SENIOR SECONDARY COURSE

GEOGRAPHY

PRACTICAL MANUAL

विद्याधनम् सर्वधनं प्रधानम्

NATIONAL INSTITUTE OF OPEN SCHOOLING

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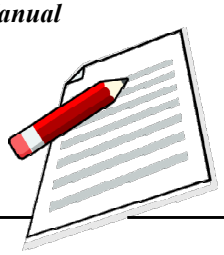

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MAPS: CONCEPTS AND SKILLS

It happened only yesterday, I was passing through a road crossing, when I saw four-five foreign tourists studying the map of Delhi stretched on their palms very carefully at the crossing. Inquisitively I stopped to see what they were doing. I saw them looking for a place on the map. Once they located it on the map, they marked the route on it and started walking towards it. As soon as they left, I went on my way. Little further I met another person new to the city, who inquired from me the way to the Red Fort. After explaining him how to reach the Red Fort. I thought for a moment that if this person also had a map. He could also locate places of his destination. Maps, as you know play a very useful role in our daily life. We use variety of maps in our day to day life. We will study about maps, usefulness, history and types in this lesson. We will also study about certain elements of map such as scales of the map, latitudes and longitudes, distance and directions on the map. Maps also have conventional signs and symbols. Map reading calls for certain skills, which you will be able to acquire after studying this lesson.

OBJECTIVES

After studying this lesson, you will be able to:

- define a map;
- explain multifarious uses of maps in various walks of life;
- describe history of map making in India;
- state elements of a map and their usefulness;
- identify different types of maps;

Notes

- identify directions on the map;
- explain the importance of scale and the different ways of representing them on a map;
- construct a linear scale;
- explain merits and demerits of each type of scale;
- locate places in the world with the help of latitudes and longitudes;
- establish relationship between longitude and local time of a place;
- differentiate between topographic sheets, wall maps and atlas maps.

1.1 WHAT IS A MAP?

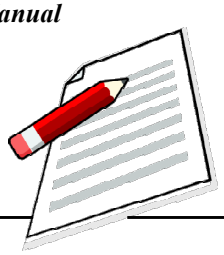
A map is the two dimensional (length and breadth) representation of the earth's surface or a part of it, drawn with the help of conventional signs and symbols, to a scale on a flat surface. The scale is the most important element of a map. This means that the actual area represented on the map is much larger than that is shown on the map but at the same time, it is proportionate in every detail to the original surface. The ratio between the distance on the map and the actual distance on the ground is the scale of the map. You will study about scale of the map later in this lesson.

> A map, firstly is the representation of the earth or its part and, secondly, it is drawn to a scale.

1.2 IMPORTANCE OF MAPS

A map at a glance gives so much information which if written in words would cover several pages. Maps have been in use since ancient times. In recent years, their importance has increased manifold. The advancement in the field of transport and communication has made our world smaller and men have become more mobile. Hence our dependence on maps has increased tremendously. In this connection, J.B. Harley, a renowned Cartographer stated the following about the utility of maps:

"A map says to you
Read me carefully,
Follow me closely,
Doubt me not,
I am the earth in the palm of your hand
Without me you are alone and lost."



Now let us discuss the importance and use of maps to the people from different walks of life.

Patwari or *Lekhpal* uses maps to solve disputes of farmers regarding their land properties. Maps are used by tourists. Now a days, newspapers also give maps along with their news showing the place where a particular incident took place. Television newscast also shows maps along with their news lines. Engineers, before constructing any building, bridge or a road, prepare a map or plan of the same. No construction is taken up without a map or plan. Soldiers also use maps to plan their war strategies. Historians also require maps to show the extent of an empire, sites of archaeological excavations, routes of expeditions etc. Economists need maps to plan projects for the development of a country. Drivers and navigators use maps to find their way to unknown areas. Since ancient times, traders have been using maps to find out new trade routes and markets for their goods. Industrialists take the help of maps in selecting a place for setting up an industry. Politicians and Administrators use maps to plan and co-ordinate the project works in their areas. Maps are also required for maintaining peace and harmony in the world. Maps are the basic tools of geographers. Geography is incomplete without maps. Geography books studded with beautiful maps help learners to understand the subject better.

1.3 HISTORY OF MAP MAKING IN INDIA

The modern map making in India began after the arrival of Europeans in India. Till the beginning of the nineteenth century, the maps of India has been based mainly on route surveys, military or otherwise. With the advancement in the science of map making and the improvement of the instruments used, map maker discover ways to prepare accurate and perfect maps based on various ways of surveys. The scientific map making efforts started with the inception of the survey of India in 1767, during British rule. In those days making of land record become important to collect revenue from the landowners. Hence, the East India company appointed James Rennell as the first Surveyor General of India in 1767. Later on, he was said to be the father of the Indian Surveys. Today all the maps are to be authenticated by the Survey of India, if it is not prepared by itself as it is the mouth piece of government decision. Its headquarters is located at Deharadun.

The pioneering work of the National Atlas and Thematic Mapping Organisation (NATMO) is also commendable. It surveys the area, prepares the map and provides authentic information to the common people through maps. Its headquarter is located at Kolkata.

It is the age of science and technology, which have helped all in preparing maps with less involvement of money having very accurate and time efficient.

Notes

In this regard, National Remote Sensing Agency (NRSA), Hyderabad is the pioneering organization in India. It uses the digital data received from satellite to prepare maps. Other concerned agencies like India Meteorological Department (IMD), Pune; Geological Survey of India (GSI), Dehradun etc. are important among various organiastions. These institutions prepare maps for their concerns.

- Can you think of some more uses of maps?

  _____

  _____

1.4 TYPES OF MAPS

Today, different types of maps are prepared to fulfill varying needs and functions. To understand them, it is better to classify them first. Maps can be classified into two categories:

(a) According to scale

(b) According to functions

(a) CLASSIFICATION OF MAPS ACCORDING TO SCALE

According to scale, maps are of four types:

(i) Cadastral maps

(ii) Topographical maps

(iii) Wall maps

(iv) Atlas maps

(i) Cadastral Maps

Cadastral maps are drawn on a very large scale to show accurately the extent and measurement of every field and plot of lands as well as properties and buildings of individuals. These maps are accepted as legal documents for local administration, levying taxes, management of estates and for defining boundaries of properties.

(ii) Topographical Maps

Topographical maps depict both natural and man-made features. Topographical maps are also prepared on large scale but their scale is smaller than that of cadastral maps and larger than that of atlas maps. Therefore, it is easier to depict both natural and man-made features such as plateaus, drainage, forests, roads, railways, canals, villages, cities, bridges, and telegraph lines etc. Surface height is shown by contours in these maps. Any feature shown

on the map can be recognised on the land surface by its shape and location. As these maps are drawn on a smaller scale than the cadastral maps, the boundaries of any property or building cannot be shown by them. Topographical maps are very useful for engineers, scientist, soldiers and geographers. These maps help in studying the regional geography of the area in detail.

(iii) Wall Maps

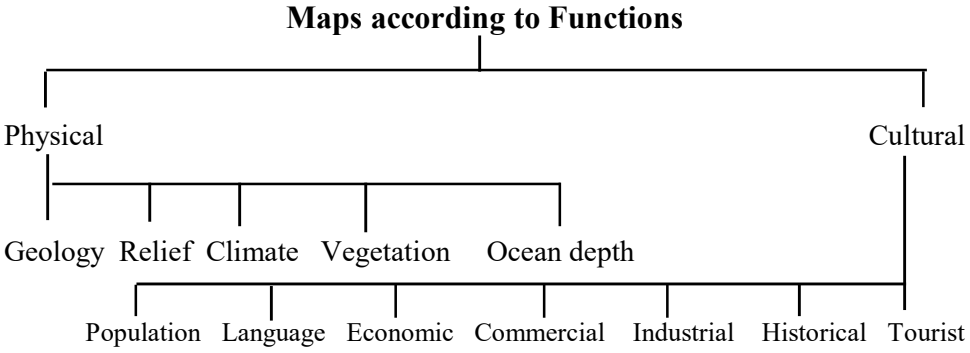
Wall maps are general maps with bold letters and lines depicting a large area. They may show relief, elements of climate, vegetation, population, trade routes, major cities etc. Like wise natural and man made features are also shown on them. These maps are very useful for teaching in the classrooms because they can be hung on the wall and can be read from a distance. In tourist offices and information centres large wall maps are very useful for providing at a glance general information to tourists and travellers.

(iv) Atlas Maps

Atlas maps are drawn on yet smaller scale. Atlas maps represent a bird's eye view of a large area. They represent a fairly large area. Therefore, they do not depict as many details as shown in the topographical maps. Even then, the atlas maps serve as a graphic encyclopaedia of geographical information about different parts of the world. They give information about the geographical location of continents, countries and states. They also represent relief, climate, soils, vegetation etc. and distribution of crops, minerals and population of different countries and states on separate sheets. These maps help us in understanding the major economic activities as well as political events discussed in daily newspapers.

(b) CLASSIFICATION OF MAPS ACCORDING TO FUNCTIONS

The second classification of maps is based on their functions, objectives or descriptions. On the basis of functions maps can be classified in two types: Physical maps and Cultural maps. These physical and cultural maps can further be sub-divided on the basis of the information depicted on them.



1.5 DIRECTIONS ON THE MAP

The directions on the map is shown with an arrow pointing to the north. Sometimes, there is no arrow mark on the map. In such maps, ordinarily, north is towards the top. Just opposite to it is south. Towards the left is west and towards the right is east. In the right hand corner of the map there is north-east and just opposite to it is the south-west direction. In the same way in the left hand corner is north-west and just opposite to it is the south-east direction. (see fig. 1.1)

Fig. 1.1 Directions on the map

1.6 GEOGRAPHICAL NORTH AND MAGNETIC NORTH

If you carefully see the lower margin of a topographical map you will find geographical north and magnetic north drawn on it. Let us try and understand what they are.

There is a little difference between geographical north and magnetic north. Geographical north is that direction which is determined by the geographical location of North Pole. As you know Pole Star is just above the North Pole. Therefore, in the night, geographical north can easily be located by finding the Pole Star. The direction indicated by Pole Star or North Pole is considered as north direction or geographical north.

The magnetic north is the direction in which the needle of the magnetic compass points. The magnetic north pole is not a permanent point. It keeps on changing its position from place to place and from time to time. Presently (2006) the magnetic north lies between the islands of Forden and Ellef Rengnse in the north of Canada.

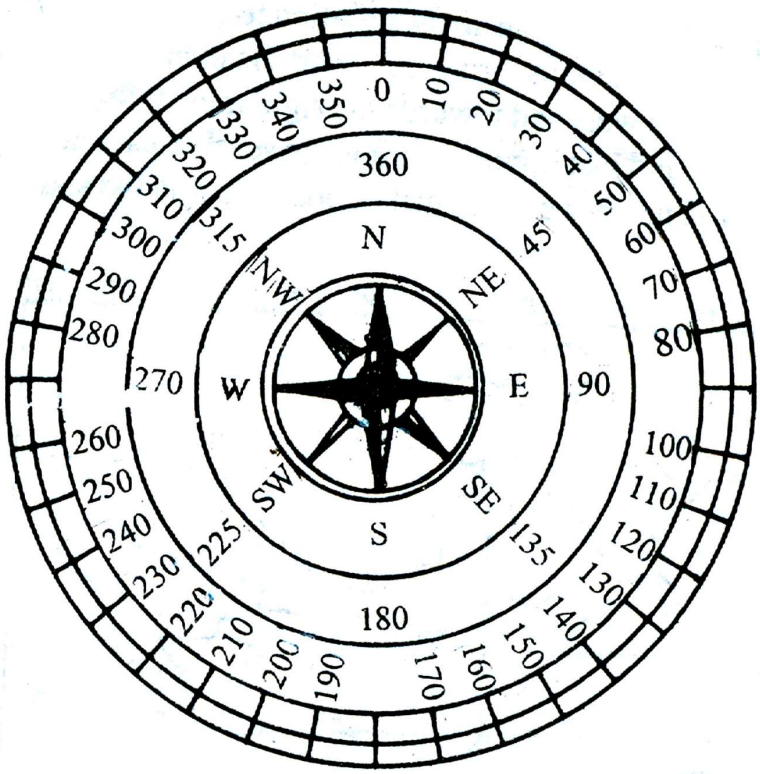


Fig. 1.2 Dial of magnetic compass

- The four main directions are North, South, East and West.
- Geographical North indicates the true direction of the North Pole.
- Magnetic North indicates the direction to which a magnetic compass will point. It changes its position with the passage of time.

1.7 MAP SCALE

If a map is to be of any use it must be an accurate representation of the surface of the area it shows. There are two basic factors involved-the size of the paper on which the map is to be drawn and the size of the area of the land to be drawn. If you were asked to draw a map of the world on a piece of paper and a map of your room on another paper of the same size, the details that you can show on both the maps will differ. On the world map you will show a city of five million people with a dot and on the map of the room you will probably be able to show all the furnitures etc.

Notes

The amount of detail you can show on a piece of paper is determined by the scale of the map. A map that can show a large area but not in detail is called a small scale map. A map that can show much more detail of a small area will be called a large scale map.

- A small scale map means that the map will show a large area but not in much detail e.g. a map of world.
- A large scale map means that the map will show much more detail on the map of your locality.

WHAT IS A SCALE?

We all know that all maps are drawn to scale. The scale is the ratio between the distance of any two points on a map and the actual distance between the corresponding points on the ground. In other words, scale is the ratio between the distance on the map and the actual distance on the ground which is represented on the map. Therefore, when we say one centimetre represents one kilometre, we mean that the distance of one centimetre between any two points on the map corresponds to a distance of one kilometre between the same points on the ground.

- Scale is the ratio between the distance of any two points on the map and the actual distance between the corresponding points on the ground.

1.8 TYPES OF SCALE

If you open your atlas, you will see at the bottom or on the side of any map given there the scale of the map. It may be shown in different ways. Now we will study the different ways of representing scales on maps.

The scales are expressed on the maps in three different ways:

(i) By a statement

(ii) By a Representative Fraction, and

(iii) By a Graphic scale/Linear Scale

Let us now see what each one of them stands for and what are their merits and demerits.

(i) BY A STATEMENT

In this method, the scale is expressed in words. For example one centimetre to one kilometre. This statement means that a distance of one centimetre on the map represents a distance of one kilometre on the ground.

Merits

1. This method is very easy and simple.
2. It is easy to understand.
3. It is easy to use.
4. Its conversion is easy into other forms of scales.

Demerits

1. A scale represented by this method can be used only in those countries in which the unit of measurement used in the statement are followed. for e.g. Kilometres or miles.
2. In this method the difficulty arises when one wants to convert one unit of distance into another unit of distance.
3. It becomes incorrect when the original map is enlarged or reduced.

(ii) BY A REPRESENTATIVE FRACTION OR R.F.

This method of expressing a scale is commonly called a Representative Fraction or R.F. In this method, the distance on the map and the corresponding distance on the actual ground are given in the same unit of measurement. The numerator and the denominator of the fraction are given in the same unit of measurement. The numerator of the fraction represents the distance on the map and the denominator represents the actual distance on the ground. Therefore, representative fraction is written as:

$$\text{R.F.} = \frac{\text{Distance between two points on the map (map distance)}}{\text{Distance between the corresponding points on the actual ground}}$$

POINTS TO REMEMBER

1. The numerator of the fraction is always one, while the denominator keeps on changing, as:

   1/1000,000 or 1: 1000,000

   1/63,360 or 1 :63,360

   1/2500 or 1 :2,500

2. The numerator and the denominator of the fraction represents the same unit of measurement. The unit may be used in centimetres or inches or any other unit.

   1/1000,000 may mean one centimetre = 1000,000 centimetres or one inch = 1000,000 inches.

Notes

1/2,500 may mean 1 centimetre = 2500 centimetres or 1 inch = 2500 inches.

1/63,360 may mean 1 inch = 63,360 inches or 1 centimetre = 63,360 cm.

3. The numerator always represents the distance on the map and denominator always represents the ground distance for example 1/ 1,000,000 means that a distance of one centimetre on the map represents a distance of 1,000,000 centimetres on the ground.

Merits

1. The most significant advantage of this method is that a map drawn on this type of scale can be understood universally.
2. Due to the above advantage, countries of the world using different units of measurement find no difficulty in using this method of scale.
3. It remains correct even if a map is enlarged or reduced.

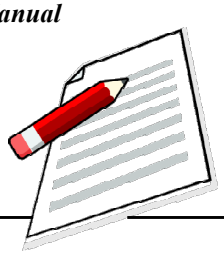
Demerits

1. Representative fraction is a difficult method of representing the scale.
2. A common person cannot easily understand the scale represented by this method because the conversion of the smaller unit of measurement into the larger unit of measurement involves multiplication and division.

- In Statement of scale, the scale is expressed in words, such as, one centimetre to four kilometres.
- In Representative Fraction, the distance on the map and the distance on the ground are shown in the same unit of measurement.
- The numerator of this fraction represents the distance on the map and the denominator represents the actual distance on the ground.

(iii) LINEAR SCALE

A linear scale is represented by a straight line which is divided into a number of equal parts. The main divisions are called primary divisions and the sub-divisions are called secondary divisions. The scale is divided in such a manner that the distances on the map can be easily measured in terms of actual distance on the ground.



Merits

1. In this method, the distance on the map can be directly and easily read in terms of the distance on the ground.
2. The scale has the advantage of remaining true even after enlargement or reduction of a map.

Demerits

1. This scale can be understood only by those people who are familiar with the units of measurement used in the scale.
2. It is difficult to draw this scale.

Linear scale is represented by a straight line which is divided into primary and secondary divisions.

INTEXT QUESTIONS 1.1

1. What is scale?

   _____

2. Name three methods of representing the scale on the map.

   (i)_____(ii)_____(iii)_____

3. On which type of scale are the map distances and the ground distances shown in the same units of measurement?

   _____

4. Which type of scale is expressed in words?

   _____

5. Name the scale represented by a straight line.

   _____

1.9 CONSTRUCTION OF A LINEAR SCALE

For constructing a linear scale, a line is drawn with the help of arithmetical calculations, based upon the statement of scale. If the scale of the map is represented by R.F., the fraction is first converted into a statement scale. The most important aspect to remember in this is that the units of measurement should be shown in round numbers. The straight line is divided into required number of divisions. For convenience, the primary divisions are shown on

the right hand side of the zero while secondary divisions (sub-divisions of the first primary division) are marked to the left side of the zero mark. (see fig 1.3)

POINTS TO REMEMBER WHILE DRAWING THE LINEAR SCALE

While drawing a linear scale, the following points should be kept in mind:

1. The length of the scale should be sufficient so that distances represented on the map can be read easily. Generally, the line is about 12 centimetres to 20 centimetres long.
2. The primary divisions in the scale are marked in round figures so that it can be easily further divided into secondary divisions.
3. Zero is marked leaving the first left hand side primary division. The divisions on the right hand side of the zero mark are called primary divisions. The left hand side division is sub divided. These smaller divisions are called the secondary divisions. (see fig. 1.3)
4. The width of the linear scale should be less than half a centimetre.

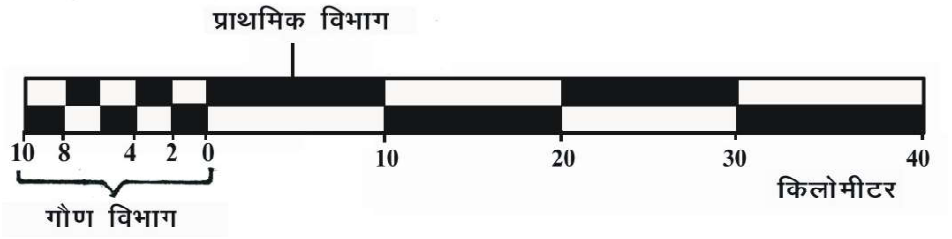


Fig. 1.3 Linear Scale

EXAMPLE

The R.F. of a map is 1: 10,00,000. Convert it into the statement of scale and draw a linear scale on which a distance of 125 kilometres can be read easily.

SOLUTION

The first step will be to convert the R.F. into the statement.

Convert the denominator 10,00,000 centimetres into kilometres.

Since one kilometre is equal to 1,00,000 cms, divide 10,00,000 centimetres with it to get kilometres.

$$\frac{1,000,000}{1,00,000} = 10 \text{ kms}$$

Thus the statement of the scale is 1 cm. to 10 kms.

Now calculate the length of the linear scale in the following manner:

Since 1 cm on map represents 10 kilometres on the ground, therefore 15 centimetres on map will represent 15 x 10 = 150 kms. on the ground.

Now draw a straight line of 15 centimetres and divide it into 15 equal parts by geometrical method.

Thus, one primary division of the scale will represent a distance of 10 kms. on the ground. Divide the first primary division on the left hand side into two parts and each of these secondary divisions will represent 5 kms. In order to read a distance of 125 kms. on this scale, add one secondary division i.e. 5 Kms and 12 primary divisions i.e. 12 x 10 = 120 Kms. This total length of the scale will represent a distance of 125 kms. i.e. 120 + 5 (see fig. 1.4).

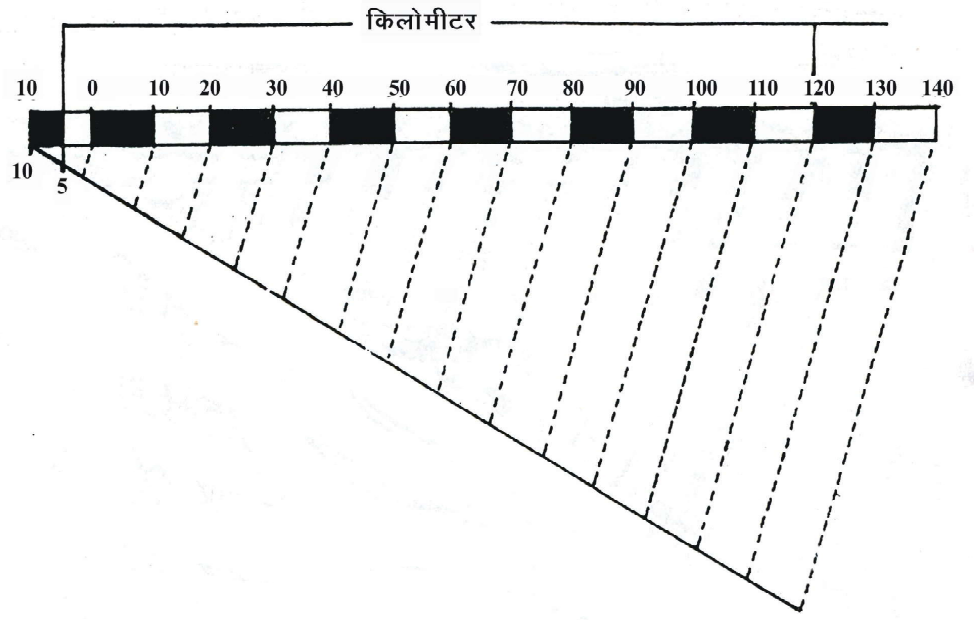


Fig.1.4 A Linear Scale representing one hundred twenty five Kilometres

- Do you know how to divide a straight line into equal parts by geometrical method. If you don't know we have given it as Enrichment Material at the end of the lesson.

INTEXT QUESTIONS 1.2

Fill in the blanks with suitable words/figures from those given in the brackets:

1. On a linear scale we show _____ numbers. (whole/fractions)

2. The larger divisions on the linear scale are called the _____ divisions. (primary/secondary)

3. The secondary divisions on a linear scale are shown on the _____ hand side. (right/left)

4. A line of 15 cms. length represents 150 kms. It is divided into 15 primary divisions. A primary division is further divided into two secondary divisions.

   Then

   (i) Each primary division represents _____ kms. (15/10)

   (ii) Each secondary division represents _____ kms. (3/5)

1.10 LATITUDES AND LONGITUDES

If you look at any map in your atlas, you will find it divided into squares by lines. These lines are called grids. The lines which are drawn from east to west direction are called parallels or lines of latitudes and lines which are drawn from north to south direction are called meridian or lines of longitudes. With the help of these two types of lines, we know the exact location of a place, area, or any particular feature. Hence, the knowledge of these lines is essential for the study of a map.

(a) Latitudes

You know that there are two basic points of reference - North and South Poles on the earth. The imaginary circle drawn around earth exactly halfway between the two poles is called the equator. Equator divides the earth into two equal hemispheres. These are Northern Hemisphere and Southern Hemisphere. Imaginary circles drawn parallel to the equator in both the hemispheres are called parallels or lines of latitudes. All the parallels or latitudes except the equator go on becoming smaller towards the poles where each pole in reality is no more than a mere point. Latitudes run always in the east-west direction. Parallels of latitude intersect the longitudes at right angle. Many parallels of latitude can be drawn on a globe. Hence, any point on the globe is located on one or the other latitude. (see fig. 1.5)

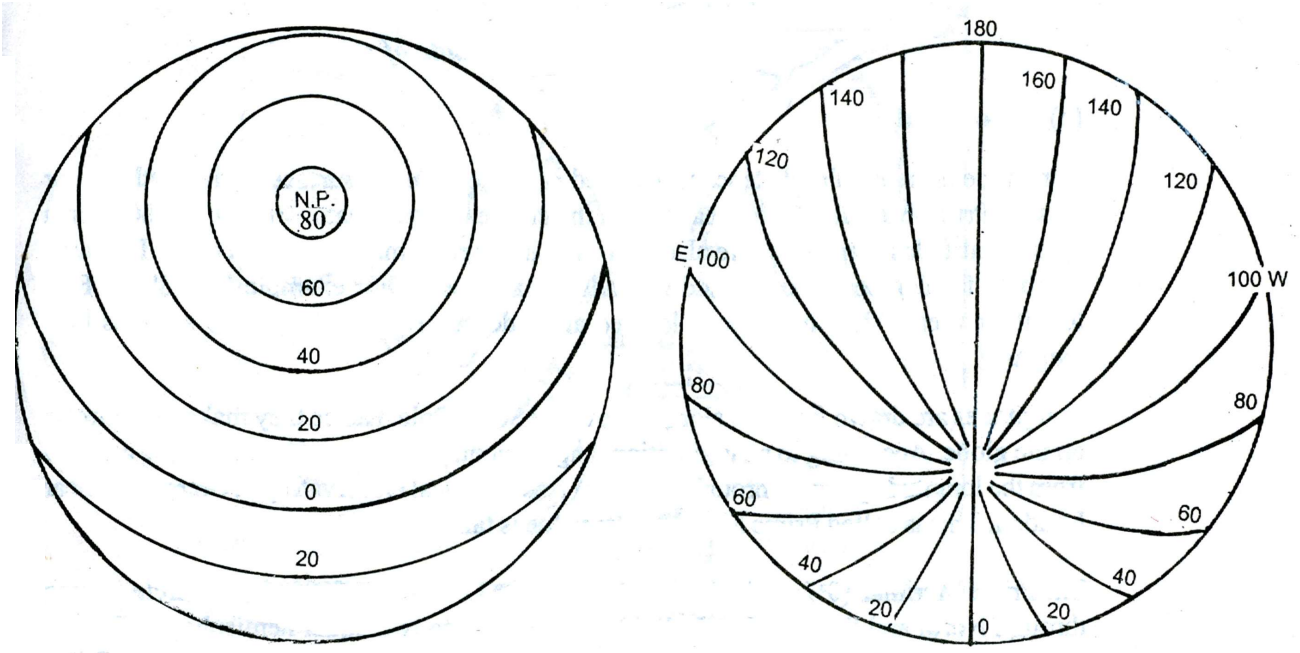


Fig. 1.5 Parallels of Latitude and Maridians of Longitude

The angular distance of any point located on the earth's surface in the north or south of the equator is called the latitude of that point. The angular distance is calculated from the centre of the earth to the longitude of that place in degrees, minutes and seconds. The symbol used for degrees is a small circle put above the figure e.g. 8°. The symbol for minute is (') and for seconds (") for example 8° 12'33" North latitude. This means that this place is located to the north of equator at 8 degrees, 12 minutes and 33 seconds.

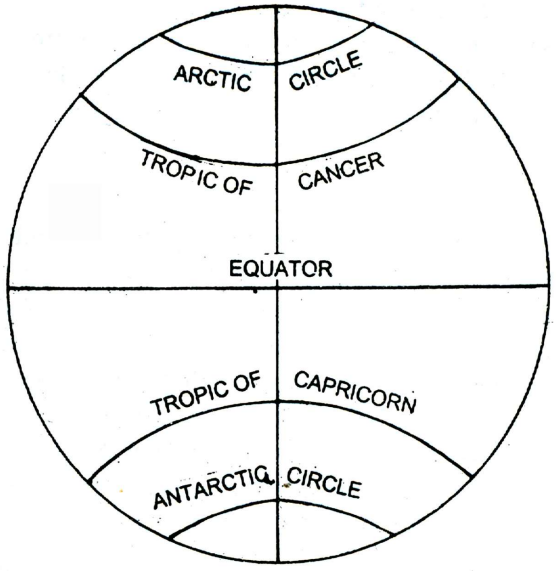


Fig 1.6 Major parallels of latitude of the earth

Notes

The Equator is zero degree (0°) latitude. North Pole is at 90° north and South Pole is at 90° south. These two poles are merely points and not circles. Tropic of Cancer is at 23° 30' north latitude. The Tropic of Capricon is 23° 30' south latitude. Arctic Circle is at 66°30' North latitude and the Antarctic circle is at 60°30' south latitude. (See fig. 1.6)

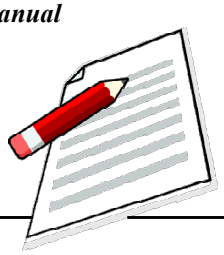
(b) Longitude

Longitude is an angular distance measured in degrees on the surface of the earth east or west of Prime Meridian. It is measured at the centre on the equator from 0° to 360°. As in case of latitudes, longitudes are also measured in degrees, minutes and seconds. The same symbols for degrees, minutes and seconds are also used. For example 15° 18' 35" East longitude means that the place is located at 15 degree, 18 minutes and 35 seconds East longitude.

Longitudes are drawn from the North Pole to the South Pole. Hence they make semi circles on the globe. According to an international agreement, meridians of longitude are counted from the longitude passing through the Old Royal Astronomical Observatory at Greenwich, near London. This is called Prime Meridian. Its value is taken to be 0°.

The Prime Meridian (0° Longitude) together with the Longitude of 180° form a circle passing through North and South poles. It divides the earth into two equal hemispheres- Eastern Hemisphere and Western Hemisphers. 180° longitudes can be drawn to the east of the Prime Meridian at a regular interval of one degree each. The value of each degree in this case is followed by the letter E indicating that all belong to the Eastern Hemisphere. Similarly at the same regular interval of 1^0 each other 180^0 longitudes can be drawn west of the Prime Meridian. In this case the value of each longitude is followed by the letter W to indicate that they all belong to Western Hemisphere. However to maintain the neutrality of the 0^0 and 180^0 longitudes (being covered in both the hemispheres), no letter either E or W is written against them. The actual distance between any two consecutive longitudes is the largest at the equator and it goes on decreasing till it becomes zero at the Poles.

- The angular distance of any point on the surface of the earth located north or south of equator is called a latitude.
- There are five major parallels of latitude viz. Equator, Tropic of Cancer, Tropic of Capricorn, Arctic Circle and Antarctic Circle.
- The angular distance measured in degrees on the surface of the earth east or west of the Prime Meridian is called longitude.
- The longitude passing through the Royal Arstronomical Observatory at Greenwich near London is called Prime Meridian. It is 0^0 longitude.



INTEXT QUESTIONS 1.3

Tick the correct alternative for the statements given below:

1. Which of the following is true of lines of latitude?

   (a) They are great circles.

   (b) They are numbered from 0 to 180.

   (c) They are circles on a globe which are parallel to the Equator and which are to the north and south of the Equator.

   (d) They are concentric circles numbered from 0 to 90.

   (e) They are semi-circles on a globe.

2. Which of the following statements best describes longitude?

   (a) An imaginary line on the Earth's surface joining the North and South Poles.

   (b) The angular distance east or west of the Greenwich Meridian.

   (c) The distance of a place east or west of the Greenwich Meridian.

   (d) The position of a place on the Earth's surface with reference to the Prime Meridian.

   (e) A line on a map that cuts the Equator at right angles.

(c) Longitude and Time

There is direct relationship between longitude and time. If we know the one we can find out the other with simple mathematical calculations.

(i) Local Time

Time, calculated according to the position of the mid-day sun at a given place on the earth's surface is called its local time. The noon of a given place is determined when the sun is at its highest point in sky and consequently the shadows for that day are at their shortest. At this point of time a watch is set to show 12 O'clock of the noon. The time shown by such a watch is taken to be the local time of the place. Due to the rotation of the earth on its imaginary axis, the places on the same meridian will have the same local noon time, although the timings of sun-rise and sun-set would vary from latitude to latitude according to the varying durations of the day. It remains exact on Equinoxes i.e. 22nd March and 23rd September. However, the places located east or west of

Notes

this longitude will show different local time. Due to rotation of the earth from west to east, the local time of the places located in the east will be ahead whereas the local time of the places in the west will be behind at the rate of 4 minutes per degree or 1 hour per 15 degrees.

(ii) Greenwich Mean Time (G.M.T)

The local time of 0° Longitude is called Greenwich Mean Time or GMT. This is also the standard time for the United Kingdom.

DETERMINING TIME WITH THE HELP OF LONGITUDES OF DIFFERENT PLACES

The earth completes one rotation in 24 hours. Since the earth's circumference consists of 360 degrees, the earth covers 15 degrees in one hour. Likewise the earth can be said to cover each degree of longitude in 4 minutes. The places lying to the east of the Prime Meridian i.e. 0° Longitude are always ahead of the Greenwich Mean Time since the earth rotates from west to east. For the same reasons places lying west of the Prime Meridian lag behind the G.M.T. For instance 1^0E longitude will have its local time 6:04 a.m. when it is 6:00 a.m. at London as per G.M.T. A place 1^0W longitude will have 5:56 a.m., when 15°E longitude will have 7:00 a.m. (G.M.T.) and the 15°W will have 5:00 a.m. as our local time is ahead of Greenwich time, it means that our place is in the east of Greenwich.

In the same way, if we know the longitude of a place and G.M.T., the local time of that longitude can easily be calculated.

Example – If the time at London is 12 noon, then the local time of Kolkata located on 90^0 East can be calculated in the following manner.

The difference of time after 15^0 Longitudes is 1 hour

The difference after 90^0 Longitude would be $\frac{90}{15} = 6$ hours

As Kolkata is in the east of London, the local time of Kolkata would be ahead of London by 6 hours. It means the local time at Kolkata would be 6 p.m.

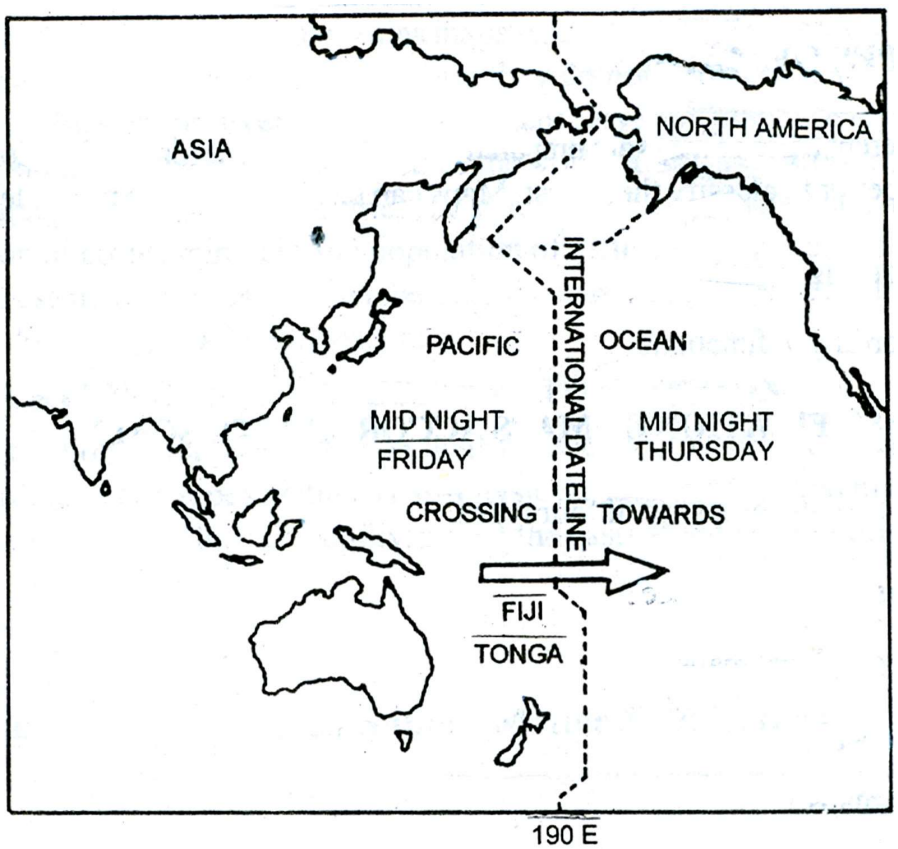
(iii) Indian Standard Time (I.S.T.)

The longitudinal extent of our country is about 30°. Hence, the sun rises in the eastern part of Arunachal Pradesh is ahead by two hours from Dwarka located on the western tip of Gujarat state. This also means that the local time of Arunachal Pradesh is ahead of Gujarat by 2 hours. Hence, to remove this anomaly of time of different places of our large country, 82° 30' East longitude, has been selected as standard meridian for India. When there is 12

noon on this longitude it is presumed that all other places in India also have the same time i.e. 12 noon. It means that the local time of this longitude has been accepted as the Indian Standard Time. Two things are kept in mind while selecting a standard meridian. Firstly, it should pass through approximately middle of the country and secondly, it should be divisible by 15° (1 hour) or 7°30' (half on hour). 82°30' East longitude satisfy both these conditions. However, large countries like Russia, U.S.A. etc. have more than one standard meridians.

(iv) International Dateline

The international date line has been drawn mainly along 180^0 longitude. The dates are changed as soon as one crosses this line. The term international date line is self explanatory. 180^0 longitude passes through some countries and islands. Hence, to avoid confusion of two different dates on the same day in a country, international date line has been drawn in such a way that it does not pass through any island or a country. When a traveller crosses international date line, he is confused with gain or loss of a full day. To remove this confusion the travellers, going from Japan towards America, count the same day again (a gain of a full day) after crossing this line, whereas the travellers going from America towards Japan drop or lose one full day after crossing this line. (see fig. 1.7)



- Local time- The time calculated according to the position of the mid-

day sun at a given place on the earth's surface is called local time.

- Greenwich Mean Time (G.M.T.)- The local time of 0° Longitude is called Greenwhich Mean Time or G.M.T.
- To prevent the confusion created by the variations of local time, standard time is adopted. The standard meridian of India is 82°30' East and the local time of this meridian is taken as Indian standard time.
- International date line has been drawn mainly along 180° Longitude. The date is repeated or dropped on crossing it from west to east and east to west respectively.

1. If it is 12 noon in London, what will be the time at 120° East [redacted]

_____

2. Along which longitude is the international date line mainly drawn?

_____

[redacted] bound into a volume is called an atlas. Atlas is extremely useful in our day to day life. Student of geography always need the help of an atlas. A number of good atlas are now available in our country. Colourful maps on a glossy paper are not only a treat to the eye but are also extremely useful. However, most of us do not know how to make the best use of our atlases. Let us find out how to use an atlas.

Suppose you have to find out the location of Bikaner on the map of India. First of all you will find the entry of Bikaner under the major alphabet B of the index given at the end of the atlas. Next look for the page number, and of the state, latitude and longitude. Now open the atlas on the page mentioned and with the help of latitude and longitude you can find out the location of Bikaner. (see Fig. 1.8).

After a little practice you can findout any place on the map. We often come across many new place names in the newspapers. We can find their geographical location with the help of an atlas within no time.

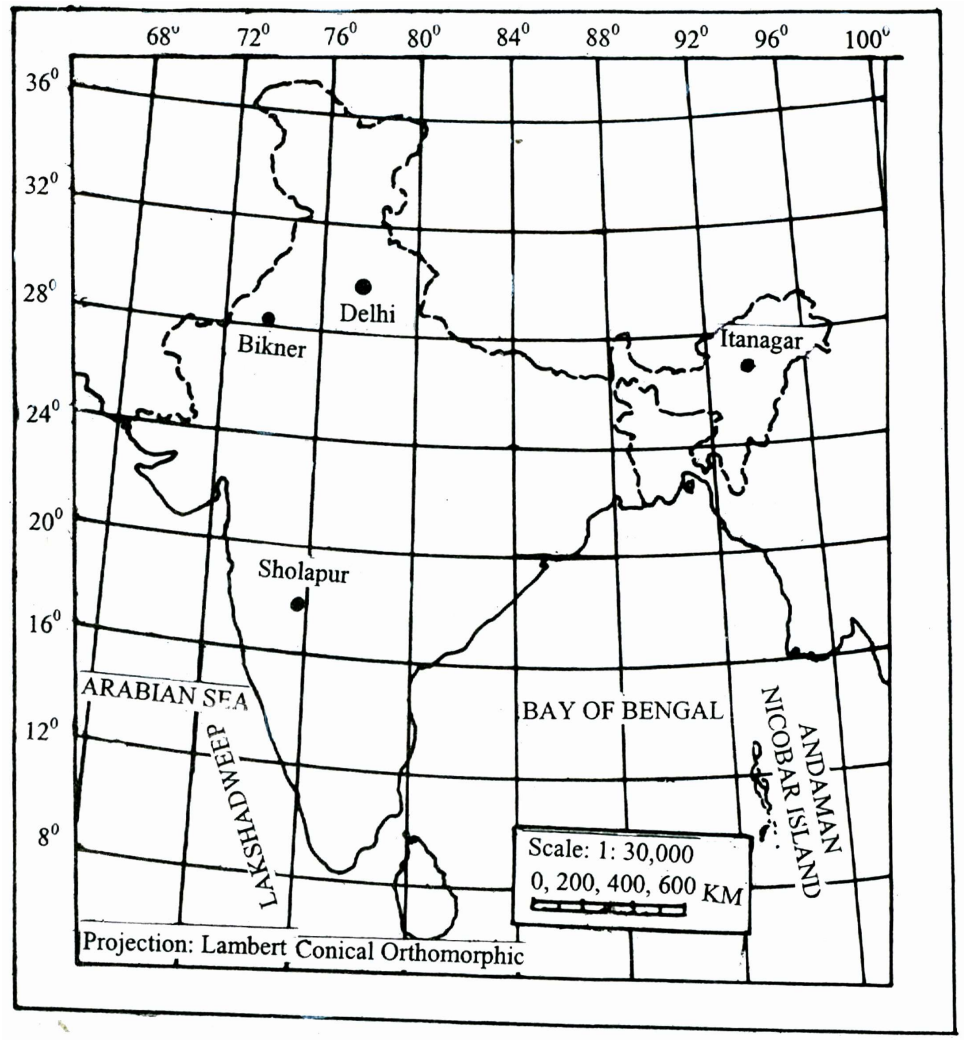


Fig. 1.8 Map of India

INTEXT QUESTIONS 1.5

1. Arrange the following towns from Rajasthan in a correct alphabatical order: Jodhpur, Bhilwara, Churu, Bikaner, Jaisalmer, Bundi and Ajmer.

_____

2. Look at the maps of India in the atlas and complete the following table

Name of the city	*Nearest latitude*	*Nearest longitude*
1. Jaipur	_____	76° East
2. _____	29° north	77° East
3. _____	19° north	73° East
4. Chennai	13° north	_____
5. _____	27° north	81° East

Notes

EXERCISE FOR PRACTICAL RECORD BOOK

1. A car running at a speed of 45 Kilometres per hour to reaches Ghaziabad from Delhi in 20 minutes. If the distance between Delhi and Ghaziabad is shown on a map by a distance of 2.5 cms draw a graphic scale for this map and calculate the R.F. also.

2. Construct a graphic scale on a R.F. of 1:40,000 so that one can read kilometres and metres directly on it.

ANSWERS TO INTEXT QUESTIONS

1.1

1. The scale is the ratio between the distance of any two points on a map and the actual distance between the corresponding points on the ground.

2. (i) By a statement

   (ii) By a Representative Fraction, and

   (iii) By a Graphic scale/Linear Scale

3. Representative Fraction

4. Statement Scale

5. Linear Scale

1.2

1. Whole

2. Primary

3. Left

4. (i) 10, (ii) 5

1.3

1. (a) False (b) False (c) True (d) False (e) False

2. (a) False (b) True (c) False (d) False (e) False

1.4

1. 8 p.m.

2. 180^0

1.5

1. (i) Ajmer, (ii) Bhilwara, (iii) Bikaner, (iv) Bundi, (v) Churu, (vi) Jaisalmer, (vii) Jodhpur.
2. (i) 27^0N, (ii) Delhi, (iii) Mumbai, (iv) 80^0E, (v) Lucknow.

ENRICHMENT MATERIAL

MEASUREMENT TABLE

10 Millimetre	=	1 Centimetre
10 Centimetre	=	1 Decimetre
10 Decimetre	=	1 Metre
1000 Metre	=	1 Kilometre

TO DIVIDE A LINE SEGMENT IN ANY NUMBER OF EQUAL PARTS

Suppose we want to divide the line AB in 6 equal parts. Draw a line AP making acute angle with AB. Along AP mark 6 points c_1, c_2, c_3, c_4, c_5 and c_6 at equal distances using compass. Join the last point c_6 to B. From other points c_1, c_2, c_3, c_4 and c_5 draw lines paralled to c_6 B. If these lines meet AB at D_1, D_2, D_3, D_4 and D_5 respectively, they divide AB in 6 equal parts.

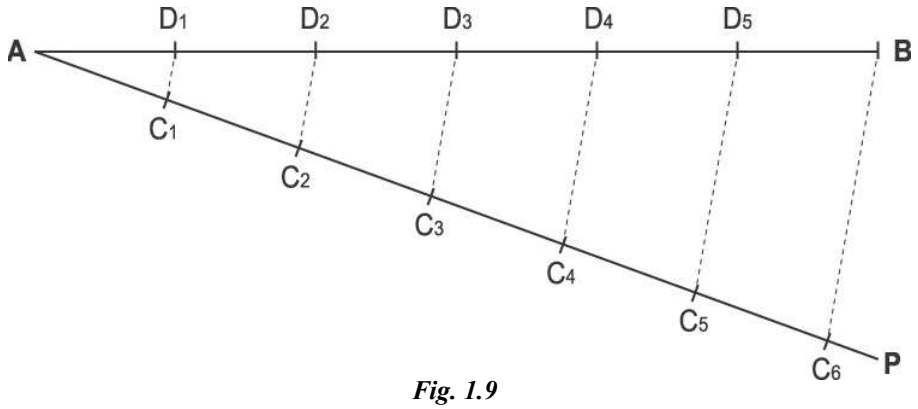
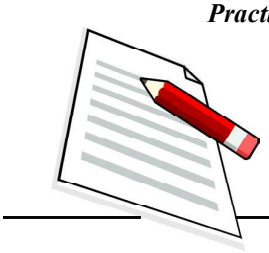


Fig. 1.9

Note that the number of points c_1, c_2 taken along AP is the same as the number of parts into which we want to divide AB.



Notes

TO DRAW LINES PARALLEL TO A GIVEN LINE

Suppose we want to draw lines through the points B and C parallel to the line AL. Draw an arc with the help of compass with A as centre meeting the lines AP at R and AL at M. Draw arcs with B and C as centres with the same radius, meeting the line AP at S and T respectively. Taking radius equal to RM, draw arcs SN and TQ with Sand T as centres. If these arcs cut the earlier arcs at N and Q respectively then the line BN and CQ are parallel to the line AL.

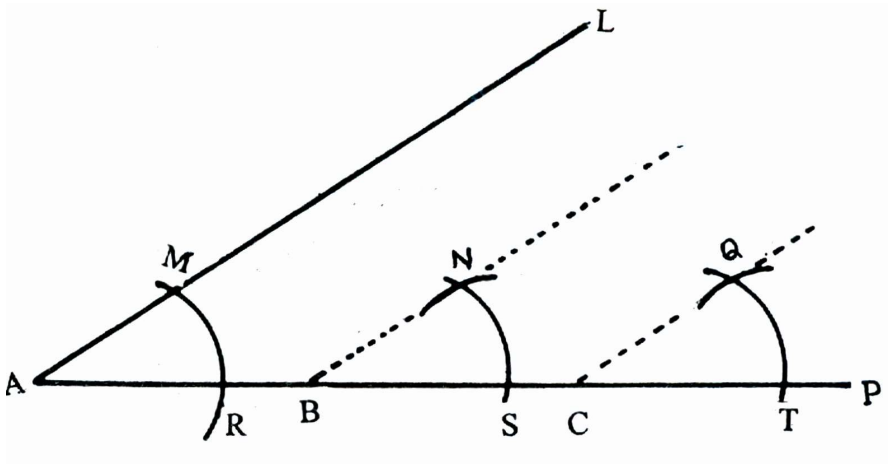


Fig. 1.10

2

MAP PROJECTIONS

As you know that the earth on which we live is not flat. It is round in shape like a sphere. A globe is the best model of the earth because it is three dimensional i.e. it has length, breadth and height. Therefore, it shows very accurately the shape and sizes of the continents and oceans. It also shows, the direction and distances very correctly. It is not easy to carry it every where. And it is not possible to show a part of the earth on globe. It can not give detailed information about network of roads, or distribution of industries etc. of a particular region or a country. Maps are more convenient and easier to carry than the globe. For making a map, the globe which is of three dimensions has to be transformed into two dimensional surface. Such transformation has to be done very carefully in order to maintain the area, shape and the direction of places on the map to the maximum possible extent.

You must have observed a network of vertical and horizontal lines on the maps in your atlases or on the wall maps. The vertical lines represent the meridians of longitude and the horizontal lines represent the parallels of latitude. This network of parallels and meridians is called a **graticule**. This network facilitates drawing of the maps. Drawing of graticules on a flat surface is called a **projection**. A number of methods have been devised to project the parallels of latitude and the meridians of longitude on a flat surface. In this lesson we are going to study some of the important projections, their construction, characteristics and uses.

> A technical person preparing maps, charts and diagrams is known as a cartographer.

Two techniques which are mostly used in the drawing of a projection are: perspective (graphical) and non perspective (mathematical). In perspective or graphical method the graticule of latitudes and longitudes is projected through the source of light. Projections prepared through this technique are known as perspective projections.

Secondly, In mathematical technique, graticules of latitudes and longitudes are drawn on the basis of mathematical calculations/derivations. Projections prepared through this technique are known as non-perspective projections. It is to be noted that projections drawn on the later method have higher accuracy than the former.

OBJECTIVES

After studying this lesson, you will be able to:

- enumerate the merits and demerits of globe and map;
- explain developable and non-developable surfaces for projecting globe on a plane surface;
- classify the map projections according to different developable surfaces;
- classify the projections based on source of light on the globe;
- choose the map projections according to their uses;
- recognize the types of map projections with the help of patterns of latitudes and longitudes;
- enumerate the characteristics of each type of map projection on the basis of graticule pattern formed by the parallels of latitude and meridians of longitudes;
- explain the function and use of the various types of map projections.

2.1 A QUICK REVISION OF GRATICULE

You know that latitudes are imaginary lines drawn parallel to the equator. The equator, a great circle, divides the globe into two equal parts known as the Northern and the Southern hemispheres. Latitudes range from 0° at the equator to 90° at the North Pole and the South Pole. Latitudes form circles over the globe. The circumferences of these circles decrease from the equator towards the poles.

The imaginary semi-circular lines joining the North Pole to the South Pole are known as meridians of longitudes. They form semi-circles over the globe at a regular distance of one degree each and range from 0° to 180° east and west of Greenwich Meridian. The meridians of longitude cut the equator and all the parallels of latitude at right angles. As the parallels of latitude get progressively smaller towards the poles, distances between two longitudes decrease correspondingly. At the equator, it is equal to approximately 111 km; at the 30°N and 30° S, it is 96.6 km, at the 60°N and 60° S, it is 56 km; and it becomes zero at the poles.

The parallels of latitude and meridians of longitude help us to determine the location of places accurately on the earth's surface. The latitude and longitude used for locating a place are also known as the geographic coordinates. In other words, geographic coordinates. In other words, geographic coordinates help us to determine the location, direction and distance of places both on the ground and on the map.

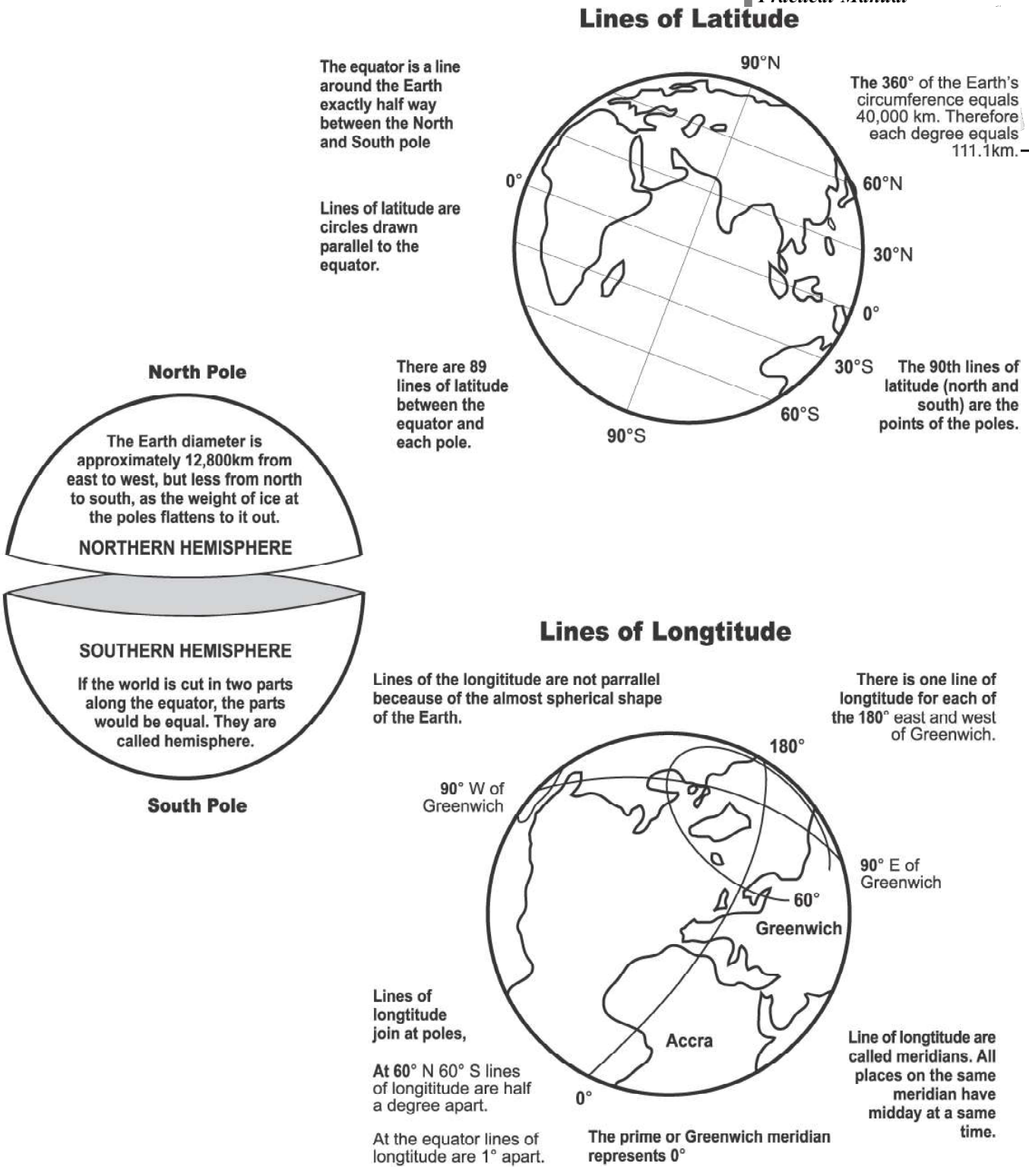


Fig. 2.1 Graticule of Latitudes and Longitudes

Notes

2.2 THE GLOBE AND MAPS

(i) Globe

It has already been mentioned earlier that the globe is a model of the earth having length, breadth and height. It, therefore, has the following properties.

(a) Merits of Globe

1. It represents the earth in its true shape. It, therefore, has the property of conformity.
2. It represents true directions between places. It, therefore, has the property of correct bearing.
3. It maintains the area correctly. It therefore, has the property of equal-area or equivalence.
4. It maintains correct distance between places. It, therefore, has the property of equidistance.
5. A globe because of the above properties is the ideal model of the earth. It is said to be the closest approximation of the earth.

(b) Demerits of Globe

However, the use of globes involves a number of problems as given below:

(i) If the earth is to represented on different scales, we will need various globes on different scales.

(ii) Their storage and transportation is yet another problem. The problems relating to transportation is partly solved through the folding and deflatable globes. These globes are like the bladder of football and they can be inflated and deflated as the need arises.

(iii) While using a globe, we can see only a part of the earth at one time and rest of it is away from us. This makes comparisons between various areas difficult. (However, most globes can be made to rotate easily).

(iv) We cannot represent a part of the earth separately on a globe which is possible only on a map.

(ii) Maps

On the other hand, a map is prepared on a flat surface which cannot have all the characteristics of the globe. However, a map is designed in such a way that it satisfies at least one of the above mentioned properties. In other words, to maintain the correct area, equal-area projections are selected. Similarly for maintaining true shape maps are prepared on orthomorphic projection and for maintaining correct directions azimuthal projections are selected. We will study about these projections later in the lesson.

In spite of all the above limitations, maps are highly useful in regional or area studies. Maps, like topographical sheets, provide a detailed information about relief, drainage, vegetation, settlements, communication network, etc while all these details may not be easily available on a globe.

2.3 NON-DEVELOPABLE AND DEVELOPABLE SURFACES

A non-developable surface is one which cannot be flattened without shrinking, breaking or stretching. A globe or spherical surface, for example, has the property of non-developable surface. In other words, it is impossible to layout a flat unbroken network of latitudes and longitudes that will conform to the network of a globe. As such, it is not possible to achieve all the properties required to make a perfect map projection.

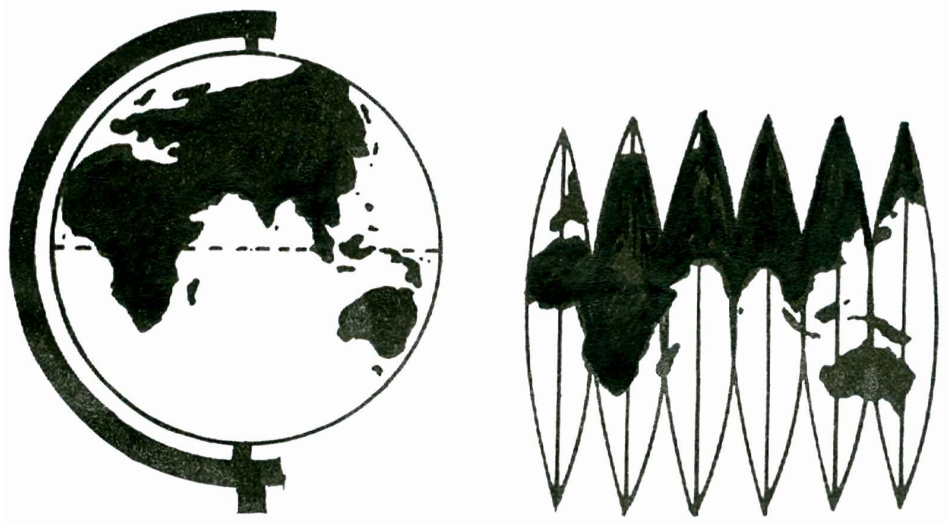
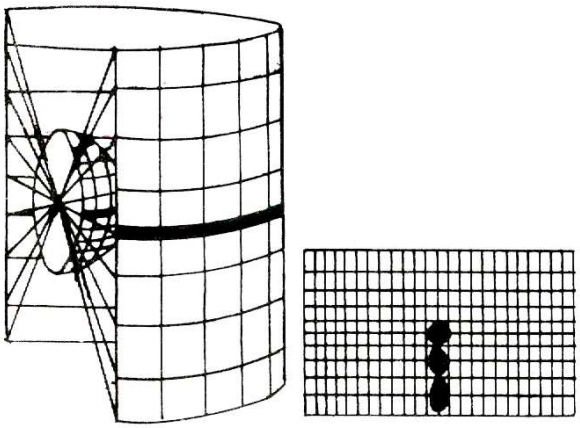
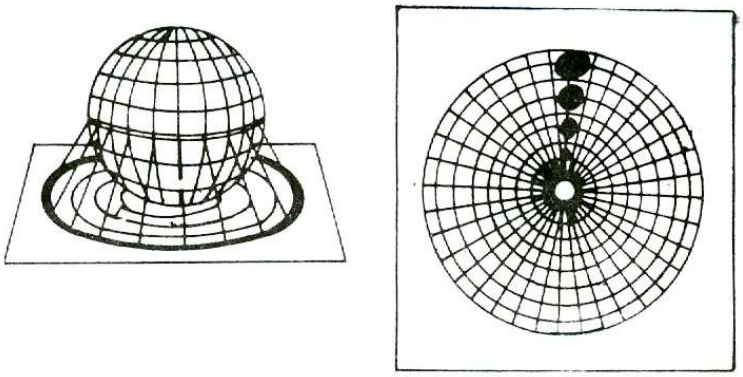


Fig. 2.2 Tearing apart of the Paper Covering the Globe

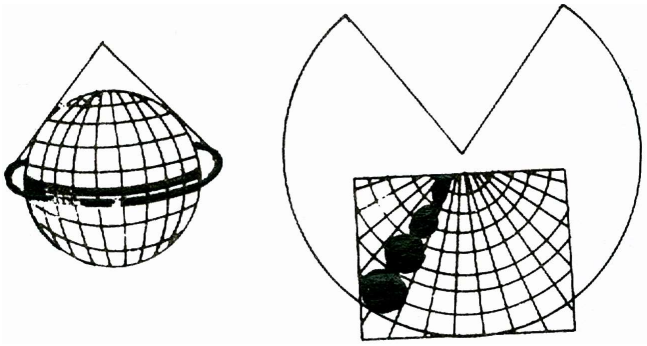
A developable surface is one which can be flattened and on which the network of latitude and longitude can be projected directly from the assumed globe. The projection of lines is done by the means of the source of light placed at the various positions to achieve various types of projections. Projections prepared by projecting the image of network of parallels and meridians of a globe on any developable surface are called perspective projections. For drawing a conical projection, we have to make a paper cone around the globe; for a cylindrical projection, we have to wrap a paper cylindrically; and for a zenithal projection, the plane has to touch the globe at any point such as the pole.



Cylindrical Surface



Plane Surface



Conical Surface

Fig. 2.3 Three types of Developable surfaces

2.4 CLASSIFICATION OF MAP PROJECTIONS

Projections are drawn by various methods and the resulting projections differ from one another. Any coherent study of map projections requires a classification of them. Projections are classified on the basis of a number of criteria. Generally, the more commonly adopted criteria for this purpose are:

(a) the nature of the developable surface,

(b) the properties of the projections,

(c) the method of construction,

(d) location of the source of light in the globe, and

(e) identification and uses.

Classifications on the basis of these criteria are discussed below.

(a) On the Basis of the Nature of the Developable Surface

On the basis of the nature of the developable surface used, the projections are of three types.

(i) Cylindrical Projections: Projection obtained through the use of a cylindrical developable surface are called cylindrical projections. In case of these projections, the globe is covered by a cylinder made of paper touching the equator, and the parallels and meridians are projected on it. When the cylinder is cut open, it provides a cylindrical projection on the plane surface.

(ii) Conical Projections: Projections obtained through the use of a conical developable surface are called conical projections. In such cases, a cone made of paper is put over the globe touching it any latitude except equator, projection on a plane surface.

(iii) Zenithal Projection: These projections are obtained directly on a plane surface. A plane paper is put on the globe touching it on one point, and the graticule is projected on it, Generally, the developable surface is so placed on the globe that it touches the globe at one of the poles.

(b) On the Basis of Properties

As the spherical surface of the globe cannot be projected on a plane surface accurately, no map projection can be absolutely correct or a true representation of the earth. Some inaccuracies do occur in all projections. The most important qualities sought in any projection are;

(i) Correctness of area;

(ii) Correctness of shape;

(iii) Correctness of direction or bearing; and

(iv) Correctness of scale.

In none of the projections can all these qualities be maintained simultaneously. According to specific requirements, a projection can be drawn in a manner so that the desired quality may be retained. According to their properties; map projections are classified as:

(i) **Equal-Area Projections:** These projections are also known as homolographic projections. The quality of these projections is that the areas of various parts of the earth are represented correctly on them.

(ii) **True Shape or Orthomorphic Projections:** They are also known as conformal projections. Shapes of various areas are portrayed correctly on these projections. The shape is generally maintained at the cost of correctness of area.

(iii) **True Bearing or Azimuthal Projections:** The projections which show directions or bearings correctly, are called azimuthal projections. On these projections the direction of all points from the centre is correctly represented.

(iv) **True Scale or Equi-distant Projections:** Projections maintaining scale correctly can be called true scale projections. However, there is no such projection which maintains scale correctly throughout. It can be maintained correctly only along some selected parallels and meridians as per specific requirements.

(c) On the Basis of Method of Construction

The concept of projection itself implies projection of the graticule from a spherical surface to a plane surface with the help of shadows cast from an illuminated globe. However, not all projections are made exactly in this manner. A large number of projections are drawn mathematically, graphically or by either imagining a developable surface covering the globe or just conventionally. According to the drawing technique, the projections are grouped into two categories:

(i) **Perspective Projections:** These projections are drawn with the help of the shadows cast from an illuminated globe on to a developable surface. Most of the zenithal Projections are perspective projections. These projections are also called natural projections.

(ii) **Non-Perspective or Conventional Projections:** These projections are drawn conventionally without the help of the shadows from an illuminated globe. In such projections either no developable surface is used or if used, it is only assumed to be covering the globe and the actual construction of the projections is based on mathematical calculations.

(d) On the Basis of the Location of Source of the Light Illuminating the Globe

The source of light illuminating the globe can have a number of locations in relation to the point at which the developable surface touches the globe. Three importance types of projections on this basis are given below.

(i) **Gnomonic Projection:** When the source of the light is located at the centre of the globe the resultant projection is called a gnomonic projection.

(ii) Stereographic Projection: When the source of light is placed at the periphery of the globe at a point diametrically opposite the point at which the developable surface touches the globe, the projection is called a stereographic projection.

(iii) Orthographic Projection: When the source of light is placed at infinity from the globe, opposite the point at which the developable surface touches the globe, the projection is called an orthographic projection.

It is to be remembered that the gnomonic, the stereographic and the orthographic projections are generally drawn when the developable surface is a plane surface. They are therefore considered as types of zenithal projections.

(e) On the Basis of Identification and Uses

As has already been mentioned earlier, map projections are of many types. Each one of them has its own property and identity which differ from one another. On the basis of their certain quality, they can easily be identified and classified under various groups. For example, projection in which the parallels of latitude and the meridians of longitude intersect at right angle, are classified under cylindrical group of projections. (see fig. 2.4).

If parallels of latitude form concentric circles or a part of it and the meridians of longitude drawn either straight or curve, then they are classified under the conical group of projections. In these projections, central meridian is always shown with a straight line. (see fig. 2.6).

Zenithal or Azimuthal group of projections are identified with the parallels of latitudes which form concentric circles while the meridians of longitude are radiating from the centre that is the pole. (see fig. 2.7).

As we have to know about the identification of the three groups of projections, it is also necessary to know their uses. Their identity differs from one group to another. For instance, cylindrical projections are best suited to represent the area along the equator. This is the reason why we show the distribution of rice, rubber and any other plantation crop on the cylindrical projections as these crops are mostly grown in the equatorial or tropical regions of the world.

The area lying between equatorial and the polar region can suitably be shown on the conical group of projections. The distribution of wheat and other crops which are mostly cultivated in the temperate regions of the world can be shown on the conical projections. These projections are also used to show the hemisphere or large continents as well as topographical maps.

Zenithal or Azimuthal projections are mostly used to represent the polar or sub-polar regions. These projections are found highly useful for weather maps, astronomical maps and maps for navigational purposes.

As none of the projections can be true representation of the globe, we have to compromise either with area or shape or direction.

Table 2.1 Characteristics of some of the common Projections

Projection	Nature of Parallels and Meridians	Scale along Meridians and Parallel	Representation of Shape, Area and Direction	Uses
Simple Cylindrical	Straight lines intersecting at right angles	Meridian scale correct, parrallel scale correct only at the equator	Shape, area and direction are incorrect. Area exaggerated	Least suitable for world maps. Restricted to tropical area.
Cylindrical Equal Area	Straight lines intersecting at right Angles	Meridian scale not correct. Parallel scale correct along equator and gets exaggerated Polewards.	Equal area. More or less orthomorphic within 30^0 from equator. Directions incorrect	Equatorial areas suitably shown. Used for distribution maps of tropical areas.
Mercator	Straight lines intersecting at right angles	Meridian scale increases pole wards. Parallel scale correct along equator	Correct shape. Area greatly exaggerated polewards. Correct directions	Used for navigation and aviation maps. Winds and Ocean currents are also shown.
Simple Conical (One Standard Parallel)	Parallels concentric circle. Meridians straight lines inters ecting at right angles	Meridian scale correct. Parallel scale correct only along standard parallel	Neither equal area nor correct shape. Directions incorrect	Used for small countries or areas of small latitudinal extent (10^0)
Polar Zenithal Equidistant	Parallels concentric circles. Meridians straight lines radiating from pole.	Meridian scale correct. Parralle scale not correct.	Shape not much distorted. Area progressively exaggerated. Directions correct	Suitable for polar areas and a hemisphere. Used to show area extending 50^0 to 90^0 latitudes.

2.5 CONSTRUCTION OF SOME IMPORTANT PROJECTIONS AND THEIR CHARACTERISTICS

(a) CYLINDRICAL EQUAL-AREA PROJECTION

This projection is also known as Lambert's Cylindrical Projection in which the distance between latitudes decreases towards the higher latitudes. In this projection, the pole is shown with the parallel equal to the equator, hence the shape of the area gets highly distorted at the higher latitudes. Therefore, the projection is non orthomorphic. The parallels of latitude and the meridians of longitude intersect each other at the right angle. Area lying between 45° N and S latitudes can be suitably shown on this projection. The projection is also suitable to show the distribution of tropical crops such as coffee, rice, rubber, etc.

Example

Draw a Cylindrical Equal-Area Projection for the world map on the scale of 1:320,000,000 with the latitudinal and longitudinal interval of 15^0.

In drawing the projection, the following steps are followed.

Calculations : Since the radius of the earth is 640,000,000 cms, divide it with given scale to get the reduced radius of the earth.

Hence, Radius (R) of reduced earth $\frac{640,000,000}{320,000,000} = 2\,\text{cm}$

Since the circumference of any circle is equal to $2\,\pi \times$ its radius, the length of equator, which is the circumference of the earth, is equal to $2\,\pi r$.

Length of Equator $2\,\pi r$ or $\frac{2 \times 22 \times 2}{7} = 12.57\,\text{cm}$

(The value of π is equal to $\frac{22}{7}$)

Internal along the equator $\frac{12.57 \times 15°}{360°} = 0.52\,\text{cm}$

Steps for construction

(i) Draw a circle of 2 cm radius. Let EOE' and POP' be the planes of the equator and polar axis respectively.

(ii) Mark the circle with the angles of 15, 30, 45,60, and 75 degrees

(iii) Draw a line E.Q. of 12.57 cm (representing equator) and divide it into 24 equal parts at the distance of 0.52 cm and draw a tangent at point E'.

(iv) Through the points a, b, c, d, e and p and also a', b', c', d', e' and p' draw lines parallels to the equator. These are the parallels of latitudes.

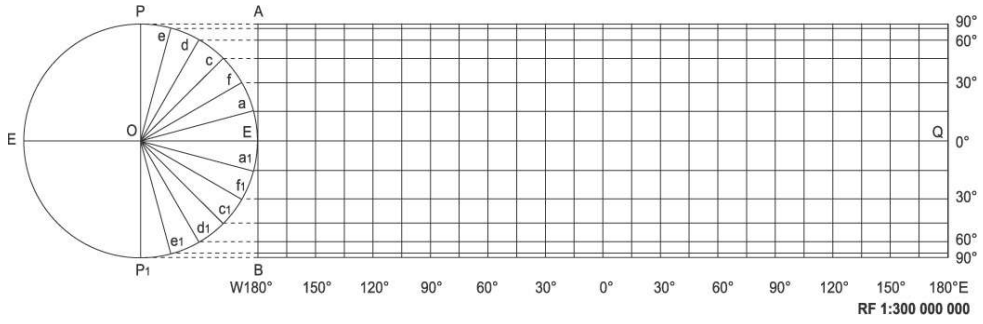


Fig. 2.4 Cylindrical Equal Area Projection

Notes

(b) MERCATOR'S PROJECTION

This projection was developed in 1569 by Mercator G. Karmer, a Dutch Cartographer. Unlike the Equal-Area projection, this is an orthomorphic projection, in which correct shape is shown. Distance between parallels increase towards the higher latitudes. As a result, this is not an equal-area projection. Like other cylindrical projections, the parallels and the meridians in this projection intersect each other at right angle. A straight line joining any two points on this projection gives a constant bearing which is called **lexodrome or Rhumb line**. This projection is used in preparing Atlas maps and the world specially to show the ocean currents, winds and other weather elements. Although this projection gives a distorted picture of the higher latitudes, it is a widely used projection. It is most suitable for navigational purposes.

Example

Draw a Mercator's Projection for the world map drawn on the scale of 1:320,000,000 at an interval of 15^0 for both latitudes and longitudes.

Calculations

Radius (R) of the reduced earth is: $\frac{640,000,000}{320,000,000} = 2\text{cm}$

Length of the Equator $2\ \pi\ r$ or $\frac{2 \times 22 \times 2}{7} = 12.57\ \text{cm}$

Interval along the Equator $\frac{12.57 \times 15°}{360°} = 0.52\ \text{cm}$

Steps for construction

(i) draw a line of 12.57 cm representing equator

(ii) divide it into 24 equal parts (360/15 = 24)

(iii) calculate the distance of latitudes from the equator with the help of given table and draw them to complete the projection as has been shown in fig. 2.5.

Latitude	Distance	Latitude	Distance
15°	*2x0.265=0.53 cm	60°	*2x1.317=2.634cm
30°	*2x0.549=1.098 cm	75°	*2x2.027=4.054 cm
45°	*2x0.881=1.762 cm		

* These are the mathematically calculated constant to be multiplied by the reduced radius of the earth (R).

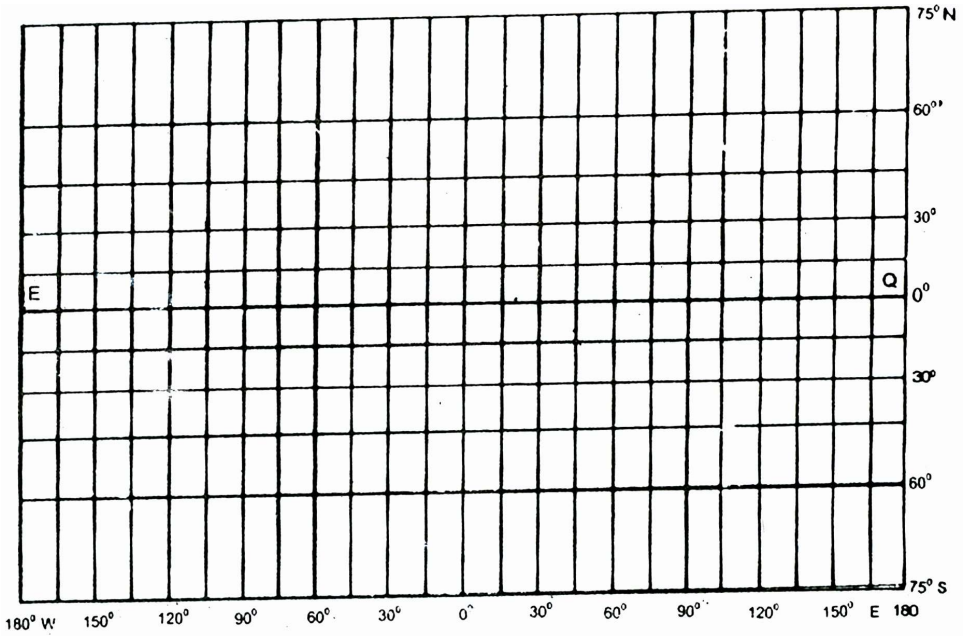


Fig. 2.5 Mercators Projection

(c) SIMPLE CONICAL PROJECTION WITH ONE STANDARD PARALLEL

This is a type of projection in which only one parallel is standard along which the scale is true. In other words, shape and area only along the standard parallel can suitably be maintained on this projection. The parallels form arcs of concentric circles and are equally spaced. The meridians are straight lines, drawn at uniform angular interval and converge towards the pole. The meeting point of meridians does not represent the pole rather the pole is shown by an arc of a circle. The projection is used for areas lying in the middle latitudes having east-west extension. The projection is not used to show areas having large latitudinal extent.

Example

Draw a simple conical projection with one standard parallel for an area lying between 50° N and 70° N latitude and between 10° E and 40° E longitude with the interval of 5 degree each on the scale of 1: 128,000,000

Calculation

Radius (R) of the reduced earth is $\frac{640,000,000}{128,000,000} = 5\text{cm}$

Central meridian is 25^0 E as the longitudes to be shown are 10,15,20,25,30,35 and 40.

Standard parallel is 60^0 N as the latitudes be shown are 50,55,60,65 and 70^0.

Construction

(i) Draw a quadrant of 5 cm radius and mark the angle 5^0 and 60^0 on it, which meet the arch of quadrant at B and C respectively.

(ii) Draw a tangent from C which meets the extended ON at R.

(iii) Draw an arc which cuts OC at y from centre O by taking the distance of AB. XY is the prependicular drawn from ON to OC.

(iv) Draw a perpendicular line PN and draw an arc with a radius of R C and taking P as its centre.

(v) The parallels of 50, 55, 65 and 70 are marked on line P N by taking the distance of AB on both sides of standard parallel and describe the arcs from these points by taking P as a centre.

(vi) The distance of xy is marked on 60 degree (the standard parallel) for drawing meridians. Straight lines are drawn by joining them with the pole. (see fig. 2.6)

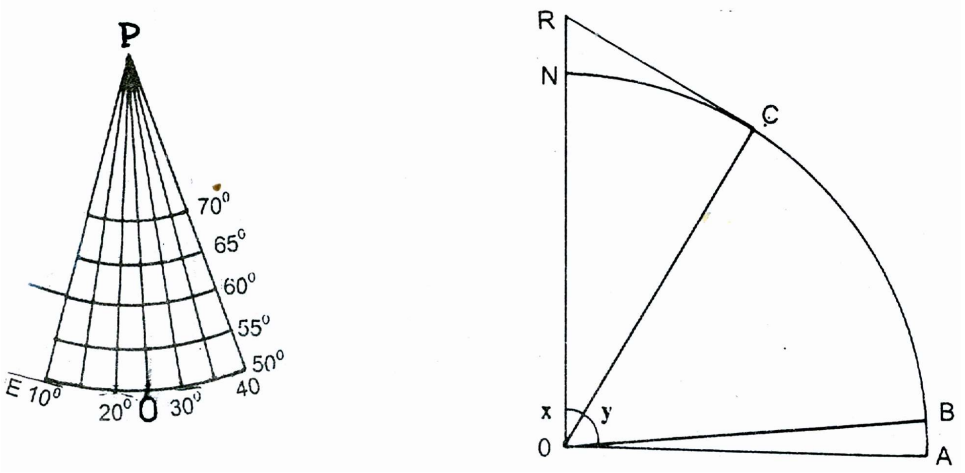


Fig. 2.6 Simple concial projection with one standard parallel

(d) ZENITHAL EQUI-DISTANT PROJECTION

In Zenithal equi-distant projection parallels are drawn at their true distances. Therefore, it is called equi-distant projection. The parallels in this projection are concentric circles. The meridians are straight lines radiating from the centre or the pole. The distance and direction of any point from the centre are correct but scale along the parallels is not correct. The projection is neither orthomorphic nor equal-area. The projection is preferred to represent the area lying between 50° to 90° latitudes. Partly it is also used to show a hemisphere.

Example

Draw a Zenithal equi-distant projection for Northern hemisphere on the scale of 1:320,000,000 at the interval of 15°. The following steps are to be followed for drawing the projection:

Calculations

Radius (R) of the reduced earth is $\frac{640,000,000}{320,000,000} = 2$ cm

The distance of each parallel along the meridian is $\frac{2\pi r \times 15°}{360}$

or $\frac{2 \times 22 \times 2}{7} \times \frac{15°}{360°} = 0.52$ cm

Setps for construction

(i) Draw a vertical line and mark six points from the centre with the distance of 0.52 cm.

(ii) Draw concentric circles from the centre for each six points, which represent parallels of latitude.

(iii) Draw straight lines from the centre with the interval of 15° which represent meridians of longitude. (see 2.7)

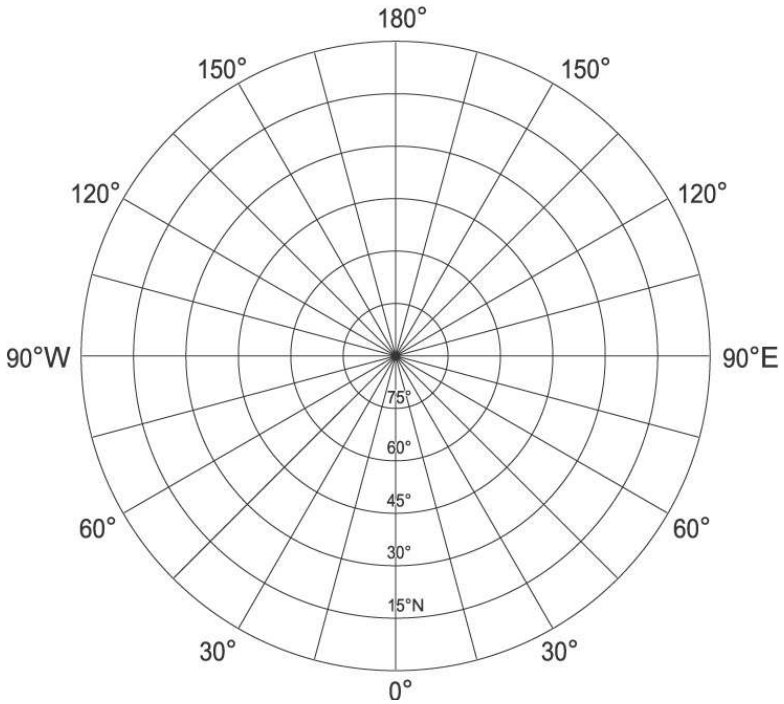


Fig. 2.7 Zenithal Equi-Distant Projection

EXERCISES FOR PRACTICAL RECORD BOOK

1. Prepare a graticule for a Cylindrical Equal-Area projection for the world on the scale of 1:160,000,000 with the interval of 15°.

2. Draw a Mercator Projection for the world on the scale of 1:2,50,000,000 at an interval of 15°.

3. Construct graticules for an area stretching between 30° N to 70° N and 40° E to 30° W on a simple conical projection with one standard parallel with a scale of 1:2,00,000,000 taking on interval of 10°.

4. Draw a Zenithal Equi-Distant Projection for the north hemisphere on the scale of 1 :2,00,000,000 at the interval of 15°.

3

INTERPRETATION OF TOPOGRAPHIC MAPS

Maps are indispensable tools in the study of geography. Various types of maps are used for different purposes. Some of these maps are drawn on a small scale and some on large scale. The main purpose of drawing maps on a very large scale is to study natural and cultural features of an area in much details. As you know, the surface of the earth is made up of a large number of relief features such as mountains, plateaus, plains, rivers, lakes, oceans etc. These relief features are best represented by models which are three-dimensional but they are very costly, heavy and cumbersome to handle. However, these difficulties are solved by representing the relief features through maps and diagrams. For representing these relief features on the maps, some specific symbols, signs and colours are used. In this lesson, we will study about these symbols, signs and colours used for representing the relief features on the maps. You will also study a given topographical map with the help of all these signs and symbols. This will provide you basis for studying other topographical maps.

OBJECTIVES

After studying this lesson, you will be able to:

- describe various methods of representing relief on a topographical map;
- interpolate contours;
- draw a cross section/profile from a contour map choosing a suitable vertical scale;
- find out the contour interval of a given topographic sheet;
- establish relationship between cultural features and relief features;
- identify different types of forest shown on the map: protected, reserve and village forest
- identify slopes : convex, concave, gentle, and steep by drawing a profile.

Notes

3.1 TOPOGRAPHICAL MAPS

Maps which represent a symbolic or conventional picture of the physical and cultural (manmade) landscape of small areas on a large scale are known as topographical maps or topo-sheets. These maps are also described as scenery maps and are based on the actual survey of the area. The scale of the map is large enough to show the physical and cultural features in detail.

The main objective of drawing these maps is to present accurately the physical and cultural features in details. One gets the knowledge of the area through the study of these maps more or less in the same way as he would have got it by visiting the area.

The topographical maps are used by various people for different purposes.

(i) A student of geography studies physical and cultural landscape of an area.

(ii) A traveller or a tourist tries to find out locations and plans his tour accordingly.

(iii) A planner studies natural and cultural resources for planning.

(iv) A defence personnel may require it to chalk out his strategy.

3.2 MARGINAL INFORMATION

Marginal information is given on the borders of the topographical sheet. The following are the marginal informations:

(i) Latitudes and longitudes covered by the topographical map,

(ii) Scale of the map,

(iii) Conventional signs and symbols,

(iv) Name of the states and districts to which the toposheet belongs,

(v) Number and name of the topographical sheet (Fig. 3.1),

(vi) Date of survey and publication,

(vii) Contour interval, and

(viii) Magnetic declination.

3.3 USE OF CONVENTIONAL SIGNS AND SYMBOLS

A map is a representation of an area of the earth's surface. It is expected to give a detailed picture. It must show all the features found within the area whether they are natural or manmade. But it will be impossible to write all the details of the area on to a map. In order to fulfill this end, various symbols and signs are used to depict physical features such as relief, drainage vegetation etc. and cultural features such as human settlements, rail and road routes, temples, churches, mosques, villages, cities, bridges etc. on the map. The main purpose of using these signs and symbols and letters is to make a toposheet informative as well as legible for easy study. These signs are called conventional signs because these have been in use for quite sometime throughout the world. So before venturing to study a toposheet, it is imperative on your part to be familiar with these signs (see fig. 3.1)

Road, metalled: according to importance: milestone.....

Road, unmetalled: according to importance: bridge.....

Cart-Track, Pack-track and pass..Foot-path with bridge.....

Bridges with piers without. Causeway, Ford of Ferry.....

Sreams:withrack in bed: undefined, Canal.....

Dams: masonry or Rockfilled earthwork. Weir/Anicut.....

River banks. shelving: steep. 10 to 19ft: over19ft.....

River dry with water channel with island & rocks. Tidel river.....

Submerged rocks. Shoal. Swamp, Reeds.....

Wells: lined, unlined Spring, Tanks:perenniel dry.....

Embankments: road or rail, tank, Broken ground.....

Railway. Broad gauge: Double/Single with station: under constrn....

Railways. other gauges: Double/Single with milestone: under constrn

Light Railway or tramway. Telegraph line. Cutting with Tunnel.....

Contours, Formlines, Rocky slopes Cliffs.....

Sand featurs;(1) flat (2)sand-hills(permanent)(3) dunes, (shifting).....

Towns or villages: inhabited: desrted Fort.....

Huts, permanent, temporary. Tower, Antiquities.....

Temple. Chhatri, Church. Mosque, Idgah, Tomb. Graves.....

Light house, Lightship, Bouys: lighted, unlighted, anchorage.....

Mine, Vine on trellis. Grass, Scrub.....

Palms, palmyra.other Plantain. Conifer. Bamboo Other trees.....

Boundary pillers surveyed. unlocated. villaget trijunction.....

Heights. triangulation: station: spot heights.....

Bench mark: .....

Post office, Telegraph office Combined PT office. Police Station.....

Bunglows:dak or travellers: inspection. Rest house.....

Circuit House. Camping ground. Forest: reserved: protected.....

Space names: administrative :locality or tribal.....

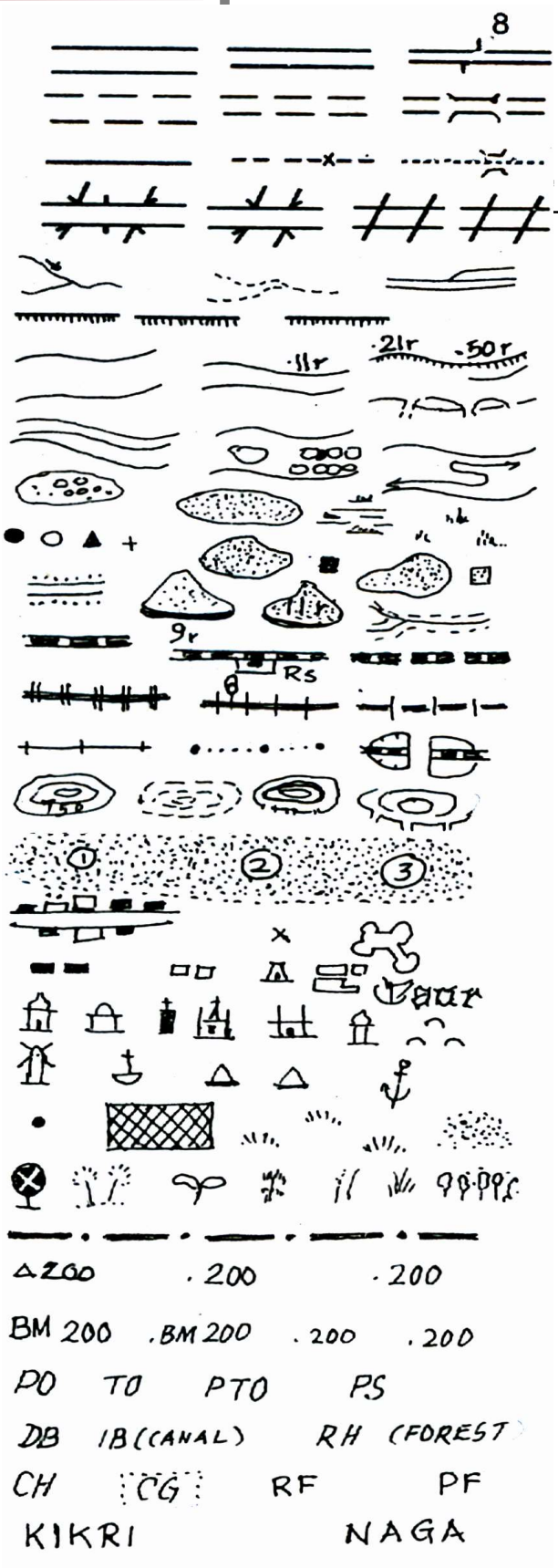


Fig. 3.1 Conventional signs and symbols used in the Topographical sheet

REFERENCE MAP OF TOPOGRAPHICAL SHEETS

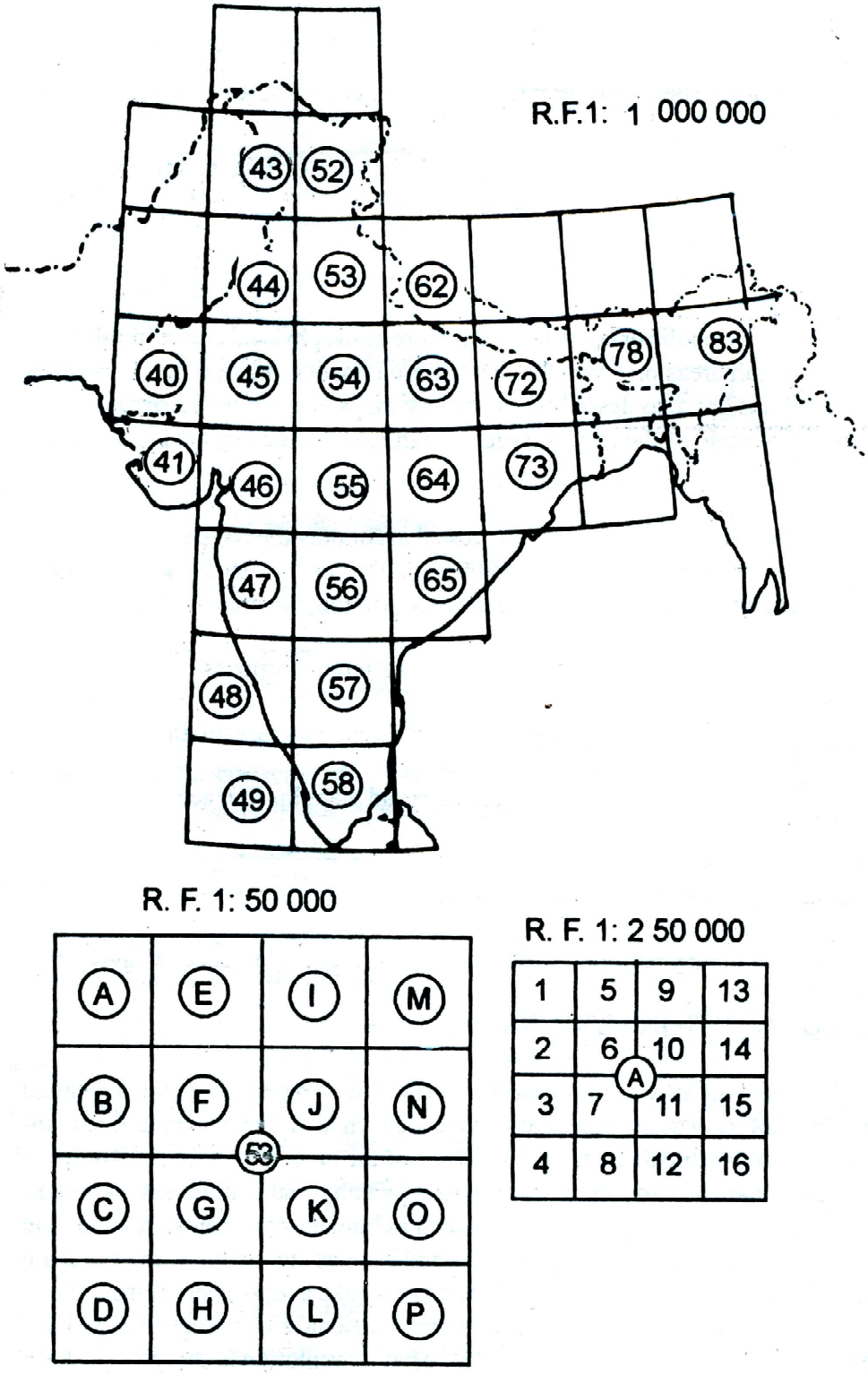


Fig. 3.2 Arrangement of Sheets

It is also imperative on your part to know the different colours by which various features are shown. These conventional colours represent the following features:

The colour	The features represented
Yellow	Area sown
Dark Green	Area under forest
Light Green	Grass lands
Brown	Contours
Blue	Water bodies
Black	Railway & power lines
Red	Roads & human settlements

3.4 METHODS OF REPRESENTING RELIEF ON MAP

Relief is the representation of the general surface variations of the ground. Relief features on a map may be represented through contours, spot heights, benchmarks, etc. Following are some techniques through which the relief features may be shown on toposheets.

1. Contouring is a technique in which all points having equal heights (from mean sea level) are joined with a smooth curve. Contours are drawn at certain intervals called contour interval. It is fixed in a given map. A contour map provides information regarding the nature of slope. Steep slopes are indicated by close contours. In the case of gentle slopes contours are placed far apart.
2. Spot-heights are exact heights of places above the mean sea level marked by dots on a map. This technique becomes more effective when it is used along with other techniques of relief representation.
3. Benchmark is a reference point which is marked on a wall of prominent buildings. On a map it is indicated by the letters B. M.
4. Triagulation points also known as triangulation stations are permanent survey points on the ground. Where points are depicted on the map with the help of a triangle (Δ) and a dot placed inside.
5. Layer colouring is a method which is used to show variable heights from mean sea level in different colours.

3.5 IDENTIFICATION OF RELIEF FEATURES ON A MAP THROUGH CONTOURS

The arrangements of contours into various shapes on a map represent a number of relief features. They may be hill, valley, escarpments etc.

The representation of some of these relief features through contours is given below.

1. **Conical hill:** A conical hill on a map is represented by a number of concentric contours at regular intervals. The value of contours increases towards the centre (Fig. 3.3)

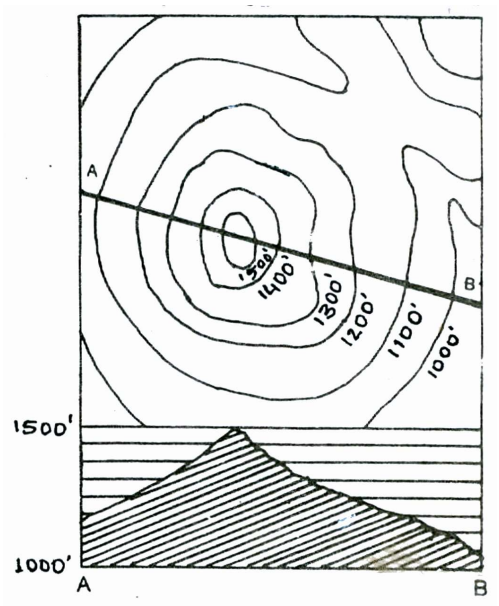


Fig. 3.3 A conical hill

2. **Plateau:** It is an upland area with steep slopes at the edge and a relatively wide flat top surface in the middle. On a map, contours are closely spaced on marginal slopes and they are absent or widely spaced on the plateau surface. The value of contours increases towards the top surface. (Fig, 3.4).

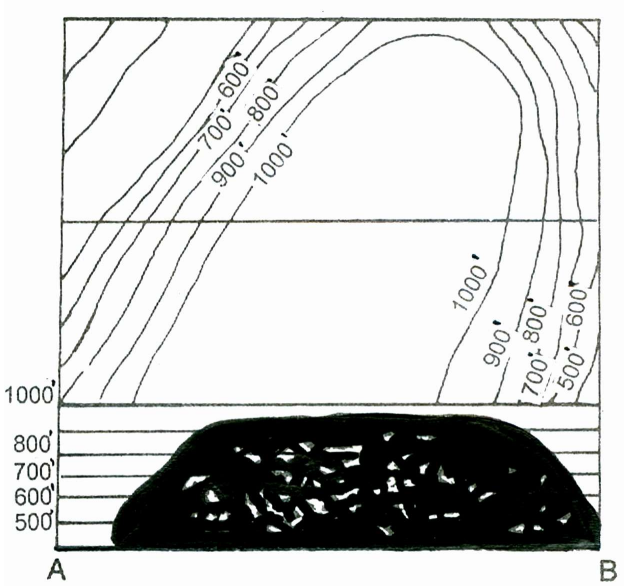


Fig. 3.4 A Plateau

3. **Ridge:** It is an elongated hill usually with a narrow width. A ridge generally

connects two and more peaks of a hill. Ridge is represented through elliptical contours on a map. (Fig. 3.5). The value of the contours decreases outwards.

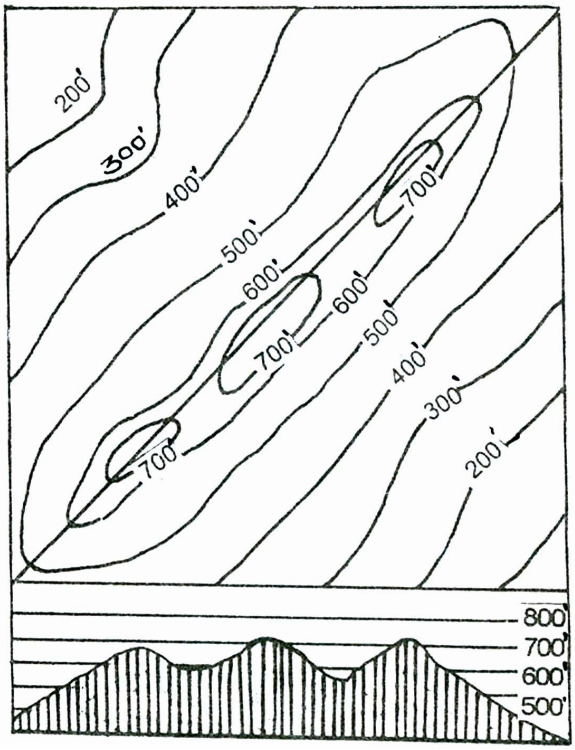


Fig. 3.5 A Ridge

4. **V-shaped valley:** It is formed by a river in its youthful stage. The shape of such valley resembles the English alphabet 'V' . Therefore, it is called V-shaped valley. On a map, it is represented by V -shaped contours with the lowest values in the inner most contour . (Fig. 3.6)

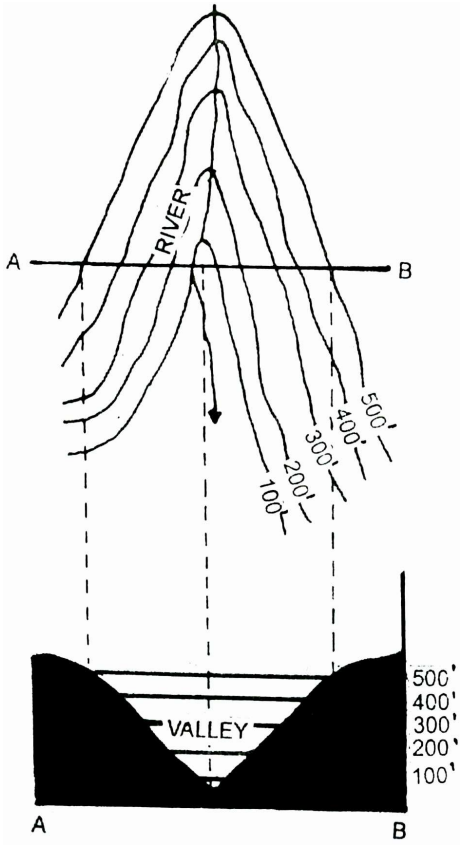


Fig. 3.6 A 'V' shaped valley

Notes

5. **Cliff:** It is an upward relief commonly seen with a sudden fall towards the sea. On a map, it is represented by contours running along the sea coast and generally merging with one another to form the face of the cliff. (Fig. 3.7)

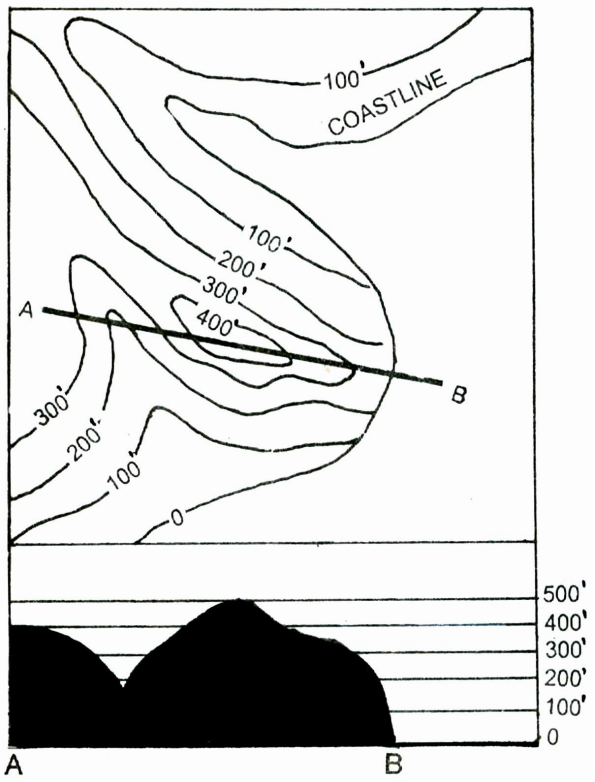


Fig. 3.7 A cliff

6. **Waterfall:** Sudden fall of a stream along a vertical slope is called a waterfall. Waterfall is represented by contours over lapping one another across the river channel (Fig. 3.8).

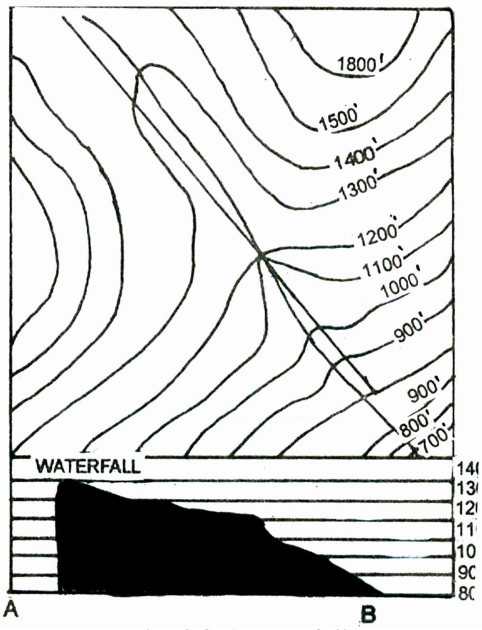


Fig. 3.8 A Waterfall

7. TYPES OF SLOPES

(a) Convex slope: It is a type of bulging slope in which the contours at the bottom are closely spaced while at the top they are widely spaced. (Fig. 3.9)

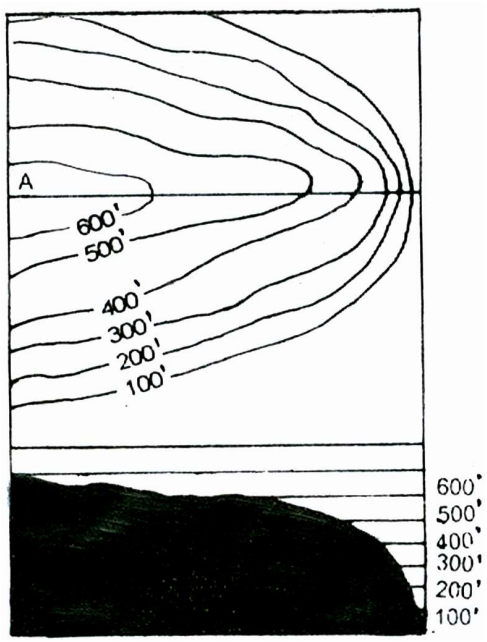


Fig. 3.9 A convex slope

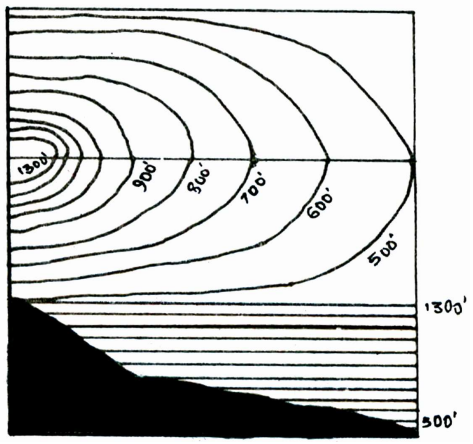


Fig. 3.10 A concave slope

(b) Concave slope: It is just opposite of convex slope in which the degree of slope is lesser at the bottom than at the top. The contours at the top are closer to one another and wider apart in lower parts. (Fig. 3.10)

(c) Gentle and steep slopes: Gentle slope is represented by wider spaced contours while steep slopes are represented by closely spaced contours. (fig. 3.11).

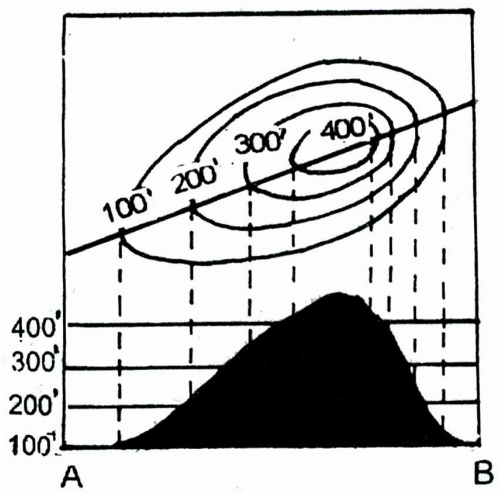


Fig. 3.11 A Gentle & Steep slope

Notes

3.6 DRAWING OF A CROSS-SECTION OR A PROFILE FROM A CONTOUR MAP

(a) Profile is an outline of relief obtained through the cross-section of a contour map. It is considered to be the easier way of showing various landforms on maps along a certain chosen line.

Following steps are needed in drawing the cross-section.

(i) Take a paper and put it on the line along which the profile is to be drawn;

(ii) Mark all the contour inter-sections along with their values.

(iii) Draw a base line equal to the line along which profile is to be drawn.

(iv) Erect a vertical line at one end of the base line and mark the chosen vertical scale on it;

(v) Transfer the contour intersecting points on the base line, errect perpendicular line at their respective base heights and join their top with the help of a curve.

(b) Horizontal equivalent and Vertical exaggeration: Horizontal equivalent (HE) is a horizontal distance between any two points at different heights projected by the perpendiculars from them at the datum of mean sea level.

Vertical exaggeration is a ratio by which vertical scale is exaggerated with reference to a horizontal scale.

3.7 INTERPRETATION OF TOPOGRAPHICAL MAPS OR TOPO-SHEETS

The interpretation of the toposheet may be taken up under the following heads:

(a) Introduction: sheet number, region, extent, scale, contour interval, date of publication etc are included under this head.

(b) Physiographic Informations: Some basic and important physiographic informations should be studied under the following heads:

(i) Relief : nature and types of landforms (mountain, plain, plateau etc), average height and general slope, important hills, valleys etc.

(ii) Drainage : important rivers and their tributaries and drainage patterns.

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

(c) Cultural lnformation: Topographical maps bear a sufficient information pertaining to cultural aspects, these include:

(i) Landuse: cultivable land, wasteland and other uses of land, means of irrigation (canal, wells, tanks etc.), occupation (fishing, forestry, cultivation).

(ii) Means of communication : railway, roadway, cart-track, post and telegraph offices, airport, seaport etc.

(iii) Settlement: urban centres, their sites and sizes, rural settlements, their types and patterns etc.

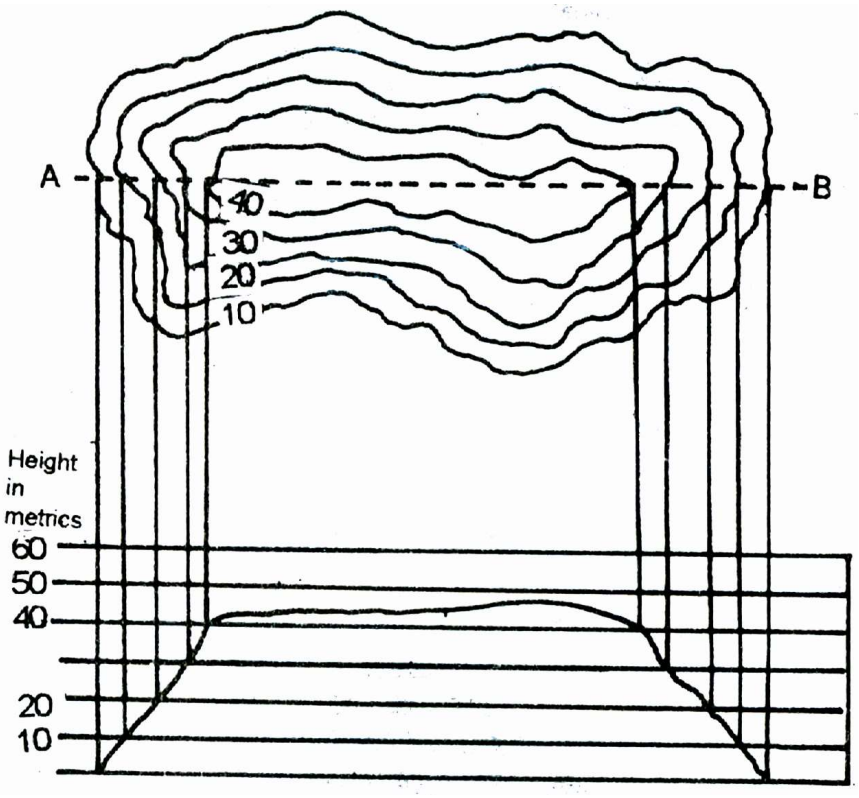


Fig. 3.12 A cross section profile

3.8 INTERPRETATION OF THE TOPOSHEET 63 K/12

1. Marginal Information

Unfold the toposheet sent to you with this lesson and see inset map given on the left hand corner, between the scale and right box of symbols at the bottom of the map. You will find that the sheet No. 63K/12 includes large part of Mirzapur district and small part of Varanasi district of Uttar Pradesh, that is why it is popularly known as Mirzapur sheet. Also, locate the number of this sheet in the map of India (Fig 3.2). This will give you an idea, where this area is located. Note the other marginal information. Read the scale and find out the area of the whole region mapped in the toposheet. It is rougly about 700 square kilometres. This region lies between 25° N to 25°15' N latitudes and 82° 30'E to 82° 45' E longitudes. So, the introduction of your interpretion should read as follows.

The sheet No 63K/12 represents a large part of Mirzapur district and some part of Varanasi district of Uttar Pradesh. The region depicted on sheet covers

Notes

an area of about 700 square kilometres. This region lies between 25° N to 25° 15' N latitudes and 82° 30' E to 82° 45' E longitudes.

2. Relief Features

The following two outstanding relief features are observed:

(i) Ganga Plain

The plain lies more or less to the north of 25° 5' North latitude and covers about two third of the region. The presence of few knolls mainly to the south of Northern Railway line makes it quite clear that the plain is flat. The average height of some of the knolls to the south of Mirzapur town is about 100 metres above sea level. The average height of the plain region is less than 100 metres above sea level, which is quite clear from the Bench Marks (BM) shown at different places. The Bench Mark near Mirzapur Railway Station is 85.6 m, near Chilh town across the Ganga, 79.3 km. Locate the Bench Marks along Northern Railway line and other places and find out the height of different places of this region.

(ii) The Plateau Region

The plateau lies to the south of 25° 5' North latitude. It is more pronounced to the south west and south central part of the toposheet as compared to south eastern part. It covers about one third of the area shown in the map. Due to erosive action of various rivers, the plateau is dissected and has undulating surface. The dividing line between the Ganga Plain and the plateau region is 100 m contour. The average height of this plateau regions is 105 m. Note the isolated flat topped and residual hills in this region.

The Dephulwa, in the extreme South Central part of the sheet with a height of 208 m. above sea level, is the highest hill. Note the height of other hills shown in this area. The contours are closely spaced. It is because of the steep slope of the plateau region toward the northern plain.

3. The Drainage

The Ganga is the main river which drains major parts of this region. It flows from west east direction and forms two loops. Many tributaries join it from south in the form of *nalas*. These tributaries are known as rivers as long as they flow in the plateau region and become *nalas* in the plain region. Note the *Harrai* river that flows through the southwestern part of this region. The famous *Tanda* Falls lie on this river. This river becomes *Jhala Nala* in the Ganga plain. Note the height of *Tanda* Falls. The *Harrai* river supply water to *Tanda Dari Tal.*

The Khajuri is another tributary of the Ganga. This is known as *Kuardari Nala* in its upper course, *Madho Nala* in the middle and *Khajuri Nala* in the lower course. Note the lower *Khajuri* dam and the tank in the north central part of the plateau region.

The Chatar Nadi is the third tributary of the Ganga. The *Pahiti, Jogladari*

and *Jamtithwa* are tributaries of the *Chatar* river which is known as *Belwan* river in its lower course. Other minor *nalas* (drains) also join the Ganga from north and south. The drainage pattern of this region will give you some idea about the direction of slope in this region.

The Ganga makes two parallel loops while flowing in a meandering course. The northern bank of the western loop is gently sloping but the southern bank is steep. The main current of the Ganga leaves the southern bank and carves out another wider north eastern loop. The river bed widens at some places upto two kilometres. It is due to the deposition on the banks of the bed.

4. The Vegetation Cover

If you observe the green patches and other symbols depicting natural vagetation, you will arrive at the conclusion that the Ganga Plain is completely devoid of natural vegetation. This is because it has been cleared off for cultivation. Only uncultivable ravines along *Chatar* and *Harrai* river have some patches of natural vegetation. The other areas under forest cover include a continuous belt of *Bar Kachha* and *Danti* Reserved Forests which cover the large parts of the plateau region. These are mixed deciduous forest of scrubs, bushes, ber and khair trees. The western part of the plateau has some clearings. This may be due to land put under cultivation or it is covered by grass. The villages are surrounded by planted trees.

5. Land Use

From the spacing of contours and gently slope, it is obvious that northern plain region is under intensive cultivation. It is also clear from the yellow colour and absence of natural vegetation in this region. Moreover, the presence of numerous villages scattered throughout this region also support this view. Some cleared patches in the southern plateau region are also cultivated. Note the distribution of villages in these patches. However, the major part of the southern plateau region is under bushy forests. Some parts are under human settlement, transport network and canals. Some land is under quarrying in the plateau region. Note the fallow land patches mainly along *nalas*.

6. Distribution of Population

A glance at the toposheet will help you to realize that the distribution of population is even in the Ganga Plain. However, the plateau region is sparsely populated. The areas under reserved forest and hills of the plateau region and the ravines of some of the rivers are very thinly populated.

7. Human Settlments

The population is mainly settled in villages and a small portion lives in four urban centres namely-Mirzapur, Vindhyachal, Khamaria and Kachhwa. The rural settlements are scattered, compact and linear in shape. Mirzapur is the most important town of this region. It is situated on the southern bank of the

Notes

Ganga on its western loop. Here the river is the narrowest. If you closely examine the map, you will understand the following facts of the site of this town.

(i) It is situated at a place along the river where it can easily be crossed because the river channel is the narrowest here and there are number of ferries on the river in the neighbourhood.

(ii) There is no danger of river flooding the town because the bank is steepest and highest towards the city.

(iii) Good navigation facilities are ensured throughout the year because the main current of the Ganga washes the southern bank.

(iv) A bridge links Mirzapur with a small town Chilh situated on the northern bank.

(v) The city is connected with other surrounding towns and cities by roads and railways network.

(vi) It is close to the southern plateau region. Thus, it is in a better position to communicate with this part also.

(vii) The town is extending in east-west direction along railway line and road running along it.

(viii) There is no possibility of settlement on the opposite bank side due to silting of river bank and absence of permanent flow of main stream of the river. The small town Chilh has developed as the terminal point of Mirzapur-Jaunpur road and North Eastern Railways. However, it has since been extended to Mirzapur Ghat railway station.

(ix) It serves as a major collecting and distributing centre of this region.

The other town Vindhyachal is situated to the west of Mirzapur at the southern bank of the Ganga. The presence of several temples here shows that the city is a religious centre. A metalled road links this town with Mirzapur. There is a facility of ferry for crossing the Ganga towards Malepur village.

Khamaria and Kachhwa are two market towns situated north of the Ganga. Khamaria is situated in the north west corner of the map. A minor metalled road links it with Jaunpur and Mirzapur towns. This town has small carpet factory. Kachhwa is situated in the north eastern part of the toposheet. It lies about two kilometers east of the Ganga. This town is linked with roads to villages and smaller towns scattered towards west, north and east.

8. Means of Transport and Communication

Note the two railways that serve this region. You will find out that North Eastern Railways (metre gauge) and Northern Railways (broad gauge) are two main lines. The former runs along the northern margin of the map from east to west. It is a part of the Varanasi–Allahabad branch of North Eastern Railways. Between Madho Singh and Mirzapur Ghat Railway Stations, a branch runs parallel to Jaunpur-Mirzapur road.

The Northern Railways passes through the heart of the region. It has four main railway stations namely Vindhyachal, Mirzapur, Jhingura and Pahara. The main line is electrified. Note that both these lines have been constructed at several places on embankment. What does it show? It shows that these railway lines pass through low lying areas experiencing floods.

You may observe all types of roads in the toposheet. The roads in the western part of the region are generally metalled. These roads radiate in all direction from Mirzapur town. Mirzapur is the focal point for all types of traffic. The following metalled roads are worth noticing–

(i) **The Great Deccan Road**: It runs toward south west from Mirzapur and connects Lal Gunj Town. It is also known as National Highway No.7.

(ii) **Mirzapur-Robertsgunj Road:** It runs toward South and is the only road crossing the plateau region of this map.

(iii) **Mirzapur-Allahabad Road:** This road runs parallel to Northern Railways. It connects Allahabad via Vindhyachal town.

(iv) **Mirzapur-Bhatauli Ghat Road:** This road links Bhatauli Ghat- a town in making along the southern bank of the Ganga towards north east. It connects Kachhwa town. Note a ferry of six boats at Bhatauli Ghat.

(v) **Mirzapur-Varanasi Road:** This road runs parallel to North Eastern Railway line and is a part of National Highway No.7.

(vi) **Mirzapur-Jaunpur Road:** It runs parallel to North Eastern Railway line and turns towards north east from Durgapur village.

(vii) **Chilh-Gopigunj Road:** It lies in the north western part of the toposheet. Now, read the map carefully and you will find some unmetalled roads. The road that connects Mirzapur with Tanda Falls on Harrai River is worth mentioning. Note that few roads are motorable only in dry season. Find out other such roads and their connection stations. You will also see cart tracks, connecting villages and roads. Note the black dotted telegraph and telephone lines and their connecting stations.

9. Means of Irrigation and Water Supply

You have already noted down the names of important tanks. The wells and the tanks are the important means of irrigation and water supply for domestic use. The wells are scattered over plain and the tanks over the plateau areas. The Tandadari Tal near Tanda Falls supplies water to Mirzapur town through a pipeline. It is the biggest tank of the region and has been constructed by an embankment across a tributary of Harrai river. The tanks located within the Barkachha reserved forest area and formed by lower Khajuri dam and other important tanks. Note network of canals that orginate from tanks. A canal, to the east of Mirzapur runs parallel to the Ganga in north south direction. This is called left lower Khajuri Canal. Other important canals include right lower Khajuri, Harrai, Amai Minor, right upper Khajuri and left upper Khajuri canals. Lift irrigation facilities are also available in the

Notes

central and eastern plain, south of the Ganga. Note the Kanaura Ghat and Sakhaura pump canals.

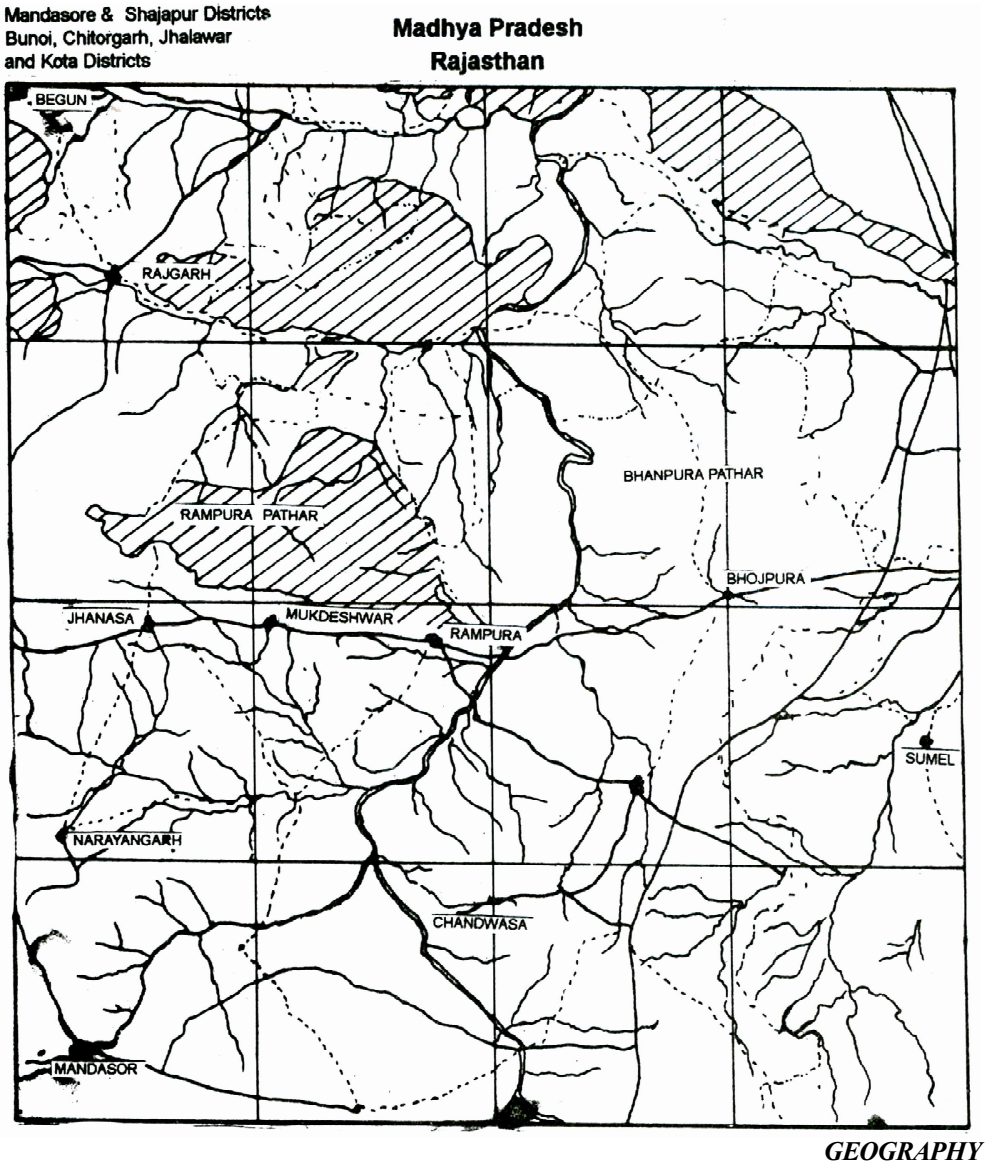
10. Human Occupations

Since the rural settlements are scattered predominantly throuhout the region, the main human occupation is agriculture. The Ganga plain provides extensive fertile cultivable lands. In the plateau region, such cultivated lands are in patches. The other occupations of plateau region are lumbering, cattle and sheep rearing and quarrying. Note the important quarries of the plateau region. Some people are also engaged in manufacturing industries such as cotton textile at Mirzapur and carpet factory at Khamaria. Tertiary occupations of this region include business, transport and communication, health, education and administration.

EXERCISE FOR PRACTICAL RECORD BOOK

Interpret the given part of a topographical map under the following heads:

(a) landforms (b) lines of communication (c) Settlements



4

STUDY OF WEATHER MAPS

You know that the word "weather" refers to the atmospheric conditions of a place at a given time. These atmospheric conditions are very important for us. We are interested to know about them in advance as these affect our day to day activities. That is why, weather forecast is an important news item, in most of the radio and television news bulletins and daily newspapers. Some leading news papers publish weather maps also. In this lesson, we will study the importance of weather forecast, various instruments used for measuring weather elements and then learn how to interpret weather maps.

OBJECTIVES

After studying this lesson, you will be able to:

- explain recording and uses of data collected from weather instruments;
- recognise various signs and symbols used in the weather maps;
- identify areas of high and low pressure in a weather map;
- recognise the steep and gentle pressure gradients in a weather map;
- establish relationship on a weather map between (a) temperature and pressure; (b) pressure and the direction of winds and (e) pressure gradient and velocity of wind;
- state the distribution of precipitation on a weather map;
- predict the possibility of precipitation/rainfall on the basis of cloud cover given on a weather map;
- interpret a weather map.

4.1 WHAT IS A WEATHER MAP?

A weather map is a symbolic representation of weather conditions of an area at a

Notes

given time. So in a weather map you will find various symbols related to temperature, pressure, direction and velocity of winds, clouds, amount of precipitation and other weather phenomena. All these weather phenomena are calculated numerically and different symbols have been provided for each weather element.

4.2 IMPORTANCE AND USES OF WEATHER MAPS

We all know that weather affects the condition and way of life of people everywhere. Hence, to know about it in advance is of universal importance. Due to the developments in the field of meteorology, the science of weather, we are in a better position to forecast weather conditions. Meteorological departments spread all over the world keep recording and exchanging with one another the data relating to weather through telecommunication networks. Artificial satellites orbiting our earth are also being used to measure and interpret weather phenomena. India is using its own satellite-INSAT-2D for this purpose.

Following are the uses of weather maps

(i) Weather maps are used in predicting weather conditions for a day, a week or a month in advance. These predictions help us to take safety measures.

(ii) Weather forecasts are also very useful to farmers, fishermen, and crew of ships.

(iii) Prediction of atmospheric conditions a few hours ahead may facilitate air flights

4.3 WEATHER INSTRUMENTS

The study of climate and weather conditions is an important aspect to the student of geography. A number of instruments are used to measure the weather elements such as temperature, humidity, pressure, wind and rainfall. Therefore, there is a need to study these instruments to understand their functions, applications and uses. A brief account of some of these instruments is given below:

(a) Thermometer

Thermometer is used to measure the temperature. It is made of a glass tube having a narrow and uniform bore. It is sealed at one end and another is fitted with a bulb. The bulb is filled with mercury or alcohol. The air is evacuated from the bore before sealing it.

Thermometer is marked with two fixed points i.e., the lowest which indicates the freezing point of water and the other is the uppermost indicating the temperature of boiling point of water. (see fig. 4.1) The difference between the boiling and freezing points is graduated into equal divisions called degrees. There are two most common types of thermometers i.e., Celcius and Fahrenheit.

Celcius Thermometer was invented by a swedish astronomer, Anders Celsius in 1742. On this thermometer 0^0C is the temperature at which water freezes

and 100^{0}C is that of boiling water. The interval of these two points (freezing and boiling) is graduated into 100 equal divisions.

Fahrenheit Thermometer was invented by a German physicist, Danial Fahrenheit in 1710. On this thermometer 32^{0}F is the freezing point and 212^0 F is the boiling point of water. The interval between them is graduated into 180 equal divisions. Thus, the difference between Celcius thermometer and Fahrenheit thermometer is 1:1.8 (1^{0}C is equal to 1.8^{0}F). The following formula is used for the conversion of Celcius to Fahrenheit and vice-versa.

(i) From Celcius to Fahrenheit (Cx(9/5))+32

(ii) From Fahrenheit to Centrigrade (5/9) (F-32)

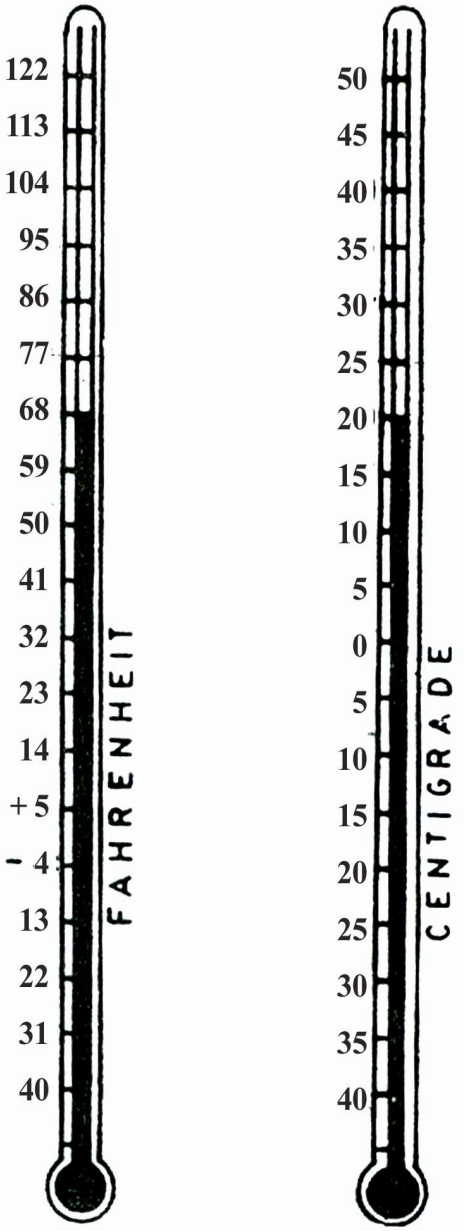
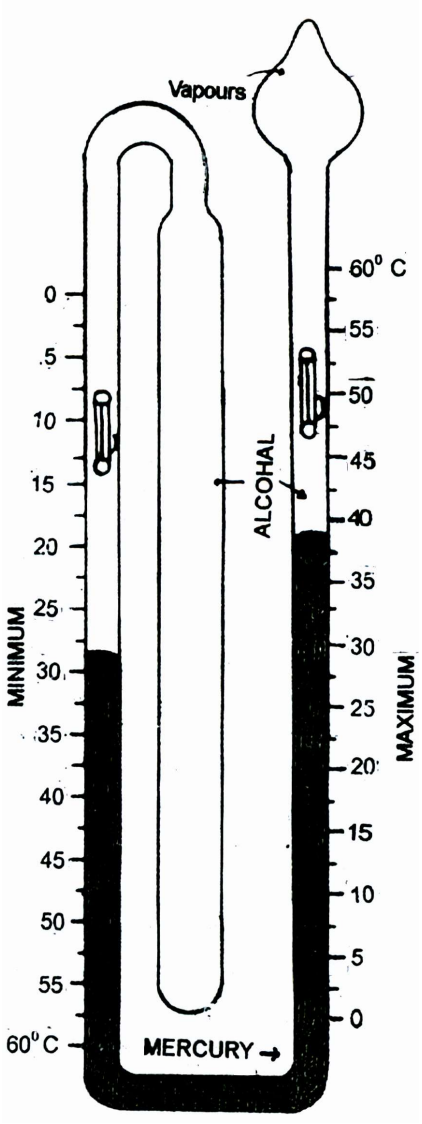


Fig. 4.1 Thermometers

(i) Maximum and Minimum Thermometer (Six's Thermometer)

It is a special type of thermometer used for measuring the maximum and minimum temperature for a given point of time. It is made of a U-shaped glass tube consisting of two bulbs on the top of both limbs. The lower part of the tube is filled with mercury and the bulbs contain alcohol and its vapour. In each limb there is a steel index on the mercury surface. Both limbs are graduated according to scale. The scale reads opposite along either limbs. Usually, the right limb reads maximum temperature on the other hand, the left limb is used to measure the minimum temperature in which reading goes on decreasing from the bottom. (see fig. 4.2). The thermometer is set by bringing the indices on the mercury surface with the help of a small horse shoe shaped magnet. As the temperature increases, the alcohol of the bulb starts expanding and pushing the mercury

in the right limb and the index is pushed upward. On the other hand, the alcohol starts contracting with a low temperature resulting in rise of mercury in the left limb. The indices of both the limbs are pushed upward in the case of increase or decrease of temperature. The lower end of each index gives correct reading of maximum and minimum temperature. The thermometer is again set for measuring the temperature for the next day by bringing down the indices to the mercury level with the help of the magnet.



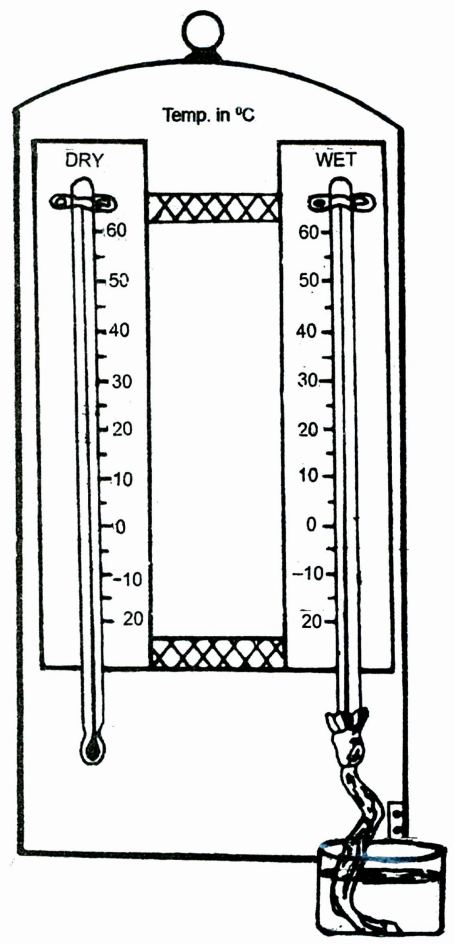


Fig. 4.2 Maximum & Minimum Thermometer *Fig. 4.3 Wet and Dry Bulb Thermometer*

(ii) Wet and Dry-Bulb Thermometer

Wet and dry-bulb thermometer is also known as hygrometer which helps to measure the humidity of the atmosphere. This instrument consists of two identical thermometers fixed to a wooden or a metal frame. The bulb of dry bulb thermometer is uncovered. This is known as dry-bulb thermometer while the bulb of other thermometer is covered with a piece of a muslin cloth. It is known as wet bulb thermometer. The muslin is kept continuously moist by dipping it into a small vessel of water (see fig. 4.3).

The temperature in the dry-bulb thermometer is not affected by the amount of water vapour available in the air and therefore, it records always more temperature than the wet-bulb thermometer. On the other hand, temperature in the wet-bulb thermometer changes according to the amount of water vapour present in the air. The difference between the readings in the wet-bulb is called wet bulb depression. If there is no depression, the air becomes saturated and the relative humidity reaches 100 per cent. The difference between wet and dry-bulb thermometers becomes small when humidity is more in the air but it becomes larger when the air is dry. The temperature of wet and dry bulb thermometers helps to find out the relative humidity with the help of a table.

(b) Barometer

It is used to measure the atmospheric pressure. There are mainly three types of barometers in use.

(i) **Mercurial Barometer** is the most accurate instrument commonly used for the measurement of pressure, and other related atmospheric phenomena. It works on the principles of balancing the column of air against column of mercury in a glass tube. The tube is sealed at one end and is filled with mercury and inverted into a cup which also contains mercury (see fig. 4.4). Under standard conditions the mercury rests at 76 cm. or 29.92 inch high in the tube at the sea level. Fluctuations in pressure will produce differences in the height of the mercury in the tube. It is measured through the scale mounted along the tube. The actual pressure is determined by adjusting the temperature, errors in the instrument and variations of gravitational force with latitude and altitude. The corrected reading is known as station pressure. The station pressure of mountains will be lower than that of valleys. The station pressure is converted to sea-level pressure in order to make a direct comparison of pressure at different altitudes.

Fig. 4.4 Mercurial Barometer

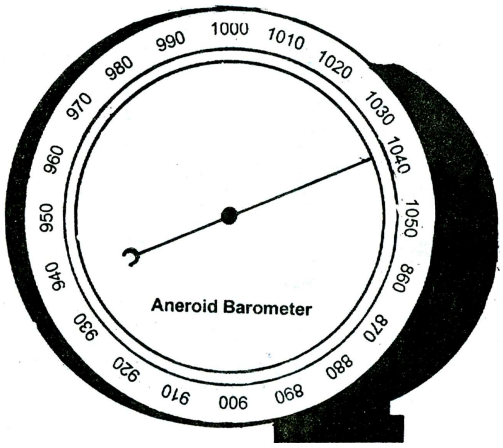


Fig. 4.5 Aneroid Barometer

If measurement is given into inch, it is necessary to convert it into millibar by multiplying it with 33.864 (because one inch of mercury exerts the pressure equal to 33.864 mb.). On an average the atmospheric pressure is about 1013.2 mb. at the mean sea-level.

(ii) Aneroid Barometer is also common in use for measuring the atmospheric pressure. Aneroid is derived from the Greek word aneros which means without liquid. It is a light and portable instrument and, therefore, it suits explorers, mountaineers, travelers, etc.

It consists of a sealed, circular and airtight metalled box. The lid of the instrument is very sensitive fitted with a spring inside the box. (see fig. 4.5). With an Increase or decrease of pressure, the lid helps in the movement of the attached pointers. There is a lever connected to the pointer indicating the readings on the graduated dial. The pointer moves in clockwise direction when the pressure increases, and it moves in the counter-clockwise direction with the decrease of pressure. Unlike mercurial barometer, the reading of aneroid barometer is not corrected for temperature. The pressure of a place

is taken directly with the help of the pointer moving on the dial. This barometer is less accurate than the mercurial barometer.

(iii) Fortin's Barometer, a sophisticated barometer is used for measuring the atmospheric pressure. It consists of a glass tube whose upper end is closed and the bottom is left open. The tube is filled with mercury and inverted into a cistern which also contains mercury. The bottom of the cistern is fitted with an adjusting screw S (see fig. 4.6). Before taking readings, the screw S is used to bring the mercury level in the cistern to a fixed point. With an increase of pressure, the level of mercury rises into the tube and it comes down when the pressure is decreased. An ivory index (I) pointing down vertically, is fixed to the cistern to indicate both the fixed point and zero of the scale together.

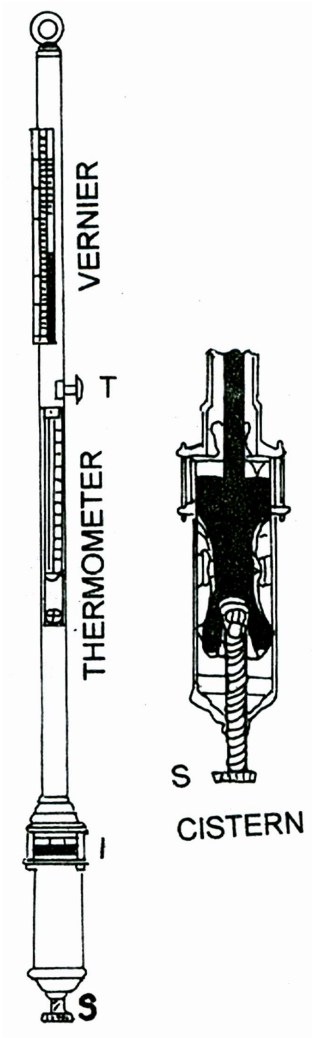


Fig. 4.6 Fortin's Barometer

The barometer is fitted in a brass container on which scale is marked. It has a slit through which mercury level in the tube can be seen clearly. There is a vernier (V) attached to a brass plate. The slit and vernier are adjusted by means of another screw (T). On the barometer, there is a thermometer attached for temperature corrections for every reading of pressure.

Two adjustments are required before setting up the instrument for reading. First, by bringing the mercury level in the cistern to touch the tip of the ivory index (I) through operating screw S and secondly, by bringing the zero of the vernier (V) to coincide with the surface of the mercury in the tube through operating the screw (T).

(c) Rain Gauge

It is an instrument used for measuring the amount of rainfall. It is cylinder-shaped usually made of metal and fitted with a funnel which directs the rain into the receiving bottle (see fig. 4.7). The standard rain gauge has a diameter of 20 cm. (8 inches) with a capacity of 60 centimetres (23 inches) of rainfall. The circumference of the base of the bottle is equal to the circumference of the funnel mouth. The funnel is fitted with 12.5 cm below the mouth

of the cylinder to avoid splashing out the water from the funnel. Thus, all the rain water accumulates into the bottle. The instrument should be placed in an open and leveled area away from trees, buildings, and other high objects to allow free and uninterrupted fall of rain drops into the rain gauge.

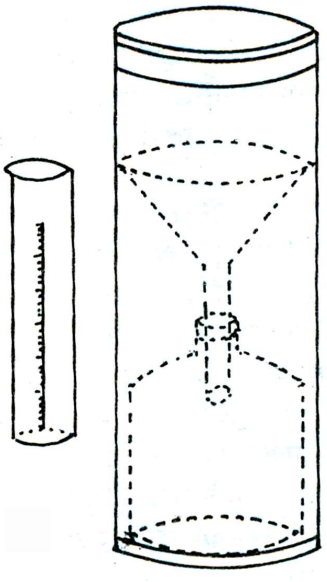


Fig. 4.7 Rain Gauge

The water collected in the bottle is measured in a measuring jar which is graduated either in millimeters or inches. The area of the measuring jar has a definite relationship with the area of the receiving bottle. For example, if the ratio is 10:1, meaning thereby 10 millimeter water in the jar represents 1 centimeter rainfall. The amount of rainfall is also measured through a thin graduated stick by inserting it into the bottle. In India, the reading is taken everyday at 8:00 a.m. which gives the amount of rainfall for the previous 24 hours.

When snowfall, hailstorm or other ice forms are expected, the funnel and receiving bottle are removed from the gauge and only the cylinder is used. A known quantity of warm water is added to the gauge for melting snow and ice. When melting is completed, the water is measured with the help of the measuring jar and the quantity of added warm water is deducted to know the actual amount of precipitation.

(d) Wind Vane

This is an instrument used for determining the wind direction. It consists of a rotating plate or a cock which is balanced on a vertical rod. It moves freely without any friction therefore, it can respond even to slight blow of wind. The plate has a pointed arrow on the one end but the other end is broad and is known as, tail. The arrow always points to the source or direction from where the wind comes and the tail to the direction to which the wind goes. The four directions (north, south, east and west) are shown below the plate to facilitate in determining the actual direction of the wind. (see fig. 4.8).

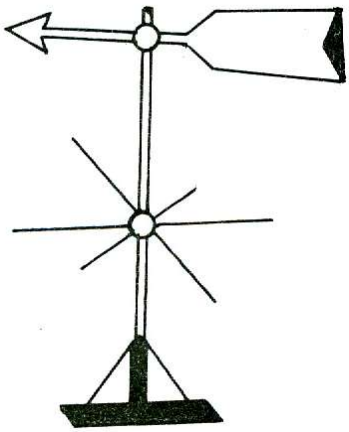


Fig. 4.8 Wind Vane

(e) Anemometer

This is an instrument used to measure the wind velocity. The most common type in use is the Robinson's cup anemometer. The instrument consists of three or four hemispherical metalled cups mounted with arms (see fig. 4.9). These cups rotate freely even with the slight movement of air and help the vertical spindle to rotate. At the bottom of the spindle there is a dial to record the velocity of the wind (kilometers, or miles or knots per hour).

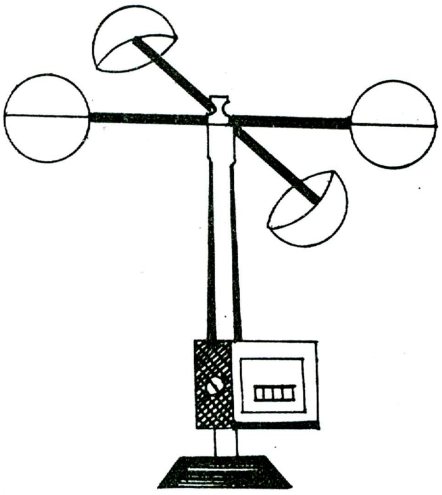


Fig. 4.9 Anemometer

4.4 WEATHER SYMBOLS

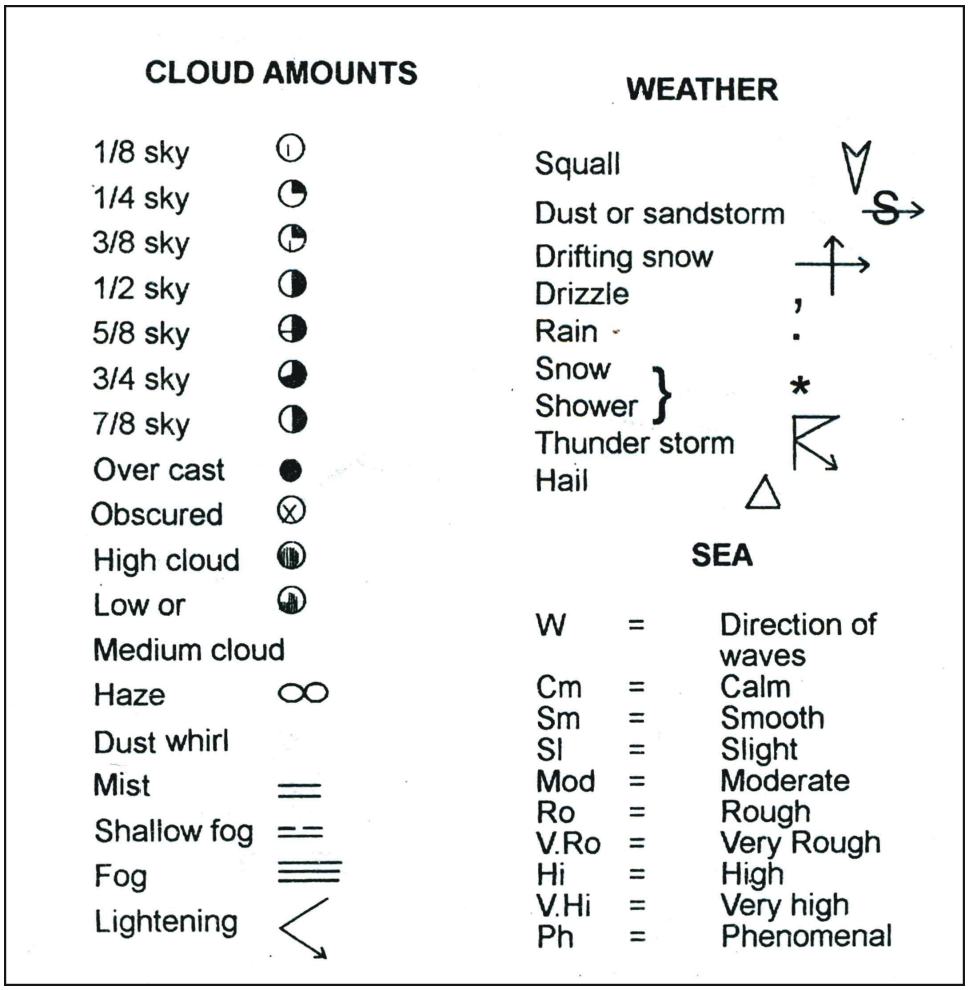


Fig. 4.10 Conventional Signs and Symbols in a weather map

As has been mentioned earlier that without signs and symbols, it would be difficult to derive information from a map. Weather maps cannot be properly understood without weather symbols. A detailed key of these symbols is generally given at the top on the top right side of every weather map. These symbols provide information regarding wind-direction and speed, rainfall, amount of cloud, other forms of precipitation, lighting, storms and sea conditions. In short, weather symbols help us to understand and to interpret weather maps.

The system of weather symbols was first devised by Admiral Beaufort in 1806. He later modified it in 1830. The same system is even now being used with a few modifications. The symbols are given below. (see fig. 4.10).

4.5 STUDY OF ISOBARIC SYSTEMS

We have studied earlier that pressure conditions are shown by isobars on a weather map. Isobars are the lines which join the places of equal atmospheric pressure converted to sea level. Different pressure conditions are depicted by different isobaric patterns on weather maps. Hence it is imperative to understand first these isobaric patterns or systems. It will train your mind to read and interpret weather maps easily and correctly. These isobaric systems are associated with different weather conditions. It is not necessary at all these isobaric systems appear in all the weather maps.

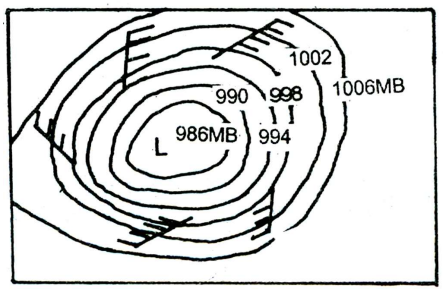


Fig. 4.11 Depression

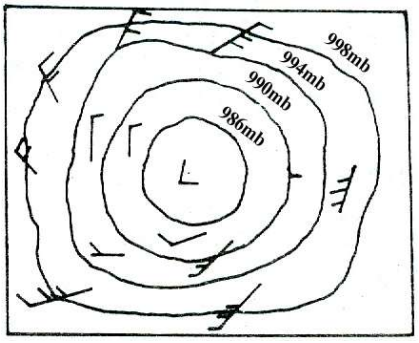


Fig. 4.12 Cyclone

(i) Depression or Cyclones

When the isobars are arranged as concentric circles or ellipses with decreasing pressure towards the centre, the system is called a depression or a cyclone. (see fig. 4.11 and 4.12*)*. The diameter of these depression varies from a few hundred kilometres to a diameter of over two thousand kilometres. The direction of winds in the depression is anti-clock wise in northern hemisphere and clockwise in southern hemisphere. These depressions are of two types shallow and deep depressions. When the

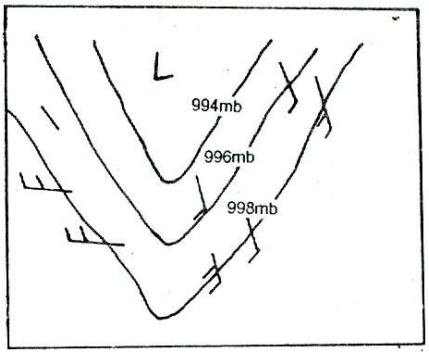


Fig. 4.13 Trough of low pressure

isobars are drawn closer to each other, it is called deep depression in tropical regions. The velocity of winds within such depression is more due to steep pressure gradient. When isobars are drawn at some distance from each other, the system is called a shallow depression or a temperate cyclone. Because of shallow pressure gradient the velocity of winds is comparatively less than in a deep-depression. Tropical cyclones are generally of smaller diameter (900 kms) than temperate cyclones or depressions (1600 to 3000 kms). Due to difference in pressure gradient the tropical cyclones are more intense than the temperate depressions.

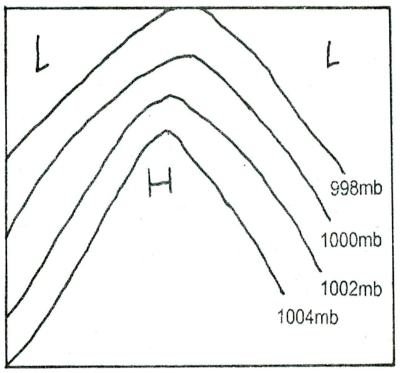


Fig. 4.14 Wedge

(ii) Trough of low pressure

When a low pressure area lies between two high pressure areas, the isobars take the form of letter "V" with low pressure within it, is called a trough of low pressure. (see fig. 4.13).

(iii) Wedge

Sometimes, a high pressure area lies between two depressions. The isobars, in such a situation resemble an inverted "V" with high pressure within it. Such an isobaric system or arrangement of isobars is called a wedge. (see fig. 4.14). The weather conditions in the front part of wedge are fine. The rear part of it is associated with cloudy and muggy weather.

(iv) Anticyclone

As the name suggests, anticyclone is a pressure system just reverse of the cyclone. The isobars are oval or circular in shape with high pressure in the centre. (see fig. 4.15). The winds blow outwardly in a clockwise direction in Northern Hemisphere and anti-clock wise in the Southern Hemisphere. The associated weather conditions with anticyclones include light winds, clear sky and at times, slight drizzle may occur. The diameter of an anticyclone is generally large and its movement is very slow. Its life is longer as compared to cyclone.

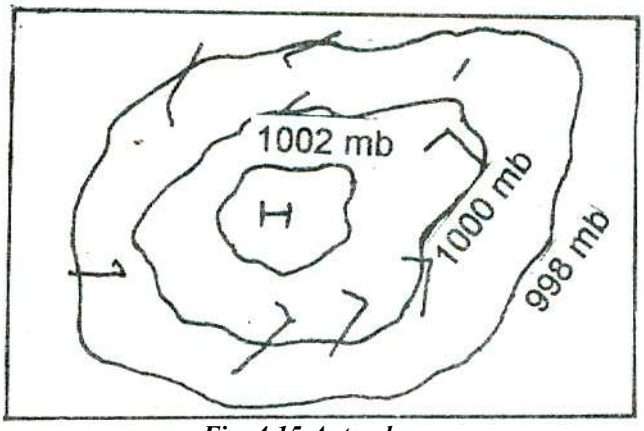


Fig. 4.15 Antycylone

(iv) Col

When the isobaric system representing a region lying between two highs and two lows gives an appearance of saddle back, called a Col. (see fig. 4.16). It is associated with light variable winds. The direction of winds depends on the intensity of the lows and highs.

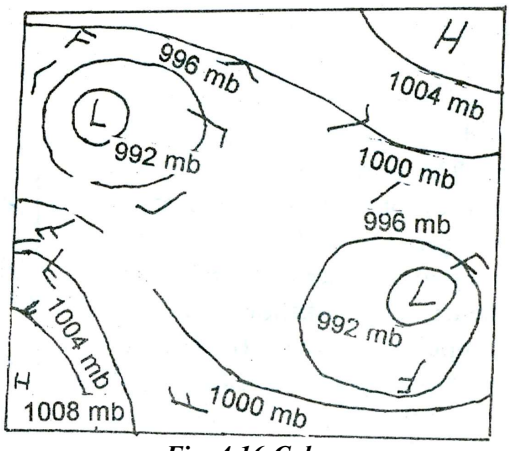


Fig. 4.16 Col

4.6 INTERPRETATION OF A WEATHER MAP

A weather map is generally interpreted under the following headings:

(i) General Information

This includes the day, date and time and the area to which the weather conditions are related. This information is printed on the top of each weather map. It also includes the scale of the map and important symbols used in showing various weather conditions.

(ii) Pressure

Pressure conditions include the interpretation of isobaric systems represented by the isobars. It also includes the studying of pressure gradient.

(iii) Wind

The wind system includes the direction and velocity of winds in relation to the distribution and spacing of isobars.

(iv) Sky Condition

This includes the nature and amount of cloud cover and other atmospheric phenomena such as haze, lightning, mist, fog and dust storms etc.

(v) Precipitation

Under this heading, general distribution of precipitation and special areas of heavy and scanty precipitation are studied.

(vi) Sea Conditions

Conditions of the sea are described as rough, smooth and calm.

Now, we are in a position to study and interpret a weather map.

Example 1

(i) General Information

Look at the weather map given overleaf. The map shows the weather conditions observed on Wednesday, 12 December, 1984 (21, Agrahayana, 1906 Saka) at 08.30 hrs. I.S.T.

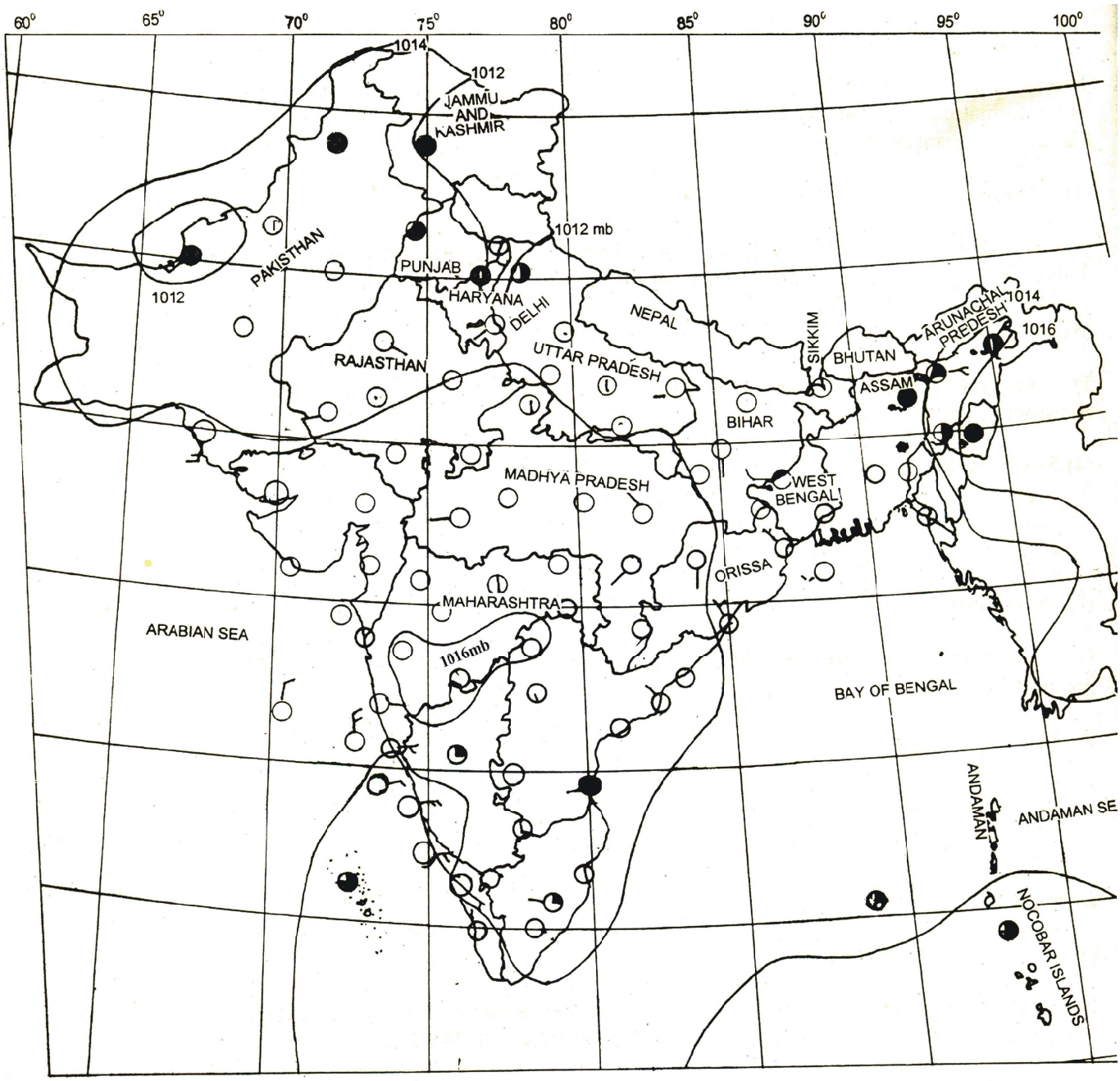


Fig. 4.17 Weather Map of 12th December 1984

(ii) Pressure Conditions

If you look at the isobars, you will see two areas of high pressure and three areas of low pressure prevailing over Indian subcontinent.

(a) Areas of High Pressure

Two areas of high pressure are well marked. One spreads over southern Maharashtra, north western Andhra Pradesh and northern part of Karnataka and it is enclosed by an isobar 1016 mb. The other area of high pressure lies in the north eastern part of the country and occupies greater part of Myanamar (Burma). This area of high pressure is also marked by an isobar of 1016 mb.

(b) Areas of Low Pressure

Three areas of low pressure are existing over the sub-continent. These low pressure areas are marked by isobar of 1012 mb. One of these low pressure occupies areas lie over Jammu and Kashmir and adjoining parts of Himachal Pradesh, Punjab, Haryana and north western Uttar Pradesh. The second low pressure area lies in the western part of Pakistan. The third area lies in the southern parts of the Bay of Bengal. It encloses parts of Nicobar Islands also.

(c) Pressure Gradient

As the isobars are widely spaced throughout the country except in north eastern part, it indicates a gentle pressure gradient in the whole country in general.

(iii) Wind

(a) Wind Direction

The general direction of winds is north east over the sea and south west over the land.

(b) Wind Velocity

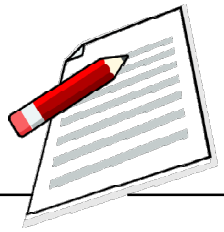
Since the gradient of pressure is gentle over most parts of the sub-continent, the velocity of wind is less than 5 knots (1 knot = 1.852 km) per hour. However, it is above 10 knots along Konkan coast, southeast of Sri Lanka and parts of Baluchistan in Pakistan. Thus, most of the areas in the country experience light breeze.

(iv) Sky Conditions

These refer to cloud cover, nature of clouds and other atmospheric phenomena.

(a) Cloud Cover

The sky is almost clear from clouds in most parts of country except in north western and north eastern states, Gujarat around Surat, Malabar and Coromandal coastal areas, interior Karnataka and Andaman and Nicobar



Islands. In these areas, the cloud cover varies from 1/ 8 to overcast sky.

(b) Other Atmospheric Phenomena

Mist is reported around Imphal and hazy weather conditions prevail in most parts of the country.

(v) Precipitation

Rain has been fairly widespread in Jammu and Kashmir, showers have also been experienced in part of Sub-Himalayan region, West Bengal, Sikkim and Himachal Pradesh. The weather remained mainly dry over the rest of the country.

(vi) Sea Conditions

The sea is normally calm and smooth. However, it is reported to be moderate in the south west of Thiruvananthapuram.

(vii) Weather Forecast

It is expected that rain or snow will be fairly widespread in Himachal Pradesh, Jammu and Kashmir and scattered in hills of Uttarakhand. Rain or thunder showers may also be isolated in Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Meghalaya, Nagaland, Manipur, Mizoram, Tripura. Sub-Himalayan region of West Bengal and Sikkim, Haryana, Punjab, Southern Tamil Nadu and South Kerala. The weather will be mainly dry over rest of India.

Example 2

You have studied weather conditions on a winter day of 1984. Now, let us take another weather map and study weather conditions on a rainy day of the same year.

(i) General Information

Look at the weather map given overleaf. The map shows the weather conditions observed and recorded on Friday, the 6th July 1984 or 15 Asadha 1906 Saka at 08.30 hrs. I.S.T.

(ii) Pressure Conditions

From the weather map it is quite clear that pressure decreases from south to north and towards north west.

(a) Areas of High Pressure

Two areas of high pressure are well marked, one lies in Arabian Sea off the Malabar Coast and the other lies south east of Nicobar Islands. Isobars of 1008 millibar and 1010 millibar mark the boundaries of these high pressure areas respectively. A weak wedge of high pressure has also developed along the western coast.

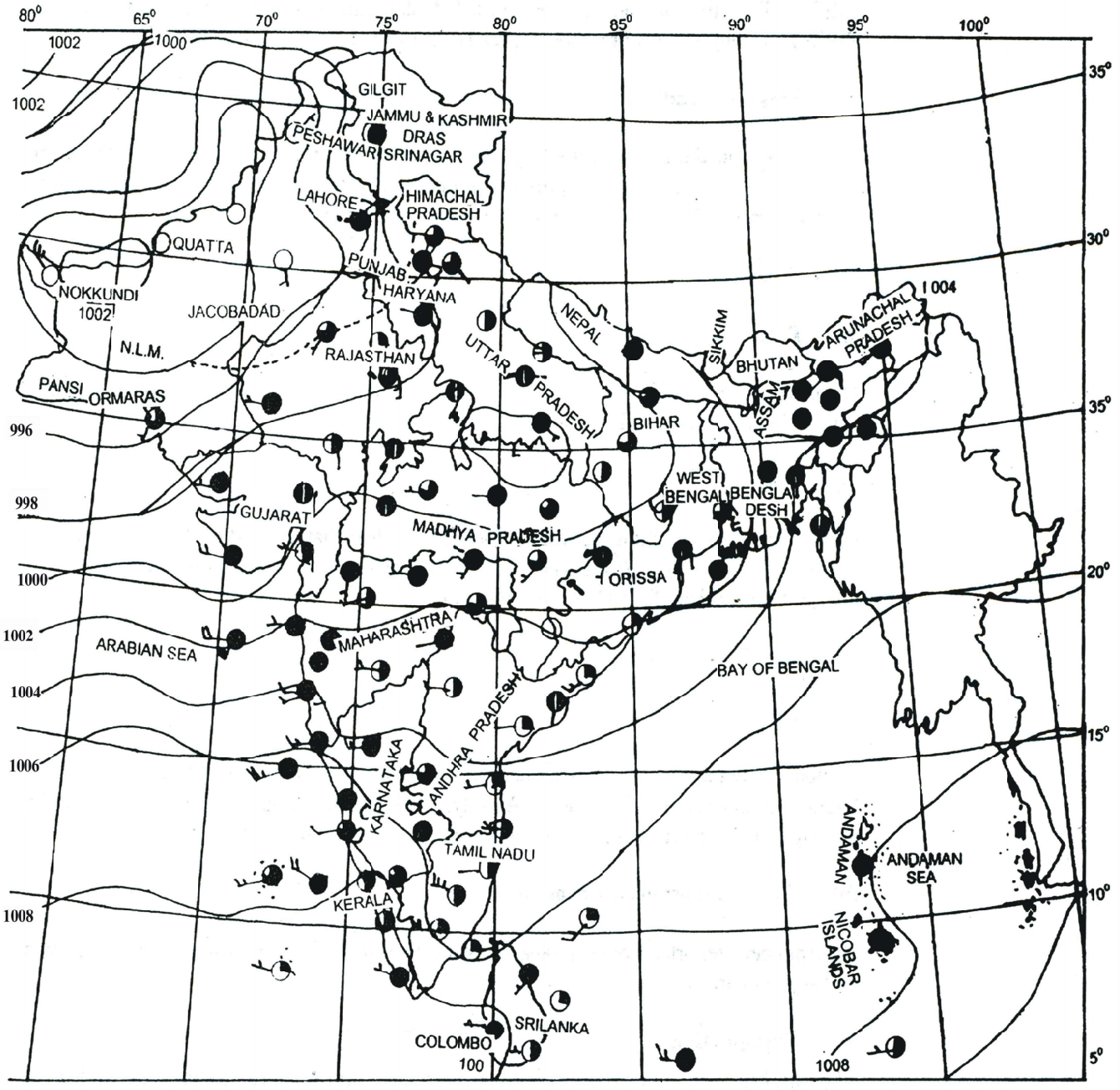
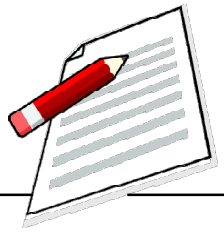


Fig. 4.18 Weather Map of 6th July 1984



(b) Areas of Low Pressure

Two areas of low pressure exist over two different parts of Indian sub-continent, one of these lies over Madhya Pradesh and adjoining Uttar Pradesh and is bounded by the isobar of 998 millibar. The other area exists over Pakistan and is bounded by the isobar of 992 millibar. A trough of low pressure is spread over most of North West India.

(c) Pressure Gradient

The isobars on the map are well spaced except on the western coast where there are comparatively closer. A gentle pressure gradient prevails over most parts of the country, Arabian Sea and West Coastal regions have moderate pressure gradient.

(iii) Wind

(a) Direction

The direction of wind is south west in most parts. However, it is easterly in upper Gangetic plains, Punjab, Himachal Pradesh and Jammu and Kashmir.

(b) Velocity

Look at the symbols showing wind velocity. It is clear that in most of northern parts, the velocity of winds is 5 to 10 knots per hour. It is however above 10 knots along western coast, interior Maharashtra, Tamil Nadu and Baluchistan.

(iv) Sky Conditions

(a) Cloud Cover

Symbols showing cloud cover ranging from 1/4 to overcast sky are distributed throughout the country. It makes quite clear that on 6th July, 1984 monsoon was active in all parts of India and vigorously active in Gujarat, Assam, Andaman Islands and parts of Punjab.

(b) Other Atmospheric Phenomena

Haze has been reported from Haryana, north and west Rajasthan and eastern Madhya Pradesh and adjacent areas.

(v) Precipitation

The rain has been widespread in north eastern parts and western coastal areas and fairly widespread in Uttarakhand, Himachal Pradesh, Madhya Pradesh, central and eastern Maharashtra, and northern Andhra Pradesh. Rain has been scattered in interior parts of central and eastern states and isolated in western, central parts of India. South West Andhra Pradesh, Rajasthan and Lakshadweep experienced dry weather. Amount of rainfall

varied from less than 1 cm to 13.9 cms (Cherrapunji). Note the rainfall of different places.

(vi) Sea Conditions

Since the winds along the eastern coast and Bay of Bengal are gentle, the sea is normally calm and smooth. However, it is moderate along Konkan coast in Arabian Sea.

(vii) Weather Forecast

It is expected that rain or thunder showers will be widespread in greater parts of the subcontinent and fairly wide spread in Andaman and Nicobar Islands, Eastern States, Gangetic Plains, Central States and coastal areas. Rains will be scattered in rest of the country.

EXERCISE FOR PRACTICAL RECORD BOOK

1. Study the given weather map of 12 Dec. 1984 and answer the following questions:

   (i) Name the two areas of high pressure

   _____

   (ii) Name the two areas of low pressure

   _____

   (iii) Which area experienced misty conditions?

   _____

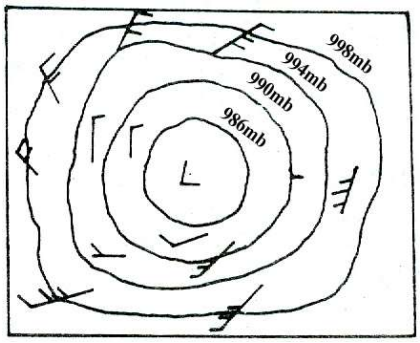
   (iv) Name an area which received rainfall.

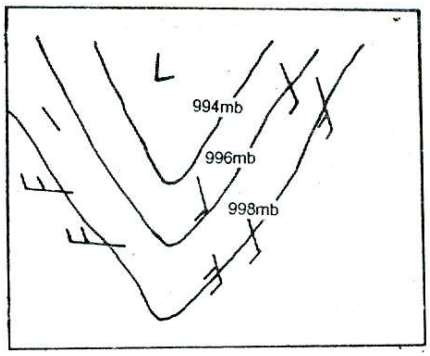
   _____

2. Show the following pressure systems with the help of isobars:

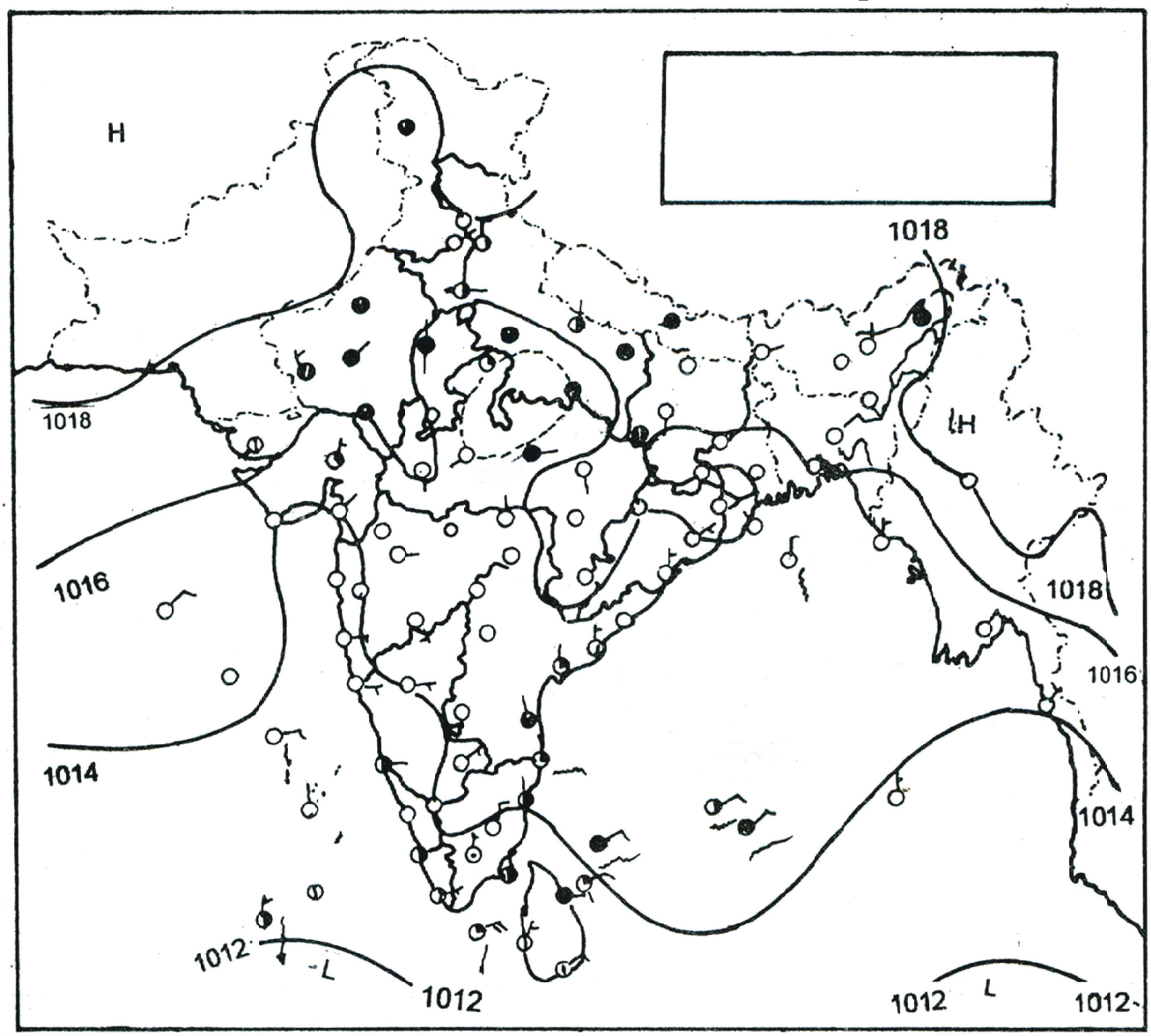
   (a) Tropical Cyclone (b) Temperate Cyclone

3. Recognise and name the following isobaric systems:

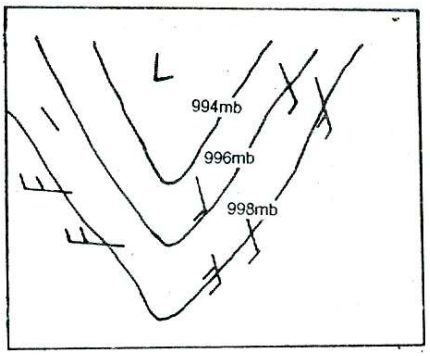


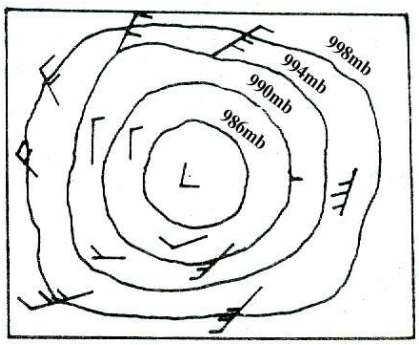


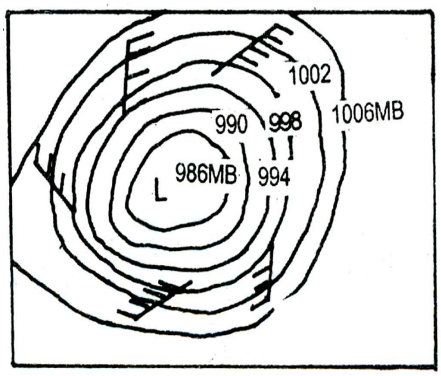
4. Study the given weather chart and find the general wind direction, cloud conditions and sea conditions.

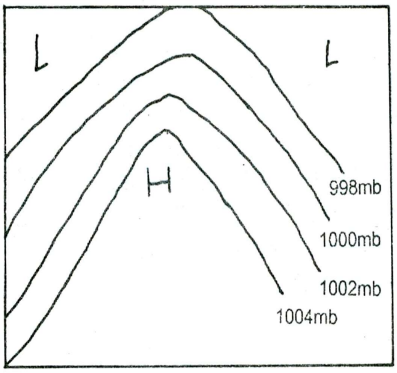


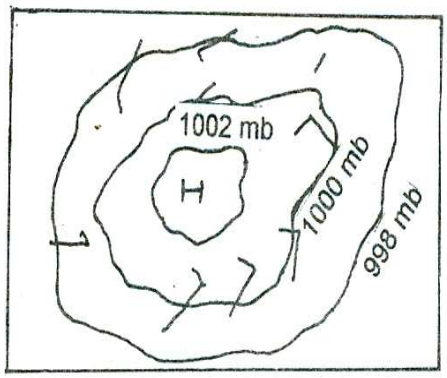
5. The map given below shows, different isobaric systems-depression, tropical cyclones, anticyclone, wedge, trough and a col. These are marked by a, b, c, d and e on the map. Recognise these pressure systems and write below-the map their appropriate names.

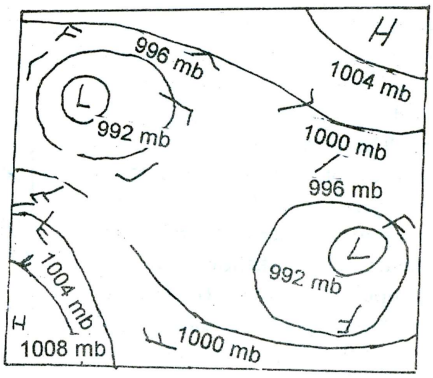


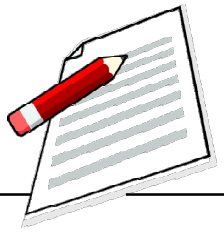












5

DATA INTERPRETATION AND STATISTICAL DIAGRAMS

In our daily life we come across different types of information through newspaper, television, computers and conversation. Some of this information is quantitative and others are qualitative, which can not be measured numerically. Statistics is concerned mainly with information that is quantitative or measured numerically. In this lesson we will study about statistical data and their representation through various types of diagrams and maps.

OBJECTIVES

After studying this lesson, you will be able to:

- distinguish between statistical information (statistical table) and diagram;
- calculate mean, median, mode and percentile;
- recognise various types of diagrams such as a line, bar, pie and star diagram and a dot map;
- construct line, bar, pie and star diagrams;
- select a suitable diagram for the given data;
- explain merits and demerits of each diagram.

5.1 STATISTICAL DATA : PRESENTATION AND INTERPRETATION

Let us take a poor man from the United States of America (USA) and a rich man from India. If the income of the Indian is higher than the income of the poor man of the USA, can we say that India is richer than the USA? Certainly not. Why? Because comparison is between two specific persons from the USA and India, which does not represent their countries so far as their individual income is

Notes

concerned. For any such comparison we have to see the income of larger population in the USA as well as in India. For this we will have to collect information about the annual income of individuals, agricultural production, industrial production, unemployment rates, total population of different areas etc. All such information will be numerical and will relate to a large number of individuals or areas. Numerical information related to the measurement of groups or masses is termed as data, (singular is datum). When information is related to an individual or event, it is not data.

In geography, statistical data play a very important role. The data gives us numerical information about geographical facts such as temperature, rainfall, agriculture/ industrial production, population, etc. We arrange them, analyse them, draw valid conclusions from them.

Source of Data

There are two sources from where data can be obtained. They are:

1. Primary source and
2. Secondary source

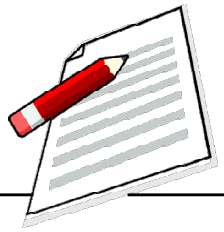
1. **Primary source:** If the data obtained through field investigation is called primary data. It is a lengthy process requiring a lot of time, money and manpower.

2. **Secondary source:** If the data are the published in the form of reports and tables prepared by various public agencies for general use is called secondary data. For the user the data from secondary sources are thus less expensive, time saving and do not require large manpower for their collection. Secondary data, however, is very general. Census of India is one of the best sources of secondary data.

5.2 PRESENTATION OF STATISTICAL DATA

The data collected through various sources needs to be processed statistically for precise explanations. Very often it becomes necessary to obtain a single representative value for the whole data set. The statistical measures that enable us to work out a single representative figure for the entire data distribution, is known as central tendency. Measures of central tendency help us to compare different distributions besides being representative for each distribution. These measures normally denote the central points of values, distance and occurrence in a distribution. The commonly used measures of central tendency are:

(i) Arithmetic mean or average
(ii) Median
(iii) Mode
(iv) Percentile



1 quintal = 100 kg

(i) Arithmetic Mean

It is most frequently used and is calculated by adding the sum of all individual values in a distribution and dividing the sum by the total number of individuals. For example, the production of rice per acre in five districts is 10, 8, 12,9 and 6 quintals. The average production of rice for these districts is :

$$\frac{10+8+12+9+6}{5} = \frac{45}{5} = 9 \text{ quintals per acre}$$

The arithmetic mean is expressed in the form of equation noted below:

$$\bar{X} = \frac{\Sigma X}{N} \qquad ...(i)$$

Where $\bar{X}$ is the mean value,

ΣX = The total of X values

N= Number of individuals/observations.

The arithmetic mean can be easily worked for small ungrouped data. However, when the number of observations are large and data is in the form of frequency distribution of groups, arithmetic mean will be worked out with the help of following equation.

$$\bar{X} = \frac{\Sigma fm}{\Sigma f} \qquad ...(ii)$$

Where $\bar{X}$ is the arithmetic mean,

f is the frequency,

m is the mid value of the classes

Example

Calculate the arithmetic mean from the temperature (in degree celsius) data given in the following table.

Table 5.1

Temperature Classes *x*	No. of days *f*	Mid values *m*	*fm*
1-05	20	3	60
06-10	24	8	192
11-15	44	13	572
16-20	72	18	1296
21-25	76	23	1748
26-30	60	28	1680
31-35	52	33	1716
36-40	4	38	152
41-45	8	43	344
	Σ f = 360 days		Σ fm=7760

From the above

$$\Sigma fm = 7760$$

$$\Sigma f = 360$$

$$\bar{X} = \frac{7760}{360} = 21.56°C \text{ temperature}$$

Merits of the Arithmetic Mean

1. It is easy to understand the complete idea of the distribution and simple to workout.
2. It is the average of the values in a distribution. Hence, it has a balancing property in case of sample surveys. Therefore, the mean is the centre of gravity.
3. It is widely used in case of normal distributions.

The arithmetic mean has certain limitations. It is affected by the extreme values especially when they are large. For example, income variations are very wide in case of Indian population.

(ii) Median

Median is the middle most positional average. It is worked out by arranging data in an ascending or descending order. For example, the value of the median is worked out by adding 1 to the number of observation and the sum divided by two. It is expressed as:

$$\text{Med} = \frac{N+1}{2} \qquad ...(iii)$$

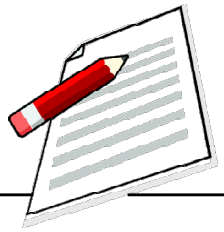
For example if we are interested in working out the median latitude and longitude for the country, we must arrange these distributions in a tabular form.

Latitudinal Extent of the Mainland of India (8'4' N to 37' 6' N)

Table 5.2

8	9	10	11	12	13	14	15	16	17
18	19	20	21	22	23	24	25	26	27
28	29	30	31	32	33	34	35	36	37

The median or middle most latitude of India is 23°N which is close to the Tropic of cancer (23° 30' N). Since mainland of India starts from 8° 4' N which is a part of 9th latitude and extends up to 37° 6' N which covers the 37° latitude completely,



hence the latitudinal coverage of India is approximately 29° latitudes. The median latitude is therefore, 23°N i.e.

$$\text{Med} = \frac{N+1}{2} = \frac{29+1}{2} = \frac{30}{2} = 15°+8°+ = 23°\text{N}$$

8° (Southern tip of India)+ 15° (median value)=23° (middle east latitude of India). Similarly, we can also workout the median value for the longitudinal extent of India. The Longitudinal Extent of India ranges between = 68°7' E to 97°25'E.

The median or middle most longitude for the country is 83°E.

Table 5.3

68	69	70	71	72	73	74	75	76	77
78	79	80	81	82	83	84	85	86	87
88	89	90	91	92	93	94	95	96	97

Longitudes are used to calculate local time, standard time of a nation and international time, which is linked to Greenwich Mean Time (GMT). Indian Standard Time is calculated keeping 82°30´E longitude as the base. The median longitude for the country is 83°E which is close to the standard meridian used for Indian Standard Time calculation.

$$\text{Med} = \frac{N+1}{2} = \frac{29+1}{2} = \frac{30}{2} = 15°+68° = 83°$$

Merits of Median

1. Being the middle most value, median remains unaffected by the extreme values in the distribution as in the case of arithmetic mean.
2. It is a partition value which divides the series into two nearly equal parts and remains the centre of gravity.
3. However, it cannot be worked out without putting data in an ascending or descending order. If data are large, it might be a time consuming and tedious job. The values of median will be erratic if one or two items are added or subtracted from the series.

(iii) Mode

It is one of the important measures of central tendency. The maximum concentration of items occurring in a distribution is known as mode. The value which occurs most frequently is identified as mode in case of ungrouped data. Similarly, for grouped data the mode can be calculated by identifying the class with the highest frequency. The mode denotes the centrality of the occurrence of an item in the distribution. The distribution of rural settlements in Uttar Pradesh is given below. Workout the mode for the data.

Table 5.4
Distribution of Rural settlements in Uttar Pradesh (2001)

Size of Rural Settlements	Very small (Below 500 Population)	Small (500-999)	Medium (1000-1999)	Large (2000-4999)	Very Large (5000 and above)
Proportion of distribution	16.70	23.45	47.96	10.60	1.29

Solution: Arrange the data in a sequence (either from small to large or from large to small). Put up the frequency values against each. Now compare the frequencies. The distribution registering maximum frequency in medium size of rural settlement (1000-1999) 47.96 is identified as 'mode'.

Merits of the Mode

1. It is the most typical value of a series. Mode can be located easily by the inspection and can be used by common people also.
2. The occurrence of a few extreme values does not affect the mode, since it is the most typical value of series.

It is, however, not a significant measure of central tendency unless the number of observations is large. Both in case of uniform as well as skewed distributions, mode ceases to be a measure of central tendency.

(iv) Percentiles

Percentile is a measure which divides a series into 100 equal parts. It helps to understand various classes or categories that constitute a distribution. It is expressed as:

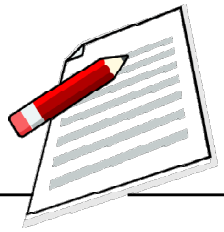
$$P = \frac{P \times N}{100} \quad \text{... (iv)}$$

Where P is the percentile and N is the number of observations.

There are 99 percentiles, P_1 P_2 ……P_{99}

Table 5.5
Distribution of Monthly Income Among Households of a locality

Income group (Rs.)	Actual Number	Percentage Distribution
Economically weaker sections (Below Rs.500)	112	56.0
Lower Income Group (500-999)	41	20.5



Middle Income Group (1000-4999)	29	14.5
High Income Group (5000 and above)	18	9.0
Total	200	100.00

Table 5.6
Distribution of Per Capita Monthly Income of the Households of a locality

Income group (Rs.)	No. of Frequency Households	Cumulative Frequency
Below 500	112	112
500-999	41	153
1000-4999	29	182
5000 and above	18	200
Total	**200**	

Let us calculate 60^{th} percentile as P_{60}.

Now $P_{60} = 60 \times 200 \div 100 = 120$

The income lies in the group 500–999.

5.3 REPRESENTATION OF STATISTICAL DATA THROUGH DIAGRAMS

The data collected either through primary source or through secondary source, are raw and unorganized form. They do not give a clear picture because some values are very large, some are low and some are in between low and high. These are all scattered values lying here and there. The data becomes clear once they are organized and put in to some systematic tabular form. Statistical tables are very handy and represent the data in a systematic and manageable form. A direct-mental comparison of such values is also possible if these are represented through diagrams.

WHY DO WE REPRESENT DATA THROUGH DIAGRAM

The below mentioned points reveals the advantages of diagrams over the raw data. The advantages are as followes:

(i) The diagram creates greater interest in the subject matter which has been represented by it.

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(ii) It clarifies and simplifies the subject matter.

(iii) They help in making quick and accurate comparison of data.

(iv) They bring out hidden facts and relationship and can stimulate analytical thinking.

(v) It is more illustrative and attractive than the statistical information

Following are important diagrams/maps through which various types of statistical data can be represented:

(i) Line graph

(ii) Bar diagram

(iii) Pie diagram

(iv) Star diagram

(i) LINE GRAPH

There are certain variables whose values fluctuate with time, like temperature of an area or rainfall etc. There are some other variables which increase or decrease with time like population, agricultural and industrial production and prices of various commodities. The data for all such variables are collected and tabulated with reference to time. If we plot such data on a graph paper in such a way that time is plotted on x-axis and values of the variables are plotted on y-axis and join the points by straight lines what we get is known as a line graph.

Example

Average monthly maximum temperature of a place 'A' is given below for 12 months. Plot the data by a line graph.

Table 5.7

Month	Jan	Feb	Mar	Apr	May	June	July	August	Sep	Oct	Nov	Dec
Temp. ^{0}C	24.5	26.6	32.2	38.1	42.5	44.3	40.4	33.4	30.2	29.7	29.2	25.0

In order to plot the given data, the most suitable diagram would be a line graph since the values of the temperature are given against months. Plot months on the x-axis and temperature on the y-axis. Keeping the temperature of various month, plot 12 points. If we join these points by straight lines as given in figure 5.1 we get the required line graph.

We observe from the table that the monthly average of maximum temperature is least in the month of January and it rises marginally in February. In March and April it increases rapidly and reaches maximum of 44.3°C in June. It remains quite hot in July also. From August onward the temperature starts declining again.

This conclusion, about the temporal variations or changes in temperature does not require any elaborate description in the presence of the line graph. Anybody looking at the linegraph given in figure 5.1 can quickly make out the picture of this cyclic variations in the temperature of the area.

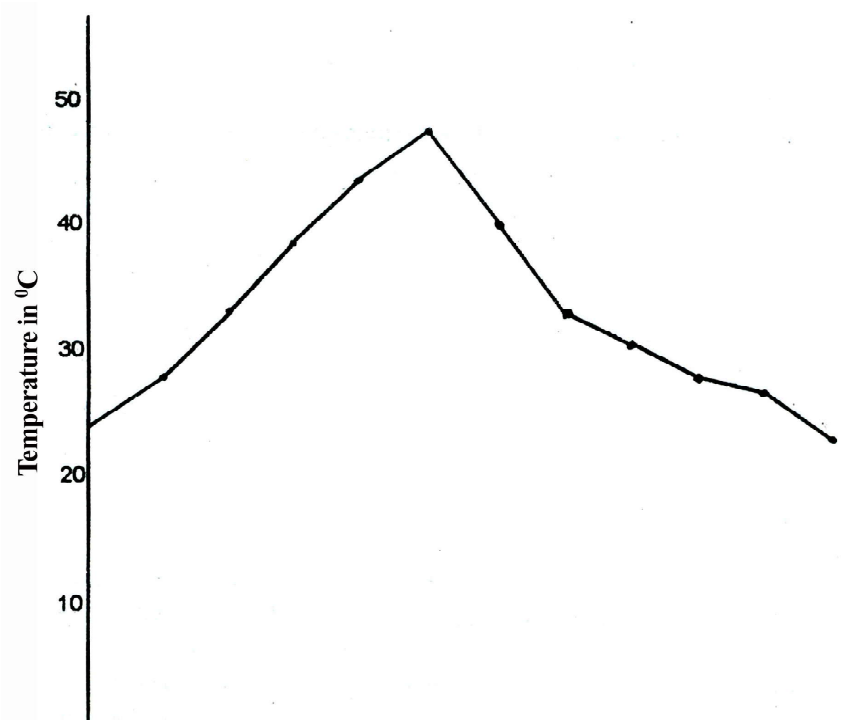


Fig. 5.1 Line Graph

Rules for making line-graph

1. Time which is an independent variable is plotted on x-axis and temperature, rainfall, production or any other variable which is varying over time is plotted on y-axis.
2. All such points obtained by plotting the values on x-axis and y-axis should be jointed with the help of straight lines.
3. Since units of both x-axis and y-axis are different, separate scales should be chosen for these. For x-axis, the time unit-could be hours, days, months, years or any other unit of time. For y-axis the unit-could be °c, cm, tonnes or any other unit.
4. Normally vertical scale should start with zero so that the absolute magnitude of the values are represented. However, if most of the variations start after some fixed value, that value may start from origin of y-axis, for example take the values 12050, 12020,12180,12200,12140, 12040, 12120……..etc. As among these values variations are found after 12000, we can take 12000 as the starting value on the y-axis.

Notes

5. In a line graph time variable in most of the cases, is at fixed intervals. It could be hours, days, months or years etc. Although this rule is not a necessary condition but is generally observed for the sake of clarity.

Characteristics of a line graph

1. It shows the past as well as the present trends in the variations of a phenomenon.
2. With the help of it the intermediate values can be estimated (interpolated) as well as future values can also be predicted (extrapolated).
3. In comparison to mathematical relationship between time and the values of a variable, the relationship shown through line graph is only approximate.
4. It occupies more space as compared to a mathematical relationship.

Compound line graph

Some times more than one variable can also be plotted on a line graph to compare their relative changes. For example, we can plot export and import figures on one graph for several years. It will give the changes in export in relation to imports. The difference between the two, will also give trade deficit. Similarly we can plot birth rates and death rates of a country for several years. The difference between the two in this case will give natural growth rate of the population. We may also plot the production of various agricultural crops to see as to which crop is maintaining upward trend and which is going downward. We can also plot the monthly maximum and minimum temperature on the same graph. Difference between the two will give monthly range of temperature.

Example

Line graph showing temporal variations in more than one variable is known as compound line graph.

The estimated Crude Birth Rate (CBR) and Crude Death Rate (CDR) of India are given below for the following years. Plot the data on a line graph.

Table 5.8

Year	1921	1931	1941	1951	1961	1971	1981	1991
CBR (per 1000)	49	47	45	43	44	42	37	30
CDR (per 1000)	49	37	33	31	26	20	15	10

The data is plotted on the graph given in figure 5.2. There are two types of lines representing two different types of population data as indicated in the table. The compound line graph of crude birth rates and crude death rates shows a decline in both during 1921-1991. However, the graph shows a steep fall in crude death

rate in relation to crude birth rate. This increasing gap is also highlighted on the graph by the shaded area between CBR and CDR.

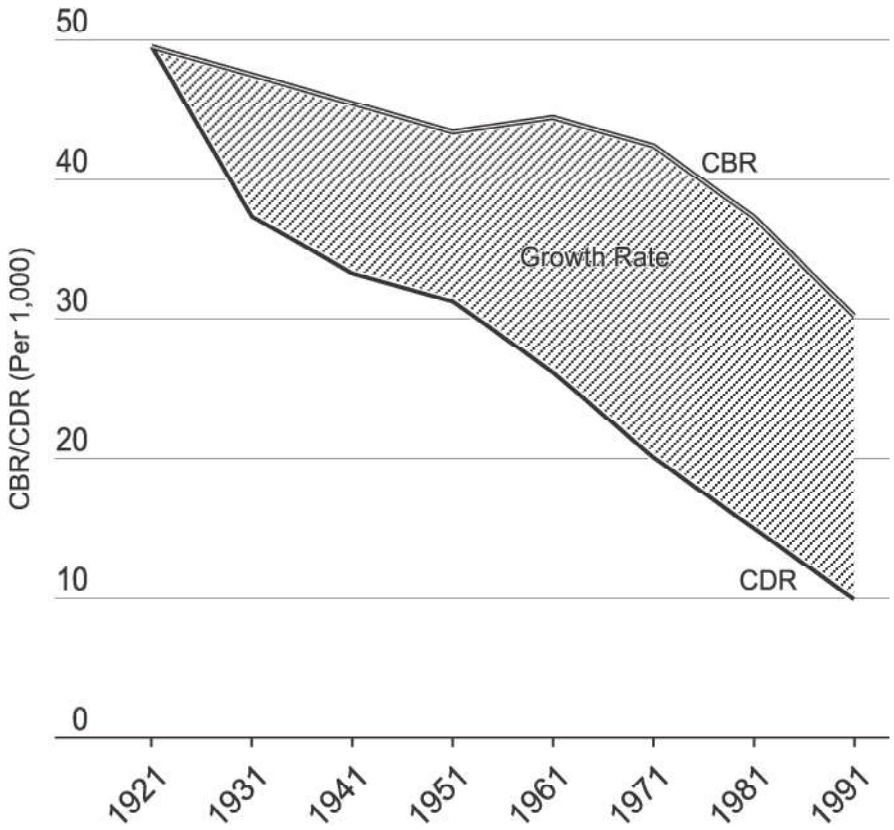


Fig. 5.2 Compound Line Graph

(ii) BAR DIAGRAM

Some times the values of a variable are given for areas, commodities or for anything other than time. In such cases these values are represented by bar diagram instead of a line graph.

How to construct a Bar Diagram

1. First of all, constant (or independent variable) data (here major parts) are shown on the 'x' axis and variable data (here tonnage) on the 'y' axis. The bars are drawn vertically.

   Three scales are assumed:

(i) Scale for width of the bars: The width of all the bars must be equal.

(ii) Scale for interval between two bars: The interval should be less than the width of the bars.

(iii) Scale for variable data : It is to be shown on 'y' axis. It should be in round

Notes

figures. The principle of selecting scales is the same as in case of line graph.

2. Now length of the bars are calculated as per the scale and the data.
3. Then points are marked and bars are drawn.
4. Labelling of the diagram is done in the same manner as is done in the line graph.

Example

Population of the major states in India is given below for 1991. Represent the graphical data using the bar diagram.

Table 5.9

Sl.No.	*State*	*Populattion (in Million)*
1.	Andhra Pradesh	66.5
2.	Assam	22.4
3.	Bihar	86.4
4.	Gujarat	41.3
5.	Haryana	16.5
6.	Himachal Pradesh	5.2
7.	Jammu & Kashmir	7.7
8.	Karnataka	45.0
9.	Kerala	29.1
10.	Madhya Pradesh	66.2
11.	Maharashtra	78.9
12.	Orissa	31.7
13.	Punjab	20.3
14.	Rajasthan	44.0
15.	Tamil Nadu	55.9
16.	Uttar Pradesh	139.1
17.	West Bengal	68.1

***Source: Census of India* 1991**

The above data is plotted on a graph paper by bar diagram as shown in (fig. 5.3). You will note that the states are plotted on x-axis in the order these are given in the table. Equal distance from one state to another state has no meaning here. It is only a nominal distance we have taken to separate anyone state from any other

state. On the y-axis, however, the height of the bars in the case of each state is in proportion to their population and it has a scale (half centimeter is equal to 10 million population).

Some time the states can be rearranged on the basis of ascending or descending order of the population size as per the convenience.

The bar diagrams discussed above are known as vertical bar-diagrams since the bars are shown vertically. We can show these bars as horizontal bars also. In that case it will be known as horizontal bar diagram. In horizontal bar diagram vertical scale i.e. y-axis, will be nominal and horizontal scale i.e. x-axis will be a numerical scale.

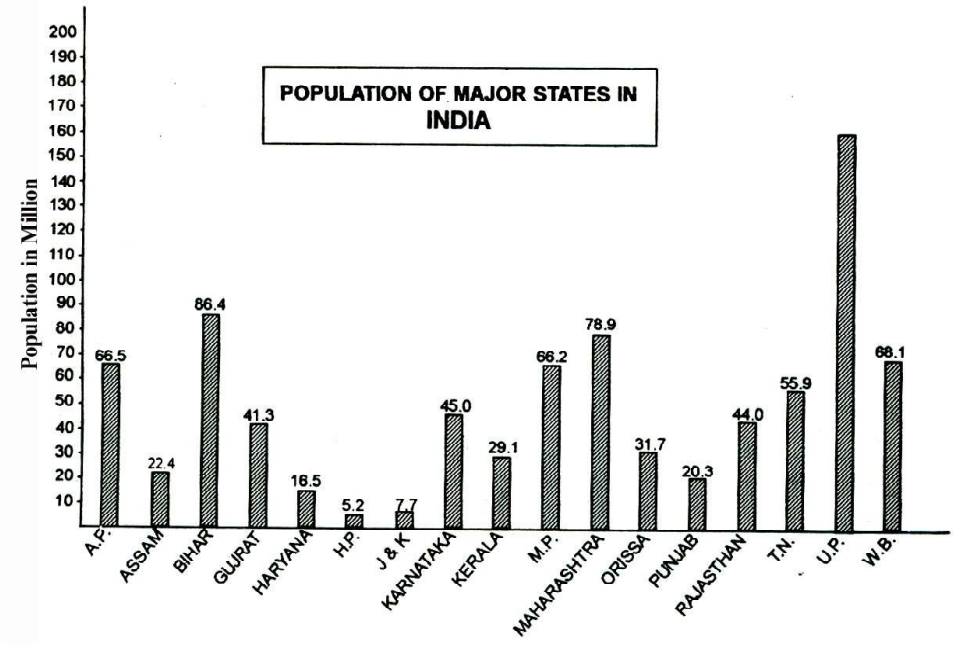


Fig. 5.3 Bar Diagram

Compound Bar Diagram

Quite often the variable being shown by the bars may consist of few different categories. These categories can also be shown on the bar itself. Such a bar diagram shows the magnitude of different values as well as share of its different categories and is known as compound bar diagram. It is also known as stacked bar diagram. In a compound bar diagram alongwith the magnitude bars also show the share of different categories of the variable which is shown by the bars.

Example

The population of the major states of India is given below with rural and urban

breakup. Plot the data on a compound bar diagram showing rural and urban break up of each state.

Table 5.10 Population (in million)

Sl.No.	State	Rural	Urban	Total
1.	Andhra Pradesh	48.6	17.9	66.5
2.	Assam	19.9	2.5	22.4
3.	Bihar	75.0	11.4	86.4
4.	Gujarat	27.1	14.2	41.3
5.	Haryana	12.4	4.1	16.5
6.	Himachal Pradesh	4.7	0.5	5.2
7.	Jammu & Kashmir	5.9	1.9	7.7
8.	Karnataka	31.1	13.9	45.0
9.	Kerala	21.4	7.7	29.1
10.	Madhya Pradesh	50.8	15.4	66.2
11.	Maharashtra	48.4	30.5	78.9
12.	Orissa	27.4	4.3	31.7
13.	Punjab	14.3	6.0	20.3
14.	Rajasthan	34.0	10.0	44.0
15.	Tamil Nadu	36.8	19.1	55.9
16.	Uttar Pradesh	111.5	27.6	139.1
17.	West Bengal	49.4	18.7	68.1

***Source: Census of India* 1991**

Construction of compound bar diagram is not very much different from the ordinary bar diagram. In the final form the bars are divided into their categories using the same scale. These categories are indicated in the index, The above data is plotted by a bar diagram and is shown in fig. 5.4.

In the present case only two categories are there. In some other cases there may be several categories. In such cases each bar will be subdivided into several categories. All these categories, however, will have to be shown in an index.

In some cases the differences in absolute values may not be as important as their

proportional distribution in different categories. In such cases the categories are converted into percentages such that these percentages add to 100. Each unit in this case therefore is represented by bar of equal size symbolising total of all the percentages as 100. Percentages of different sub categories are then shown on each bar by different sheds or colours.

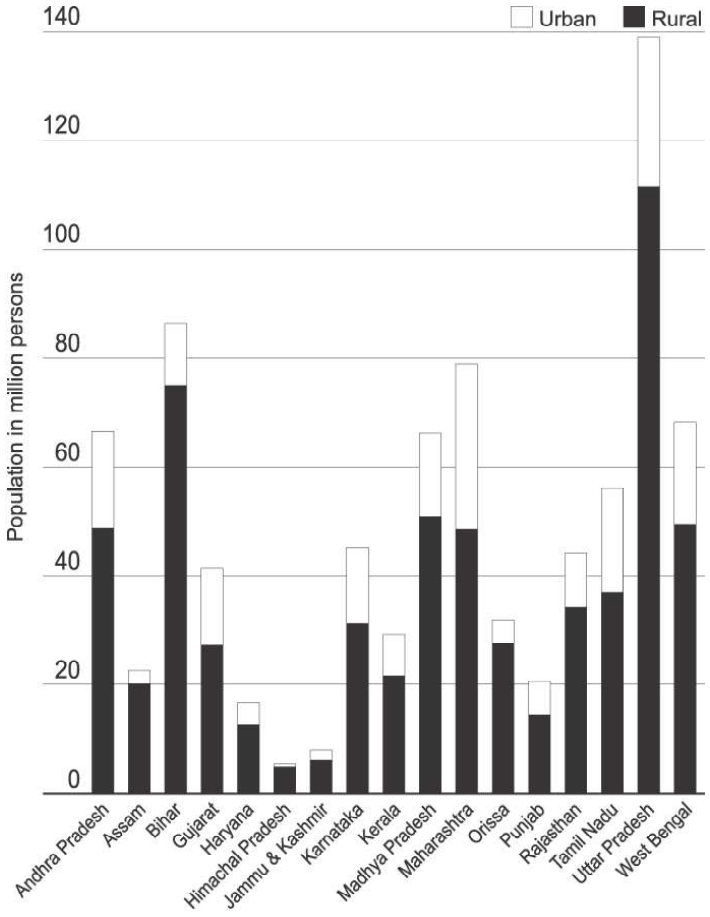


Fig. 5.4 Compound Bar Diagram

Multiple Bar diagram

Many a times it is more useful to plot sub-categories of a variable side by side. In these cases the bar of one category is placed alongwith the bars of other categories for each area. Each category is shown by a separate shade and is given in the index. The advantage of multiple bar diagram over compound bar diagram is that in this case camparision is direct. In compound bar diagram the categories are placed one over the other, whereas in multiple bar diagram these are placed side by side making comparison more direct and quicker. When there are many categories and less observations/units, multiple bar diagram is more appropriate. On the other hand, there are more observations/units and lesser categories, a compound bar diagram is always better.

Example

Electricity sold for different purposes in four states of India is given below for 1994-1995. Plot the data on multiple bar diagram and compare its use for different purposes.

Table 5.11 Electricity used (in crores kw/h) for different purposes in selected states

Sl. No.	State	Domestic Purposes	Commercial Purposes	Industrial Purposes	Other	Total
1.	Andhra Pradesh	332.0	68.3	754.9	1208.6	2363.8
2.	Bihar	73.6	42.2	637.0	219.0	971.8
3.	Maharashtra	685.3	256.5	1665.1	1481.9	4088.9
4.	Uttar Pradesh	613.3	190.5	482.7	1566.2	2552.4

***Source: Statistical Abstract of India* 1997**

Multiple bar diagram is shown in figure 5.5 there are four categories of uses of electricity there are four bars for each state-one bar for each category. The heights of these bars are proportional to their magnitude of the electricity used (in crores kw/h.)

The multiple bar-diagram given in fig 5.5 very clearly shows that in Maharashtra, Andhra Pradesh and Bihar consumption of electricity for industrial purpose is quite high and in Uttar Pradesh it is very low. The diagram also shows that consumption of electricity for domestic and commercial purpose is strikingly low, in all the four states of India.

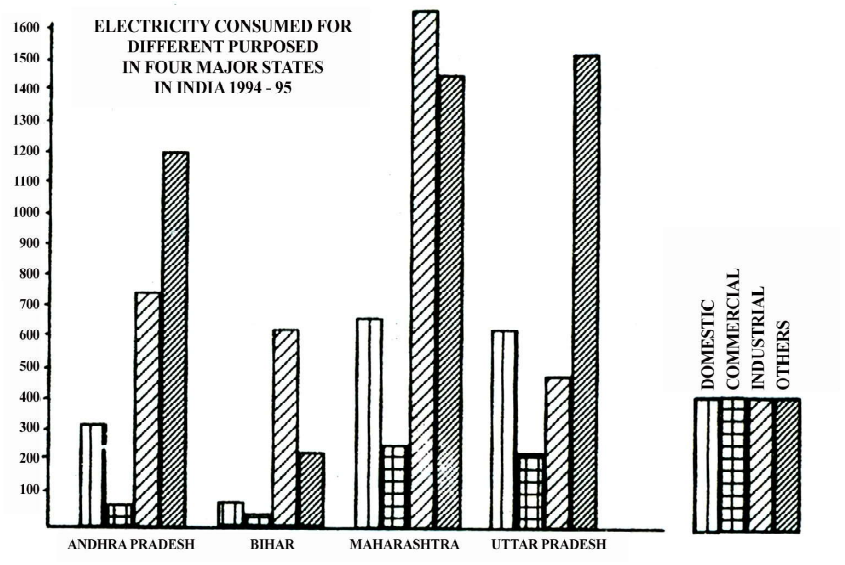


Fig.* 5.5 *Multiple Bar Diagram

Characteristics of a Bar Diagram

1. Bars give a visual comparison which is more effective than the quantitative comparison.
2. Multiple classifications are easily compared by a bar diagram, compound or a multiple bar diagram.
3. It can be shown on maps also.
4. It is easy to prepare and understand
5. For minor differences bar diagram or any other graph is not suitable because these are less accurate than numerical values.
6. It occupies more space.

(iii) PIE DIAGRAM

In a multiple bar diagram we compare categories of a variable for different areas. However, when number of categories increase further and number of observations are only a few, pie diagram is found to be more handy to represent these categories than the bar diagram. In a pie diagram each category is represented by different segments of a circle. The proportional share of each category is reflected in the area of the segment as well in the angle it makes at the centre.

In the construction of pie diagram one has to find out the angle of each category of the diagram. These angles are then drawn at the centre of a circle of suitable size. It will be observed that the proportional share of each category will be reflected in the area of the corresponding segment as well as in the angle.

The angle of each category is worked out by taking the ratio of the component value (C) to the total value (T) and multiplying it by 360 i.e. (CT)x360. In case component values are given in percentages, each percentage is multiplied by 3.60 to convert it into corresponding angles. Sum of all such angles has to be 360^0. Before making any pie diagram one should always verify this fact.

Example

Land use categories of India are given below for 1950 and 1992. Show the shift in the land use graphically with the help of a pie diagram.

Table 5.12 Land under different uses in India (in million hectare)

Year	Forrest	Non-Ag. use	Barren	Pastures	Groves	Culturable Waste	Fallow	Net Sown Area	Total
1950	40.5	9.4	38.1	6.7	19.8	22.9	28.1	118.8	284.3
1992	68.1	21.9	19.4	11.3	3.7	14.7	23.6	142.5	305.2

***Source: Statistical Abstract of India* 1997.**

The land use categories given above are converted into the angles using the method given earlier.

Year	Forrest	Non-Ag. use	Barren	Pastures	Groves	Culturable Waste	Fallow	Net Sown Area	Total
1950	51.3	11.9	48.2	8.5	25.1	29.0	35.6	150.4	360
1992	80.3	25.8	22.9	13.3	4.4	17.3	27.8	168.2	360

To explain the calculation of angles let us take area under cultivable waste in 1950 which is 22.9. Its corresponding angle would be 22.9/284.3 x 360 = 28.9975° which after rounding upto one decimal place is 29.0. Similarly the angle of the same cultivable waste in 1992 will be 14.7/305.2 x 360 = 17.3394° which after rounding up to one decimal place would be 17.3 only. Note that as has been mentioned in demerits of a bar diagram, all graphical methods are less accurate than numerical methods. Rounding, therefore, upto only one or two decimal places is sufficient. Minute differences can not be depicted on the graph effectively.

The proportional composition of land use categories given in angles are shown below in fig. 5.6.

A close look of fig 5.6 will not only show proportional composition of various land use categories but also show a change that has taken place between 1950 and 1992. Pie diagram very clearly shows that forest cover has increased quite substantially between 1950-92. Also it shows a significant increase in net area sown. The diagram on the other hand shows a decline in fallow land, culturable waste, barren land and area under groves.

If we show the categories of two different areas such that one is very high and the other is low, in absolute term the size of the circle of the pie diagram can be taken in proportion to the total size. For example if we show the land utilisation of two states like Uttar Pradesh and Haryana, the size of the circle for these states may be in proportion to their area. Rest of the procedure will remain the same. One of the pie diagrams will be larger and the other will be smaller in size. Internal division of the circle, however, will show relative position of land use in two states.

Characteristics of Pie Diagram

1. It highlights the proportional composition of a phenomenon in a better way since it uses two dimensional space, unlike bar diagram which uses only heights, length for differentiating the values.
2. When there are large number of components in compound or multiple bar diagram it becomes very difficult to show them. The pie diagram is more convenience way of handling such cases.
3. It occupied lesser space as compared to bar diagram

4. It requires more mathematical calculations

5. It is effective only when proportional comparison of a few units is to be made (say two or three). In case large number of units are to be compared, a Pie diagram may not be preferred over multiple bar diagram.

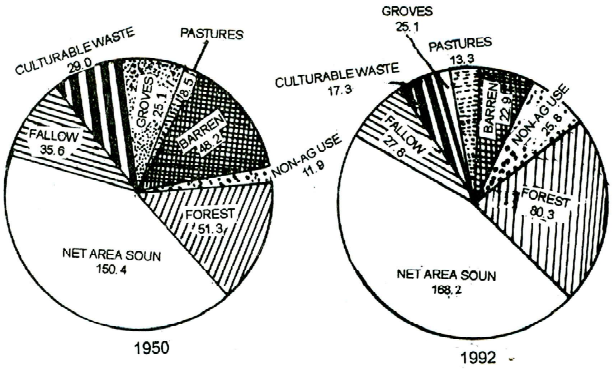


Fig. 5.6 Pie Diagram

(iv) STAR DIAGRAM

In this diagram radiating lines are drawn from a centre to represent a certain quantity or number of days etc. The length of the lines is proportional to the quantity which is to be represented. When the outer points of the lines are joined together, they give the appearance of a star. Hence, the diagram is named as a star diagram. Wind rose is a typical example of star diagrams.

Example

Construct a star diagram for the following data.

Table 5.4

Wind coming from	No. of days
North (N)	51
North East (NE)	22
East (E)	17
South East (SE)	42
South (S)	55
South West (SW)	57
West (W)	32
North West (NW)	52
Calm Days	37
Total	365

How to construct a Star Diagram

The following steps are involved in the construction of a star diagram:

(i) There are eight directions from which wind is blowing. Hence, we draw eight lines radiating from a centre indicating all the eight directions of the wind.

(ii) Now write eight directions on these lines as N, NE, E, SE, S, SW, Wand NW.

(iii) Assume a suitable scale for showing the flow of the wind from various directions keeping the size of the paper in view. Each line will depict the number of days the wind is blowing from each direction. Here the scale is 1cm = 20 Days.

On the basis of the scale, the length of the lines from Centre will be calculated as under:

$$L = D \div S$$

Where L stands for length of the line.

D stands for no. of days for which wind is blowing from a direction.

S stands for scale (here 1 cm = 20 days).

Thus the length of lines of each direction will be

N = 2.55 cm

NE = 1.1 cm

E = .85 cm

SE = 2.1 cm

S = 2.75 cm

SW = 2.87 cm

W = 1.6 cm

NW = 2.6cm

Calm = 1.85 cm

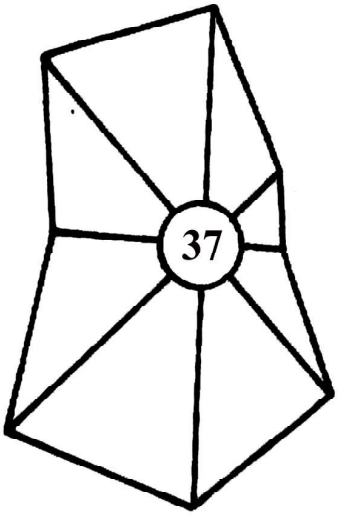
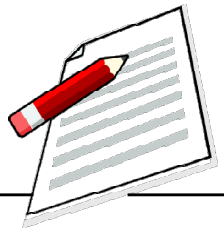


Fig. 5.7 Star Diagram

Now put points for the calculated length on each line. For the number of calm days, a circle of 1.85 cm radius will be drawn at the centre. (see fig. 5.7).

(iv) The terminal points of each line are joined together to form the star diagram.



(v) Number of calm days is written in the centre of the circle for which it has been drawn.

Characteristics of Star Diagram

1. Construction of star diagram is very simple. It does not involve any mathematical calculation, except the calculation of the length of lines.

2. Star diagrams are shown on climatological maps and pilot charts. They give us an understanding about the weather conditions (windy or calm) in an area of a region.

5.4 DISTRIBUTIONAL MAPS

Any phenomena or statistical data which pertains to an area is shown on the map. This map is said to be a distribution map. A variety of distributional maps may be prepared like distribution of soil, crops, population, density, literacy, rainfall, temperature, etc. For the preparation of a distribution map, following are needed–

1. An outline map of a region/area/administrative unit.

2. A relief map of the same area showing forested area/water body/marshes and contours.

3. Soil as well as climatic maps of the same area is required when crops are to be shown.

4. To show the distribution of population a map is needed on which at least urban centres are shown.

There may be a number of methods for showing the distribution but here only two methods dot and choropleth have been taken to discuss.

(A) DOT MAPS

A dot map provides a visual impression of relative density of phenomena with the help of dots of uniform size. It uses discrete data or absolute figures, which are later converted into certain number of dots.

The *dot* is a point symbol used to represent the spatial distribution of phenomena. A dot map employs either *mono-dot method* or *multiple-dot method* in representing the data. Here, we are concerned with mono dot method only.

In *mono-dot method,* the size of the dots is kept uniform throughout the region to be mapped. The dots in this case may be single coloured, when one phenomenon is to be shown, e.g., Population distribution by numbers; or multicoloured where more than one features of the same phenomena are mapped. For example, in a map showing distribution of tribes, dots of different colours indicate different tribes, but the size of dots is uniform all over, irrespective of the colour.

Example

Fig. 5.8 is a dot map showing population distribution in Haryana in 2001 (Table 5.15). In column 4 of the Table 5.15 we have worked out the number of dots to be placed in each district. The scale selected for the purpose is one dot representing 20,000 persons. The method of construction is elaborated in the following paragraphs.

Table 5.15 Population Distribution in Haryana, 2001

S.No	District	Number of Person	Number of Dots
1	2	3	4
1.	Ambala	1013660	51
2.	Kurukshetra	828120	41
3.	Karnal	1274843	64
4.	Jind	1189725	59
5.	Sonipat	1278830	64
6.	Panipat	967338	48
7.	Rohtak	940036	47
8.	Panchkula	469210	23
9.	Faridabad	2193276	110
10.	Gurgaon	1657669	83
11.	Mahendergarh	812022	41
12.	Bhiwani	1424554	71
13.	Hisar	1536417	77
14.	Sirsa	1111012‘	56
15.	Riwari	764727	38
16.	Kaithal	845631	47
17.	Yamuna Nagar	982369	49
18.	Fatehabad	806158	40
19.	Jhajjar	887392	44
20.	Haryana	21082989	

Source: Census of India, 2001

Construction of dot map

First of all you need a base-map of the region to be mapped and the data in

numbers. The boundaries of the individual administrative units, for which the figures are obtained are drawn in pencil or light ink. Such administrative units are called unit-areas and the value represented by each dot is the unit-value. In Example, illustrated here, 'district' is the unit-area and "20 persons per dot" is the unit-value. The preparation of dot map depends on:

(i) Careful selection of the unit-value and size of the dots;

(ii) Determination of uniform and proper size of dots;

(iii) Proper placing of the dots.

It is only after the unit-value of the dot and its proper place on the map are decided, the dots of uniform size are put within the unit-areas demarcated on the map.

(i) Selection of unit-value and size of the dots

Unit value determines the number of dots to be placed in each unit area. The first step is to examine the range of quantities involved, and then to select a value to be represented by each dot. The selected unit value is always a round number (and generally a multiple of 10). Secondly, the fractions of the actual figure are never plotted.

The unit value adopted should neither be so low that it creates difficulty in inserting dots in high density areas, nor it should be so high that the area units with low density should loose their significance. The best approach is by experimenting. Dot Map in fig. 5.8 uses the unit value of 20,000 persons per dot.

(ii) Placing of Dots

The base maps showing physical and cultural features are of great help for the placement of dots on the maps. On the basis of these the positive and negative areas should be marked first. The positve areas are the parts of the region which are favourable for the distribution of the phenomena while negative areas are the relatively unfavourable parts of the region. In population distribution maps, for instance, these negative areas are known as *non-ecumene* areas, viz. the lands unsuitable for human settlements such as deserts, swamplands, flood plains etc.

In placing the dots, care must be taken not to leave the boundary areas blank. Care must also be taken so that the dotting does not inadvertantly produce lines and clusters of dots that do not occur in reality. In fig. 5.8, dots have been placed after a careful study of the districtwise distribution of population in Rajasthan, and the physical and cultural features of the state.

Interpretation of a dot map

As the distributional patterns on the dot map are shown by dots, theoretically one

should count the number of dots in each unit area and multiply it with the unit-value assumed for one dot. The following principles should be kept in mind while interpreting a dot map:

- Divide the entire region into high, moderate and low concentration areas and describe each of them seperately.
- The areas or districts not conforming to the general pattern can be discussed as exceptional cases.
- If necessary, the facts of distribution may be supplemented by the absolute figures given in the respective table.

The above principles may, now, be used to interpret the patterns of distribution of rural population in Haryana as shown in fig. 5.8. The distribution is almost even in nature. Because of gentle variation in the data, the nodes of very high concentration do not exist on the map, but the general pattern reveals the fact clearly that the south-east region of Haryana is more crowded than the north-west part. In terms of the total number of dots, the population appears to be the highest in Faridabad district. The lowest number of rural people appears to be in Panchkula.

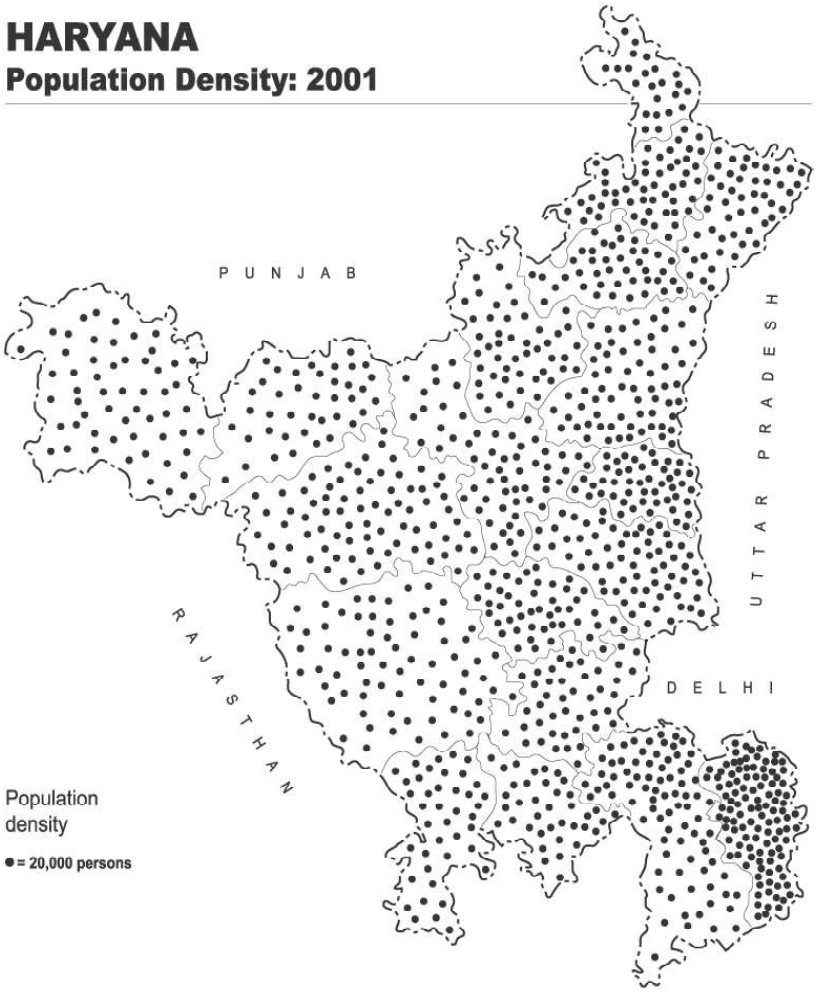


Fig. 5.8 Dot Map

Characteristics of a dotmap

1. A dot map exhibits more vivid picture of the distributional pattern.
2. It is easily commensurable.
3. A dot map may be converted into an isopleth or choropleth map, but the reverse is not possible.
4. The dot method is sometimes referred to as the "absolute method", because of the absolute ratio between quantities represented and the number of dot employed.
5. Dot maps are comparatively easier to construct. No much computation is required in determining the number of dots required.
6. The dot may not be near the place where feature to be mapped actually exists.
7. Dot method fails to show the distribution of a phenomenon having very uneven distribution.
8. Sometimes the dots coalesce in denser areas and are rarely counted. For precise information one has to turn to the basic source of data.

(B) CHOROPLETH MAP

Choropleth is a technique for representing spatial data on map in which shadings are drawn depending upon the intensity/density of information. The raw spatial data is analysied first and different categories are made. An uniform shade/colour is assigned to one category/class. The shades are selected based on certain norms. In general darker shades are allotted to higher values/density/intensity and that of lighter shades to lower values/density/intensity.

Example

Figure 5.9 is a map showing the density of population in Haryana (Table 5.16). Column III and IV show the area of districts and their population, respectively.

The density has been computed by deviding the population of a district by its respective area. Thus it is an average number of people residing in text particular district in our square km of area. The method of construction is elaborated in the following paragraphs.

Table 5.16 Population Density in Haryana, 2001

S.No. I	District II	Area (Sq.Km.) III	Population IV	Density V
1.	Ambala	1569	1013660	646
2.	Kurukshetra	1217	828120	680
3.	Karnal	2471	1274843	516

4.	Jind	2736	1189725	435
5.	Sonipat	2260	1278830	566
6.	Panipat	1250	967338	774
7.	Rohtak	1668	940036	564
8.	Panchkula	816	469210	575
9.	Faridabad	2105	2193276	1042
10.	Gurgaon	2700	1657669	614
11.	Mahendergarh	1683	812022	483
12.	Bhiwani	5140	1424554	277
13.	Hisar	3788	1536417	406
14.	Sirsa	4276	1111012	260
15.	Riwari	1559	764727	491
16.	Kaithal	2799	945631	338
17.	Yamuna Nagar	1756	982369	559
18.	Fatehabad	2491	806158	324
19.	Jhajjar	1868	887392	475
20.	Haryana	44152	21082989	478

Source : Census of India 2001

Construction of Choropleth Map

Choropleth map in the one where real information is shown, hence a map with its subdivision boundary is needed. The sub-division of map (block/district or even state) as administrative unit becomes the unit area for the construction of choropleth map.

As we know that the people live in clusters like villages, towns or cities. The distribution of population on the space surface is not uniform or continuous. The counting of heads residing in clusters are taken on the total population. If we divide the total population of a block/district by the area of a block/district it gives the density of population. A single value of an administrative boundary is an average density considered to be uniformly distributed for mapping purpose. Hence entire district is shown by that particular shade.

After getting the density/productivity/literacy they are grouped into different classes. All the administrative units falling into that class are assigned the same shading. Therefore, wherever there is greater value darker shade is used and the lighter shade is used for smaller value. In between these two ranges shades are kept in a particular order of values.

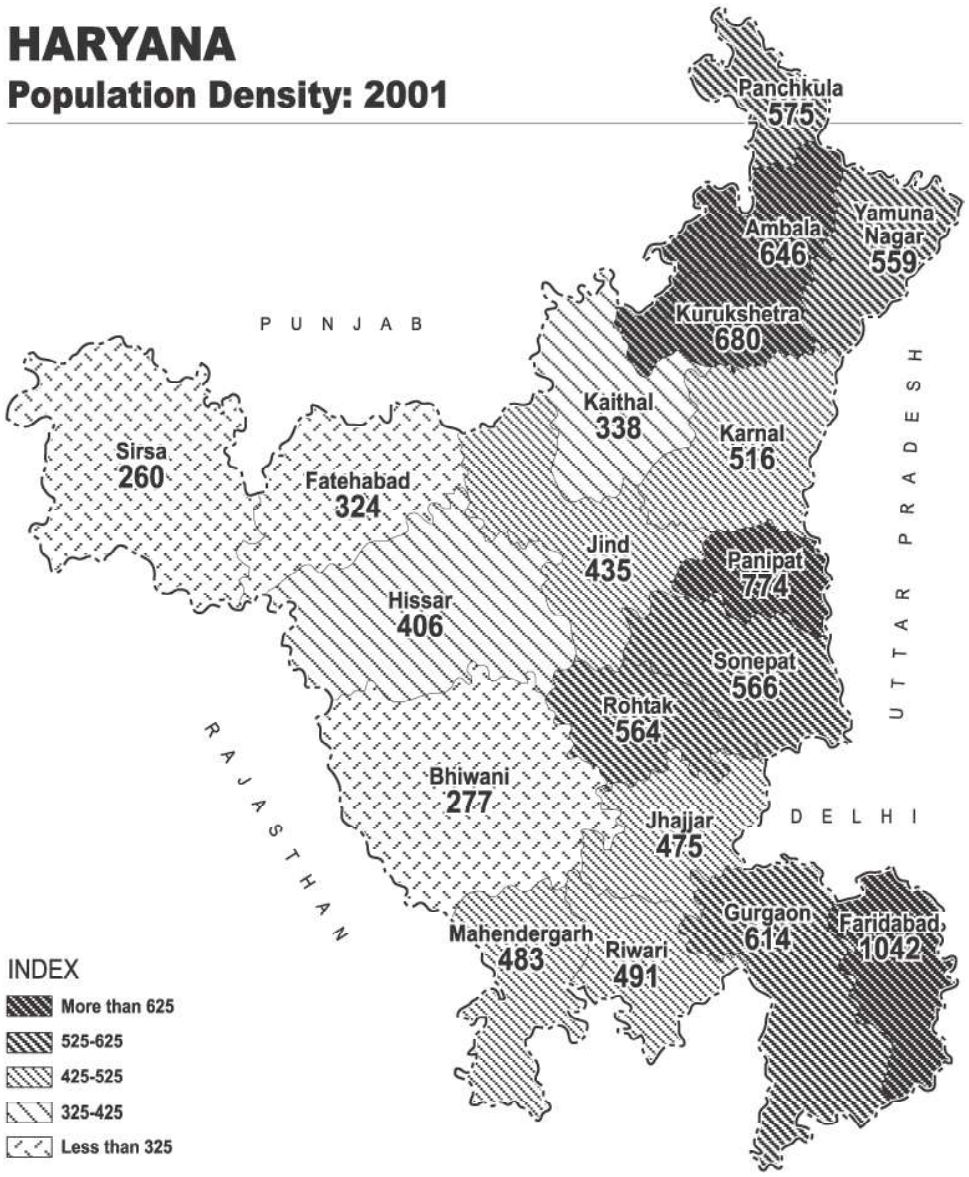


Fig. 5.9 Choropleth Map

Interpretation of choropleth map

Before making any statement about the interpretation of the choropleth map, one should always keep in mind the general pattern of shading. Pattern may be seen in terms of increasing or decreasing trend on the surface. Sometimes, a few isolated pockets of high concentration of density may be attributed due to some other favourable conditions. Hence, it may be explain in that perspective.

Just by giving a glance on the figure 5.9 it is quite clear that the higher concentration of population density is in the eastern part of Haryana. As one goes from east to

Notes

west the density decreases and to the north, west and south-west, density is the lowest. Excessively high density (1042 person per Km2) is found in Faridabad, located on the south-eastern most corner. The density map shows five categories of density concentrations; very low, low, moderate, high and very high. The minimum density (260 persons/Km2) is recorded in Bhiwani district in south western part of Haryana. The difference between the highest and lowest is the more than 750 persons/Km2. The high density districts are adjoining to the very high density districts of Haryana. The list of districts falling under different density categories are as follow –

Very High Density – Faridabad, Panipat, Kurukshatra and Ambala;

High Density – Gurgaon, Panchkula, Sonipat, Rohtak and Yamuna Nagar;

Moderate Density – Karnal, Riwari, Mahendergarh, Jhajjar and Jind;

Low Density – Hissar and Kaithel;

Very low Density – Fatehabad, Bhiwani and Sirsa.

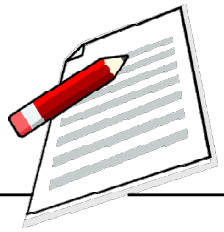
Characteristics of a Choropleth Map

1. Choropleth map shows different shadings. The darkness of the shade exhibits the changing scale of the value in an ascending or decending order.
2. The shade of a class / category exhibits the same values, though, the range may vary a lot.
3. The entire administrative unit considered to be uniform in terms of distribution but in reality it may not be true.
4. The administrative boundary represents a sharp divide between adjacent unit.
5. The darkest and the lowest shades may be adjacent to each other.
6. Many a time it may not be able to show the varying trends on the earth surface.
7. Pockets/Patches may appear on the map distinctively.
8. Varrying trend can be compared by preparing two sets of map of two time period.

EXERCISES FOR PRACTICAL RECORD BOOK

1. Draw a line graph showing growth of population in India from 1901-91.

Years	1901	1911	1921	1931	1941	1351	1961	1971	1981	1991
Population (in million)	23.8	25.2	25.1	27.9	31.9	36.1	43.9	54.8	68.6	84.4



Notes

2. Construct a bar diagram showing Annual Rainfall in Thiruvananthapuram.

Months	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall (in mms)	22.9	20.8	38.6	105.7	207.8	356.4	223.0	145.5	137.9	273.3	205.5	74.5

3. Prepare a star diagram to represent the following data:

Direction	**No. of days the wind is blowing**
N	45
NE	110
E	25
SE	27
S	23
SW	15
W	90
NW	20
Calm days	10
Total	**365**