"A map Projection is The Representation of The Earth's ~~Mater~~ parallels and meridians as a net or graticule on Plane Surface.

Important things

i) True direction or Correct direction
ii) Correct Shap
iii) Correct area
iv) scale.
v) Easy draw.

Basic Term.

- Longitude.
- Great circle
- P. meridian 0°
- Latitude
- Parallels.
- Equator
- Graticule.
- 250 [illegible]
- 250,000,000 / Radius

~~Types based~~ methods of development.

1) mode of develop.
i) perspective or Graphical method
ii) Non perspective or mathematical method
- Group of family.
- Conventional

CHAPTER 5

Map Projections

WHAT IS A MAP ?

A map is a representation to scale of either the whole earth or a portion a plane surface. Besides depiciting various features of the earth, it has a network of the latitude and the meridians of longitude. The parallels and the meridians serve as co-ordinates the absolute positions of the various points on the ground. They are known as geographic c

What is a map projection? A map projection is a systematic representation of the paralle and the meridians of longitude of the spherical surface of the earth on a plane surface. In oth is a method of representing the parallels and the meridians of the earth on a plane surface. Th the parallels and the meridians so formed is called a *graticule.*

Our earth resembles a sphere. Therefore, a globe being spherical in shape represents the Thus a globe is a true representation of the earth. In other words a globe is true map of the e a map represents a flat surface and a globe a spherical surface, the shape of the network of th and the meridians on a map is always different from that on a globe. There are a number of transferring the parallels and the meridians of a globe on a plane surface, *i.e.* constructing map p Now the shape of the network of the parallels and meridians drawn by one method differs f the other methods. Therefore, there is a great variety of graticules. A variety in the graticules i to meet various specific purposes.

We cannot reproduce on a plane surface a map or an exact copy of the parallels of latitu meridians of longitude of a large part of the globe. Therefore, earth relationships such as shape countries and direction of one place from the other, as maintained on a globe, are not maintained A map projection showing the area of a globe correctly will not maintain the shapes and directi areas truly. Thus it is not possible to construct a map projection showing the globe truly and ther some distortion in the shape of the graticules. Being unable to acquire all the qualities of a glo projection cannot be used as a complete substitute for a globe.

Why is it necessary to construct a map projection? Our earth is round and it resembles Therefore, a globe which is also spherical in shape is a true representation of the earth and it g dimensional effect of the earth. Although size, shape and direction of an area are correctly repre a globe, we cannot make use of a globe always conveniently as explained below :

(a) We cannot see all the countries of the globe at a glance because we see only one half of at a time.

(b) It is difficult to measure distances on a globe due to the spherical nature of its surfac

(c) It is difficult to construct a large-sized globe and it is equally difficult to carry such a globe from place to place. It will be impossible for tourists, planners and army personnel to carry large-sized globes. The diameter of the globe on a scale of 1:1,000,000 will be 14 yards (12.82 metres) and on a scale of 1:50,000 it will be 278 yards (254.6 metres).

(d) It is not possible to trace maps from a globe accurately because a tracing paper on coming in contact with a globe develops many creases. In contrast maps on flat surfaces can be traced without any difficulty.

Even if a globe is split into various parts, it will not be convenient to carry and use them.

(e) A map on the other hand can be rolled and even folded and can thus be easily carried from place to place.

Thus the disadvantages of a globe are eliminated to some extent on a map.

Developable surface. A geometric form that makes a flat surface on unrolling, is called a dev[...] surface. Cylinder and cone are the two geometric forms that are developable. Let us have a cylin[...] of thick paper and let it stand on a table. If we cut this cylinder vertically downwards, we ca[...] make a flat sheet resembling a rectangle. Similarly if we cut a cone from its apex downwa[...] it, we get a flat sheet resembling a portion of circle. There shall not be any distortion in[...] any change in the areas on the flat sheets so developed. Evidently it would have been very [...] the earth on flat sheets had it resembled either a cylinder or a cone and we would have not needed [...] methods of transferring the parallels and meridians of the reduced earth on a flat surface, i.e. there would have been no topic of the name "map projections".

The globe which represents the earth correctly being spherical, *i.e.* three dimensional in shape, is not a developable geometric form. If we flatten a part of a globe, stretching must occur and that too in a non-uniform manner. Thus we need to develop methods to project a globe on a flat, *i.e.* two dimensional surface. The resultant map will not, however, represent the earth truly and it will have some shortcomings.

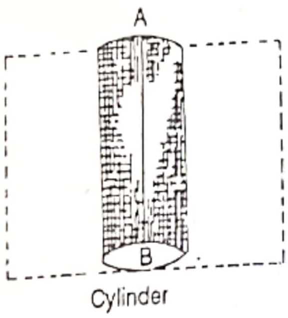

Fig. 36

When cut along the line AB, the cylinder unrolls to form the surface (rectangle) shown by broken lines.

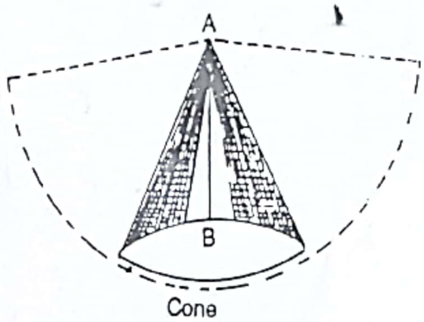

Fig. 37

When cut along the line AB the cone unrolls to form the surface (a part of circle) shown by broken lines.

The parallels and meridians on a globe. It will be useful for students to know how the parallels of latitude and the meridians of longitude appear on a globe.

(a) *The parallels of latitude :*

1. The parallels are circles. The equator which is the central parallel is marked as 0°, the North Pole as 90°N and the South Pole as 90°S.

2. The spacings between the parallels are uniformly equal.
3. The lengths of the parallels decrease towards the poles. The poles are points on a globe. T parallel, 45° parallel and 60° parallel are 866/1000, 707/1000 and ½ of the length of the eq respectively.
4. The equator is a *great circle* (a great circle on a globe is that circle the centre of which coin with the centre of the globe). All other parallels are called *small circles* and their planes a right angles to the axis of the earth. In other words, the axis of the earth passes through the c of each parallel on the globe.

(b) ***The meridians of longitude :***

1. The meridians are semi-circles.
2. They run from the North Pole to the South Pole and they cut all the parallels at right angl
3. The meridian passing through Greenwich (near London) is marked as 0° and the meridian pla opposite to it as 180°; 0° and 180° meridians together make a complete circle. Similarly any opposite meridians make a complete circle. Each of these circles is also a great circle and is eq to the length of the equator.
4. All meridians are of equal length.
5. The length of a meridian is half that of the equator.
6. The distance between the meridians is maximum at the equator. The distance between th progressively shortens towards the poles until at *the poles* they meet at a point.

Equal-area projection. A map projection is said to be equal-area or *homolographic* if area of a coun shown on it is equal to the area of the same country on the globe constructed on the scale on which map projection has been drawn. It is drawn when comparison of areas is required. A projection, howe achieves the property of equal-area only at the cost of the shape of the area it shows. If the scale is la along the parallels, the scale along the meridians is reduced and *vice versa.* Thus there being a mar inequality between the scale along the parallels and that along the meridians, shapes of areas are deform on the equal-area projections. Since comparison of areas is necessary when the distribution of commodi is shown these projections are used mainly for showing the distribution of population, animals, area und forest, area under agricultural crops, etc. In this book we shall study the following equal-area projectio

1. Cylindrical Equal-Area Projection.
2. Bonne's Projection.
3. Zenithal Equal-Area Projection.
4. Sinusoidal Projection.
5. Mollweide's Projection.

Orthomorphic projection. An orthmorphic projection is also knwon as a *conformal projection* literally means 'true shape'. In every orthomorphic projection (i) the parallels and the meridians inters each other at right angles and (ii) the scale along the parallels and the meridians is the same at a poi If the scale along the parallels increases, the scale along the meridians is also increased so that the sc along the parallels and the meridians is the same at a point. Owing to these two important properties conformal map projection preserves the shapes of small areas that is the shape of a very small country appe on the projection as it appears on the globe. The scale is, however, different in the different parts of projection. The shapes of large areas are, therefore, not preserved on this projection. In this book we sh study the following orthomorphic projections.

1. Mercator's Projection
2. Stereographic Projection (Polar case)

In the case of Mercator's Projection, the exaggeration in the shapes of areas increases away from equator and in the case of Stereographic Projection (Polar case), the exaggeration in the shapes of ar increases away from the centre of the projection. These projections are useful for preparing general purpose maps showing relief, drainage systems, ocean currents, wind direction, etc. Mercator's Projection is used for navigational purposes.

CLASSIFICATION OF MAP PROJECTIONS

There are two ways of classifying map projections. The first is based on the principle involved in their mode of development and the second is based on the group or family to which they belong.

I. CLASSIFICATION BASED ON THE MODE OF THEIR DEVELOPMENT

Under this scheme we have perspective, non-perspective and conventional map projections.

(a) ***Perspective map projections.*** The word perspective in the usual sense means the art of representing solid objects on a flat surface in such a way as to give the same impression of relative distance, size, etc., as the objects themselves do when viewed from a certain point. Thus in a perspective map projection the parallels and the meridians of the globe are represented on a surface geometrically from a point. There are three types of surfaces on which the parallels and meridians of the globe are transferred and they are (i) a cylinder in which the globe is placed, (ii) a cone which is placed on a globe in such a way that its apex is vertically above the North or South Pole, and (iii) a plane which is placed tangentially to the globe at the North or South Pole. The cylinder and the cone being developable surfaces are unrolled into flat surfaces. The projection developed on a cylinder is called a cylindrical perspective projection, that developed on a cone is called a conical perspective projection and that developed on a plane is called a zenithal perspective projection.

There are three positions of the viewpoint. They are (i) the centre of the globe, (ii) a point on the globe antipodal to the surface on which the projection is drawn, and (iii) infinity. Any one of these three positions is selected for the viewpoint. The position of the viewpoint and the nature of the surface are selected with a view to developing a particular property in the projection. In actual practice we draw rays from the viewpoint on to the surface.

In pure form very few perspective map projections are useful. To make them useful they have been greatly modified.

In the following pages we shall study only three zenithal perspective projections namely (i) Gnomonic Projection in which the surface is a plane placed tangentially at a pole of the globe and the 'viewpoint' at the centre of the globe, (ii) Stereographic Projection in which the surface is a plane placed tangentially at a pole of the globe and the viewpoint at the other pole of the globe and (iii) Orthographic Projection in which the surface is a plane placed tangentially at a pole of the globe and the viewpoint at infinity

(b) ***Non-perspective Map Projections.*** The perspective projections being of limited use have been modified to develop useful properties. Being modified to a great extent they remain no longer geometrical and are, therefore, known as non-perspective projections. They are so modified as to acquire any one or more of the following useful properties:

(i) Equal-area; (ii) Orthomorphic; (iii) General-purpose.

The non-perspective map projections since meet a number of requirements are far more useful and, therefore, more important than the perspective map projections.

As already mentioned there are three types of surfaces to which the parallels and the meridians of a globe are transferred. They are (i) a cylinder, inside of which the globe is so placed that its equator touches the cylinder, (ii) a cone which is placed on a globe in such a way that its apex is vertically above the north or south pole of the globe and (iii) a plane which is placed tangentially to the globe at the north or the south pole. The one developed on a cylinder is called a cylindrical projection, the one developed on ... is called a conical projection and the one developed on a plane is called a zenithal projection.

We shall study the following non-perspective projections:

1. ***Cylindrical map projections***
   - *(i)* Simple Cylindrical Projection.
   - *(ii)* Cylindrical Equal-Area Projection.
   - *(iii)* Mercator's or Cylindrical Orthomorphic Projection.
2. ***Conical map projections (normal cases)***
   - *(i)* Simple Conical Projection with one Standard Parallel.
   - *(ii)* Simple Conical Projection with two Standard Parallels.
   - *(iii)* Bonne's Projection.
   - *(iv)* Polyconic Projection.
   - *(v)* International Projection.
3. ***Zenithal map projections (normal cases)***
   - *(i)* Zenithal Equidistant Projection.
   - *(ii)* Zenithal Equal-Area Projection.

(c) ***Conventional projections:***

These projections do not fall into the systems of cylindrical, conical and zenithal projections. In ... projections, the parallels and the meridians are drawn arbitrarily so as to make the graticule of a proj... more useful for specific purposes. They are drawn generally for showing the whole world. We shall ... the following conventional projections.

(i) Sanson-Flamsteed or Sinusoidal Projection

(ii) Mollweide's Projection.

II. CLASSIFICATION BASED ON THE FAMILY OF THE PROJECTIONS

They are (i) cylindrical map projections (for details see pp. 52 & 53), (ii) conical map projection... details see p. 63) (iii) zenithal map projections (for details see pp. 83 & 84) and (iv) conventional ... projections (for details see p. 96).

Scale of a globe. The radius of the earth is not the same at all the points on the surface of the e... For example, the equatorial radius of the earth is 6378.2064 km (3963.0 miles) and the polar rad... 6356.5838 km (3949.5 miles). If we consider the earth as a perfect sphere its radius works o... 6370.9972km (3958.5 miles). In this book we consider the earth as a perfect sphere.

(i) Radius of the earth if it were a perfect sphere = 6370.9972 km or 637,099,720 cm or 635,000... cm approximately.

A globe of 1 cm radius is $\frac{1}{635,000,000}$ th of the size of the earth. In other words, if the R.F. ... globe is $\frac{1}{635,000,000}$ its radius is one cm. If the R.F. is $\frac{1}{127,000,000}$, the radius of the globe is 5 cm if the R.F. is $\frac{1}{80,000,000}$, the radius of the globe is $\frac{1}{80,000,000} \times 635,000,000$ or 7.937 cm.

(ii) Radius of the earth if it were a perfect sphere = 3958.5 miles

or 250,810,560 inches

or 250,000,000 inches approximately.

A globe of 1 inch radius is $\frac{1}{250,000,000}$ th of the size of the earth. In other words if the R.F. of a globe is $\frac{1}{250,000,000}$, its radius is 1 inch.

If the R.F. is $\frac{1}{125,000,000}$, the radius of the globe is $\frac{1}{125,000,000} \times 250,000,000$ or 2 inches.

Thus we can find out the radius of the globe if we know its scale.

QUESTIONS

1. What is a map projection? Why is it necessary to study map projections? Explain why no projection represents the globe truly.
2. Explain the following terms:
   (a) Developable surface, (b) Equal-area projection,
   (c) Orthomorphic projection, (d) Conventional projection,
   (e) Graticule, (f) True to scale.
3. Classify map projections and explain the characteristics of each classification.
4. Differentiate perspective map projections from non-perspective map projections.
5. Comment on the following:
   (i) No projection can be both orthomorphic and equal-area. *(P.U., 1973)*
   (ii) Network of parallels and meridians on the globe is drawn on no projection. *(P.U., 1973)*

Cylindrical proj.	Conical proj.	Zenithal proj.	Conventional proj.
i) simple cylindrical proj.	i) Simple Conical projection with one standard parallel	i) Polar Zenithal Equal Area projection	i) The Sinusoidal projection
ii) Cylindrical Equal Area P.	ii) Simple Conical proj. with Two S-P	ii) P.Z. Equidistant proj.	ii) Mollweide's projection
iii) Mercators projection	iii) Bonne's proj.	iii) P.P. Gnomonic proj.	
	iv) Polyconic proj.	iv) T.P. Stereographic	
	v) International map proje.	v) T.P. Orthographic projection	