and industrial products and its linkages with various means of communication may be termed as economic map.
- j) **Military Maps** – These maps records strategic point, routes, battle plans, etc.
- k) **Land utilization Maps** – They exhibit the nature and character of land use.

2.7 METHODS OF ENLARGEMENT AND REDUCTION OF MAP

The significance of the scale of any map is immediately recognized when particular map is to be enlarged or reduce. A small-scale map cannot possibly show and roads can only be shown in a much generalized way which means that these features cannot be measured to scale. A small-scale map can be enlarged to show more details and conversely a large scale map can be reduced.

Nowadays maps can be, enlarged or reduce in a number of ways, be its graphical or instrumental one common method of enlarging and reducing map is the square method.

2.7.1 Enlarging map

While enlarging any map to a given size, the following steps should be followed.

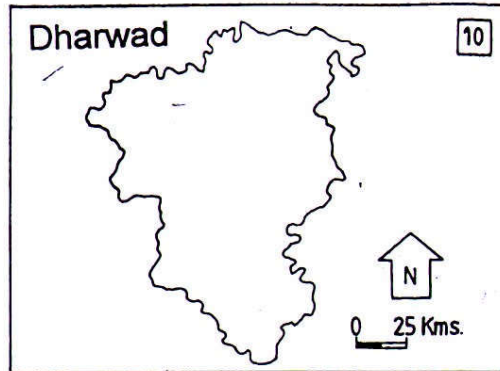
- Measure the length and width of the map.
- Multiply the length and width by 2 or 4 respectively if intend to enlarge the map to twice or thrice its original size.

For e.g.:- If the length and width of a map are 5cm and 3cm respectively such a map would measure 10cm by 6cm if enlarge to twice its size and 20cm by 12cm if enlarged 4 times its size and so on.

- Having enlarged the original map it is equally obvious that the scale would change therefore if a map has a scale of 1:60000 the scale of the map changes to 1:30000 if the size of the map has been enlarged to four times its original size.
- The feature to be shown on the enlarged map should also be proportional to the required size of the map.

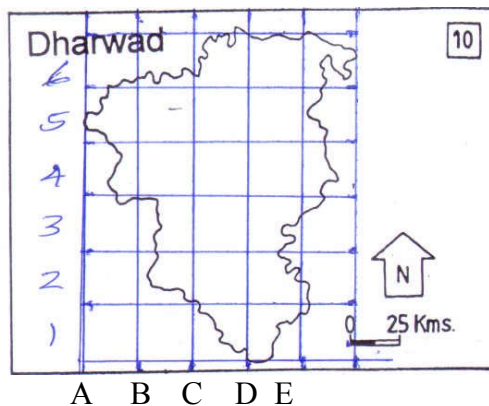
- Once it is finished drawing the enlarged map write its title and the new horizontal scale.

Q.1 Enlarge the given map of Dharwad in the proportion of 1:2

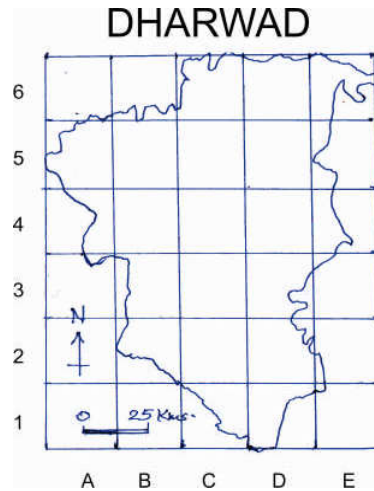


Answer -

- Draw grid of 1cm *f* 1 cm on the map.



- Give number to rows & alphabets to columns.
- Our enlargement ratio is 1:2 & so draw a grid of 2cm *f* 2cm on the plain paper give numbers & alphabets as per the original diagram.
- Now carefully transfer details on the new enlarged grid as per the original grid on the map of Dharwad carefully transfer details of each square - one by one.
- Measure length of the graphical scale. It is 1cm to 25km our enlargement ratio is 1:2 SD draw a line of 2cm on the enlarged map & write some numbers i.e. zero (0) and 25 kms.



6) Give title draw north to the enlarged map.

2.7.2 Reducing map

In reducing any map to given size the following steps to be followed.

- Measure the length and width of the map.
- Divide the length and width by 2 or 4 if you are asked to reduce the map to half or a fourth of its original size.

For e.g.:- If the length and width of a map are 24cm and 20cm respectively such a map should measure 12cm by 10cm if reduce to half of its size and so on.

- Having reduced the original map, it is obvious that the scale would equally change. Therefore if a map has a scale of 1:50000, the scale of the map changes to 1:1,00,000 if the size has been reduced to half and 1:2,00,000 if the size of the map has been reduced to a fourth of its original size.
- The feature to be shown on the reduced map should also be proportional to the required size of the map.
- Once we have finished drawing the reduced map write its title and new horizontal scale

Q.1 Reduction the map of Brazil in the proportion of 2:1.

Map-Basic

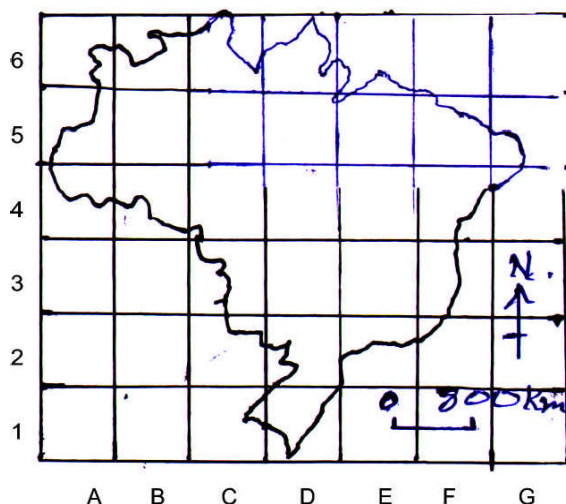


Answer -

- 1) As the map is large we can draw grid of 2cm *f* 2cm on the map. (For small maps use grid of 1cm *f* 1cm).
- 2) Give numbers to rows & alphabets to columns.
- 3) Our reduction ratio is 2:1 & SD we can prepare grid of 1cm *f* 1cm for drawing reduced map.



- 4) Now concentrate on the single square of the original map & draw carefully similar shape in the reduced grid. It is easy to complete entire map.
- 5) For drawing scale of the map, measure length of scale on the original map. It is 2.2cm our ratio is 2:1 & hence we will draw line of 1.1cm on the reduced map. The value of 800km remains same.



2.8 LOCATIONS ON MAPS

Grid lines on maps define the coordinate system. These are numbered to provide a unique reference to features. Grid references define locations on maps. The grid numbers on the east-west (horizontal) axis are called Eastings, and the grid numbers on the north-south (vertical) axis are called Northings. Numerical grid references consist of an even number of digits. Eastings are written before Northings. So in a 6 digit grid reference 123456, the Easting component is 123 and the Northing component is 456. There are varied Grid systems. But the most common is a square grid with grid lines intersecting each other at right angles and numbered sequentially from the origin at the bottom left of the map.

2.8.1 Four-figure grid references

When giving a four-figure grid reference, you should always give the eastings number first and the northings number second, just like in graph where we give the x coordinate first followed by the y.

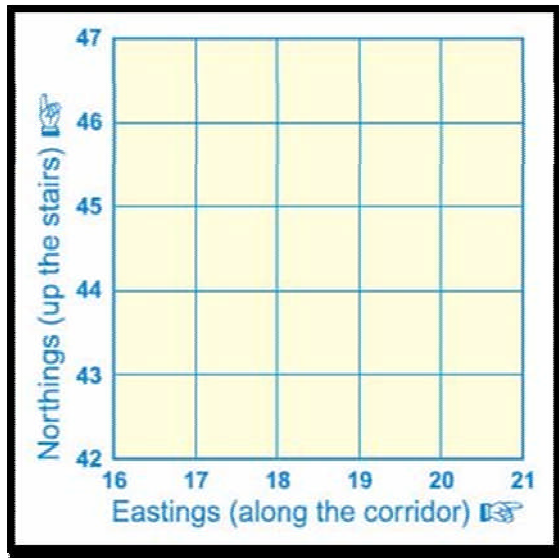
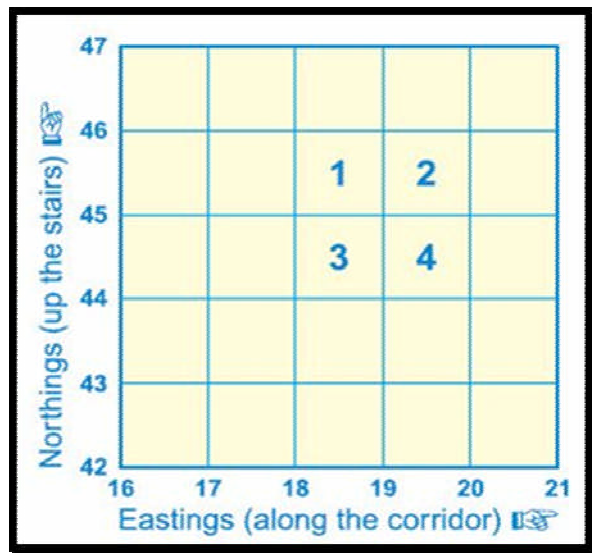


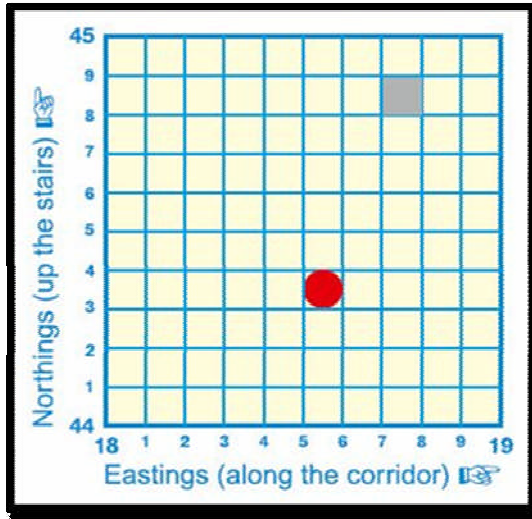
Fig: Four-figure grid references

For example, the number 2 in the diagram below is square 19 across and square 45 up and therefore, the four-figure grid reference is '1945', the number 1 in the diagram is 18 45, the number 3 in the diagram is 18 44 and the number is 19 44.



Six-figure grid references

To get the six-figure grid reference, we have to imagine that the four-figure square is further divided up into tenths. This is explained in the example below. The grey box is in the four-figure grid reference square '18 44', but more accurately it is 7 tenths across and 8 tenths up within that larger grid square, therefore the six-figure map reference is '187 448'.



The shapes on the diagram above have the following six-figure grid references:

Grey square – 187 448 and Red dot – 185 443

There are a few points that we should remember regarding grid reference. Four figure grid references are very useful but it has a major weakness. They are not very accurate because all objects in the same grid square have the same four figure grid reference even though they may be hundreds of meters apart. Hence for greater accuracy a six figure grid reference is used. A six figure grid reference does not only indicate the grid square an object is located in. It also tells us the exact point within the grid square where the object is found. Therefore, objects located in the same grid square will have the same four figure grid reference, but different six-figure grid references.

2.9 DISTANCE ON THE MAP

Maps are not only useful for directions, but can also help one determine the distance between two or more places. Thus people use a map scale to measure distance between cities and other places on a map. How we can measure distances on a map is discussed below.

- At first one should find the scale for the map one is going to use. One can use a ruler bar scale or a written scale, in words or numbers. At the bottom of each map there is a scale that indicates the distance on the map. While measuring a distance on the map, one must compare it to the scale. This will instantly tell him the real world distance.
- A ruler should be used to measure the distance between the two places. A straight line distances may be easily measured on a map with a ruler. However, when using this technique above, a pencil, fingers or a twig may be considered as a tool to get a distance and compare it to the map scale. But if the line is curved, one should use a string to determine the distance and then measure the string.

- If the scale is a representative fraction (and looks like 1/100,000 or 1:100,000), multiply the distance of the ruler by the denominator, giving distance in the ruler units.

Examples:

8.5cm measured on a 1: 25 000 scale Multiply distance by scale

$$8.5\text{cm} \times 25,000 = 212,500 \text{ cm}$$

Convert to meters $212,500 / 100 = 2,125 \text{ m}$

Convert to km:

$$2,125 / 1,000 = 2.125 \text{ km}$$

- If the scale is a word statement (i.e. "One centimeter equals one kilometer") then determine the distance.
- For a graphic scale, one needs to measure the graphic and divide the scale into the measured units on the ruler.
- One should convert the units of measurement into the most convenient units for him such as conversion of 63,360 inches to one mile.
- A graphic scale will change with the reduction or enlargement but the other scales become wrong. So one should watch out for maps that have been reproduced and have had their scale changed.
- Remember that the grid lines on a 1:25 000 scale map are 1km apart. A quick way of estimating distance is to count each square you cross in a straight line. If going diagonally the distance across the grid square is about $1\frac{1}{2}$ km.
- There are other ways to measure map distance using a romer or map measurer. A romer is a ruler that is scaled with a specific map scale. Instead of reading in cm and converting, one can read the distance directly. But the romer must have the same scale as the map is being used. A map measurer is a mechanical or electronic tool with a small wheel that you run over the map. You can then read off the converted distance. Again, check the manual to make sure you are using the correct scale conversions.

2.10 DIRECTION ON MAPS

Similar to distance, direction is difficult to measure on maps due to the distortion produced by projection systems. Nevertheless this distortion is somewhat small on maps having scales larger than 1:125,000. Direction is usually measured relative to the location of North or South Pole. Directions determined from these locations are said to be relative to True North or True South.

2.10.1 Direction and Bearings

Directions and bearings are terms we use to communicate where one location is relative to another location. Directions use the four points of the compass i.e. North, South, East and West, and bearings use a system of 360 degrees and a protractor.

We are able to communicate where one location is relative to another with the help of these two approaches. For example, Mumbai is south of Ahmedabad and Alibag is south of Mumbai.

There are four points of the compass, North, South, East and West. Importantly, North does not mean up in the sky, but means the direction that a compass points to as magnetic north (which is a location near the North Pole). Based on this being north, the opposite is south (hence the South Pole), and east and west are directions that move us around the earth parallel to the poles.

As we know that there are eight major directions that we commonly use. The first four, North, South, East and West are called the cardinal directions. Another four equal divisions such as Northeast, Southeast, Southwest and Northwest, are called Primary Inter Cardinal directions. A direction between two points, for example a direction halfway between North and East, is called North East. Similarly, a direction halfway between West and South would be called South West. Occasionally, sixteen directions are used such as WSW = West-southwest

So we can see there are sixteen divisions. With so many directions, it turns out to be utter confusing. Hence, we use numbers called bearings. There are 360° of bearings. The number would have been more had we used decimals. So commonly we use only 360.

All of these bearings and directions appear on magnetic compasses, which are used to figure out directions and calculate exact bearings. Many people use GPS systems instead of compasses today. But a simple protractor can be used to calculate bearings on a diagram or map.

2.10.2 Bearings

- **Definition:**

Bearing is a horizontal arc or angle measured from a north reference line, in a clockwise direction, to a point of interest some distance away from the point of measurement.

Bearings are a more precise way to indicate direction. We use a protractor to measure it. We know that a circle has 360 degrees, with 180 degrees in each half of the circle. A bearing will be a number, between 0 and 360 degrees, which represents the direction that one location is when viewed from a starting location.

The most important part regarding bearings is that everyone should calculate them the same way. If calculated differently error may occur

because one person may think it is 180 degrees, when it may appear as 360 degrees to another or something different entirely.

2.10.3 How to see bearings

Bearings are always calculated based on north being zero degrees, and degrees are then counted moving clockwise around the circle from there. Bearings can be seen using a protractor. The following depicts steps involved in seeing a bearing between two points:

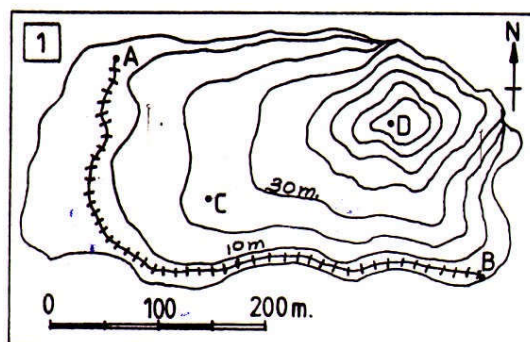
- a. Draw a line between the two points which will be long enough to see using your protractor.
- b. Place the protractor on the map, with 0 degrees pointing north, and the centre of the protractor on the starting location.
- c. Read on the protractor the degrees that the line between the two points follows. If your protractor only has 180 degrees, where the bearing is greater than 180 degrees, you may need to measure the angle from 360 to your line, and then subtract that from 360 degrees in order to calculate the bearing.

2.10.4 Common errors

- i. A common error with directions is getting the north, south, east and west labels in the wrong points on the compass.
- ii. Not placing the protractor on the starting point for determining the bearing of the second point.
- iii. Not placing the protractor with zero pointing north as indicated by the orientation on the map.
- iv. Incorrectly calculating a bearing when it is greater than 180 degrees. If the direction is between south and north on the western side, the bearing must be greater than 180 degrees and less than 360 degrees.

Location, Distance & Direction -

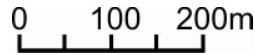
Q.1 Study the following map and answer the following questions.



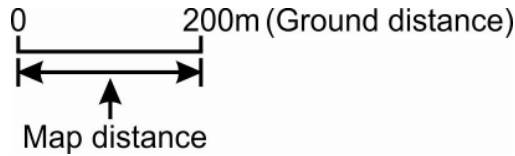
- 1) Identify the type of scale given in the map.

Ans - Linear or Graphical scale is given in this map.

2) Convert the given scale into R.F. Ans - Let us redraw scale.



This is linear scale. In this scale length of line is 4cm and measurement of distance on the ground is 200m.



Hence 4cm to 200 m or 1cm to 50 m ($200 \div 4 = 50$)

Verbel Scale = 1cm to 50m

Let us prepare simple table to convert 50m into cm

| | | | | | | |
|---|---|---|---|---|---|---|
| K | H | D | M | D | C | M |
| | | | | | | |

K = Kilometer, H = Hectometer, D = Decameter, M = Meter D = Decimeter, C = Centimeter, M = Milimter

You can remember all these in the form of simple sentence. Kind Hearted Daddy Mummy Didi Call Me

OR

Khoi Hui Duniya Me Dusara Kaun Mera

Kaafk n'ee oev'e'ee ce om'je ka'leve ce'je.

| | | | | | | |
|---|---|---|---|---|---|---|
| K | H | D | M | D | C | M |
| | | | | | | |

Verbal scale - 1cm to 50m.

In order to prepare R.F. or Representative Fraction (R.F) it is necessary that both numbers 1(cm) and 50(m) must be in the same unit. It is necessary to convert 50m into cm.

Consider following number 50, 50., 50.0 all three numbers are same. Complete numbers. So we can give dot (decimal point) after 50.D and this dot represent meters. In our table line to the right side of the words (K, H, D, M, D, C, M) is the decimal line for that word.

Put number 50m in the table.

| | | | | | | |
|---|---|---|---|---|---|---|
| K | H | D | M | D | C | M |
| | | 5 | 0 | | | |

We want to convert 50m into centimeters. Decimal line for centimeters is to the right side of word 'C'.

Put decimal point on the line.

| | | | | | | |
|---|---|---|---|---|---|---|
| K | H | D | M | D | C | M |
| | | 5 | 0 | | | |

Now cancel decimal point of meter and put zero in the 'D' and 'C' columns.

| | | | | | | |
|---|---|---|---|---|---|---|
| K | H | D | M | D | C | M |
| | | 5 | 0 | 0 | 0 | |

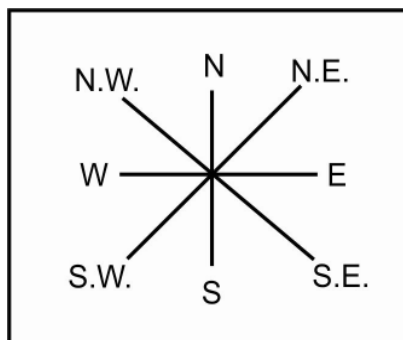
Hence 50m = 5000cm. Hence our scale is 1cm to 5000cm

so

| |
|------------------|
| R.F. is 1 : 5000 |
|------------------|

3) State the direction of 'B' from 'A' and direction of 'A' from 'B'.

Answer - Direction



'B' is to the South East of 'A'. 'A' is to the North West of 'B'.

4) Measure the straight line distance between 'A' and 'B'.

Answer - Measure distance between 'A' and 'B' points on the map it is 7.5cm.

Our scale is 1cm to 50m.

Hence 7.5cm are equivalent to $7.5 \times 50 = 375.0$ m. Hence distance between 'A' and 'B' is 375m.

5) Measure distance between 'A' & 'B' along the railway track or find out the length of railway route represented in the map.

Answer - Use thread to measure distance between 'A' & 'B' points along the railway route keep thread attached to railway line & turn it as railway route turns or bend. This distance is 11.0 cm & so as per scale 1cm to 50m. 11.0cm are $11 \times 50 = 550$ m. Hence the length of railway route is 550m.

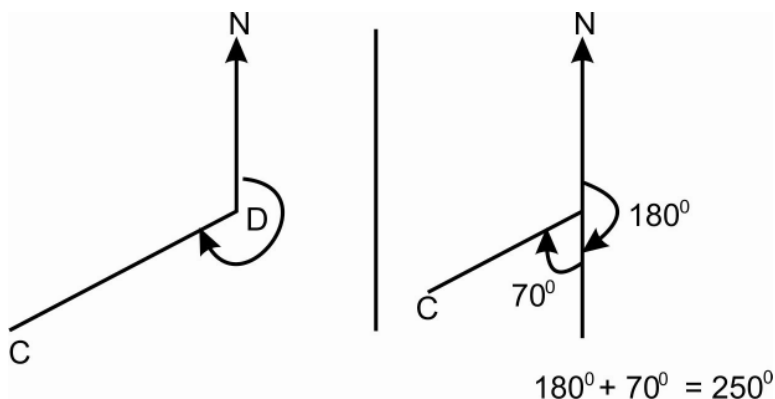
6) What is the height of point 'D'?

Answer - It is about 70m. (To find out height of point 'D' give values to all unnumbered contours.)

7) Find out the bearing of 'C' from 'D'.

Answer - Draw north direction at 'D' by drawing line parallel to north at 'D'.

Now measure angle of 'C' from north direction in the clockwise direction.



8) Find out total area covered by the map.

Ans. Area = Length x Width

= 9.5cm x 6.0cm

(Rectangular frame of map)

Scale is 1cm to 50m.

Map-Basic

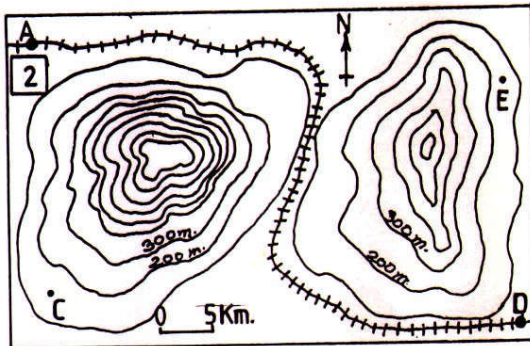
So $9.5\text{cm} = 9.5 \times 50 = 475.0\text{m}$ & $6.0\text{cm} = 6.0 \times 50 = 300.0\text{m}$

Hence area is $475 \times 300 = 142,500\text{ sq.m}$

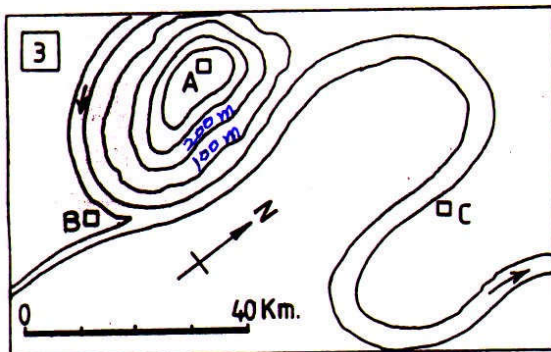
Exercise -

Answer questions related to map no. 2, 3 & 4. With reference to themaps given below.

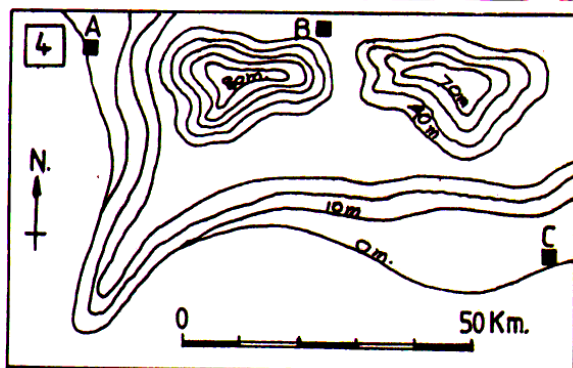
Map 2



Map 3



Map 4



Map 2 Questions -

- 1) Measure the length of railway route.
- 2) State the direction of 'A' from 'C' and 'D'.
- 3) State the bearings of 'A', 'C' and 'D' from 'E'.
- 4) State the maximum height represented in the map.
- 5) State the contour interval (Ans - $300\text{m} - 200\text{m} = 100\text{m}$)
- 6) Find out total area covered by the map.
- 7) Convert scale of the map into R.F. & Verbal scale.

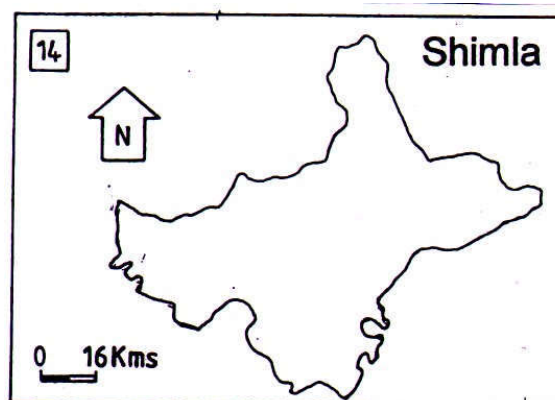
Map 3 Questions -

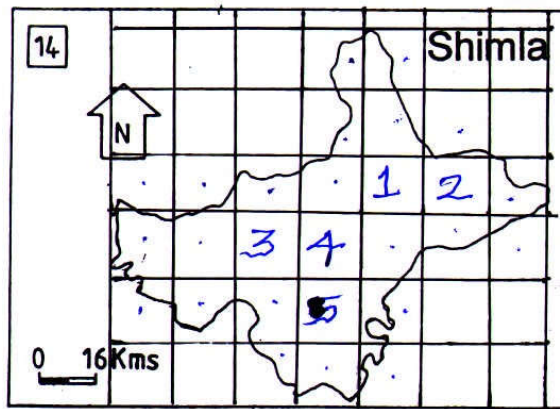
- 1) Measure the length of main river.
- 2) State the directions of 'A' & 'B' from 'C' (Please note the direction of North)
- 3) State height of point A.
- 4) Find out straight line distance between A-B, A-C and B - C.
- 5) Find out bearing of 'A' & 'B' from 'C'.

Map 4 Questions -

- 1) Identify major landform represented in the map (Ans. Sea-cliff in S.W. corner of the map. Zero m. contour line means sea level)
- 2) What type of scale is drawn on the map convert it into R.F.
- 3) State the directions & bearing of 'B' & 'C' from 'A'.
- 4) Use blue colour to represent sea (beyond zero meters) green between 0 m to 30 m & yellow from 30 m to 60 m.

Area Calculation (1) Grid Method -





Answer -

- 1) Draw grid of 1cm x 1cm on the map of Shmla.
- 2) Identify full squares. Total number of full squares are 5 (Fire).
- 3) Remaining all squares are half squares. Total number of half squares are 22 (Twenty Two).
- 4) Convert half squares into full squares by dividing by 2. Hence $22 \div 2 = 11$
- 5) Total number of full squares are $5 + 11 = 16$ (sixteen)
- 6) Scale of the map is 1cm to 16 kms.
- 7) Using this scale let us calculate are of one square cm. 1cm x 1cm to 16km x 16 km 1sqcm to 256 sq. kms.
- 8) Total number of squares (1cm x 1cm = 1 sq. cm.) are $16 = 16$ sq. cms.

\therefore 1sq cm to 256 sq.kms.

\therefore 16 sq.cm to 4095 sq kms.

Hence are of Shimla by grid method is 4096 sq. kms.

2.11 AREA CALCULATION ON MAP

2.11.1 Area calculation on map by square method

To calculate the area on a map we should follow the steps below:

Step 1: Work out the area of one grid square on the map.

For example:

If the Scale of the map is 1:50 000, then each cm represents 0.5km

Length: $2\text{cm} \times 0.5\text{km} = 1.0\text{km}$

Width: $2\text{cm} \times 0.5\text{ km} = 1.0\text{km}$

Therefore area of One Grid Square = $1.0\text{km} \times 1.0\text{km} = 1.0\text{ sq. km}$

Step 2: Determine the number of squares that the object occupies. Let us consider the area to be calculated occupies a total of about

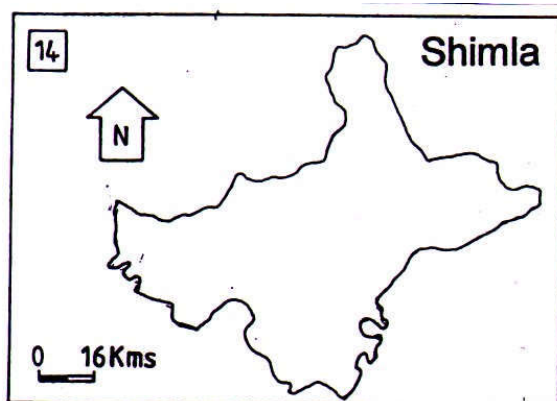
0.5 of a grid square.

Step 3: Multiply the number of grid squares that the object occupies by the area of one grid square.

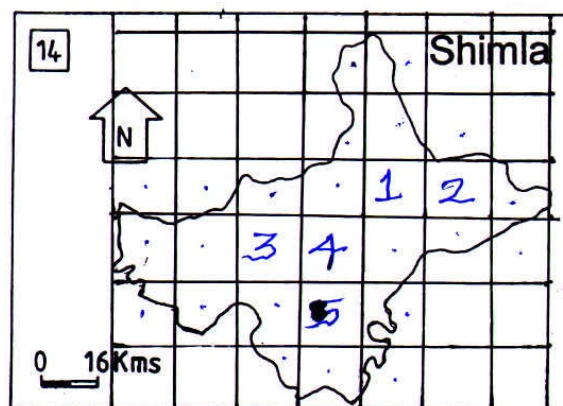
Hence, $0.5\text{ of a square} \times 1.0\text{ sq. km} = 0.5\text{ sq. km}$ is the area

2.11.2 Example of Area calculation square method

Area Calculation (1) Grid Method -



Q.1 Find out area of Shimla. Use grid method.



Answer -

- 1) Draw grid of 1cm x 1cm on the map of Shmla.
- 2) Identify full squares. Total number of full squares are 5 (Five).
- 3) Remaining all squares are half squares. Total number of half squares are 22 (Twenty Two).
- 4) Convert half squares into full squares by dividing by 2. Hence $22 \div 2 = 11$
- 5) Total number of full squares are $5 + 11 = 16$ (sixteen)
- 6) Scale of the map is 1cm to 16 kms.
- 7) Using this scale let us calculate are of one square cm. 1cm x 1cm to 16km x 16 km 1sqcm to 256 sq. kms.
- 8) Total number of squares (1cm x 1cm = 1 sq. cm.) are $16 = 16$ sq. cms.

\therefore 1sq cm to 256 sq.kms.

\therefore 16 sq.cm to 4095 sq kms.

Hence are of Shimla by grid method is 4096 sq. kms.

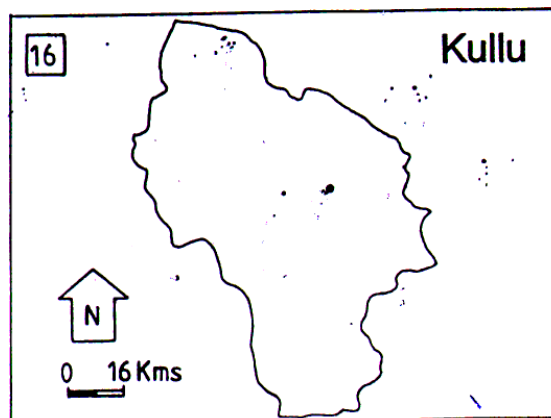
2.11.3 Area calculation on map by strip method

❖ **Example**

- Calculate the area of the given map in sq. mts with the help of strip method.

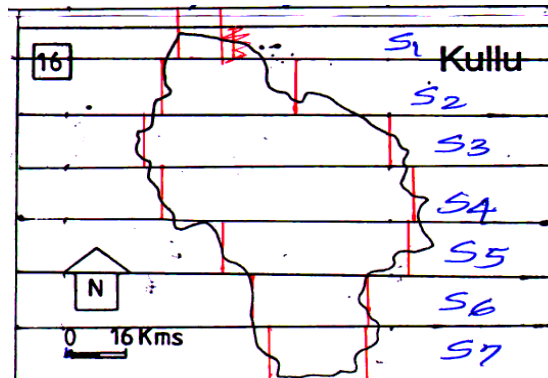
Area calculation (2) Strip Method -

Q.1 Find out area of Kully by strip method.



Answer -

- 1) Draw grid of 1cm width on the map Kullu.

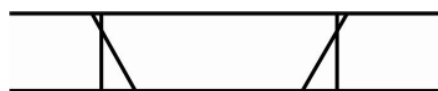


- 2) Draw Give & take lines for each strip.

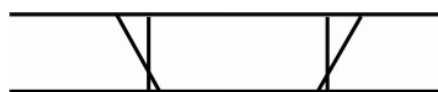
Give & take lines are small vertical lines. These are drawn at the Western & Eastern border of map area for each strip. These lines are used to convert irregular shape of the country / area into regular shape (Rectangle) so the measurement of area becomes easy.

- 3) Give & take lines are drawn vertically (i.e. Perpendicular to the horizontal lines) These lines are drawn with proper judgement that the portion of map included in the rectangle and excluded from rectangle are almost same. Hence these lines are known as Give & take lines. Consider following examples.

A)



B)



C)



- A) Wrong - Extra area is included.
 B) Wrong - More area is excluded.
 C) Correct Method - Area included & area excluded are same.
 4) Give numbers to all strips as S-1, S-2....
 5) Measures length of all strips.

$$S_1 = 0.7\text{cm}, S_2 = 2.2\text{cm}, S_3 = 4.0\text{cm}, S_4 = 4.1\text{cm}, S_5 = 3.0\text{cm}, S_6 = 1.9\text{cm}$$

$$S_7 = 1.6\text{cm}$$

- 7) Find out total length of all strips.

Total length =

$$S_1 + S_2 + S_3 + S_4 + S_5 + S_6 + S_7$$

$$= 0.7 + 2.2 + 4.0 + 4.1 + 3.0 + 1.9 + 1.6$$

$$\text{Total length} = 17.5\text{cm}$$

- 8) Width of each strip is 1cm.

- 9) Total area = Total length x Width (1cm)

$$= 17.5\text{cm} \times 1\text{cm}$$

$$= 17.5\text{cm}^2$$

- 10) Scale of the map is 1cm to 16 kms
 11) Find out area of 1sq. cms

$$= \text{length} \times \text{width}$$

$$= 1\text{cm} \times 1\text{cm} \text{ to } 16\text{kms} \times 16\text{kms} \text{ 1 sq.cm to } 256\text{ sq. kms.}$$

$$12) 1\text{ sq. cm to } 256\text{ sq. kms.}$$

$$\therefore 17.5\text{ sq.cm to } 4480\text{ sq.kms. Area of Kullu is } 4480\text{ sq.kms.}$$

2.12 SUMMARY:

After going through this unit we may conclude that Map is a diagrammatic representation of an area of land or sea showing physical features, cities, roads, etc. It is a form of human communication that represents geography and culture. Moreover to show distribution of resources and bring out relationship amongst geographic elements map are needed. These are also used as tools for planning urban development along with selection of areas for the construction of dams and highways. There are four parts of a map such as Title, Scale, Compass Rose and Key. Title, usually found on the top or bottom of the map, tells us what the map is. Scale states the relationship between distance on a map and actual distance on the earth. Scale may be represented by words (e.g., "one inch equals one mile"), a ratio or fraction (e.g., 1:63,360). Students use a map scale to measure

distance between cities and other places on a map. Compass Rose is an object that appears on maps to identify four main directions: North, South, East and West. Key is found on the bottom of the map. The map key tells us what the symbols on the map stand for. Symbols are small pictures on the map used for representing real things on our Earth like mountains, hills, and valleys etc.

Maps can be classified on the basis of scale and contents. Cadastral Maps, Topographical Maps, Wall maps, Chorographical or atlas maps, Astronomical Maps, Geological Maps, Orographic or Relief Maps, Weather and climate Maps, Political Maps, Historical Maps, Social Maps, Population Maps, Economic Maps, Military Maps and Land utilization Maps are the names of different types of maps. At present maps can be enlarged or reduced in a many ways. It may be graphical or instrumental. One common method of enlarging and reducing map is the square method. Locations on maps may be done by Four-figure and six figure grid references. Scale on map is use to measure distance between cities and other places on a map. There are many ways by which distances on a map is measured. Similar to distance, direction is difficult to measure on maps. Bearings are a more precise way to indicate direction. We use a protractor to measure it. Area is calculated on map by square method and strip method.

2.13 CHECK YOUR PROGRESS/ EXERCISE

1. True false

- a. Map is a two-dimensional form of the three dimensional earth that represent geography and culture.
- b. The scale of a map tells the reader what they are looking at.
- c. A map legend, or key, helps the reader interpret what is on the map.
- d. While finding the location of any place on a map at first we should measure the length and width of the map.
- e. To get the six-figure grid reference, we have to imagine that the four-figure square is further divided up into tenths.

2. Fill in the blanks

- a. The __ on the map orients the reader with the cardinal directions, East, West, North, and South, of the map.
- b. __ maps are drawn to register the ownership of landed property by demarcating the boundaries of fields and buildings etc.
- c. -- maps, where the world as a whole or in hemisphere is distinctly represented, are used in classrooms.
- d. Land utilization Maps exhibit the __ and _ of land use.

- e. A scale will change with the reduction or enlargement but the other scales become wrong---

3. Multiple choice question

- a. Every map must have a date because
- i. it allows the reader to see the size and the distance of the features on the map.
 - ii. this tells the reader when the map was created and without it the reader would not know the relevance of the map.
 - iii. it clearly explains what the map maker (cartographer) is trying to show.
- b. There are various ways by which the earth is mapped such as
- i. by actual survey with the help of the instruments like chain, prismatic compass, plane table, theodolite etc., by photographs, by freehand sketches and diagrams and by computer.
 - ii. by multiplying the length and width of the area to be mapped by 2 or 4 respectively if intend to show the area to twice or thrice its original size.
 - iii. By measuring the Bearings of the area to indicate direction with a protractor.
- c. A Social Map
- i. denotes distribution of man over an area.
 - ii. displays the distribution of important centres of agricultural, minerals and industrial products and its linkages with various means of communication.
 - iii. denotes Social organism tribes and races their languages, religions, etc. on maps.

4. Answers the following Questions

1. What are the Basic components of map?
2. What is a map? Elaborate your answer stating different types of maps.
3. State the methods of enlargement and reduction of maps
4. How will you find the location of a place on map?
5. State how to calculate Area on map.
6. Write short notes on:
 - a. Four-figure grid references

- b. Six-figure grid references
- c. Distance on map
- d. Directions on map

2.14 ANSWERS TO THE SELF LEARNING QUESTIONS

- 1.a. true
- 1.b. false, The title of a map tells the reader what they are looking at.
- 1.c. true
- 1.d. false, While enlarging or reducing any map to a given size at first we should measure the length and width of the map.
- 1.e. true
- 2.a. Compass rose
- 2.b. Cadastral
- 2.c. Wall
- 2.d. nature and character
- 2.e. graphic
- 3.a.ii.
- 3.b.i.
- 3.c.iii.

2.15 TECHNICAL WORDS:

1. **Map** -A map is a visual representation of an entire area or a part of an area, typically represented on a flat surface. There are many kinds of maps; static, two-dimensional, three-dimensional, dynamic and even interactive. Maps attempt to represent various things, like political boundaries, physical features, roads, topography, population, climates, natural resources and economic activities.
2. **Grid reference**-a map reference indicating a location in terms of a series of vertical and horizontal grid lines identified by numbers or letters.
3. **Four figure grid** -A four figure grid reference points you towards a particular square on a map. On all OS maps these squares represent one square kilometre. All maps will have lines numbered around the edge
4. **Six figure grid**- Numerical grid references consist of an even number of digits. Eastings are written before Northings. Thus in a 6 digit grid reference 123456, the Easting component is 123 and the Northing component is 456.

5. **Map scale-** it refers to the relationship (or ratio) between distance on a map and the corresponding distance on the ground. For example, on a 1:100000 scale map, 1cm on the map equals 1km on the ground.
6. **Cartographer-** map maker

2.16 TASK

1. Convert Representative Fraction into graphical form in cms. to kms. R.F is 1:7820000
2. Convert Representative Fraction into vertical scale in cms. to kms. R.F is 1:2570000
3. Convert vertical scale into Representative Fraction when vertical scale is 2 cm: 5 kms.

2.17 REFERENCES FOR FURTHER STUDY

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- Sarkar A.K Practical Geography: A Systematic Approach, Oriental Longman, Calcutta, 1997.
- Oxford dictionary



SURVEY OF INDIA TOPOSHEETS

After going through this chapter, you will be able to understand the following features:

- 3.1. Objectives
- 3.2. Introduction
- 3.3. Subject discussion
- 3.4. Definition of topographical map
- 3.5. Methods of showing relief and landforms
- 3.6. Topographical map index
- 3.7. Colour scheme used in topographical maps
- 3.8. Interpretation of map: a) S.O.I. Topographical Maps
- 3.9. Conventional signs and symbols
- 3.10. Utility of topographical maps in geographical analysis
- 3.11. Summary
- 3.12. Check your Progress/Exercise
- 3.13. Answers to the self-learning questions
- 3.14. Technical words and their meaning
- 3.15. Task
- 3.16. References for further study

3.1. OBJECTIVES

By the end of this unit you will be able to:

- Understand the Definition of a topographical map
- Learn Methods of showing relief and landforms
- Discuss Topographical map index
- Learn Understand Colour, skim used in topographical maps
- Understand Conventional signs and symbols
- Learn the Utility of topographical maps

3.2 INTRODUCTION

In this unit, we will study topographical maps along with the methods of showing relief and landforms. After that there will be a discussion on Topographical map index. We will also study colour, skin used in topographical maps. Conventional signs and symbols and utility of topographical maps will also be discussed in the latter part of this unit.

3.3. SUBJECT-DISCUSSION

The topographical maps represent the Earth's features accurately and to scale on a two dimensional surface. It is characterized by large-scale detailed and accurate illustration of man-made as well as natural features on the earth surface such as roads, railways, power transmission lines, contours, elevations, rivers, lakes and geographical names. Hence, Topographic maps are an excellent planning tool and guide. These maps give us a variety of information identifying innumerable ground features. We may group these features into the following categories:

- a. Relief: mountains, valleys, slopes, depressions as defined by contours
- b. Hydrography: lakes, rivers, streams, swamps, rapids, falls, coastal flats
- c. Vegetation: wooded and cleared areas, vineyards and orchards.
- d. Transportation: roads, trails, railways, bridges, airports/airfield, seaplane anchorages
- e. Culture: buildings, urban development, power transmission line, pipelines, towers
- f. Boundaries: international, provincial/territorial, administrative, recreational, geographical
- g. Toponymy: place names, water feature names, landform names, boundary names

The map legend gives us a complete list of all features present in the map along with their corresponding symbols. If we see the map minutely we will find some information along the map borders. These provide valuable details which in turn help us understand and use a topographic map. We can determine relative and absolute positions of mapped features from the geographic graticule and a coordinate grid that the Topographic maps usually show.

The most important part lies in the representation of these maps because as these are two-dimensional representation of the Earth's three-dimensional landscape at a given time, are not always entirely up to date.

Topographical maps for territorial coverage of India are prepared and published by Survey of India. In India topographical maps are available in two series:

- a. India and adjacent Countries Series and

- b. International Map Series of World or La carte International Du Monde (CIM) series.

Topographic maps are based on topographical surveys. Performed at large scales, these surveys are called topographical in the old sense of topography, showing a variety of elevations and landforms. This is in contrast to older cadastral surveys, which primarily show property and governmental boundaries. The first multi-sheet topographic map series of an entire country, the Carte géométrique de la France, was completed in 1789. The Great Trigonometric Survey of India, started by the East India Company in 1802, then taken over by the British Raj after 1857 was notable as a successful effort on a larger scale and for accurately determining heights of Himalayan peaks from viewpoints over one hundred miles distant.

These maps are also prepared on a fairly large scale. They are based on precise surveys conducted by the Survey of India, Dehradun. They show general surface features in detail both natural and cultural. Principal topographic features depicted on these maps are relief, drainage, swamps and lakes, forests, villages, towns, means of transport and communication like roads and railways, and canals. Indian topographic maps are generally prepared on the scale of 1:50,000.

3.4. DEFINITION OF TOPOGRAPHICAL MAP:

In modern mapping, a topographic map is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines, but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features. A topographic map is typically published as a map series, made up of two or more map sheets that combine to form the whole map. A contour line is a line connecting places of equal elevation.

Natural Resources Canada provides this description of topographic maps:

These maps depict in detail ground relief (landforms and terrain), drainage (lakes and rivers), forest cover, administrative areas, populated areas, transportation routes and facilities (including roads and railways), and other man-made features.

Other authors define topographic maps by contrasting them with another type of map; they are distinguished from smaller-scale "**chorographic maps**" that cover large regions, "**planimetric maps**" that do not show elevations, and "**thematic maps**" that focus on specific topics.

However, in the vernacular and day to day world, the representation of relief (contours) is popularly held to define the genre, such that even small-scale maps showing relief are commonly (and erroneously, in the technical sense) called "topographic".

The study or discipline of topography is a much broader field of study, which takes into account all natural and man-made features of terrain.

3.5. METHODS OF SHOWING RELIEF AND LANDFORMS:

Topography is the study of the shape and features of the surface of the Earth. This field of geoscience and planetary science is concerned with local detail in general, including not only relief but also natural and artificial features, and even local history and culture. Mapmakers use several methods to depict relief of the terrain.

A. Hachures: Hachures are short, broken lines used to show relief. Hachures are sometimes used with contour lines. They do not represent exact elevations, but are mainly used to show large, rocky outcrop areas. Hachures are used extensively on small-scale maps to show mountain ranges, plateaus, and mountain peaks. Hachures are an older mode of representing relief. They show orientation of slope, and by their thickness and overall density they provide a general sense of steepness.

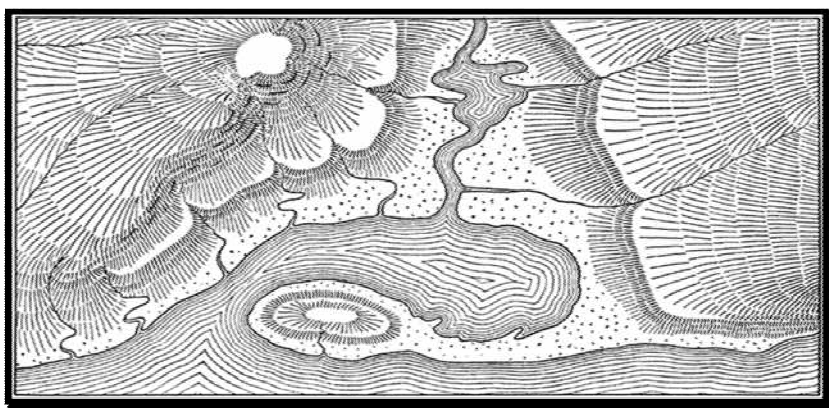


Fig: showing contours

B. Contours: Imaginary lines joining all the points of equal elevation or altitude above mean sea level. They are also called “level lines”.

Cross-section: A side view of the ground cut vertically along a straight line. It is also known as a section or profile. .

A map showing the landform of an area by contours is called a **contour map**. The method of showing relief features through contour is very useful and versatile. The contour lines on a map provide a useful insight into the topography of an area. Earlier, ground surveys and levelling methods were used to draw contours on topographical maps. However, the invention of photography and subsequent use of aerial photography have replaced the conventional methods of surveying, levelling and mapping. Henceforth, these photographs are used in topographical mapping. Contours are drawn at different vertical intervals (VI), like 20, 50, 100 metres above the mean sea level. It is known as contour interval. It is usually constant on a given map. It is generally expressed in metres.

❖ **Some basic features of contour lines are as follows:**

a. A contour line is drawn to show places of equal heights.

- b. Contour lines and their shapes represent the height and slope or gradient of the landform.
- c. Closely spaced contours represent steep slopes while widely spaced contours represent gentle slope.
- d. When two or more contour lines merge with each other, they represent features of vertical slopes such as cliffs or waterfalls.
- e. Two contours of different elevation usually do not cross each other.

❖ **Types of slope** -The slopes can broadly be classified into gentle, steep, concave, convex and irregular or undulating. The contours of different types of slopes show a distinct spacing pattern.

- **Gentle Slope** -When the degree or angle of slope of a feature is very low, the slope will be gentle. The contours representing this type of slope are far apart.
- **Steep Slope**-When the degree or angle of slope of a feature is high and the contours are closely spaced, they indicate steep slope.
- **Concave Slope**-A slope with a gentle gradient in the lower parts of a relief feature and steep in its upper parts is called the concave slope. Contours in this type of slope are widely spaced in the lower parts and are closely spaced in the upper parts.
- **Convex Slope**-Unlike concave slope, the convex slope is fairly gentle in the upper part and steep in the lower part. As a result, the contours are widely spaced in the upper parts and are closely spaced in the lower parts.

❖ **Types of Landforms:**

- ❖ **Conical Hill**-Conical hill rises almost uniformly from the surrounding land. A conical hill with uniform slope and narrow top is represented by concentric contours spaced almost at regular intervals.
- ❖ **Plateau** –Plateau is a widely stretched flat-topped high land, with relatively steeper slopes, rising above the adjoining plain or sea. The contour lines representing a plateau are normally close spaced at the margins with the innermost contour showing wide gap between its two sides.
- ❖ **V-Shaped Valley**-A Geomorphic feature lying between two hills or ridges and formed as result of the lateral erosion by river or a glacier is called a valley. It resembles the letter 'V'. A V-shaped valley occurs in mountainous areas. The lowermost part of V- shaped valley is shown by the innermost contour line with very small gap between its two sides and the lows value of the contour is assigned to it. The contour value increases with uniform intervals for all other contour lines outward.

- ❖ **U-Shaped Valley**-A U-shaped valley is formed by strong lateral erosion of glaciers at high altitudes. The flat wide bottom and steep sides makes it resemble the letter U. The lowermost part of the U-shaped valley is shown by the innermost contour line with a wide gap between its two sides. The contour value increases with uniform intervals for all other contour lines outward.
- ❖ **Gorge**-In high altitudes gorges form in the areas where the vertical erosion by river is more prominent than the lateral erosion. They are deep and narrow river valleys with very steep sides. A gorge is represented by very closely-spaced contour lines on a map with the innermost contour showing small gap between its two sides.
- ❖ **Spur**-A tongue of land projecting from higher ground into the lower ground is called a spur. It is also represented by V-shaped contours but in the reverse manner. The arms of the V point to the higher ground and the apex of V to the lower ones.
- ❖ **Cliff**-Cliff is a very steep or almost perpendicular face of landform. On a map, a cliff may be identified by the way the contours run very close to one another, ultimately merging into one.
- ❖ **Waterfalls and Rapids**-A sudden and more or less perpendicular descent of water from a considerable height in the bed of a river is called a waterfall. Sometimes a waterfall succeeds and proceeds with cascading stream forming rapids upstream or downstream of a waterfall. The contours representing a waterfall merge into one another while crossing a river stream and the rapids are shown by relatively distant contour lines on a map.

C. Form Lines: Form lines are not measured from any datum plane. Form lines have no standard elevation and give only a general idea of relief. Form lines are represented on a map as dashed lines and are never labelled with representative elevations.

D. Spot Height: The term is generally applied to any item used to mark a point as an elevation reference. A spot height is an exact point on a map with an elevation recorded beside it that represents its height above a given datum. On the top of hills you will see a dot and a number written beside it. The dot will be inside a small enclosed contour line.

E. Triangulation points: Triangulation pillars are another way of spotting the top of a mountain on a map. The symbol for a trig point is a small triangle. Triangulation pillars are used by map makers. They are real concrete pillars that are placed at particular places which are usually the tops of hills.

F. Bench mark: Carved or screwed in to thousands of walls around the country are symbols or devices used for map making before the advent of the global positioning system (GPS).

G. Hillshading is a shaded relief (levels of gray) on a map, just to indicate relative slopes, mountain ridges, not absolute height. Hillshading is the process of adding light and dark areas or shading to a map to highlight the location of hills or mountains. Hillshading uses light and dark areas to highlight where sunlight would hit and where shadows would form in the presence of hills and mountains.

H. Hypsometric tints are colors used to indicate elevation, usually together with contour lines. They can be used to depict ranges of elevation as bands of color, usually in a graduated scheme, or as a colour ramp applied to contour lines themselves. A typical scheme progresses from dark greens for lower elevations up through yellows/browns, and on to grays and white at the highest elevations. Hypsometric tinting of maps and globes is often accompanied by a similar method of bathymetric tinting to convey depth of oceans; lighter shades of blue represent shallower water such as the continental shelf and darker shades deeper regions.

3.6. TOPOGRAPHICAL MAP INDEX:

The survey of India has published the following 5 types of topographical maps. They are as follows:

a. Million maps

The SOI has published topographical maps on the scale of 1:1000000 under the India and Adjacent Series. Each sheet covers 4° at 4° long and is numbered as 62, 63, 64 etc.

b. Degree or Quarter-Inch series

Each of the map is divided into 16 equal parts, each measuring as 4° at 1° long. Now it has been converted on the scale of 1:250000 on the Metric scale and is referred as 63A, 63B, 63C etc.

c. Half-degree or half-inch map Series

Each of the degree sheet maps has been divided into 4 equal parts.

Hence, the each sheet is numbered as 63A/NW, 63A/NE, 63A/SW, and 63A/SE.

d. Quarter Degree or One-inch Map series

Each degree has been divided into 16 equal parts, so the sheet has been measured as $15'$ lat and $15'$ long and is given as 63A/1, 63A/2, 63A/3, etc.

e. Town Guide maps

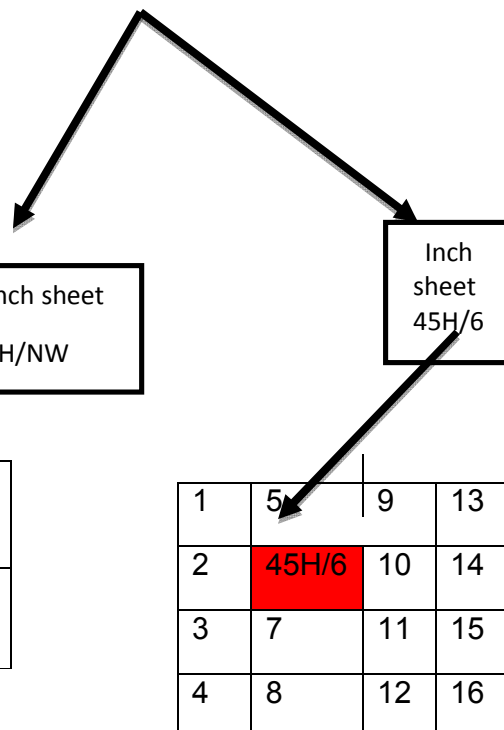
They are drawn under the scale of 1:25000, and are numbered as 63A/15/NE, 63A/15/NW, 63A/15/SE, etc. It covers the area of $7.5'$ lat and $7.5'$ long.

Degree Sheet

| | | |
|----|----|----|
| 39 | 44 | 53 |
| 38 | 45 | 54 |
| 37 | 46 | 53 |



| | | | |
|---|---|---|---|
| A | E | I | M |
| B | F | J | N |
| C | G | K | O |
| D | H | L | P |



3.7. COLOUR SCHEME USED IN TOPOGRAPHICAL MAPS:

To facilitate the identification of features on a map, the topographical and cultural information is usually printed in different colours. These colours may vary from map to map. On a standard large-scale topographic map, the colours used and the features each represent are stated under:

- a. **Black:** Indicates cultural (man-made) features such as buildings and roads, surveyed spot elevations, and all labels.
- b. **Red-Brown:** The colours red and brown are combined to identify cultural features, all relief features, non-surveyed spot elevations, and elevation, such as contour lines on red-light readable maps.
- c. **Blue:** Identifies hydrography or water features such as lakes, swamps, rivers, and drainage.
- d. **Green:** Identifies vegetation with military significance, such as woods, orchards, and vineyards.
- e. **Brown:** Identifies all relief features and elevation, such as contours on older edition maps, and cultivated land on red-light readable maps.
- f. **Red:** Classifies cultural features, such as populated areas, main roads, and boundaries, on older maps.
- g. **Other:** Occasionally other colours may be used to show special information. These are indicated in the marginal information as a rule.

3.8. INTERPRETATION OF TOPOGRAPHICAL MAPS

The study of topographical maps requires a careful planning, patience and proper attention. Conventional signs are given on the maps which should be read carefully. The study of topographical maps is classified into three broad sections.

a. Marginal Information

It is important to find out the marginal information before interpreting the topographical maps. One must know the following information's of maps:

1. States and districts to which the map belongs.
2. Latitudes and longitudes, scale, and contour interval.
3. Year of publication, name and number of the map, and its approximate area.

b. Physiographic Information

These are basic and important information and should be studied under the following heads:

1. Relief: nature and types of the landform (mountain, plateau or plain), average height and general slope, important hills, peaks, ridges, valleys etc. with their heights and their locations.
2. Drainage: important rivers their tributaries and their stages; type of drainage pattern; drainage density and texture.

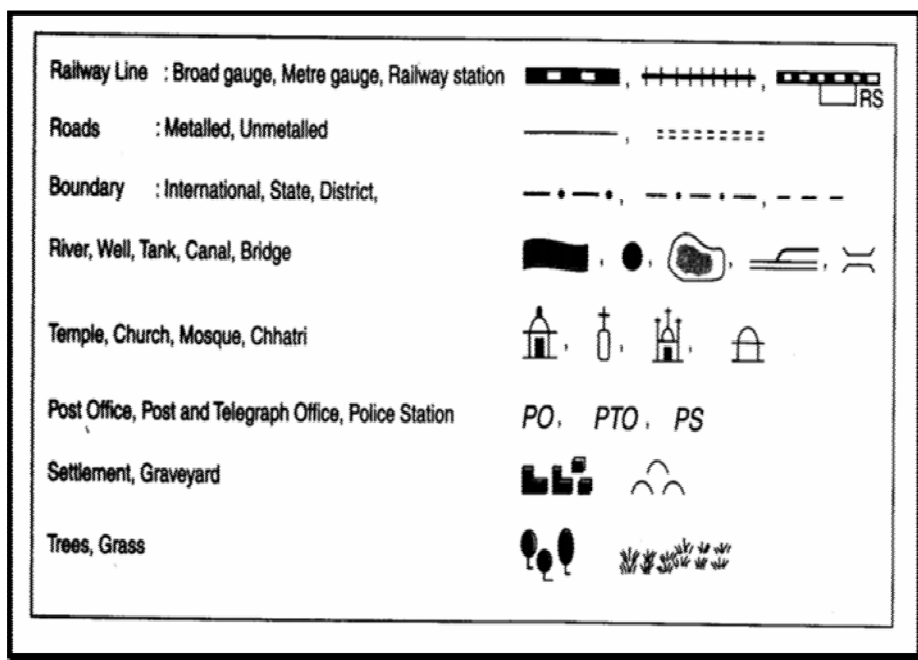
3. Vegetation: areas covered by vegetation, types of forest (protected and reserved) and other types of trees and their distribution.

c. Cultural Information

Topographical maps bear sufficient information pertaining to cultural aspects. These include the study of following information:

1. Land use: cultivated land, other uses of land and waste land; means of irrigation, (canal, well, tank), occupation of people (cultivation, mining, forestry etc.).
2. Means of Communications: railway, roadway, cart-tracks etc.; postal and telegraphic offices; Aerodrome, harbours, ports etc.
3. Settlement: Urban Centres, their sites and their sizes; rural settlements, their types and patterns, archaeological sites and their details.

3.9. CONVENTIONAL SIGNS AND SYMBOLS

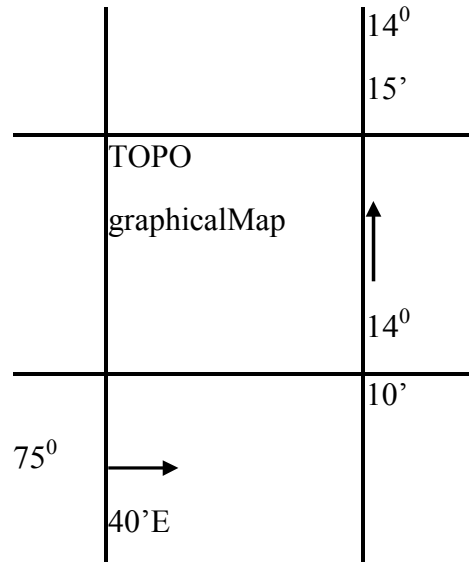


Topographical Map Karnataka - 48/N/12 (C-1)

Q.1 With reference to the map (Karnataka - 48/N/12) answer the following questions.

- 1) State extent of the map.

Ans - 'Extent' refers to the Latitudinal and Longitudinal extent of the map.



a) Latitudinal extent = 1

14° 10' N to 14° 15' North

b) Longitudinal extent

75° 40' E to 75° 45' East

2) Calculate area represented in the map.

Ans. Formula for the calculation of area
Area = Length x Width

Measure length and width of the map
Length = 18.0cm

Width = 18.2 cm

Scale of the map is 2cm to 1km.

Let us convert length & width into kms.

∴ 2cm to 1 km

(18/2=9)

∴ 18cm to 9.1 km

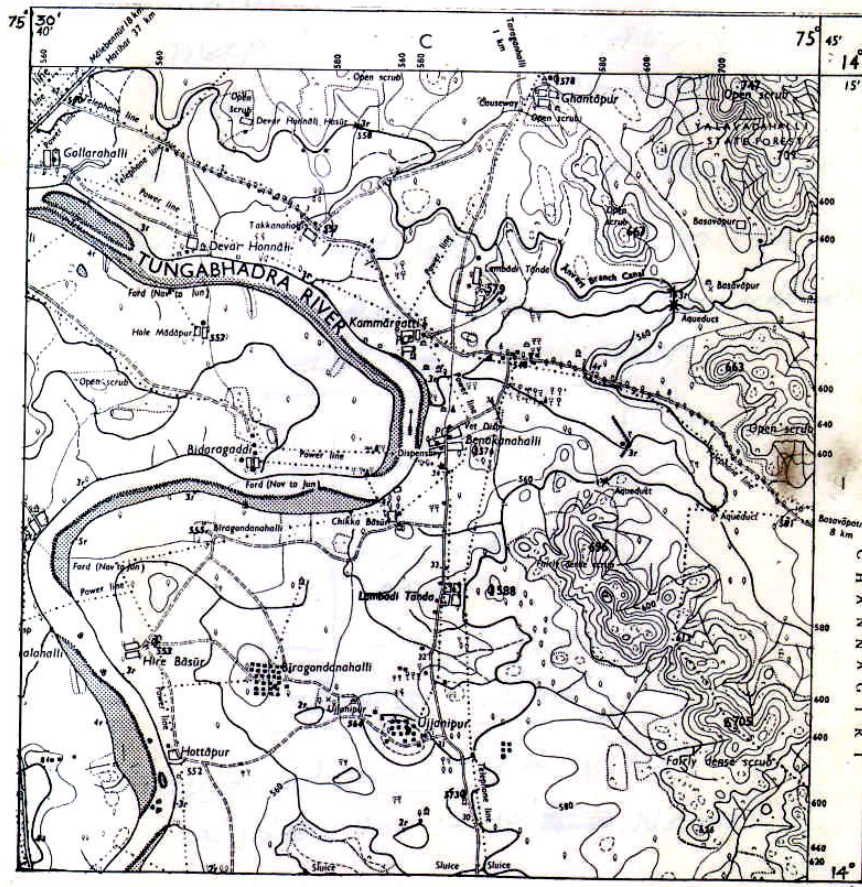
Length = 9km, Width = 9.1km
Area = 9x 9.1 = 81.9 sq. kms. Area of the map is 81.9 sq. kms.

82

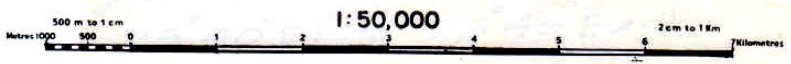
TOPOGRAPHICAL MAP

MAP SQUARE **C-1** **KARNATAKA 48 / N / 12**

Survey of India
Toposheets



SCALE 1 : 50000 2 cm to 1 km



3.10. UTILITY OF TOPOGRAPHICAL MAPS:

Topographic maps, which are two-dimensional representations of landforms and geographic features, are invaluable for landscape study and often attractive works of art. What follows is a survey of some of the major uses of these cartographic tools.

1. Route-planning

Study a topographic map from the U.S. Geological Survey or another source to assist in planning an itinerary to a wilderness region. Backpackers and cross-country hikers especially need these maps to route their travels along an efficient route (often with as little change in elevation as possible), avoid obstacles (like landslides, deep canyons and other generally rugged terrain), and locate water sources and potential shelter.

2. *Safety & Survival*

Choose a detailed-enough topographic map and keep it handy on treks to ensure your personal safety. Sharing your route with friends and family, not to mention other members of your own party, is made far easier with the detailed geographic information coded in a topographic map. If you do find yourself off-course, injured, beset by rough weather or otherwise threatened, the map can help you find springs, high points (where cellular phone and GPS reception might be stronger), nearby roads and buildings.

3. *Professional and Scientific Uses*

For planners, topographic maps can suggest potentially unstable landscapes like landslide slopes, bottomlands or cut banks and eroding shorelines that do not lend themselves easily to development. For botanists and biologists, they can be overlain with other map layers, like vegetation or soil zones, to predict species distribution. Developers might scrutinize such depictions of terrain, in concert with other data, to identify good spots for, say, wind-turbine placement. The applications are as endless as geography's impacts on our lives.

3.11. SUMMARY:

After going through the unit we have come to know that the topographical maps are sufficiently large scale maps prepared to show the micro details of the ground. The variation in the relief, vegetation, land use, forms of settlements, location of urban and market centre, drainage patterns, transport network and communication lines are some important information given on the topographical map. These maps are usually prepared and published by the official organization of national government and cover the country in continuous series of maps at various scale. Contour lines determine elevations of mountains and flat areas. The closer together the lines are, the steeper the slope. Colours like red, blue, brown and styles such as dotted, dashed, and curvy usually criss-cross a topographic map. From the colour red on a toposheets we are able to find out roads. The colour black indicates manmade or cultural features while blue, brown, green show water-related features, contour lines and elevation numbers, vegetation features respectively. White indicates any landscape feature except for trees or water - including desert, grass, sand, rocks, boulders, and so on. But remembering map colors is a fairly trivial task.

Most topographic maps show more than just topography and are updated periodically because changes occur in streets, roads, buildings; other infrastructure like power lines, wells as well as boundaries and land-use patterns.

3.12. CHECK YOUR PROGRESS/ EXERCISE

1. *True false*

- a. Closely spaced contours represent steep slopes while widely spaced contours represent gentle slope.
- b. The convex slope is fairly steep in the upper part and gentle in the lower part.
- c. A V-shaped valley occurs in lower course of a river.
- d. A U-shaped valley is formed by strong lateral erosion of glaciers at high altitudes.
- e. On a map, a Spur is identified when the contours run very close to one another, ultimately merging into one.

2. *Fill in the blanks*

- a. The topographical maps represent the Earth's features accurately and to ___ on a two _____ surface.
- b. Two contours of _____ elevation usually do not cross each other.
- c. A hill with uniform slope and narrow top is represented by concentric contours spaced almost at regular intervals.
- d. The part of the U-shaped valley is shown by the innermost contour line with a wide gap between its two sides
- e. ___ tints are colors used to indicate elevation, usually together with contour lines.

3. *Multiple choice question*

- a. The slopes can broadly be classified into
 - i. gentle, steep, concave, convex and irregular or undulating.
 - ii. big, small, concave, tall and irregular.
 - iii. sharp, pointed, gentle, steep, smooth and rough.
- b. A gentle slope occurs
 - i. when the degree or angle of slope of a feature is high and the contours are closely spaced.
 - ii. a slope with a gentle gradient in the lower parts of a relief feature and steep in its upper parts
 - iii. when the degree or angle of slope of a feature is very low.
- c. A gorge is represented by

- i. very widely-spaced contour lines on a map with the innermost contour showing huge gap between its two sides.
 - ii. very closely-spaced contour lines on a map with the innermost contour showing small gap between its two sides.
 - iii. very closely-spaced contour lines on a map with the outermost contour showing small gap between its two sides.
- d. In half-degree or half-inch map series
- i. each of the degree sheet maps has been divided into 8 equalparts.
 - ii. each of the degree sheet maps has been divided into 4 equalparts.
 - iii. each of the degree sheet maps has been divided into 2 equalparts.
- e. The contours representing a waterfall
- i. merge into one another while crossing a river stream and the rapids are shown by relatively distant contour lines on a map.
 - ii. the contours run very close to one another, ultimately merging into one.
 - iii. the contour value increases with uniform intervals for all other contour lines outward.

4. Answers the following Questions

1. Define of Topographical Map.
2. State the methods of showing relief and landforms on Topographical Map.
3. What is Cross-section?
4. Discuss Topographical map index.
5. What are the various properties of contours

3.13. ANSWERS TO THE SELF LEARNING QUESTIONS.

- 1.a. true
 - 1.b. false, the convex slope is fairly gentle in the upper part and steep in the lower part.
 - 1.c. false, A V-shaped valley occurs in mountainous areas. 1.d.true
 - 1.e. false, On a map, a cliff is identified when the contours run very close to one another, ultimately merging into one.
- 2.a. scale, dimensional

- 2.b. different
- 2.c. conical
- 2.d. lowermost
- 2.e. Hypsometric3.a.i
- 3.b.iii.
- 3.c.ii.
- 3.d.ii.
- 3.e.i.

3.14. TECHNICAL WORDS:

- **Contour lines:** Contour lines connect a series of points of equal elevation and are used to illustrate relief on a map. Numerous contour lines that are close to one another indicate hilly or mountainous terrain; when further apart they indicate a gentler slope; and when far apart they indicate flat terrain.
- **Projection:** Geometric representation of the curved surface of the Earth on a flat sheet of paper.
- **Relief:** The physical configuration of the Earth's surface, depicted on a topographic map by contour lines and spot heights.
- **Topography:** Surface features both natural and man-made, collectively depicted on topographic maps.
- **Bearing:** The horizontal angle at a given point, measured clockwise from magnetic north or true north to a second point.
- **Elevation:** Vertical distance from a datum (usually mean sea level) to a point or object on the Earth's surface.
- **Legend:** A description, explanation table of symbols, or other information, on a map or chart to provide a better understanding and interpretation of it.
- **Magnetic north:** Direction to which a compass needle points.
- **Mean sea level:** The average height of the surface of the sea for all stages of tide, used as a reference surface from which elevations are measured.

3.15. TASK

1. In a chart draw a complete conventional Signs and symbol sheet present on toposheets.

3.16. REFERENCES FOR FURTHER STUDY

- ❖ Gupta K. K and Tyagi V. C., 1992: Working with Maps, Survey of India, DST, New Delhi.
- ❖ Singh R. L. and Singh R. P. B., 1999: Elements of Practical Geography, Kalyani Publishers
- ❖ Sarkar A.K Practical Geography: A Systematic Approach, Oriental Longman, Calcutta, 1997.
- ❖ Oxford dictionary



PREPARATION OF THEMATIC MAPS

After going through this chapter you will be able to understand the following features:

Unit Structure

- 4.1 Objectives
- 4.2 Introduction
- 4.3 Subject discussion
- 4.4 Concept of Thematic Maps
- 4.5 Distinguishing characteristics of Thematic Maps
- 4.6 Various categories of Thematic Maps
- 4.7 Reading and interpretation of Thematic Maps
- 4.8 Utility of thematic maps of Thematic Maps
- 4.9 Techniques of representation of the theme of Thematic Maps
- 4.10 Interpretation and appreciation of Thematic Maps
- 4.11 Summary
- 4.12 Check your Progress/Exercise
- 4.13 Answers to the self-learning questions
- 4.14 Technical words and their meaning
- 4.15 Task
- 4.16 References for further study

4.0. OBJECTIVES

By the end of this unit you will be able to:

- Understand the Concept of Thematic Maps
- Learn about Distinguishing characteristics of Thematic Maps
- Discuss Various categories of Thematic Maps
- Evaluate Reading and interpretation of Thematic Maps
- Discuss Utility of Thematic Maps

- Understand Techniques of representation of the theme of Thematic Maps
- Learn Interpretation and appreciation of Thematic Maps

4.1. INTRODUCTION

In this unit we will study about the concept and the distinguishing characteristics of Thematic Maps. There will be a discussion on the various categories of Thematic Maps along with reading and interpretation of the same. Utility of Thematic Maps as well as the techniques of representation of the theme of Thematic Maps is very important. We will learn this in this unit. Interpretation and appreciation of Thematic Maps will be discussed in the latter part of this unit.

4.2. SUBJECT-DISCUSSION

A map is a drawn or printed representation of the Earth. Visualization of geographic and geo-referenced information is normally made through maps. There are a huge variety of maps such as Political Maps, Physical Maps, Contour Maps, Road Maps, Street Maps, Transit Maps, Thematic Maps, Resource Maps and Inventory Maps. However maps can broadly be classified into the following three main types:

- 1) General reference maps
- 2) Mobility maps
- 3) Thematic Maps

In this unit we are going to study Thematic Maps. A thematic map is a map that emphasizes a particular theme or special topic such as the average distribution of rainfall in an area whereas general reference maps show natural features like rivers, cities, political subdivisions and highways. These items are often present on a thematic map which is simply used as reference points to enhance one's understanding of the map's theme and purpose.

Thematic maps show the distribution of a single attribute or the relationship between several attributes. These maps can cover a variety of characteristics from soil types to population density. Here the cartographer bears the responsibility to make sure that the map shows the correct distribution or the relationship between the various attributes.

Initially thematic maps were made with a small scale as the available data was rather coarse, and importance was given to show the basic distribution pattern than the map's location for the data. However, with the availability of better data thematic maps are made with a larger scale to show more accurate spatial information at present. To make a good thematic map a cartographer must be careful to portray the data on the map when designing the same. This will in turn help one to use and understand that particular map. This is accomplished mainly with the

marks and symbols that the cartographer uses to represent the data. Moreover the sources of a thematic map's data are very important. Cartographers must find accurate, recent and reliable sources of information in a wide range of subjects varying from environmental features to demographic data to make the best possible maps. The designer should also give an adequate locational base for the map.

4.3. CONCEPT OF THEMATIC MAPS

Thematic map is a map that emphasizes on a particular theme or a special topic. Thematic map did not develop as a map type until the middle of 17th century. Thematic maps are used to show soil types, vegetation, land use, geology, etc. It also shows geographical concept like density and distribution of population.

4.5 DISTINGUISHING CHARACTERISTICS OF THEMATIC MAPS

Thematic map focuses on specific theme of subject area.

- a. Sometimes the thematic map also emphasizes on spatial variation of one or small number of geographic distribution.
- b. Thematic maps are sometimes referred to as graphic essays.

4.6. VARIOUS CATEGORIES OF THEMATIC MAPS

There are many different types of thematic maps. Many types have been designed for special purposes such as flow maps used in transportation analysis. Thematic mapping is the process of shading a map according to a given theme.

4.6.1. Common thematic map types include the following:

- A. Choropleth maps
 - B. Dot density maps
 - C. Isopleth Map or Contour Maps
 - D. Proportional symbol maps
 - E. Colour patch
- A. Choropleth maps**

The term 'Choropleth Map' was introduced in 1938. The earliest known Choropleth map was created in 1826. Choropleth maps are most common type of thematic map that usually portrays quantitative data as a colour and can show density, percent, average value or quantity of an event within a geographic area. Sequential colors on these maps represent increasing or decreasing positive or negative data values. Generally, each colour also represents a range of values. These maps represent a single geo-referenced variable and show variations over discrete regions.

❖ Disadvantages of Choropleth Maps

Choropleth maps give a good visual impression of change over space but there are certain disadvantages to using them:

- They give a false impression of abrupt change at the boundaries of shaded units.
- Choropleth maps are often not suitable for showing total values. Proportional symbols overlays (included on the choropleth map above) are one solution to this problem.
- It can be difficult to distinguish between different shades.
- Variations within map units are hidden, and for this reason smaller units are better than large ones.

B. Dot density maps

The Dot density maps show a symbol i.e. a dot for each individual or group of individuals. These are used together with polygons and are useful to show densities or values in a continuous way. These maps are generally used to show multiple variables (e.g., through multiple colors, dot sizes, symbols, etc.) but fails when many individuals or groups are present. Dot density maps are only used when exact location is unknown.

❖ Demerits of Dot density maps

- ❖ The limitations of Dot density maps include the difficulty of counting large numbers of dots in order to get a precise value and the need to have a large amount of initial information before drawing the map.

C. Isopleth Map

These maps are used for rendering differences in absolute or relative values on a surface perceived as a continuum. Isopleth Maps use line symbols to portray a continuous distribution such as temperature or elevation. Isopleths are lines that connect points of equal numeric value. One of the best-known types of Isopleth map is the contour map, which shows elevation above sea level.

❖ The merits and demerits of Isopleth Maps are as follows:

- Merits
 - i. Isopleth are more scientific than other methods of showing distribution and effectively show the distribution and variations.
 - ii. This is especially useful for climatic maps such as isobars, isotherms, isohyets etc. and is known as the main tool for the meteorologists.

- iii. It is very easy to determine the gradient (rate of change) with the help of isopleth maps.
 - iv. When isopleth are wide apart, they show low gradient but when they are closer together they show high gradient.
 - v. Isopleth lines are independent of political boundaries and best suited to show the natural pattern of distribution of an element.
 - vi. Isopleth is the most suited method for showing elements having transitional values, this is a reason that isopleth are invariably used to show the distribution of temperature, pressure and other climatic elements.
- Demerits
 - i. The drawing of isotherm often needs interpolation, which is a difficult process.
 - ii. The method often suffers from lack of sufficient data.

D. Proportional symbol maps

Proportional symbol maps are used for rendering absolute quantitative data. These maps represent data associated with point locations such as cities. The populations of different cities are frequently depicted on Proportional symbol maps. Data is displayed on these maps with proportionally sized symbols to show differences in occurrences. The symbols have different sizes in proportion to some quantity that occurs at that point. Circles are most often used with these maps but squares and other geometric shapes are suitable as well.

E. Colour patch

Another type of thematic map is colour patch where colour is used for identifying different groups. When these types of maps show urban or rural settlements each of them is shown through different colours such as if urban settlement is shown by red colour then rural is shown by yellow colour.

4.7. READING AND INTERPRETATION OF THEMATIC MAPS

To develop map reading abilities along with skills one should apply certain basic principles to translate map symbols into landscape images. A map reader must have ideas about the symbol as well as the landscape present in real world. This is known as the perception of the symbols and the real world. However when these two are revealed correctly the understanding of the map will coincide exactly with the real world. How a reader should interpret Thematic Maps have been discussed below.

A **Choropleth map** portrays quantitative data as a specific color and can show density, percent, average value or quantity of an event within a geographic area. There are several different types of color progressions used by cartographers. Sequential colors on these maps represent increasing or decreasing positive or negative data values. Usually, each color represents a range of values. When there is a single-hue progression fading from a dark shade of a specific color to a very light shade of relatively the same hue the darkest hue represents the greatest number in the data set while lightest shade represents the least number.

Dot density maps use dots to show the presence of a theme and display a spatial pattern. The distribution of points on a map represents the distribution of the given phenomenon in reality, and also shows the change in the intensity or dispersion. Quantitative characteristics are expressed using dots where each dot is attached by a particular value, for example 1 dot = 100 people. For the distribution of dots, topographical and cartogram approaches are used.

In an **Isopleth map** a line is drawn on a map through all points having the same value of some measurable quantity. We visually interpret the symbols to perceive areas of higher values and areas of lower values. The information in the Isopleth maps can be interpreted through the following ways:

- a. Observe all points made from the base map.
- b. Observe lines which pass in accordance to interval made, and these lines direct the reader about the number of the same values from the base map.
- c. Observe the lowest value and highest value and look on numbers where lines pass according to the made interval.
- d. Use color or shades if has been used to get more information.

The **proportional symbol map** is a widely-used form of thematic mapping. In this technique, the cartographer selects a symbol and alters its size based on the data values. The larger the symbol, the "more" of something exists at a location. The symbols increase in size as the data increase in value. In these maps the symbol sizes are directly proportional to the data values. For example in a map of the 50 states there can be up to 50 minutely different circle sizes, each one proportional to the number it represents.

In **colour maps** cartographers utilize colour on a map to represent certain features. Map colors are always consistent on a single map as well as across different types of maps by different cartographers or publishers. Many colours used on maps have a relationship to the object or feature on the ground. For example, blue is almost always the color chosen for fresh water or ocean.

4.8. UTILITY OF THEMATIC MAPS

Thematic maps serve the following three primary purposes:

- a. They provide information about particular location.
- b. They provide information about spatial pattern.
- c. They can be used to compare patterns on 2 or 3 maps.

4.9. TECHNIQUES OF REPRESENTATION OF THE THEME OF THEMATIC MAPS

I. Choropleth Map

Choropleth maps show statistical data. As the shades or pattern becomes darker or denser the values increase. Choropleth maps provide an easy way to visualize how a measurement varies across a geographical area.

❖ Usage of colors on Choropleth maps:

- Specific color progressions should be used to depict the data properly, in a way that facilitates interpretation.
- Single-hue progressions fade from a dark shade of the chosen color to a very light shade of relatively the same hue. Common method used to show magnitude.
- Bi-polar progressions use two hues and are normally used to show a change in data numbers from negative to positive.
- Blended hue progressions use related hues to blend together the two end point hues. This type of color progression is typically used to show elevation changes.
- Full spectral progression contains hues from blue through red. Usually not recommended.

II. Isopleth Map or Contour Maps

Isopleth maps show a range of quantity. Isopleth maps usually have ranges of similar values filled with similar colours or patterns showing changes over space. Isopleth maps differ from Choropleth maps. In those maps, the data is not grouped to define a region like a state or a country. Isopleth are used to show climatic elements, temperature, pressure and cloudiness. Care should be taken to show the index of concentration before actually plotting them on the map while showing density of population and distribution of crops etc. These maps are generated from data that occur over geographical areas and values represent numerical (quantitative) differences between features on an interval or ratio scale of measurement. Isopleth maps also require a large amount of data for accurate drawing.

III. Dot Map

A Dot map is used as a distribution map or density map. Actually the dot symbol shows the presence of a feature. These maps represent the distribution of discrete phenomena with point symbols that each denotes the same quantity.

- ❖ When constructing a dot map, two parameters must be considered:
 - a. the graphical size of each dot and
 - b. the value associated with each dot
- ❖ There are different types of dot maps.

a. One-to-one

In this type of dot map, each dot represents one single phenomenon since the location of the dot corresponds to only one piece of data, care must be taken to assure that the dot is represented in correct spatial location.

b. One-to-many

In this type of dot map, each dot on the map represents more than one type of phenomenon being mapped.

IV. Proportional symbol Maps

The proportional technique uses symbols of different sizes to represent data. For example: A square may be shown of each city to represent the population of the respective cities in the map.

V. Colour patch

This map uses colour for identifying different groups, for example: The map shows urban or rural settlements. Here urban are shown by purple colour and rural are shown by yellow colour.

4.10. INTERPRETATION AND APPRECIATION OF THEMATIC MAPS

As the name suggests, thematic maps are concerned with a particular theme or topic of interest. While reference maps emphasize the location of geographic features, thematic maps are more concerned with how things are distributed across space. These maps are one of the most compelling forms of information for several reasons. These are artistic and scientific. These maps while preserving history clarify and reveal the invisible. We also get information of the future. Regardless of the reason, these maps capture the imagination of people around the world. One of the strengths of thematic mapping is that it can make some abstract and invisible concepts such as life expectancy around the world, per capita gross domestic product (GDP) in Europe, or literacy rates across India visible and comparable on a map.

4.11. SUMMARY:

After going through this unit of thematic maps we can conclude that these maps are usually made with a single purpose in mind. Often, that purpose has to do with revealing the spatial distribution of one or two attribute data sets. We have also explored different types of thematic maps and which type of map is conventionally used for different types of data along with different goals. The discussed thematic maps include choropleth, dot density, proportional symbol, isopleths and colour patches. We have come to know that thematic maps are considered as primary mechanism for summarizing and communicating the increased volumes of geographically related information. In this unit we have learnt about the most common thematic mapping techniques as well as their interpretation.

4.12. CHECK YOUR PROGRESS/ EXERCISE

1. True false

- a. A map is a drawn or printed representation of the globe.
- b. Thematic maps are sometimes referred to as graphic essays.
- c. Thematic mapping is the process of shading a map according to a given time.
- d. The term 'Choropleth Map' was introduced in 2017.
- e. Isopleth Maps use line symbols to portray a continuous distribution such as temperature or elevation.

2. Fill in the blanks

- a. One of the best-known types of Isopleth map is the __ map, which shows elevation above sea level.
- b. Isopleth lines are independent of -----boundaries and best suited to show the natural pattern of distribution of an element.
- c. The drawing of isotherm often needs -----which is a difficult process.
- d. -----maps are used for rendering absolute quantitative data.
- e. Sequential colours on -----maps represent increasing or decreasing positive or negative data values.

3. Multiple choice question

- a. The most common type of thematic map that usually portrays quantitative data as a colour and can show density, percent, average value or quantity of an event within a geographic area is known as

- i. Colour patch
 - ii. Choropleth map
 - iii. Dot density maps
- b. The Dot density maps
- I. use line symbols to portray a continuous distribution such as temperature or elevation.
 - II. a dot is used together with polygons and is useful to show densities or values in a continuous way.
 - III. circles are most often used but squares and other geometric shapes are suitable as well.
- IV. In an Isopleth map
- i. a line is drawn on a map through all points having the same value of some measurable quantity.
 - ii. quantitative data is portrayed as a specific colour and can show density of population in a specific area.
 - iii. the symbol sizes are directly proportional to the data values.
- V. In One-to-one dot maps
- i. different coloured dots represent urban or rural settlements only.
 - ii. each dot on the map represents more than one type of phenomenon being mapped.
 - iii. each dot represents one single phenomenon since the location of the dot corresponds to only one piece of data.

VI. In Choropleth maps

- i. bi-polar progressions use two hues and are normally used to show a change in data numbers from negative to positive.
- ii. use of each point symbol denotes the same quantity.
- iii. isopleth is used to show elements having transitional values.

4. Answers the following Questions

1. What is a map?
2. What are the distinguishing characteristics of Thematic Maps?
3. State the disadvantages of Choropleth Maps.
4. Define Dot density maps and state its demerits of the same.
5. Discuss the merits and demerits of Isopleth Maps.

6. How will you interpret Isopleth maps?
7. Define thematic maps. Elaborate your answer describing utility of thematic maps.
8. What are the different techniques of representation of the theme of Thematic Maps?
9. Write short notes on:
 - a. Choropleth maps
 - b. Dot density maps
 - c. Isopleth Map or Contour Maps
 - d. Proportional symbol maps
 - e. Colour patch

4.13. ANSWERS TO THE SELF LEARNING QUESTIONS

- 1.a. false, A map is a drawn or printed representation of the Earth.
- 1.b. true
- 1.c. false, Thematic mapping is the process of shading a map according to a given theme.
- 1.d. false, The term ‘Choropleth Map’ was introduced in 1938
- 1.e. true
- 2.a. contour
- 2.b. political
- 2.c. interpolation
- 2.d. Proportional symbol
- 2.e. choropleth
- 3.a.ii
- 3.b.ii
- 3.c.i
- 3.d.iii
- 3.e.i

4.14. TECHNICAL WORDS:

1. **Maps:** a diagrammatic representation of an area of land or sea showing physical features, cities, roads, etc.
2. **Cartographer:** a person who draws or produces maps.
3. **Reference map:** It shows the location of the geographic areas for which census data are tabulated and disseminated.
4. **Mobility map:** gives information on facilities and access in the city centre for aged and disabled people.
5. **Thematic Maps:** A thematic map is a map that emphasizes a particular theme or special topic such as the average distribution of rainfall in an area. They are different from general reference maps because they do not just show natural features like rivers, cities, political subdivisions and highways.
6. **Choropleth maps:** a map which uses differences in shading, colouring, or the placing of symbols within predefined areas to indicate the average values of a particular quantity in those areas.
7. **Dot density map:** It is a map type that uses a dot symbol to show the presence of a feature or phenomenon. Dot maps rely on a visual scatter to show spatial pattern.
8. **Isopleth:** a line on a map connecting points at which a given variable has a specified constant value.

4.15. TASK

1. In a chart show different techniques of representation of the theme of Thematic Maps.

4.16 REFERENCES FOR FURTHER STUDY

- Gupta K. K and Tyagi V. C., 1992: Working with Maps, Survey of India, DST, New Delhi.
- Singh R. L. and Singh R. P. B., 1999: Elements of Practical Geography, Kalyani Publishers
- Sarkar A.K Practical Geography: A Systematic Approach, Oriental Longman, Calcutta, 1997.
- Oxford dictionary



USE OF COMPUTERS IN GEOGRAPHICAL DATA REPRESENTATION

After going through this chapter you will be able to understand the following features:

Unit Structure

5.1 Objectives

5.2 Introduction

5.3 Subject discussion

5.4 Construction of Line and bar graph using MS- Excel

5.5 Construction of the divided bar graph and pie charts using MS- Excel

5.6 Calculation of central tendency and standard deviation using SPSS

5.0. OBJECTIVES

By the end of this unit you will be able to:

- Understand Line and bar graphs,
- Discuss the Construction of Line and bar graphs using MS- Excel
- Know the Construction of the divided bar graph and pie charts using MS- Excel
- Calculation of central tendency and standard deviation using SPSS

5.1. INTRODUCTION

In this unit we will study about Line and Bar graph which are mathematical representation of data. We will learn what are they used for along with how to interpret the data presented in the same. Next we are going to learn Importance and uses of Computer at first. After knowing what a computer is we will learn about the Basic terms related to computers. We will also learn MS Word and MS EXCEL. The Use of Internet will be discussed in the latter part of this unit.

5.2. SUBJECT-DISCUSSION

Statistics is a special subject that usually deals with large numerical data which can be represented graphically. In fact, the graphical representation of statistical data is an essential step during statistical analysis. A graph

is the representation of data by using graphical symbols such as lines, bars, pie slices, dots etc. A graph does represent numerical data in the form of a qualitative structure and provides important information. The most astonishing part is that these graphs tell a story with visuals rather than in words or numbers and thus help readers understand the substance of the findings instead of the technical details behind each number. There are innumerable graphing options to present data. In this unit we will learn most popularly used ones such as line and Bar Graphs, Computer is the wonderful and mastermind gift of the science to the humankind. The term computer has been derived from the Latin term 'computare', which means to calculate. Computer is an electronic device that is designed to work with Information. It is a programmable machine and thus cannot do anything without a Program. The two principal characteristics of a computer are (a) it responds to a specific set of instructions in a well-defined manner and (b) it can execute a prerecorded list of instructions i.e. a program. It represents the decimal numbers through a string of binary digits. The Word 'Computer' usually refers to the Center Processor Unit plus Internal memory. The first mechanical computer designed by Charles Babbage is known as Analytical Engine. It uses read-only memory in the form of punch cards. Charles Babbage is called the "Grand Father" of the computer.

We should remember one thing not to associate a personal computer with the phrase computer. A personal computer or PC is a small and relatively inexpensive computer. It is based on the microprocessor technology and designed for an individual use. Personal computers at home can be used for a number of different applications including games, word processing, accounting and other tasks. Besides PC there is Workstation which is a powerful, single-user computer. Minicomputer is a multi-user computer capable of supporting from 10 to hundreds of users simultaneously while Mainframe is a powerful multi-user computer capable of supporting many hundreds or thousands of users simultaneously. An extremely fast computer that can perform hundreds of millions of instructions per second is known as Supercomputer. Computers are used in many fields in our daily life.

5.3. LINE AND BAR GRAPH.

5.3.1. A **line graph** is a graphical display of information that changes continuously over time. It is a type of graph which displays information as a series of data points called 'markers' connected by straight line segments. A line graph has two axes. The x-axis of a line graph shows the occurrences and the categories being compared over time and the y-axis represents the scale, which is a set of numbers that represents the data and is organized into equal intervals.

5.3.2. A **bar graph** is a pictorial presentation of statistical data and is drawn using rectangular bars to show how large each value is. It is a chart where bars are used to show comparisons between categories of data. The bars are either horizontal or vertical. A bar graph has two axes where one axis describes the types of categories being compared, and the

other has numerical values that represent the values of the data. It does not matter which axis is which, but it will determine what bar graph is shown. If the descriptions are on the horizontal axis, the bars will be oriented vertically, and if the values are along the horizontal axis, the bars will be oriented horizontally.

Generally, the temperature and rainfall data of a particular station is shown by combined line and Bar graph.

5.4. DIVIDED BAR & PIE CHART

DIVIDED BAR

In a Divided Bar Graph, a bar is divided into several segments to represent a set of quantities according to the different proportions of the total amount. In divided bar charts, the columns are subdivided based on the information being displayed. Divided bar charts are used to show the frequency in several categories, like ordinary bar charts. It is a type of compound bar chart. But unlike ordinary bar charts, each category is subdivided.

PIE CHART

The “pie chart” is also known as a “circle chart”, dividing the circular statistical graphic into sectors or sections to illustrate the numerical problems. Each sector denotes a proportionate part of the whole. To find out the composition of something, Pie-chart works the best at that time. In most cases, pie charts replace other graphs like the bar graph, line plots, histograms, etc.

Formula

The pie chart is an important type of data representation. It contains different segments and sectors in which each segment and sector of a pie chart forms a specific portion of the total (percentage). The sum of all the data is equal to 360° .

5.5. MEASURES OF CENTRAL TENDENCY

In order to compare one set of data (1000 values) with another set of data (1000 values) we require average or central number which represents the entire data.

“Average is an attempt to find one single figure to describe whole of figures.”

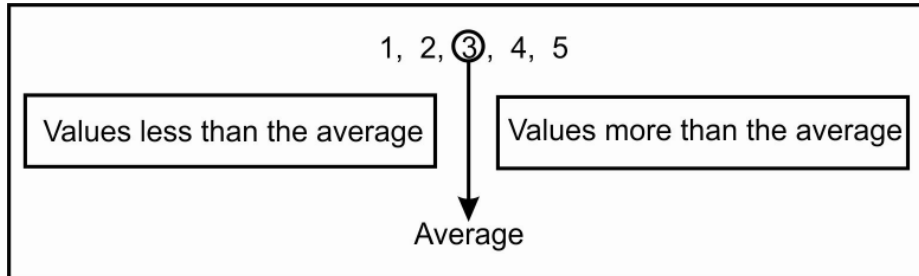
- Clark

Average is normally value near to the middle value in the given data, so it is also called as the Central value. Some values in the data are less than the average value and some values are more than the average value.

e.g. Find out average of following numbers. 1, 2, 3, 4, 5

Let us add these numbers $1 + 2 + 3 + 4 + 5 = 15$. Total number of values = 5

$$\text{Average} = \frac{15}{5} = 3$$



Average of the given numbers is 3. The average value, being central value is also termed as Measures of Central Tendency. Different types of measures of central tendency are

- 1) Mean
- 2) Median
- 3) Mode

5.6.1 MEASURES OF CENTRAL TENDENCY – MEAN

1) Mean - It is also termed as ‘average’ or arithmetic mean. It is obtained by adding together all items and by dividing this total by the number of items.

$$X = \frac{\sum x}{n}$$

Where X = Arithmetic average or mean

$\sum X$ = Total of all values in the data.

n = Total number of values.

Find out mean of the following data 0, 10, 20

$$\text{Median} = 11 + \frac{l_2 - l_1}{f_1} (m - c)$$

l_1 = lower limit of the class

$$\sum X = 0 + 10 + 20 = 30 \quad l_2 = \text{upper limit of the class}$$

f_1 = Frequency of the median class

m = middle value

c = Cumulative frequency of the preceding class

Total of all values in the data.

$n = 3$ Total number of values.

$$X = \frac{\sum x}{n} = \frac{30}{3} = 10$$

$$\bar{X} (\text{Mean}) = 10$$

Ungrouped data

Mean - 1, 2, 4, 6, 8, 10, 10

$$\sum X = 1 + 2 + 4 + 6 + 8 + 10 + 10 = 41$$

$n = 7$

$$\begin{aligned} \therefore X &= \frac{\sum x}{N} \\ &= \frac{41}{7} \\ &= 5.85 \end{aligned}$$

The average value of the given data according to the Mean is 5.85

Grouped data - discrete -Mean -

| Rainfall(in cm) | Regions |
|-----------------|---------|
| 100 | 2 |
| 200 | 5 |
| 300 | 3 |

| Rainfall (in cm) X | Regionsf | fx |
|--------------------|----------|------|
| 100 | 2 | 200 |
| 200 | 5 | 1000 |
| 300 | 3 | 900 |

$$\sum X = 2100$$

$$\sum f = 10$$

$$\begin{aligned}\bar{X} &= \frac{\sum fX}{\sum f} \\ &= \frac{2100}{10} \\ &= 210 \text{ cms}\end{aligned}$$

The average amount of rainfall per region according to mean is 210 cms.

Grouped data - continuous -Mean -

| Rainfall (in cm) X | Regions f | Mid point x | fx |
|--------------------|---------------|-------------|------------------|
| 0 - 100 | 4 | 50 | 200 |
| 100 - 200 | 10 | 150 | 1500 |
| 200 - 300 | 6 | 250 | 1500 |
| | $\sum f = 20$ | | $\sum fX = 3200$ |

$$\sum fX = 3200$$

$$\sum f = 20$$

$$\text{Mean } \bar{X} = \frac{\sum fX}{\sum f}$$

$$= \frac{3200}{20}$$

$$\bar{X} = 160$$

The average agricultural yield per region according to mean is 160 thousand tonnes.

Merits of Arithmetic Mean -

- 1) It is central value, it is the centre of gravity balancing values on either side of it.
- 2) It is affected by the value of every item in the series.
- 3) It is easy to understand and calculate.
- 4) It is calculated by a rigid formula.

5) It is useful for further statistical analysis.

Limitations of Arithmetic Mean -

1) Extreme values of the data affect Mean -e.g.

a) Average of 1, 2, 3 is $1 + 2 + 3 = 6$

$$6 \div 3 = 2$$

b) But average of 1, 2, 1002 is $1 + 2 + 1002 = 1005 \div 3 = 335$ In the second example the extreme value affects Mean.

2) It can not be calculated for incomplete data. i.e. all values are required for calculation of mean.

5.6.2 MEASURES OF CENTRAL TENDENCY - MEDIAN

‘Median’ means middle value in a distribution (of data). Median splits the observation into two parts. (lower & higher values) median is also termed as a Positional average.

The term ‘Position’ means the place of value in a given data.

e.g.

Q.1 Find out median for the following data 1, 2, 4, 6, 8, 10, 10

Median -

| | |
|------------|--|
| 1 | $\begin{aligned} \text{Median Value} &= \frac{n+1}{2} \\ &= \frac{7+1}{2} \\ &= \frac{8}{2} \\ &= 4^{\text{th}} \text{ value} \end{aligned}$ |
| 2 | |
| 4 | |
| 6 ← Median | |
| 8 | |
| 10 | |
| 10 | |

∴ The average value according to median is 6

Q.2 Find out median for the following data 3, 4, 2, 1, 5, 7

Let us rearrange numbers in proper order - 1, 2, 3, 4, 5, 7

As the number is even (six) the mid point will be between 3rd & 4th value. Hence Median

$$= \frac{3+4}{2} = \frac{7}{2} = 3.5$$

Grouped data - discrete Median -

Rainfall (in cms) - 100, 200, 300

Regions - 2, 5, 3

| Rainfall(in cms) | Regionsf | Cumulative frequency less than |
|------------------|---------------|--------------------------------|
| 100 | 2 | 2 |
| 200 | 5 | 7 |
| 300 | 3 | 10 |
| | $\sum f = 10$ | |

$$\text{Median} = \frac{n+1}{2} = \frac{11}{2} = 5.5^{\text{th}} \text{ value}$$

As this number - (5.5th value) is more than 2 (cumulative frequency) but less than 7, hence the median is located in the class whose cumulative frequency is 7. the rainfall amount of this class is 200 cm.

∴ The average amount of rainfall per region according to median is 200 cms.

Median -

| Agricultural yieldin thousand tons | Regions | Cumulative frequency less than |
|------------------------------------|---------------|--------------------------------|
| 0 - 100 | 4 | 4 |
| 100 - 200 | 10 | 14 |
| 200 - 300 | 6 | 20 |
| | $\sum f = 20$ | |

$$m = \text{middle value} = \frac{n}{2} = \frac{20}{2} = 10$$

∴ As number 10 is more than 4 but less than 14, median will be found in the class 100 - 200 - (median class)

$$\text{Median} = l_1 + \frac{l_2 - l_1(m-c)}{f_1}$$

$$l_1 = 100, l_2 = 200, f_1 = 10$$

$$\begin{aligned}
 &= 4m = 10 \\
 &= 100 + \frac{200 - 100}{10}(10 - 4) \\
 &= 100 + \frac{100}{10}(6) \\
 &= 100 + 10(6) \\
 &= 100 + 60 \\
 &= 160
 \end{aligned}$$

The average agricultural yield per region according to median is 160 thousand tonnes.

$$\text{Median} = 11 + \frac{l_2 - l_1}{f_1}(m - c)$$

l_1 = lower limit of the class
 l_2 = upper limit of the class
 f_1 = Frequency of the median class
 m = middle value
 c = Cumulative frequency of the preceding class

Merits of Median -

- 1) Extreme values do not affect the median.
- 2) It is useful for open end data as only the position and not the values of items must be known.
- 3) It is easier to compute than the mean.
- 4) It can be used for qualitative data i.e. where ranks are given.
- 5) The value of median can be found out graphically.

Limitations of the median -

- 1) It is necessary to arrange data in proper order for calculation of median.
- 2) As it is a positional average, its value is not determined by each and every observation.
- 3) It is not much used for further statistical analysis.
- 4) The value of median is affected by sampling fluctuation than the value of the arithmetic mean.

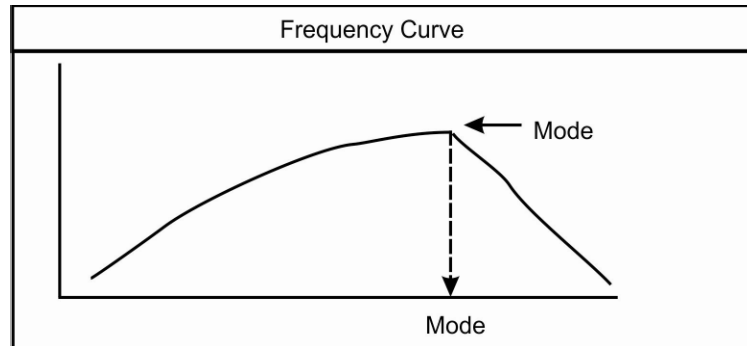
5. 6.3 MEASURES OF CENTRAL TENDENCY - MODE

The mode or the modal value is that value in a series of observations which occurs with the greatest frequency.

Mode - 1, 2, 4, 6, 8, 10, 10

Mode = 1 - as 10 is the most common number in the given data.

The Mode, this word is derived from the French word 'La Mode' means fashion. Where most of the people in the society use similar type of dress. Mode is at the highest peak of the frequency curve.



Mode - Discrete series

| Rainfall (in cms) | Regions |
|----------------------|---------|
| 100 | 2 |
| 200 | 5 |
| 300 | 3 |

← Maximum value - ∴ Modal class Mode = 200 cms.

The average amount of rainfall received by each region according to mode is 200 cms.

Mode - Continuous Series

| Agricultural production in thousand tons | Regions |
|---|---------|
| 0 - 100 | 4 |
| 100 - 200 | 10 |
| 200 - 300 | 6 |

← Maximum value - Modal class

$$\begin{aligned}
&= 1_1 + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} (1_2 - 1_1) \\
&= 1_1 = 100, f_1 = 10, f_0 = 4, f_2 = 6 \\
&\quad 1_2 = 200 \\
&= 100 + \frac{10 - 4}{2(10) - 4 - 6} (200 - 100) \\
&= 100 + \frac{6}{20 - 10} (100) \\
&= 100 + \frac{6}{10} (100) \\
&= 100 + \frac{600}{10} \\
&= 100 + 60 \\
&= 160
\end{aligned}$$

The average amount of agricultural production per region according to mode is 160 thousand tonnes.

The mode can also be obtained by using following formula based upon the relationship between mean, median & mode.

$$\text{Mode} = 3 \text{ Median} - 2 \text{ Mean}$$

Merits of mode -

- 1) It is easy to find mode in a given data.
 - 2) It is not affected by the extreme values.
 - 3) It can be used for the qualitative data.
- e.g. Most preferred colour of dress by girls.

- 1) Alka - Pink
- 2) Swati - Blue
- 3) Narendra - Red
- 4) Sonali - Pink
- 5) Soni - Pink
- 6) Kshama - Red

From the data it is clear that 3 out of 6 girls prefer Pink and so mode is pink colour. We can say that girls prefer pink dresses.

4) The value of mode can also be obtained from frequency curve (without doing calculation)

Limitations of Mode -

- 1) The value of mode cannot always be determined. - e.g. in the bimodal (Two modes) or multimodal frequencies.
- 2) It is not multi used in further statistical analysis.
- 3) It does not include all items of the data.
- 4) It is not much used.

5.7 STANDARD DEVIATION

Standard deviation is the square root of the arithmetic average of the squares of the deviations measured from the mean.

To find the S.D. the following steps are taken.

- 1) Find the deviations from the mean.
- 2) Square those deviations.
- 3) Find the mean of the sum of these deviations squared.
- 4) Find the square root of this mean.

Standard deviation-Grouped data - discrete.

Q. Find out S.D. for the following data.

| Yield (in 000' kg)(X) | No. of regions(f) |
|-----------------------|-------------------|
| 40 | 10 |
| 45 | 15 |
| 50 | 25 |
| 55 | 30 |
| 60 | 28 |
| 65 | 13 |
| 70 | 9 |

| Yield (X) | Regions (f) | fx |
|-----------|----------------|------------------|
| 40 | 10 | 400 |
| 45 | 15 | 675 |
| 50 | 25 | 1250 |
| 55 | 30 | 1650 |
| 60 | 28 | 1680 |
| 65 | 13 | 845 |
| 70 | 9 | 630 |
| | $\sum f = 130$ | $\sum fx = 7130$ |

$$Mean = \frac{\sum fx}{\sum f} = \frac{7130}{130}$$

Ungrouped data - Standard deviation -

1, 2, 4, 6, 8, 10, 10

| X | d | d ² |
|---------------|-------|-------------------|
| 1 | - 4.9 | 24.0 |
| 2 | - 3.9 | 15.2 |
| 4 | - 1.9 | 3.6 |
| 6 | 0.1 | 0.01 |
| 8 | 2.1 | 4.4 |
| 10 | 4.1 | 16.8 |
| 10 | 4.1 | 16.8 |
| $\sum x = 41$ | | $\sum d^2 = 80.8$ |

$$Mean = \frac{\sum x}{n}$$

$$= \frac{41}{7}$$

$$= 5.85$$

$$\bar{X} = 5.9$$

$$d = X - \bar{X}$$

$$Standard\ deviation = \sqrt{\frac{\sum d^2}{n}}$$

$$= \sqrt{\frac{80.8}{7}}$$

$$= \sqrt{11.54}$$

$$= 3.39$$

∴ Standard deviation of the given data is 3.39.

Standard deviation - ungrouped data. Find out S.D. for the following data.

Height (in inches) 60, 60, 61, 62, 63, 63, 63, 64, 64, 70

| Height (in X | Deviations from mean (63°) d | d ² | $Mean = \frac{\sum x}{n}$ |
|-----------------|------------------------------------|-----------------|---|
| 60 | - 3 | 9 | $= \frac{630}{10}$ $= 63$ $= (X - X)$ |
| 60 | - 3 | 9 | |
| 61 | - 2 | 4 | |
| 62 | - 1 | 1 | |
| 63 | 0 | 0 | |
| 63 | 0 | 0 | |
| 63 | 0 | 0 | |
| 64 | +1 | 1 | |
| 64 | +1 | 1 | |
| 70 | +7 | 49 | |
| $\sum x = 630$ | | $\sum d^2 = 74$ | |

$$\begin{aligned}
 \text{Standard deviation or } \sigma &= \sqrt{\frac{\sum d^2}{n}} \\
 &= \sqrt{\frac{74}{10}} \\
 &= \sqrt{7.4} \\
 &= 2.72
 \end{aligned}$$

∴ Deviation in height according to Standard deviation is 2.72'.

Group data -

Standard deviation - Continuous series.

Find out S.D. for the following data.

| Rainfall(in cm) | Regions |
|--------------------|---------|
| 0 - 100 | 2 |
| 100 - 200 | 5 |
| 200 - 300 | 4 |
| 300 - 400 | 2 |

| (in cm) | Mid point X | f | fx |
|-----------|-------------|---------------|------|
| 0 - 100 | 50 | 2 | 100 |
| 100 - 200 | 150 | 5 | 750 |
| 200 - 300 | 250 | 4 | 1000 |
| 300 - 400 | 350 | 2 | 700 |
| | | $\sum f = 13$ | 2550 |

$$Mean = \frac{\sum fx}{\sum f}$$

$$= \frac{2550}{13}$$

$$= 196.15$$

$$d = (X - \bar{X})$$

| Rainfall(in cm) | Mid point X | f | Deviation from mean 196.15 (d) | fd | fd ² |
|-----------------|-------------|---------------|--------------------------------|--------------------|------------------------|
| 0 - 100 | 50 | 2 | - 146.15 | 292.3 | 42719.6 |
| 100 - 200 | 150 | 5 | - 46.15 | 230.75 | 10649.1 |
| 200 - 300 | 250 | 4 | 53.85 | 215.4 | 11599.3 |
| 300 - 400 | 350 | 2 | 153.85 | 307.7 | 47339.6 |
| | | $\sum f = 13$ | | $\sum fd = 1046.2$ | $\sum fd^2 = 112307.6$ |

$$\sigma = \sqrt{\frac{\sum fd^2}{\sum f}}$$

$$= \sqrt{\frac{112307.6}{13}}$$

$$= \sqrt{8639}$$

$$= 92.95 \text{ cms}$$

∴ Rainfall variability according to S.D. is 92.95 cms.

Standard Deviation

| Rainfall (in cm) X | Regions f | fx |
|--------------------------|---------------|------------------|
| 100 | 2 | 200 |
| 200 | 5 | 1000 |
| 300 | 3 | 900 |
| | $\sum f = 10$ | $\sum fx = 2100$ |

Mean

$$\begin{aligned}
 &= \frac{\sum FX}{\sum F} \\
 &= \frac{2100}{10} \\
 \bar{x} &= 210 \\
 D &= X - \bar{X}
 \end{aligned}$$

| Rainfall (in cm) X | Regions f | Deviation from mean =210 d | fd | fd ² |
|-----------------------|---------------|----------------------------------|-------|----------------------|
| 100 | 2 | - 110 | - 220 | 24,200 |
| 200 | 5 | - 10 | - 50 | 500 |
| 300 | 3 | 90 | 270 | 24,300 |
| | $\sum f = 10$ | | | $\sum fd^2 = 49,000$ |

$$\begin{aligned}
 S.D. &= \sqrt{\frac{\sum fd^2}{\sum f}} \\
 &= \sqrt{\frac{49000}{10}} \\
 &= \sqrt{4900}
 \end{aligned}$$

S.D. 70 cms. Of rainfall

Variation in the amount of rainfall according to standard deviation is 70 cms.

Standard deviation -

| Agricultural Production in thousand tonnes | Mid point X | Regions f | fx |
|--|-------------|---------------|------------------|
| 0 - 100 | 50 | 4 | 200 |
| 100 - 200 | 150 | 10 | 1500 |
| 200 - 300 | 250 | 6 | 1500 |
| | | $\sum f = 20$ | $\sum fx = 3200$ |

$$\text{Mean} = \frac{\sum fx}{\sum f} = \frac{3200}{20} = 160$$

$$\bar{X} = 160 \text{ thousand tons. } d = (X - \bar{X})$$

| Agricultural Production in thousand tons | Mid point X | Regions f | Deviation from mean 160 d | fd | fd ² |
|--|-------------|---------------|---------------------------|-----|----------------------|
| 0 - 100 | 50 | 4 | - 110 | 440 | 48,400 |
| 100 - 200 | 150 | 10 | - 10 | 100 | 1000 |
| 200 - 300 | 250 | 6 | 90 | 540 | 48600 |
| | | $\sum f = 20$ | | | $\sum fd^2 = 98,000$ |

$$\begin{aligned} \text{Standard Deviation} &= \sqrt{\frac{\sum fd^2}{\sum f}} \\ &= \sqrt{\frac{98,000}{20}} \\ &= \sqrt{4900} \\ &= 70 \end{aligned}$$

The variation in the agricultural production among diffregions according to standard deviation is 70 thousand tons.

Merits of S.D.

- 1) It is the best method of deviation.
- 2) It is based on every item of the distribution.
- 3) It is used in further statistical analysis.

Limitations of S.D.

- 1) It is difficult & time consuming to calculate than other methods.
- 2) It gives more weight to extreme items & less to those which are near the mean.

