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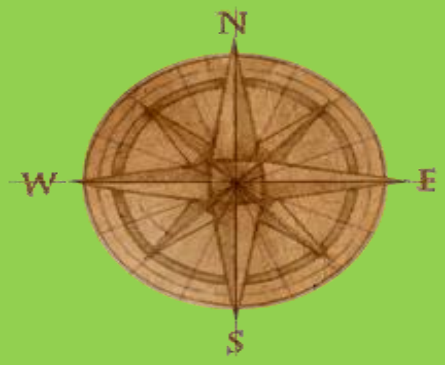

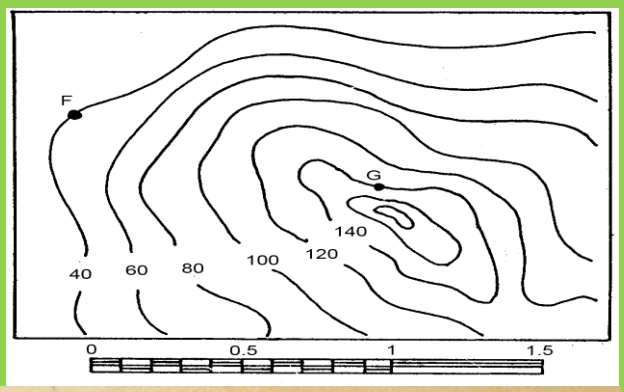

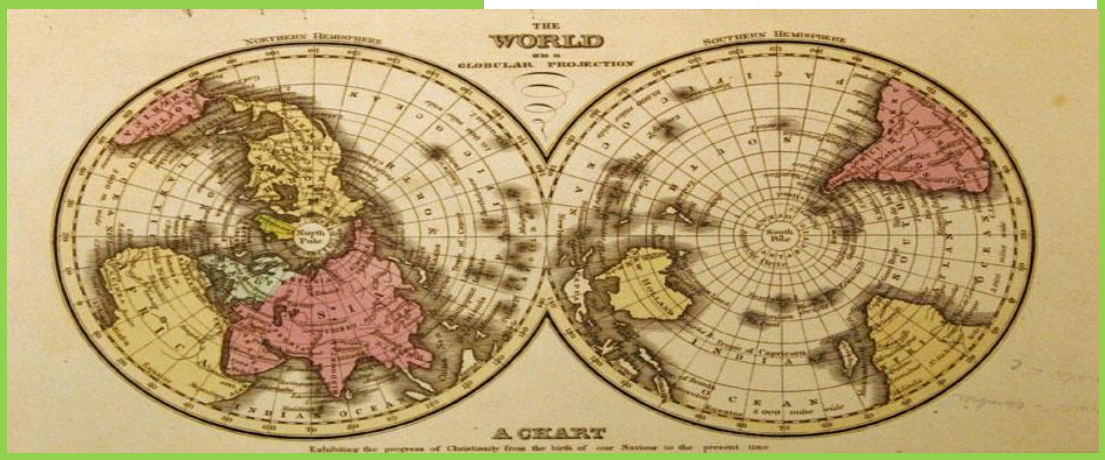

DEPARTMENT OF GEOGRAPHY

SCHOOL OF SCIENCE

UTTARAKHAND OPEN UNIVERSITY, HALDWANI

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CONTENTS

BLOCK-1

SCALE AND MAPS

UNIT–I
SCALE: PLAIN, COMPARATIVE AND DIAGONAL

1.1 OBJECTIVES

After studying this Unit, you should be able to:

- Understand the meaning and definition of Scale and Map
- Explain the types of scale and its methods to show on the map
- Describe enlargement and reduction of maps

1.2 INTRODUCTION

Scale has the meaning of a ratio. It signifies the proportion of a length on the map which bears actual distance on the ground. To speak, the scale of one cm. to a km. means that if we measure two cm. as the distance between two buildings shown on the map, the actual distance would be two km. In determining the scales, it is necessary to bear in mind the purpose, for which the map is intended, as well as the amount and the character of the detail to be shown. Town plans require a large scale in order to show the layout of buildings and other related aspects. An Atlas map is designed to show the main details in a brief form. So, It is essential that on any plan or map there should be some indication of the scaleso that the actual distances may be calculated.

1.3 DEFINITION OF SCALE

The distances on the map are smaller than the corresponding distance on actual ground. Maps always bear a definite proportion to the area shown on that. So, the scale is the proportion of the distance between any two points on the map, corresponding to the actual distance between these two points on the ground. Actually, scale is a ratio of two distances i.e. the map distance and the ground distance. Thus, the ratio between these two distances is the scale of the map. For example, if we say that scale is one cm. to one km., we mean that a length of one cm. on the map corresponds to a distance of one km. on the ground i.e. 1cm = 1km.

The scale we chose primarily depends on:

- The size of the area to be mapped
- The amount of details to be shown and
- The size of the paper

According to our need-we can have ‘Small Scales’ and ‘Large Scales’

- Small scales show km. to the cm. such as 5kms to 1 cm.
- Large scales show cm. to the km. such as 10 cm. to 1 km.
- Small scale depicts large area covered on a small size of paper. The map with such scale shows only important features. It may have a loss of information.
- Large Scale depicts small area covered on a good size of paper. The map with such scale shows in detail the geographical features.

The choice of proper scale for a map always depends upon the purpose for which it is drawn.

1.4 *METHODS OF EXPRESSING SCALE ON A MAP*

There are three methods, by which the scale of map is expressed: (i) by a statement method, (ii) by a numerical fraction or (iii) by a graphical scale method :

(i) By Simple Statement Method : In this method, the scale is expressed in words, such as one cm. to 1km. or 1 inch to 1 mile, etc. This indicates that one cm. on the map corresponds to one km. on the ground or so on. This method is easy and is understood well especially for those who are less educated. This method has two limitations. Firstly, it can be understood only by those who are familiar with the unit of measurement used. Secondly, when a map is reduced or enlarged from the original, the scale will not be the same. This creates problems in measurement.

(ii) By a Representative Fraction Method: This expresses the proportion of the scale by a fraction in which the numerator is one and the denominator is also in the same unit of length. For example, if the Representative Fraction (Commonly written as R.F.) is stated to 1/1,00,000 or 1:1,00,000 this means that one units on the map represents, 1,00,000 of the same unit on the ground. If it is an inch then 1" on the map represents 1,00,000 inch on the ground i.e. 1.578 miles. If it is in centimeter, then 1cm. on the map represents 1,00,000 cm. on the ground i.e., 1 cm represents 1 km.

$$\text{R.F.} = \frac{\text{Distance on the Map}}{\text{Distance on the ground}}$$

Hence, this method of stating the scale is independent of any particular unit of measurement. It is an universal unit. It can be converted into any unit. It can be used by any country according to its own unit of measurement. However, the R.F. will no longer be true, when the map is enlarged or reduced photographically. In that case, the linear method of scale will be better.

(iii) By a Graphical Scale Method: This is also known as a plain or a linear scale. This is merely a straight line divided at certain intervals, so that the distances on the map can easily be measured with the help of a scale in terms of distances on the ground. This scale is expressed as a horizontal or straight line. In the construction, a convenient length of the line should be drawn, so that the distance on the map can be easily read. The line is usually about 10 to 15 cm. in length. The units should be shown in round number in kms. The divisions are usually in multiples of tens so that further sub-divisions, if necessary become possible. For convenience, the primary divisions are shown on the right hand side of zero, while secondary divisions (sub-divisions of the primary division) are marked off to the left of the zero mark.

Draw a straight line AB, 12 cm. in length. From A draw another line AC making a convenient actual angle of about 20o to 25o BAC. On AC mark six equal division (a, b, c, d, e, f) by means of a pair of dividers, join the last point f to B and from the other points (a, b, c, d, e) drawn lines parallel to fB to meet the line AB. These

parallel lines will cut AB into six divisions, each being equal to 5km. These are the primary division (Fig. 1.1).

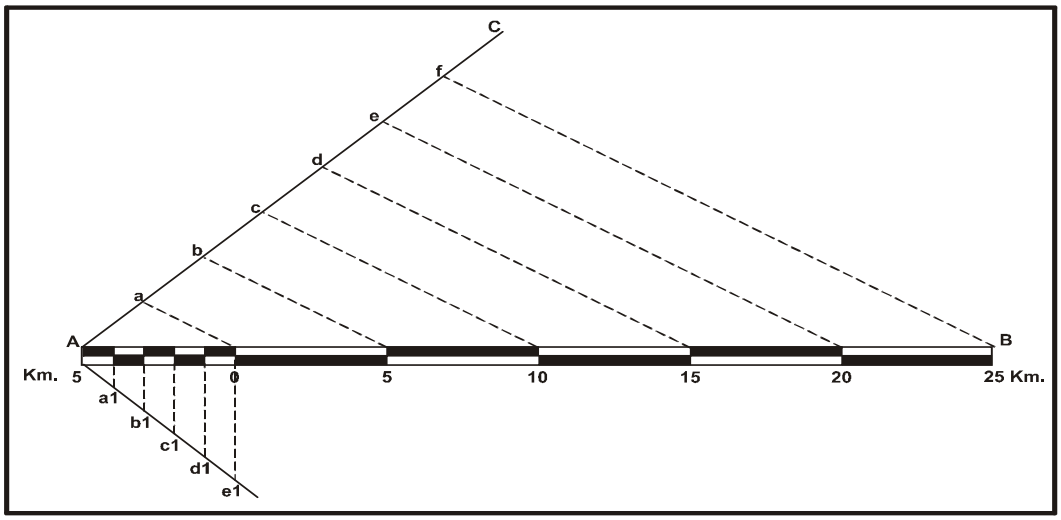

Fig. 1.1 Construction of Linear Scale

To obtain the secondary division, sub-divide the first primary division, i.e. the division on the extreme left into five equal parts as shown in Fig. 1.1 Each of the these secondary division will represent one km.

While numbering the scale, zero should be marked after one interval from the left, so that the left hand end of the line can be numbered 5 and the primary divisions to the right of zero can have numbers 5,10,15,20 and 25. This method of numbering enables us to read off directly the whole numbers as well as the fraction from the scale.

Example 1: Construct a linear or graphical scale for a map drawn to a scale of 1:1,00,000 to read into km. and divide it into primary and secondary division.

Solution: If we take 10 cm. lines on the paper, it will represent 10 km. It is a convenient round number in scale because it can be divided into 10 primary divisions, and thus one division will represent one km. The first primary division on the left side of the linear scale is divided here in two equal parts, called as secondary division. Each secondary division will represent 500m, while numbering the scale, zero should be marked after one primary division from the left. This method of numbering enables us to read off directly the whole numbers as well as the fraction from the scale.

Example 2: If the scale of a map is 1:2,50,000, construct a graphical scale with primary and secondary divisions to read up to one km. Here 1cm. represents 2.5 km. or 2,50,000 cm.

Suppose, if we take a line of 12 cm. length, the length of the scale line will represent 12×2.5 cm. = 30 km.

This is an even number and is convenient for the construction of a scale. Now, to construct a linear scale for 30 km to read upto 1 km firstly we will have to determine the number of primary divisions. Here 12 cm. represents 30 km. It means that 1 cm will represent

2.5 km. We may conveniently divide 12 cm line into six divisions, so that each primary division reads 5 km. and to read secondary division, one primary division of the extreme left of the scale, is divided into five equal divisions to represent one small division equal to 1 km.

1.5 *SCALE CONVERSION*

The statement scale and the representative fraction scale, both are substitutes of one other. So, both are not shown on the map at one time. Though there is a tradition that R.F. is shown along with the linear scale on the map. Sometimes, when the map is reduced or enlarged then, this R.F. needs the change, as because; the length of linear scale also gets changed. It is also to be noted that sometimes we need to change the statement scale into representative fraction or in ratio scale. Thus, it becomes necessary for us to acquaint ourselves with the technique of the conversion of all these methods of scale into each other.

The following examples will be able to clarify these methods of all these changes.

1. Calculate the R.F. when the scale is 5" to one mile.
   5" = 1 mile or 63360"
   5" = 63360 or R.F. is 1:12672

2. Calculate the scale in inches, when the scale of map is one cm. = one km.
   1 cm. = 1 km. or 1,00,000 cm. or R.F. is 1:1,00,000
   In inches 1 inch = 1,00,000 inch
   63360 inch = 1 mile 1:100,000 × 63360 = 0.63" the scale is 0.63" to the mile or 1" = 1.578 miles

3. The distance between Meerut and Delhi is 60 km. This distance on a map is shown by a line of 6 cm. Find out the R.F. of the Map :
   : 6 cm. represents 60 km. or (60 × 1,00,000) cm.
   : 1 cm. will represent = 60/10 = 10 km.
   : So the R.F. of the map is 1 : 1,00,0000

4. Find the R.F. when the scale is 1" to 3 miles
   1″ = 3 miles or 1″ = 3 × 63360″ = 190080
   So R.F. is 1 : 1,90,080
   R.F. of a map is 1:50,000, Draw a simple linear scale of this map.
   1 cm. = 50,000 cm. 1 cm. = $\frac{50000}{100000}$ km.
   1 cm. = ½ km. or 2 cm. = 1 km.

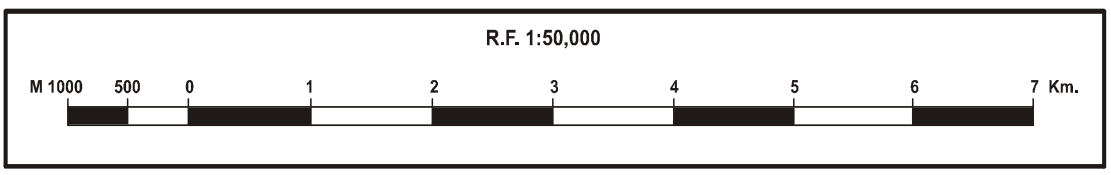

Fig. 1.2

Draw a line of 16 cm. length, and divide it into eight primary divisions, and thus one primary division will show a distance of 1 km.

1.6 GRAPHICAL SCALE

It is also known as linear scale, as it is shown with the help of a line. The length of the line is determined according to the size of paper. The following points should be kept in mind, at the time of construction of linear scale:

1. Linear scale should indicate the actual distance in round figure, such as 5,10,15 and so on.
2. The length of linear scale may not be in round or full digit. It may be in decimal, which is obtained after the calculation.
3. The length of the graphical scale should be between 4 to 6 inch or 10 cm to 15 cm. This length may be adjusted with an addition of half inch or 1 cm.
4. The division of linear scale into primary and secondary divisions should be made by geometrical methods.
5. The value of each division should be mentioned on the upper side.
6. The left side of the scale has the secondary division, showing the smallest measurement of the scale.
7. The linear scale, if it is decorated with two parallel lines in that case the lower line should be thick. Each section of the scale may be shaded in alternate manner.

Types of Graphical Scale

This scale has so many specialized forms. These are based on various purposes:-1.Plain Scale, 2.Pace Scale, 3.Time Scale, 4.Comparative Scale, 5.Diagonal Scale, 6.Vernier Scale.

(1) Plain Scale

This scale simply represents the measurement of distances. In one scale, the measurement in two units can easily be shown, such as km. and metre, mile and furlong or yard, yard and feet. This scale is generally used on the maps. This scale may be drawn as a single or double line. Double lines scale with alternate spaces filled black, are commonly used for good effect.

Example 1: The R.F. of a map is 1:250,000. Construct a plain scale with primary and secondary divisions to read upto one km.

Solution: Here, one cm. represents 250,000 cm. if we draw a line of 12 cm. it will represent the number of km. in following way:

Here, 1 cm. represents 250,000 cm or $\frac{250000}{100000}$ km. = 2.5 km.

A line of 12 cm. will represent 2.5 km. × 12 = 30 km.

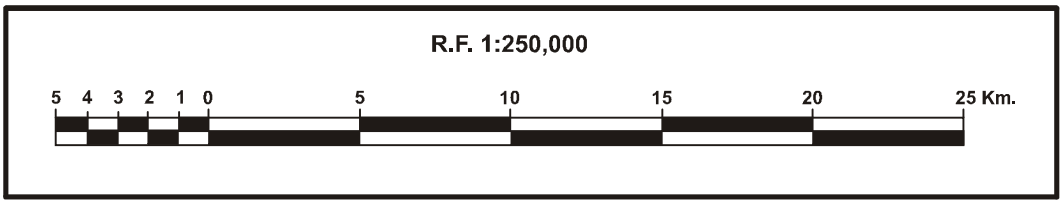

Fig. 1.3

This is an even number and is convenient for the construction of a scale. As we have to read upto 1 km. in this linear scale for 30 km, we will divide this scale into six primary divisions. Thus, each primary division will read 5 km. One primary division of extreme left of the linear scale, we will divide it into five equal divisions, so that these secondary divisions will give us to read a minimum distance of one km.

While numbering the scale, zero should be marked after one interval from the left, so that the left hand end of the line can be numbered 5 and the primary divisions to the right of zero can have number 5,10,15,20 and 25. This method of numbering enables us to read off directly the whole numbers as well as the fraction from the scale.

Example 2: The R.F. is 1:100,000. Construct Plain scale to read into miles and furlongs.
Here 1 inch represents 100,000 inches

If we draw a line of 6 inch then $\frac{100000 \times 6}{63360}$ = 9.469 miles

Thus 6″ will represent 9.469 miles.
As 9.469 mile is not a round figure, in that condition we will take the round figure of 10 miles, then we will calculate the length of the linear scale for a distance to show 10 miles.
Now 9.469 miles in shown by = 6 inch

1 mile will be shown by = $\frac{6}{9.469}$ inches

10 mile will be shown by $\frac{6 \times 10}{9.469}$ inch = 6.336” or 6.3”

Draw a line of 6.3″ and divide it into 10 equal parts. One part will represent the ground distance of one mile. The primary division of the left side will be divided into eight equal parts. This one small part as a secondary division will represent 220 yards or one furlongs.

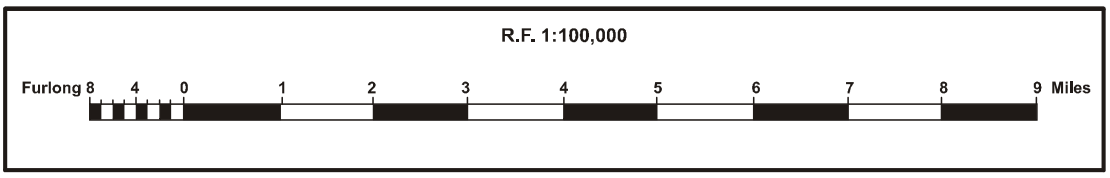

Fig. 1.4

Example 3: Draw a plain scale for R.F. 1:7920 and show the distance of 3 Furlong 165 Yards.

Solution :

1″ represents 7920 inches 1 Furlong = 220×36=7920 inches

6″ will represent $\frac{7920 \times 6}{7920}$ Furlongs

6” = 6 Furlong

Draw a line of 6" length and divide it into 6 equal parts, and each primary division will represent 1 furlong. Divide the first primary division into four secondary divisions, thus one secondary division will represent 55 yards, See Fig. 1.5.

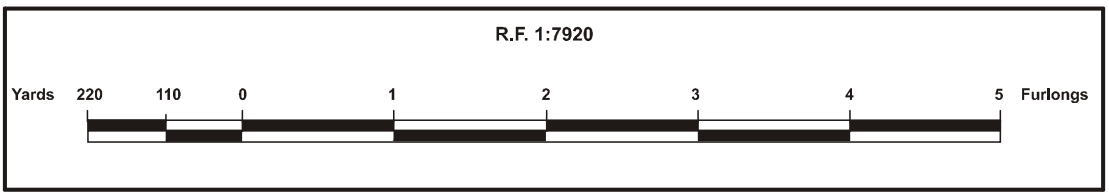

Fig. 1.5

Example 4: The distance between two places on the ground is 4 hectometer and 10 decameter, when the distance on the map is 5cm. Find out the R.F. of the map and also draw a plain scale to show 6 Hm. and 5 Dm. distance.

P.S. 1 HM = 10000 cm. or 100 m. / 1 DM = 1000 cm. or 10 M.

1 km. = 10 HM or 100 DM

Solution: Distance on Map is 5 cm.

Distance on Ground $= 4 \times 10000 + 10 \times 1000$ cm.

$= 40000 + 10000$

$= 50000$ cm.

R.F. = 5/50000 = 1/10,000

Draw a line of 15 cm. length, which will represent 15 Hm. It means that if 15 cm. line is divided into 15 equal parts than one cm. will represent 1Hm. Divide the first primary division into two equal parts i.e. into secondary divisions. Thus, one secondary division will represent 5 Dm. distance (Fig. 1.6).

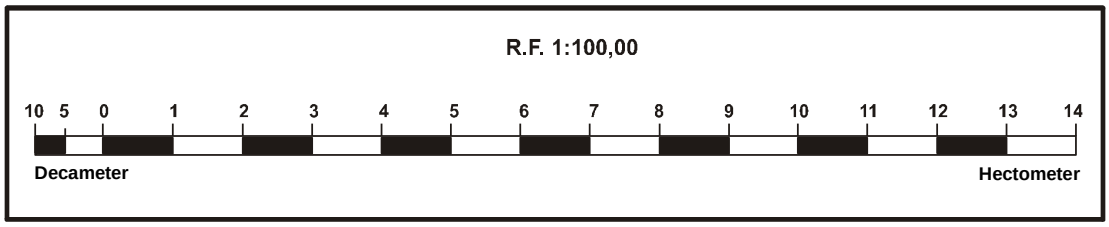

Fig. 1.6

Example 5: An area of 5 sq.cm. on the map represents an area of 2,50,000 sq.km. Draw a corresponding scale to read km. What is the R.F. of the scale.

Solution: 5 Sq.cm. = 250,000 sq.km.on ground

1 sq. km. = 50,000 sq.km.

Distance of one cm. on map = $\sqrt{50,000}$ =223.6 km.

= 223.6 km.

= 22,36,00,00 cm.

R.F. = 1:223600,00

1 cm. = 223.6 km.

15 cm. = 3354 km.

Here, 3354 km. are shown by a line of 15 cm.

1 km. is shown by a line of $\frac{15}{3354}$

3000 km. will be shown by = $\frac{15 \times 3000}{3354}$ = 13.8 cm.

Draw a line of 13.8 cm. and divide it into six equal primary divisions. Thus, one primary division will represent 500 km. One primary division of extreme left, divide it into five secondary divisions. Thus, one secondary division will represent 100 km. (Fig. 1.7)

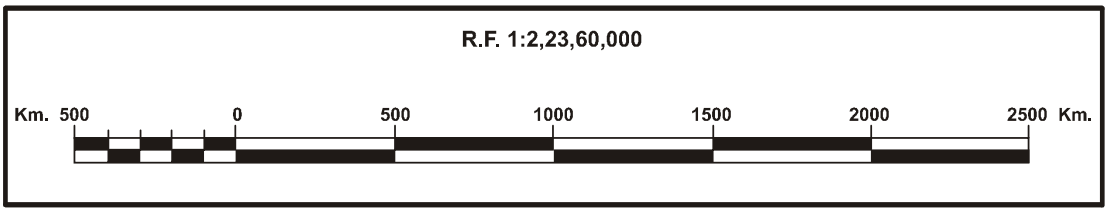

Fig. 1.7

(2) Comparative Scale

It is that graphical scale which measures the distances in the units of measurement of different length. The main aim of the construction of these scales is to know the distances such as in mile and km, metre and yard, time and distance. Following are the main points for the drawing of these scales:

The scale is drawn on the basis of one R.F.
The R.F. is converted into distance of both the different measurements.
Both the scales of different units are vertically aligned on the mark of zero of primary division for the drawing .
The calculation of both the scales is just the same as of the plain scale.

Example 1: Draw a comparative scale to show the distances in yards and metres for the R.F. 1:50,000.
For Yards : R.F. 1: 50,000 i.e. 1″ = 50,000″

Or 1″ = $\frac{50000}{36}$ = 1388.88 Yards.

If we take a length of 6” of scale then it will represent 6 ×1388.88 yards = 8333.28 yards

Take a round number 8000 yards, the length of the line will be:
So, 8333.28 yards are represented by 6″

1 yard will be represented by $\frac{6 \times 8000}{8333.28}$ inches

8000 yards will be shown by = 5.07 inches

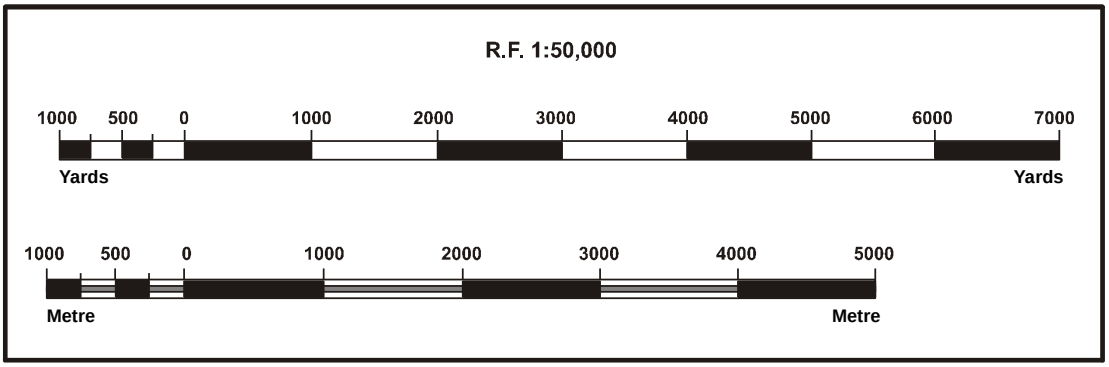

Fig. 1.8

Draw a line of 5.07 inches and divide it into eight equal parts and each primary division will represent 1000 yards. Divide the first left primary division into four parts and thus each part will represent 250 yards.

For metre : R.F. 1: 50,000

Or 1 cm = 50,000 cm. or 500 metres,

Suppose if we take a line of 12 cm. length, it will represent : 12cm × 500m = 6000m or 6 km.

Draw a line of 12cm. and divide it into 6 equal parts to represent one part or to say primary division 1000m. Divide the left side one primary division into 4 equal parts to represent one secondary division 250 metre. Draw this scale of metre just above the previous one. In this case, care should be taken that the zero point of the yard should coincide with the point of the metre scale.

Example 2: A map is on the scale of R.F. 1:100,000. Draw a comparative scale to read the distances in Mile-Furlong and Kilometer- Hectometer.

Solution: For mile: R.F. is 1:100,000

Thus 1 inch represents 100,000 inch

Then 6″ will represent $\frac{100000 \times 6}{63360}$ miles

= $\frac{625}{66}$ = 9.46 miles

It is not the round figure.

If we take the round figure of 10 miles, in that case the length of the scale will be determined as follows:

625

: ------ miles are shown by a line of 6″

66

$$\text{: 1 mile will be shown by a line of } \frac{6 \times 66''}{625}$$

$$\text{: 10 miles will be shown by } \frac{6 \times 66 \times 10''}{625} = 6.3''$$

For km : 1 cm. represents 100,000 cm or 1 km.
Then 15 cm. will represent 1 km. × 15 = 15 km.

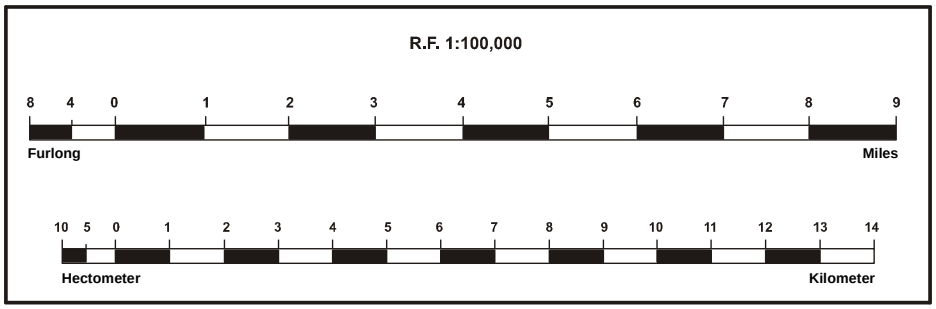

Fig. 1.9 Comparative Scale

Now, we will draw two straight lines separately. Firstly for mile, the length of the line is 6.3″. Divide this line into 10 equal parts to show the primary division of one mile distance. The left primary division will be divided into two equal parts. Thus, one secondary division will represent 4 furlongs. Secondly, for km. divide the line of 15 cm. into 15 equal parts. Thus one division as a primary division will represent 1km. To measure distance in hectometer, divide left primary division into two equal parts. Thus, one secondary division will measure the distance of 5 hectometer. Now draw the comparative scale on the basis that the zero of both the scales should coincide to each other.

Example 3: Draw a comparative scale for R.F. 1:1,000,000 to read the distances in Kilometer, statue miles and nautical miles.

For km. 1cm. represents 1000000 cm.

$$\text{15 cm. will represent } \frac{1000000 \times 15}{100000} = 150 \text{ km.}$$

For Statue Mile : 1″ represents 100000 inches

$$6'' \text{ will represents } \frac{1000000 \times 6}{63360} = \frac{3125}{33} = 9469 \text{ mile}$$

Now $\frac{3125}{33}$ miles represented by 6″

$$1 \text{ mile represented by } \frac{6 \times 33 \times 100}{3125} = \frac{19800}{3125} = 6.336''$$

100 miles will be represented by 6.3″

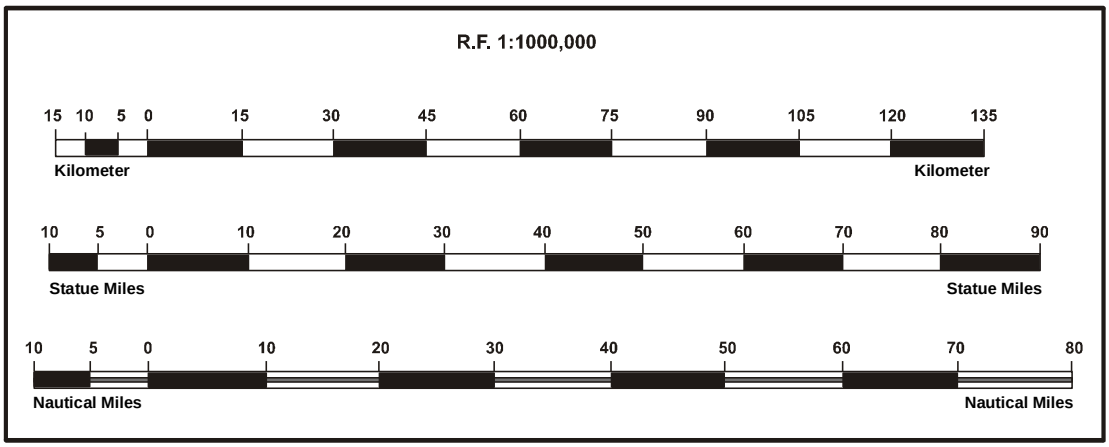

Fig. 4.10

For Nautical Miles :

Please see that one nautical mile = 72960 inches

1″ represents 1000000″

$$6'' \text{ will represent } \frac{1000000 \times 6}{72960} \text{ Nautical Mile} = \frac{100000}{1216}$$

$= 82.236$

Take round figure of 90 nautical miles

$$: \frac{100000}{1216} \text{ Nautical Miles are represented by } 6''$$

$$1 \text{ Nautical Miles are represented by } \frac{6 \times 1216}{100000}$$

$$90 \text{ Nautical Miles will be represented by } \frac{6 \times 1216 \times 90}{100000}$$

$$= \frac{729600}{100000} = \frac{656640}{100000} = 6.56''$$

90 Nautical Miles = 6.56″

For km. : Draw a line of 15 cm. and divide it into 10 equal parts, thus one part of primary division will represent 15km., divide one primary division into two secondary divisions of 500m each.

For Statue mile : Draw a line of 6.3″ and divide it into 10 equal parts and thus one primary division will represent ten miles, and divide one primary division into two equal parts and thus one secondary division will represent 5 miles.

For Nautical Mile- Draw a line of 6.56″ length and divide it into nine equal parts. Thus, one primary division will represent 10 nautical miles. Repeat the same process and divide one primary division into two equal parts, and it will give the measurement of one secondary division as 5 nautical miles.

(3) Diagonal Scale

Diagonal scale is that type of scale, by which we can read micro measurements. Besides giving primary and secondary divisions, a diagonal scale gives divisions which are smaller than secondary divisions. In a way, this scale is an elaboration of the graphical scale and brings considerable precision in map making. It can read upto three units of one measurement such as yard, feet, inch; km, hm and decameter; mile, furlong, yard.

A diagonal is conveniently used for dividing a short line into equal parts. Suppose the line AB is of one inch, and is to be divided into ten equal parts. Draw two perpendicular CA and DB of any convenient length and mark ten small equal division on both CA and DB. Now join the corresponding point of CA and DB by parallel lines. Now also divide CD and AB into ten small equal divisions. Now do draw diagonals join the C with the first division of AB line. Draw the other diagonals, repeat this process. In this way you will be able to measure the distances of 0.1 to 0.9 and 1.0.

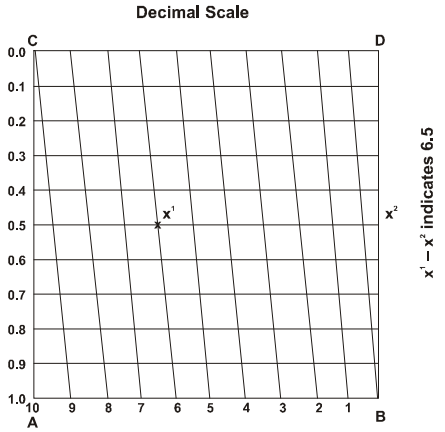

Fig. 1.11: Reading of Micro-Distance in a Diagonal

Example 1: Draw a diagonal scale for R.F., 1:50 to read the distances in hectometer and Decameter.

Here. 1cm.represents 50 cm.

15 cm. will represent $\frac{50\times15}{100}$ m = 7.50m

Suppose if we take the distance of 7m, then the length of the line will be

$=\frac{15\times7}{75}$ or $\frac{15\times10\times7}{75}$ = 14 cm.

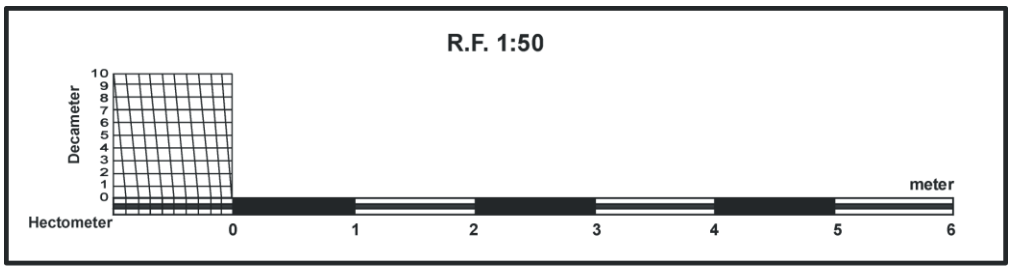

Fig. 1.12

Now draw a line of 14 cm. length, and divide it into 7 equal parts. One part will represent 1 metre as a primary division. Divide one primary division of extreme left into ten small divisions, thus one small division will give the measurement of 1 hectometer. To read one Decameter, draw 10 parallel lines of equal distance on the above of this primary division. And divide the top and bottom lines of this division into ten equal parts. Now draw diagonals on the basis as stated above, thus, one small part will give the measurement of one Decameter.

Example 2: Draw a diagonal scale for R.F. 1:36 to read the distances in yards, feet and inches. Mark the measurement of 3 yard, and 2 feet, 7 inches.

Here 1″ = 36″ or 1 yard, so that a line of 6″ length will represent 6 yards. Now draw a line of 6 inches and divide it into 6 equal parts. Each part as a primary division will represent one yard. Erect a rectangle ABCD as shown in Fig 1.13 and divide AB and CD draw 12 parallel lines to AB and CD with equal distances. Now divide the first primary division into three secondary divisions, thus one secondary division will represent one foot. To show the distance of one inch, join the diagonal lines as stated above. Now mark on the scale the distance of 3 yard 2 feet 7 inches.

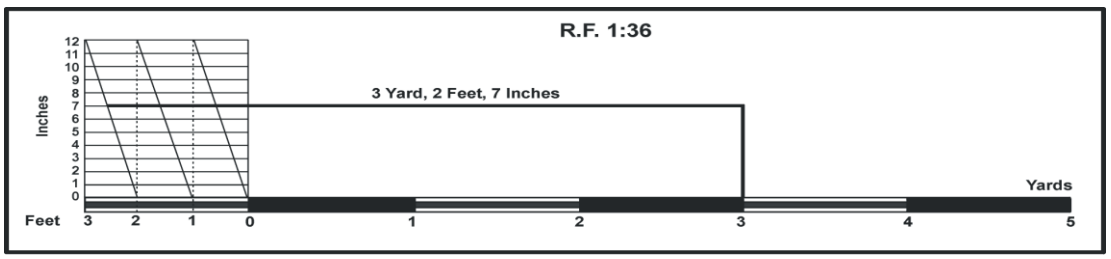

Fig. 1.13

Example 3: To read the distance of one hundredth part of a mile, draw a diagonal scale on R.F. 1:63360 and also show the distance of 1.56 mile on the scale.

Here 1″ represents 1 mile, as 1 mile is equal to 63360″. So now draw a line of 6″, and divide it into 6 primary divisions and thus, one primary division will represent one mile. Now divide the first primary division of the left side into ten secondary divisions, and, thus, the one secondary division will represent 0.1 mile distance. To read the distance of 0.01 mile draw 10 parallel lines to the main scale and on the left side primary division mark 10 points of equal distances on the upper most line of the scale. Join these 10 small distances with the diagonals.

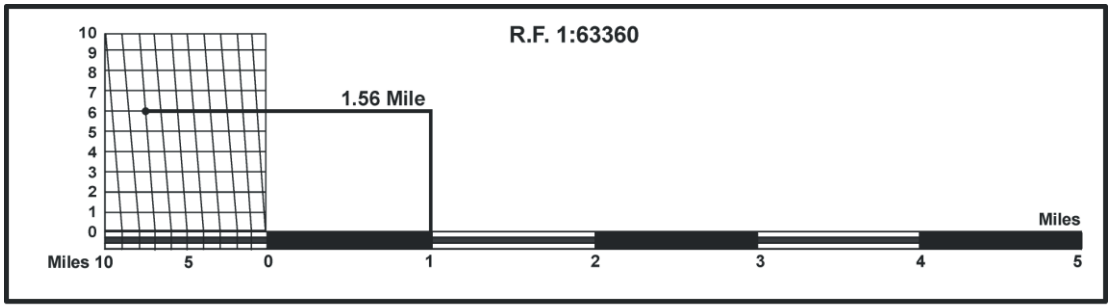

Fig. 1.14

1.7 CONCLUSION

Scale is a ratio. This ratio corresponds to the distance on the ground and the distance on the map between the same points. A map without scale has got no meaning. It is the scale that has made possible the measurement of the earth or any part of it on the paper. Scale can be expressed in the form of statement, representative fraction and graphical. The main types of scale are plain, comparative and diagonal.

1.8 SUMMARY

Map is the tool of a geographer. Map means its representation with certain scale. This scale has brought the earth or any part of it in a smaller size on the paper. Scale is the proportion of two distances, the distance between two points on the map and the corresponding distance on the ground. The scale that we choose, primarily depends on the size of area to be mapped, the amount of details to be shown and the size of our paper. Small scale represents the large area, while the large scale shows the small area. There are three methods of expressing the scale on the map. The statement method expresses the scale in words. The representation in the form of a fraction is known as Representative fraction, where the numerator denotes the distance on the map and the denominator indicates the distance on the ground. The graphical scale is the third method in which a straight line divided at certain intervals indicates the ratios of the ground and of the map. The linear scale is divided into primary and secondary divisions. The units of scale are shown in round figure on these divisions. The first primary division on the

left side has the value of zero. The divisions on the scale are conveniently drawn with the help of a line of an acute angle.

The scale conversion in also necessary, as the statement scale and representative fraction scale both are substitutes to each other. But it is also important that the scale if it is shown by a line, in that condition, if the map is reduced or enlarged, it gives the correct measurement. In the case of R.F., it is not possible.

Graphical scale is also known as linear scale. The length of this scale depends on the size of paper, on which it is to be drawn. Linear scale shows the actual distances in round figure. It has primary and secondary divisions both, which help us to measure the small distances on the map. Linear scale has three main types-Plain, comparative and diagonal. Plain scale simply represents the measurement of distances. It shows the distances maximum in two units. Comparative scale measures the distances in two different units of measurement for example it shows the distances in km. and mile, metre and yard and so on. Diagonal scale is used to measure the micro-measurements. It gives the divisions smaller than the secondary divisions. It can read upto three units of measurements.

1.9 GLOSSARY

Scale: The ratio between two distances i.e. distance on a map and the actual distance on the ground between the corresponding points.

Linear Scale - A method of expressing scale with the help of a line.

One inch	= 25.4mm or 2.54 cm.
One mile	= 1.609347 km. or 1.61 km.
One foot	= 0.304801 metre
One square inch	= 6.452 sq. cm.
One square foot	= 0.09290 sq.m.
One square mile	= 2.59000 sq.km.
One Acre	= 0.4047 hectare
2.471 hectare	= one hectare
One km.	= 10 Hectometer
One Hm.	= 10 Decameter
One Dm.	= 10 meter
One M.	= 10 Decimeter
One Dcm.	= 10 centimeter
One Cm.	= 10 Millimeter
One Nautical mile	= 72960 inches
One Statue mile	= 63360 inches
One Sq.km.	= 0.3861 sq.mile
One Sq.m.	= 10.764 sq. feet
One Sq. cm.	= 0.15500sq.inch
Small scale means	= 5 km. to 1 cm. Cover large area
Large scale means	= 10 cm. to 1 km. Cover small area

Statement scale denotes the scale expressed in words such as

1cm to 1 km.

Representative fraction- A fraction of ratio between two distances, where numerator is one and denominator, in same units of length.

Graphical scale Means linear scale

Primary divisions	-	The main divisions of the linear scale.
Secondary divisions	-	The sub-division of a primary division.
Scale Conversion	-	Denotes the conversion of scale in any method of expressing the scale.
Plain Scale	-	represents the measurement of distance.
Comparative scale	-	Measures distances in two different units of measurement.
Diagonal scale	-	used to read the micro-measurements

1.10 ANSWER TO CHECK YOUR PROGRESS

- Scale is a ratio between two distances: Ground and Paper.
- Scale helps in true representation of the earth or part of it.
- The distances on the map are shown smaller because of the scale.
- Scale selection depends on size of area, details to be shown and size of paper.
- Small scale helps to show large area on a small size of paper.
- Large scale helps to show small area on a large size of paper.
- Statement method means to explain the scale in words.
- Fraction in the case of scale is called as representative fraction.
- Numerator of the fraction is always one,
- Denominator of the fraction is always in the same unit of length as is numerator.
- Denominator represents the distance on ground.
- The method of measurement of scale by R.F. is quite universal.
- R.F. is not fit or useable when the map is reduced or enlarged.
- Plain scale is a linear scale.
- Linear scale has primary and secondary divisions both.
- The divisions of linear scale are always put in round figure.
- The conversion of scale denotes that all the methods are substitutes of each other.
- Statement scale is conversable into representative fraction.
- Graphical scale is also called as linear scale.
- Graphical scale has specialized forms on the basis of various purposes.
- Plain scale simply represents the measurement of distances.
- Plain scale measures mainly the distances in two units of one length.
- Comparative scale measures the distances in two units of different length.
- Comparative scale has its drawing on one R.F.
- Diagonal scale helps in the measurements of micro-units.
- Diagonal scale is an elaboration of the graphical scale.

- Diagonal scale can read three units of one measurement length.
- Pace scale is based on the distance of the pace of man which is equal to 30 inches.
- Time scale shows the correlation between time or speed and distances.

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3 Singh, R.B. (2003) :Practical work in Geography Pt I NCERT, New Delhi.
4 Singh, R.L. & P.K. Dutt (1966) :Elements of practical Geography, Students friends, Allahabad.

1.13 TERMINAL QUESTIONS

1. What is the meaning of scale. Explain it.
2. Discuss the methods to represent the scale with examples.
3. Discuss the importance of Scale.
4. Explain those factors, on which the scale depends.
5. What do you mean by statement, a method of scale.
6. What is representative fraction. Explain it with examples.
7. What is graphical scale. How a line of the scale is divided into primary and secondary divisions.
8. What is scale conversion. Define the conversion of scale into all three methods.
9. What points should be kept in mind at the time of construction of linear scale.
10. Discuss the various types of scale.
11. What is Plain scale. Discuss its chief characteristics.
12. Discuss the characteristics and importance of diagonal scale.
13. A comparative scale can be used for all units of measurements. Explain it.
14. A map is on scale 1:10,000, and the distance between A and B on the map is 5 cm. Find out the actual distance between these two points.
15. Draw a plain scale for R.F. 1:50,000 to read the distance in Km and metre.
16. An area of 81 sq. km. is shown by 9 sq.cm. on the map. Find out the R.F. of the map. Draw a plain scale to read the distance in km. and hectometer.
17. Draw a comparative scale for R.F. 1:200,000 to read the distances in km and miles.

18. Draw a comparative scale for R.F. 1:6000 to read the distances in yard and metre.
19. Draw a diagonal scale for R.F. 1:100 to read the distances in metre, cm and mm.
20. A train covers a distance of 100 km in 2 hours. This distance is shown by 5 cm. on the map. Find out the R.F. and draw a plain scale showing time also.
21. Draw a diagonal scale for R.F. 1:25, to read the distance in metre, decimeter and cm.
22. Draw a diagonal scale for R.F. 1:50 to read the distances in cm. Also mark the distance of 243 cm. on the scale.
23. Draw a diagonal scale for R.F. 1:36, to read the distances in yard, foot and inch. Also mark a distance of 4 yard 2 feet and 7 inches.
24. A map is on the scale of 1:25,000. Draw a diagonal scale to read the distances of hundred part of a km. Also mark the distance of 2.47 km. on the scale by a thick line.

UNIT–II ELEMENTS AND TYPES OF MAPS

2.1 OBJECTIVES

The description of the earth as a home of man is 'Geography'. If we want to explain the geography of an area then we need to present the relative description of natural and cultural environments. Earth is so vast, that man himself cannot visualize all these features from his own eyes. So he needs to take the help of certain tools and among these tools map is the main. Maps are so important for a geographer as the arms and ammunitions are important for military personnel. In a real sense, map is the symbolic script of geographers.

2.2 INTRODUCTION

The spherical earth is best represented by a three dimensional model of the earth, called a globe. It cannot show much detail of surface features. Hence, maps are much useful tool than globes. A map is a two dimensional diagrammatic representation of the whole or part of the earth. It is a picture of physical and cultural features at a given scale on a flat surface. These have unique advantage of showing objects or patterns that may be intangible or invisible. For example, the distribution of the production of crops on the surface cannot be easily marked on the ground, but on the map, it can be easily identified. It may help us the pattern of crop production in a vast area.

There are various ways by which the earth can be mapped: (a) By freehand sketches and diagrams; (b) By actual survey with the help of survey instruments; (c) By photographs-ground and aerial both; (d) By manmade satellites. The use of computers has developed the digital mapping through Geographic Information System and Global positioning system. The amount of information given on the map depends on:

*Scale, *Projection, *Conventional signs and symbols, *Skill of the cartographer, *Method of map making; and *Requirement of the user.

2.3 DEFINITION OF MAP

The word 'map' is taken from Mappa, a word of Latin origin. This term means a piece of cloth or cloth handkerchief. This term was used for the first time by a head of the monastery named as Micon. His world map was called as **Mappa Mundi.** With time, the term map got popularity, and is defined by a number of scholars.

- **Finch and Trewartha :** Maps are the graphic representations of the surface of the earth.
- **Dudley Stamp-**"Map is a representation of the earth surface or a part of it, its physical and political features, etc. or of the heavens, delineated on a flat surface of paper.″ Each object on the map corresponds to a geographical position according to a definite scale or projection.
- **Erwin Raisz :** A map is, in its primary conception, a convention alized picture of the earth's pattern as seen from above, to which lettering is added for identification.

- **R. Ogilvie Buchanan :** A map is the scaled representation on a flat surface of the earth's surface, or a section of it, showing certain selected features- physical, political, historical or economic.
- **R.P. Misra and A. Ramesh :** A map is a symbolic drawing to scale of the visible as well as conceived locational and distributional patterns of the whole or part of the earth, the sky, or any other heavenly body.

The above definitions reveal the following characteristics of the map:

1. Map is a graphic representation of the earth or part of it.
2. It shows the physical and cultural features.
3. It is a flat piece of paper.
4. It is drawn on a definite scale.
5. It has its extension on a graticule of lines known as latitudes and longitudes.
6. The identification of objects is made either by symbols or lettering.
7. It shows selected features.
8. It is a two-dimensional representation of the earth.

2.4 CLASSIFICATION OF MAP

Maps are of different types. Each map is unique in its design, content and construction and hence, a type by itself. Maps are broadly classified mainly on two basis: Scale and purpose or content. These are also classified further on two other bases: topographic features and nature of construction.

I. Classification Based on Scale

There are two broad categories of maps:

(i) Large Scale maps, (ii) Small scale maps

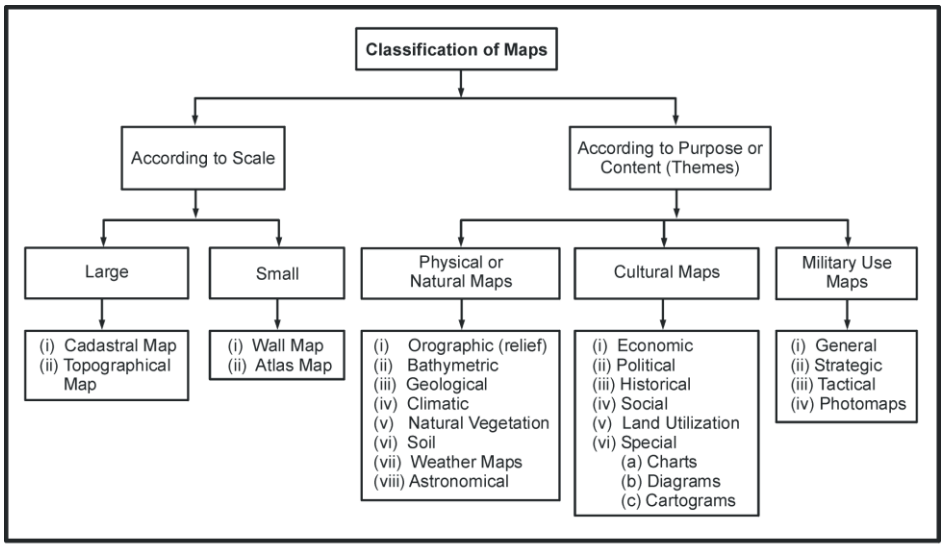
(i) Large Scale Maps: These maps represent small area of the earth surface on a large size of paper with greater details. Cadastral maps, town plan maps, topographical maps are such maps.

(a) Cadastral Maps: The term cadastral is derived from French word cadastre. It means a register of terrestrial property. The cadastral maps are drawn to register the ownership of landed property. It shows the demarcation of the boundaries of fields, buildings. These are especially prepared by government to realize land revenue and property taxes.

The village maps are the large scale maps showing the field boundaries, footpath, water bodies, public places, residential houses and so on. These maps are drawn on a very large scale, varying from 20 cm to a km to 40 cm to a km, so as to fill up in all possible details. Rural land use maps also belong to this category.

The city maps may also be included in this category. These maps are used to show the different details like water-line, sewer line, roads, individual houses, public

buildings, parks, play grounds and so on. The layout plan of a house is also included in it. This is a very large scale map. Town plan maps also belong to this category. Survey of India publishes city and town guide maps on a scale of 1:20000.



(b) Topographical Maps: These maps are also prepared on a fairly large scale. These are based on precise surveys conducted by survey of India, Dehradun. They show general surface features in detail comprising both natural landscape and cultural landscape. According to Survey of India, 'A topographical map is on a sufficiently large scale to enable the individual features shown on the map to be identified on the ground by their shape and position'.

These maps do not have the boundaries of individual plots or buildings. These are rather to depict the principal topographic forms like relief and drainage, swamps and forests, villages and towns, means of communication like roads and railways, spot and relative heights, contours.

In India, these maps are prepared mainly on the scale of 1:25:000, 1:50:000 and 1:250:000. It is to be noted that with the increase in the largeness of the scale, the nature of details increases. For example, a map of 1:25:000 scale shows much more details than the map of a scale of 1:250:000. Various details on these maps are shown with the help of conventional signs. These maps are very important for the study of geography of an area. So, some scholars have defined them as tools of geographers. These are very useful for the study of an area at micro level.

These maps are numbered according to their scale; suppose if the number of a map is 53 K, it means that the scale of map is 1:250,000, when the number of topographical map is 53K/15, it is understood that the map is on the scale of 1:50,000. The number of map with 53K/15/4 denotes the scale of 1:250,00. Such topographical maps are not still in much use.

(ii) Small Scale Maps: These maps represent large areas on a small sheet of paper. They have fewer details. Atlas and wall maps are the best examples of small scale maps. The maps included in any book, magazines, newspaper are also small scale maps. They give only a general picture of the area represented.

(a) Wall maps : Though these maps have large scale than Atlas or book maps, but their scale is comparatively smaller one. These are drawn boldly so that they can be seen from a distance. They are used in classrooms and cater to the needs of large audience. These are hanged on the flat surface wall, so these are called as wall maps. In real sense, these are geographical maps. They show very large areas like world as a whole, continents, hemispheres, countries, states, districts and tehsils. These maps are also drawn with certain purposes like to show, climatic conditions, type of soils, type of vegetation, distribution of minerals, population, means of transport, social, cultural, economic and political patterns. These maps are of different size. It depends on nature of objects, to be shown therein. Our Survey of India prepares these wall maps on a scale of 1:15,000,000 to 1:250,000.

(b) Atlas Maps : 'Atlas' is defined as 'book of maps'. These are drawn on a very small scale and give a highly generalized picture of natural and cultural aspects, such as physical, climate, drainage, soils, agricultural crops, industries and so on. These are mainly prepared on 1:20,000,000 scale or less than that. In our country, National Thematic Mapping Organisation (NATMO) is a well-known important organization. It publishes all kinds of maps for various purposes, depicting different parts of the country and its product is known as National Atlas of India. Other important Atlas are Oxford Atlas, Reader's digest Atlas, School Atlas, District Atlas, State Atlas, Census Atlas, and so on. These maps are also called as chorographical maps.

II Classification Based on Purpose

These are mainly thematic maps usually prepared on small scale. They highlight specific features of the area concerned. These are broadly categorized into two main divisions:

(a) Physical Maps, (b) Cultural Maps

(a) Physical or Natural Maps: The maps which depict various aspects of natural environment are defined as physical maps. These highlight various physical aspects like relief, climate, natural vegetation, soils. These may be categorized as follows:

(i) **Orographic or Relief Maps: These** maps represent surface features like mountains, plains, plateaus, rivers etc. The maps showing the average slope of the area, relative relief also are of such type.

(ii) **Bathymetric Maps: Such** maps are used to depict the depth of the oceans and seas. These depths are mainly shown with the help of different tone of the colour.

Fig 2.2: Physical Map of India

(iii) **Geological Maps: These** maps show the distribution and type of rocks. They also represent the pattern of occurrence and deposition of rocks.

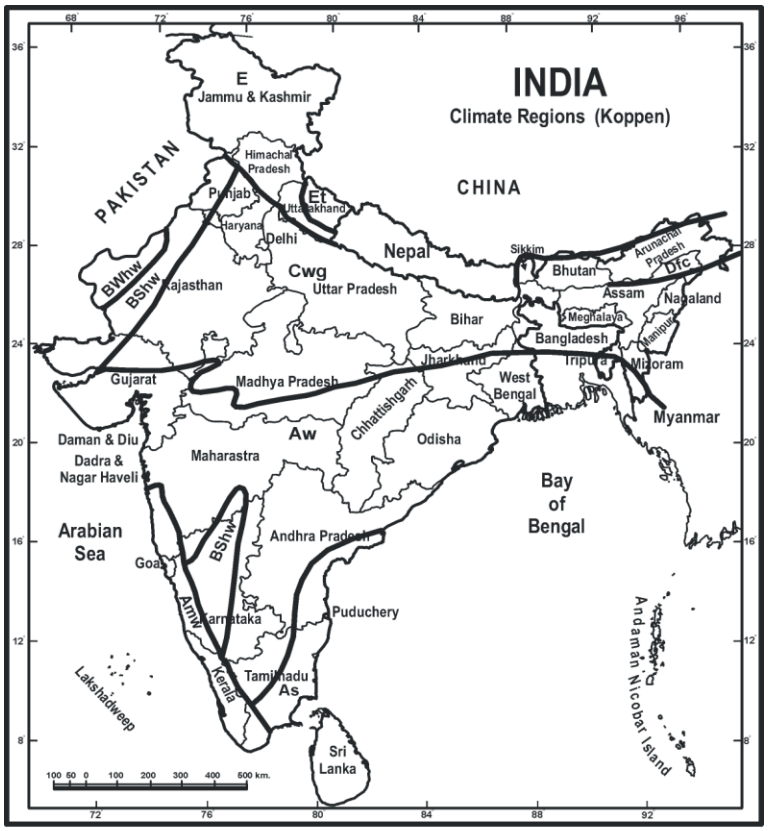


Fig. 2.3 Climate Regions :Koppen

(iv) **Climatic Maps: Maps** showing climatic conditions of an area are known as climatic maps. They show amount of rainfall. Variations in temperature according to seasons, air pressure, climatic regions, direction and flow of winds for a long period of time.

(v) **Weather Maps:** These maps show the weather conditions of a particular time and day. They show the direction and velocity of winds, sky conditions, weather conditions, isobar, sea conditions and amount of rainfall, if it is so. They also depict the weather forecasts.

(vi) **Soil Maps: These** maps show the type and distribution of soils in any area.

(vii) **Natural Vegetation Maps :**These maps are used to depict the types of vegetation, distribution of forests, in an area.

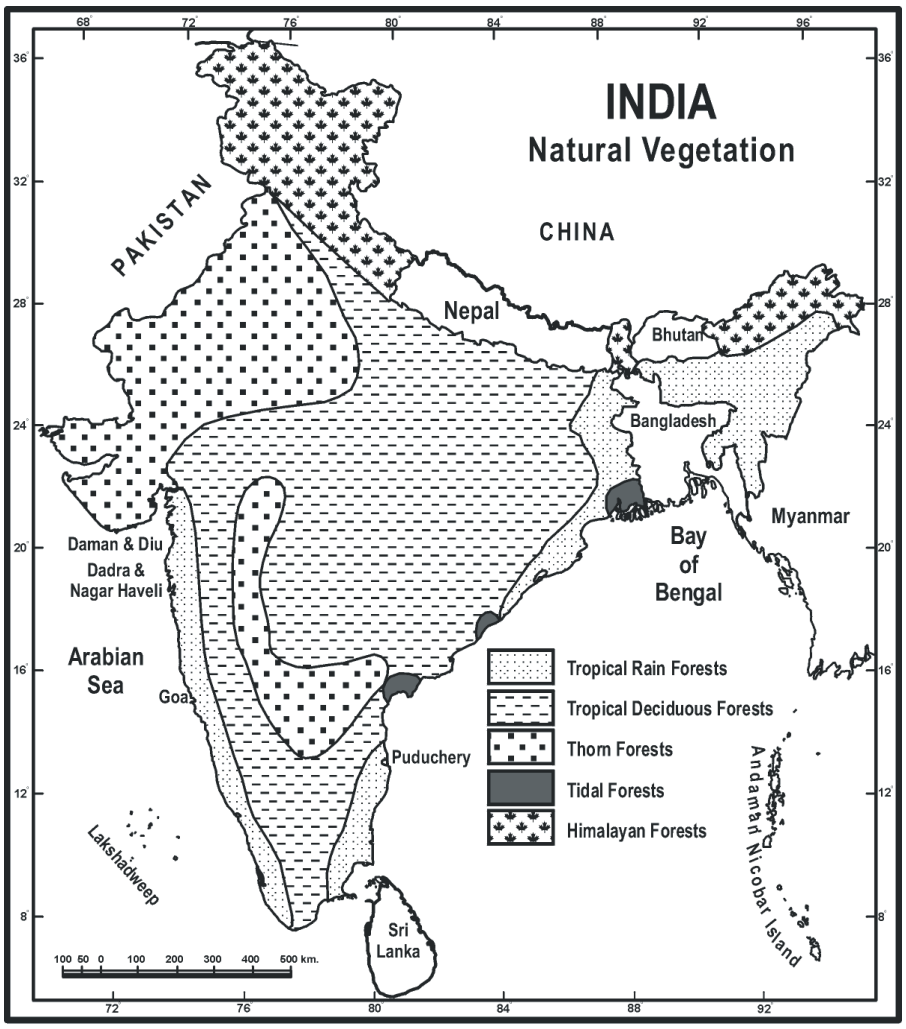


Fig. 2.4 Political Map of India

(viii) **Astronomical Maps:** They show the position of stars and planets of the sky.

(b) **Cultural Maps:** These maps show the man-made features or human aspects. These are categorized into following groups:

(i) **Economic Maps :** These maps show the distribution of minerals, agricultural crops, types of land use, type of industries, means of transport and communication, sea ports etc. These maps also depict the stage of economic development, economic regions, potential regions and so on.

(ii) **Political Maps :** These maps show boundaries between two countries and states. They show the extension of continents. The boundaries of districts, block, tehsils are also shown on these maps. These are also used to show the capitals and administrative boundaries.

Fig. 2.5 Political Map of India

(iii) **Historical Maps :**Maps showing the past events, the places of historic importance, the dynasty of emperors and rulers of various times, are called as historical maps.

(iv) **Socio-cultural Maps :**The maps depicting language, caste structure, religious faith, ethnic groups, migration of races and tribes are known as socio-cultural maps.

(v) **Population Maps :**These maps are very important, as they acquaint with the socio-cultural and economic development of the area concerned. They show the distribution and density of population, level of literacy, age-structure, sex-ratio, percentage and distribution of rural and urban population, working population and its occupational structure.

(vi) **Military Maps: Maps** used or prepared by defence services are called as Military Maps. These are of different types:

(a) General maps on a scale of 1:1000,000 or more depict only the broad topographical features. These are used by the defence services for general planning purpose.

(b) Maps prepared as the scales ranging from 1:1000,000 to 1:500,000 are often classified as strategic maps. These maps are used for planning concentrated military action.

(c) Maps with a scale of 1:500,000 or less are called tactical maps. They serve as guides to small units like battalions and patrol units prior to and during movements anywhere near the front line.

(d) Photo map is an Aerial Photograph with strategic and tactical data superimposed on it.

2.5 ELEMENTS OF MAP

All maps have some **common elements**: Location, graticule of lines of latitudes and longitudes, direction, scale, distribution of various features and phenomena with the help of various symbols, shades and conventional signs.

2.6 CONCLUSION

Maps are the tools of geographers. Geography cannot be studied without maps. Though a number of disciplines are involved in the study of earth, but geography is the only discipline which is involved in the mapping of the earth or any part of it. These are more efficient than books. Maps are records of various facts of the earth. These maps make direct appeal to the mind and bring before us the unknown and unseen areas in their original form.

2.7 SUMMARY

Map is two dimensional. It is true representative of three-dimensional earth. Map is a picture of physical and cultural features of earth or any other area. There are also other ways to represent the features of earth. Sketches, diagrams, photographs, are also used to depict certain features of the earth.

Maps have lot of information, but it depends on the scale, projection, use of conventional signs, skill of the cartographer, method of its making and also requirement of the person concerned. Map is a graphic representation of the earth. It shows certain physical and cultural features. It is a bird's eye view. Each feature is the true representation of the object of the earth.

Maps are classified on the basis of scale and purpose. The maps are of two categories. On the basis of scale, large scale maps show small area on a large size of paper with much detail, whereas small scale maps show large area on a small size of paper with selected details. Topographical maps are large scale maps, mainly published by Survey of India on the

scales of 1 cm to 250m, 1 cm to 500m and 1 cm to 2.5 km. Wall maps and Atlas maps are main categories of small scale maps.

Maps prepared with certain purposes are known as thematic maps. These have two broad categories- Physical and Cultural. Physical maps highlight various physical aspects like relief, climate, soils, natural vegetation and geology. Cultural maps show the manmade features. Economic, political, historical, socio-cultural, population and military map are such maps. The variety and types of maps on the basis of purpose is quite unlimited.

2.8 GLOSSARY

Map: A conventional representation of any area of the earth's surface, small or large, drawn to scale on a flat surface.

Topographical Map :	A map of small area drawn on a large scale depicting both natural and manmade features.
Cadastral Map:	A map on large scale, showing the accurate detail of the extent and measurement of every field and plot of land.
Climatic Map :	A map of the world or any part of it, showing average conditions of climatic elements over a long period of time.
Legend :	A description, explanation, table of symbols and other information printed on a map.
Relief Map :	A map showing relief of an area on a flat surface.
Large Scale Map :	Represent small area of the surface on a large size of paper.
Small Scale Map :	Represent large area of the surface on a small size of paper.
Topographical Map :	It shows general surface features in detail. These features are natural and cultural both.
Wall Maps :	The maps hanged on the wall are called wall maps. These are geographical maps.
Atlas Maps :	These are in the form of a book of maps.
Thematic Maps :	These maps are small scale maps, and are drawn with certain themes or purposes.
Bathymetric Map :	Map showing the depth of ocean and seas.
Geological Map :	It represents the distribution and type of rocks.
Weather Map :	A map showing weather conditions of a particular time and day.
Soil Map :	Represent type and distribution of soils.
Population Map :	Represent various aspects of population geography.
Political Map :	Map showing political extent of different administrative units.
Military Map :	This map is also known as defence map.
Economic Map :	Maps showing the distribution of economic resources.
Socio-cultural Map :	These represent the socio-cultural aspects of the area.

2.9 ANSWER TO CHECK YOUR PROGRESS

- Map is a graphic representation of the surface of the earth.
- Map is originated from the Latin word *mappa*.
- Map is defined by a number of scholars.
- Map shows physical and cultural features both.
- Map is a flat piece of paper.
- Certain objects on the map are shown by conventional signs and symbols.
- Maps are classified on the basis of scale and purpose.
- Large scale maps show a very small area.
- Cadastral map a large scale map shows details of land.
- Village map shows the boundaries of field.
- City map depicts buildings with their use.
- Topographical maps are large scale maps.
- In India, topographical maps are published by survey of India.
- Topographical maps are prepared on two main scales 1:50,000 and 1:250,000.
- Topographical maps are very useful to study the area at micro level.
- A topographical map of 53K denotes the scale of 1:250,000.
- The number of 53K/15 is an indication of the scale of 1:50,000.
- Atlas is a book of maps.
- Small scale maps represent large area on a small sheet of paper.
- Wall maps are larger than Atlas maps.
- Wall maps are also called as geographical maps.
- In India, Atlas is published and prepared by NATMO.
- NATMO denotes National Atlas Thematic Mapping Organisation.
- There is a variety of Atlases.
- Atlas maps are also known as chorographical maps.
- Physical maps are natural map.
- Relief, climate, vegetation, soil maps are physical maps.
- Relief maps shows nature of surface, rivers.
- Bathymetric maps- show depth of ocean bodies.
- Geological maps- show type and structure of rocks.
- Climatic maps- they show the climatic conditions for a long period of time.
- Weather maps-show the weather conditions for a particular day and time.
- Soil map- shows types of soils and their distribution.
- Natural vegetation maps are forest maps showing their distribution.
- Economic maps- show the distribution of economic resources.
- Political maps are the maps of continents, countries and all type of administrative units.
- Historical maps- represent the old events of the area.
- Socio-cultural maps- depict social and cultural aspects.
- Population maps- show density, distribution of population and related aspects.

- Military maps- are defence service maps.
- Photo map- is an air photo map.

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2.12 TERMINAL *QUESTIONS*

1. Define map. Also explain its main concepts.
2. Explain in detail the meaning, importance and utility of maps.
3. Discuss the main characteristics of maps.
4. Discuss the classification of maps. Justify your base of classification.
5. Write an essay on the maps based on scale.
6. Discuss the types and characteristics of small scale maps.
7. Give the main types of maps based on various purposes.
8. Explain wall maps with examples.
9. Atlas maps are very necessary for the study of geography of an area. Elaborate it.
10. Differentiate between climate maps and weather map.
11. Discuss the main type of physical maps.
12. Discuss the main type of cultural maps.
13. Discuss various types of military maps.
14. Map is a true representation of the earth. Explain it.

UNIT–III ENLARGEMENT AND REDUCTION OF MAPS

3.1 OBJECTIVES

This chapter explains the change in the scale of map or a portion of it. It is necessary when we require to add or minus the details shown on the map. To get more space, on the map, we try to enlarge the map and if the map is required in a small space, we try to reduce the map with the help of scale.

3.2 INTRODUCTION

The enlargement and reduction of maps is related to the scale. It denotes the change in the original scale of the map. It helps in the enlargement and reduction of maps. It can enlarge or reduce the map by so many times i.e. two, three or four times. The scale of the map is also reduced or enlarged in that ratio of the scale.

The cartographer or the researcher is always in need of the maps to get them either in enlarged or reduced form. If the original map is so small in size, that it seems to be very difficult for him to show much detail as per his requirement, then it becomes necessary to enlarge the original map. This should be exercised in accordance to the scale. On the other hand, sometimes we require the reduced size of the original map, to get them incorporated in the book, magazines, and project or research reports.

3.3METHODS OF ENLARGEMENT AND REDUCTION OF MAP

(Photographical, cartographical and Instrumental)

There are a number of methods for the reduction and enlargement of maps. These are of two categories:

(a) Mechanical Methods (Photographical), (b) Diagrammatic Methods (Cartographical), (c) Instrumental methods,

(a) Mechanical Methods: The change in scale of maps is made by the instruments. These are quite easy and simple, and can change the size of map within no time. These involve the use of proportional compasses, pantograph, camera Lucida, photostat and photographic equipments. These are of two types:

(i) **Photographical Method:** This method is no doubt the costliest of all the methods. At the same time, it is capable of giving the high degree of precision. It involves the use of standard cameras and the preparation of film negative and paper prints. It gives a little more precision than the photostat in which there is the possibility of some distortion at the edges. This method can enlarge the map of any size, and vice versa. It is costlier than photostat methods. It takes very little time in the process of enlargement and reduction of maps. It needs the good practice of handling the camera. The camera should be of high quality, rather to say that now digital cameras are being used.

(ii) **Photostat Method :** It is based on photostat machine. This machine is a camera-like device with a prism fixed to its front frame and a magazine to its back frame. It is mounted on a heavy pedestal stand. The original map is placed on an adjustable subject

or copy holder which lies in a horizontal position vertically below the prism. The prism transfers the image on to a sensitized photostat paper placed in a vertical plane in the magazine. These days photostat machines have highly developed techniques. These give the prints in colour or in black. These have also such device by which the map can be enlarged or reduced from the original one. Photostat machines are now of different types. They have the prints not only in 9″×11″ but also in 18″×24″. If a map is to be enlarged, it can be done into sections. After the proper matching of these sections, a large size of the map can be obtained. Sometimes, the difficulty in matching these enlarge sections may arise due to unequal shrinkage of the prints in developing the photostat copies.

However, photostat is a boon for researchers and students in as much as it gives a few relatively inexpensive copies in the quickest possible time. Its utility encourages each Geography Department to have a photostat machine of latest technique in its premises. This is the cheapest method to get a number of copies of the required map both in enlarged and reduced form.

(b) Diagrammatic Methods (Cartographical Methods): These methods are based on geometrical figures, so these are called as diagrammatic methods. The enlargement and reduction of maps is suitably done with the help of squares and triangles.

(i) **Square Method:** The enlargement and reduction of maps is done with the help of squares. This geometrical figure has its all four arms of equal length. The original map that is to be enlarged or reduced is divided into the grid of squares of suitable size, so that each and every part of the map is covered by these squares. Then on a sheet of paper squares are drawn representing the squares to be reproduced on the new scale proportionally larger or smaller. The number of squares should remain the same, as we have drawn on the original map. The size of squares is determined by the scale on which it is to be transferred. The following formula is used to determine the length of arm of a new square.

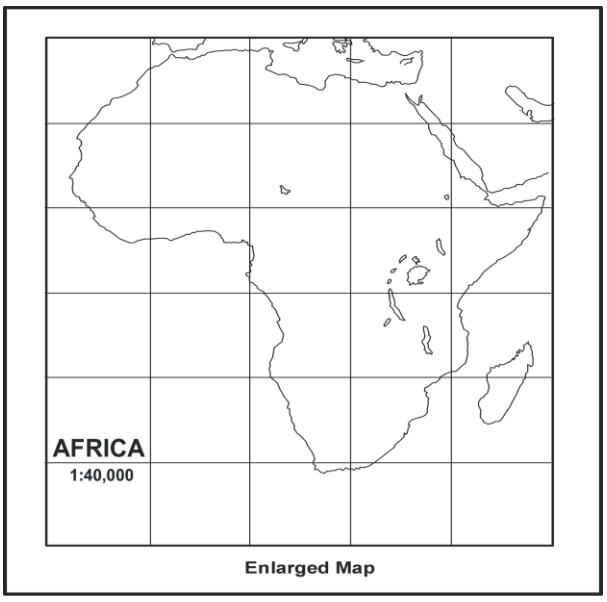

Fig. 3.1(a)

$$\text{The arm of the square of new map} = \frac{\text{The arm of square of original map} \times \text{R.F. of denominator of the original map}}{\text{The denominator of the R.F. of new map.}}$$

For example an original map is drawn on 1:15840, transfer it on R.F of 1:3980. Suppose the arm of original map is 1 cm

$$\text{The arm of the square of new map} = \frac{1\text{cm} \times 15840}{3980}$$
$$= 4 \text{ cm}$$

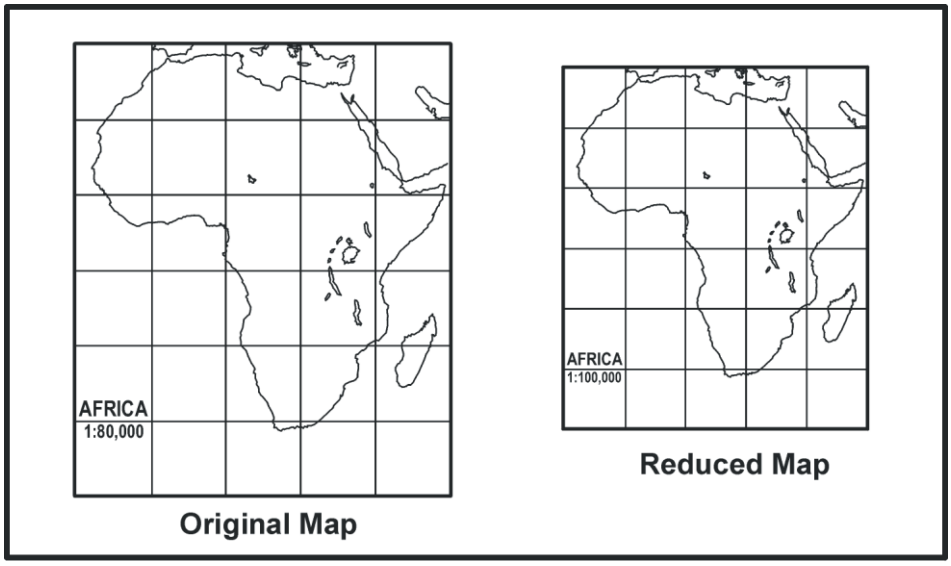

Fig. 3.1(b)

It is obvious that the size of the squares for the new map will be 4 cm. It means that it will be an enlarged map. Suppose, if we require the reduced size of the original map, in that case the following example will clarify the issue:

For example: An original map is drawn on 1:40000. Transfer it on R.F. 1:80000. Suppose the arm of the original map is 1 cm. The calculation of the new reduced map is based on the formula, given above :

$$\text{The arm of the square of new reduced map} = \frac{1\text{cm} \times 40000}{8000}$$
$$= 0.5 \text{ cm}$$

So, calculation is necessary to find out the size of the squares required on the new scale to represent the squares on the original. It is also to be noted that the number of squares of the original map should be transferred on a fresh sheet of paper proportionately larger or smaller in the same number, and the details should also be carefully transferred square by square on the reduced or enlarged map as the case may be.

(ii) Similar Triangle Method: This method is used for reducing or enlarging a narrow area, such as a road, river, rail line, canal. This method is just similar to square method,

but the difference is that, it is based on similar triangle and not on squares. The triangle here has the value of 60° of all its three angles. In this method the length of the base line of the similar triangle is to be calculated with the help of following formula:

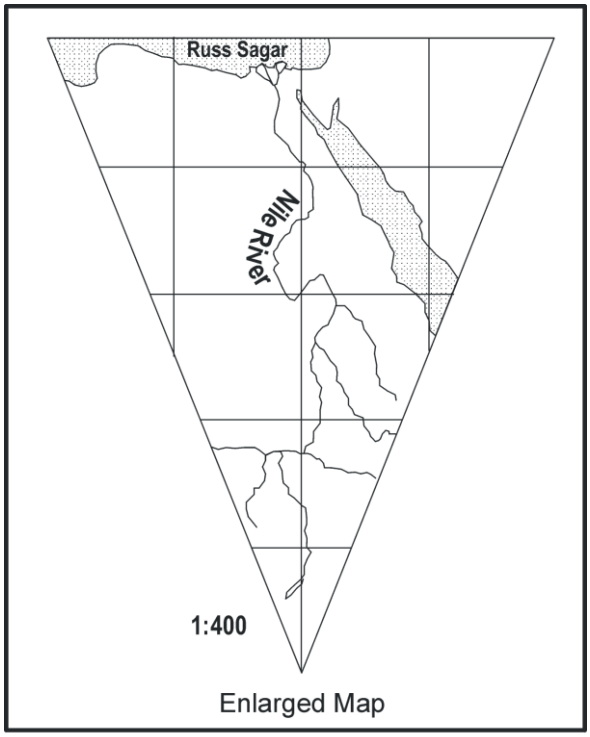

Fig. 3.2(a)

$$\text{The length of base of triangle of new triangle} = \frac{\text{The base of the original triangle} \times \text{Denominator of the original map}}{\text{Denominator of the new map}}$$

Example: A map of River Nile and its adjoining area is drawn on a scale of 1:8000. Enlarge it on a scale of 1:4000 and also reduce it on the scale of 1:12000.
Suppose the original map has the length of base 3.6 cm. The length of the reduced triangle will be: $\frac{4.0\text{cm} \times 8000}{12000} = 2.66\text{cm}$

The length of enlarged map will be= $\frac{4.0\text{cm} \times 8000}{12000} = 2.66\text{cm}$

It can also be done with the base of the original triangle divided into equal parts. A perpendicular should be drawn on the base from axis of the triangle. Both sides of the base should be divided into equal parts, and then the squares may be drawn in the original triangle.

The squares in the triangle will help us in the transfer of the map from the original to the reduced or enlarged map.

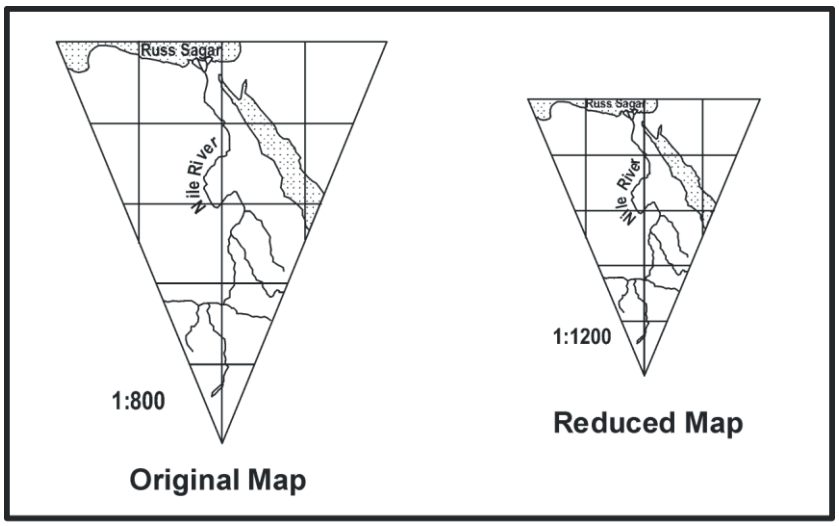

Fig. 3.2 (b)

C. Instrumental methods

These involve the use of proportional Compass, pantograph, Camera Lucida and Eidograph.

(i) Pantographic Method

This method involves the use of pantograph instrument. It is based on the principle of similar triangles or parallelogram. It is comprised by a framework of four tabular bars-two large ones and two short ones; freely hinged together at the joints to form a parallelogram. It is mounted on small wheels (castors), to give it the free movement. One corner of the arm is hinged in the fulcrum (stand), and the remaining three arms can be moved.

The instrument is generally used for reduction of maps. It can also be used for enlargement, but in doing so, a little error in the movement of the tracer point on the original map may appear in the magnified form on the enlarged copy.

This pantograph is made either of brass or aluminum. It is of different length mainly of 60, 75, 90 and 120 cm. Fig 3.3 shows the structure of pantograph. It has four arms named as A, B, C and D. These are fixed together and can be rotated in any direction. The castors fixed with these arms help in this rotation. The fulcrum is fixed to a triangular weight or circular block with needle points in its bottom, which keep it in firm position. A and B bars are of the same length. A bar has the fixed index. B arm has the sliding index. The same index is graduated on the D arm. This D arm has also sliding index. At the time of reduction or enlargement both these sliding index are fixed on the same ratio. The fulcrum, the pencil and the tracer holder are provided with clamping screws and are interchangeable. There is a cord operated mechanism to raise the pencil from the paper while one passes the tracer from one point to the other on the original map. A number of small circular weights are also provided

with the instrument which may be placed on the pencil holder to vary pressure and to get a sharp copy.

The sliding frames may be fixed to any division or ratio engraved on their respective bars to give the necessary reduction or enlargement.

B and D bars have the ratios of enlargement and reduction such as 1-2, 1-3, 1-4, 1-5 etc. when the instrument has been set accurately, the fulcrum, the pencil point and the tracer must lie in one straight line. Further if the sliding index of fulcrum, the sliding index of D and the tracer point of the fixed index on bar A has been set. Say for the reduction in the 2-1 than, the original map is being reduced to half of its size. The accuracy of the instrument can be tested by measuring the two distances, FT and FP which must bear the same ratio as the setting of the instrument.

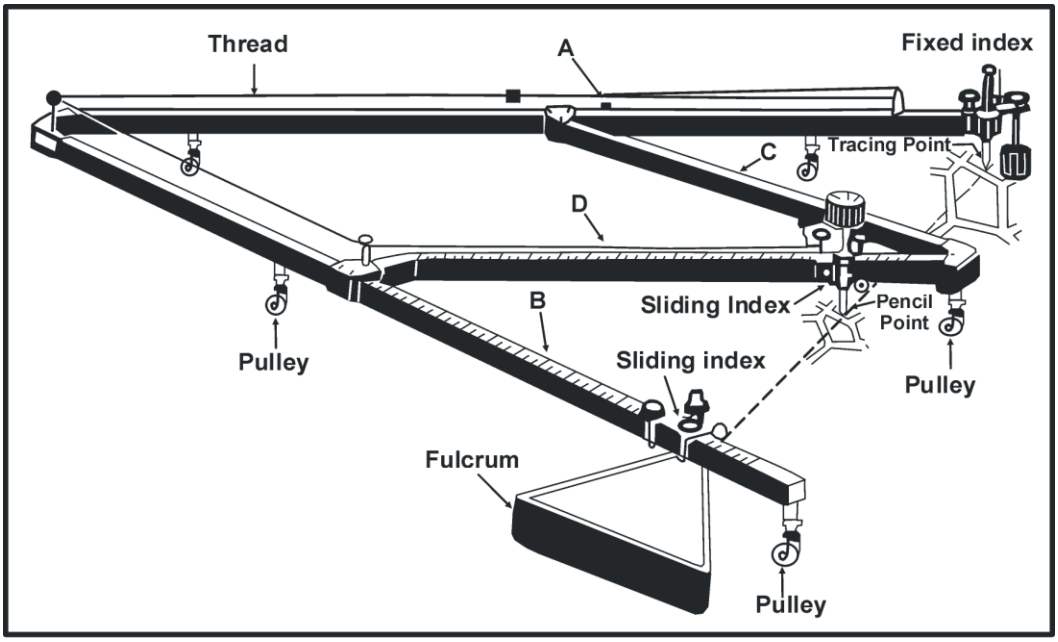

Fig. 3.3Pantograph

There are two methods for the reduction and enlargement:

(a) Erect Method (b) Reverse Method

(a) Erect Method: In this method, the fulcrum remains in arm **B**. At the reduction, the pencil holder remains in the socket of arm **D**, while at the time of enlargement the pencil holder remains in the socket of arm **A**. In the same way, the tracing holder is kept in the socket of arm '**A'** at the time of reduction, while it is kept in arm **D** at the time of enlargement.

(b) Reverse Method: This method produces the original map in reverse form as a reduced map. This is suitable for the large size maps or charts. It has the original map and traced map at a far distance. In this method, the fulcrum is kept in the socket of arm **D**. In the case of

reduction of map, pencil holder is fixed in arm **B** and the tracing holder is fixed in the socket of arm **A**. In the case of enlargement, the position of both these holders is interchanged.

(ii) Eidograph

The eidograph consists of a simple framework of three graduated bars of tabular construction-two parallel bars and one central bar. It has only one support, viz. at the fulcrum base and three joints and hence is more precise and reliable than the pantograph. There are two castor wheels at the two ends of the central bar, operated by an adjustable steel hand which always keeps the other two bars in a parallel position. Below the castors, there are attached to these two tabular slides through which pass the two parallel bars. There is also a third tubular slide through which passes the central bar and is attached to the fulcrum fixed in a circular weight. All the three bars are graduated into 100 divisions each way from the centre and the vernier on the tabular slides gives a reading to one-tenth of a division.

The working of eidograph is just similar to pantograph. It is based on the principles of similar triangles. The instrument is considered to be set when the fulcrum, pencil point and the tracer point lie in one straight line. The distances of the pencil point and tracer point should have the same ratio on measurement in accordance to the ratio of setting.

(iii) Camera Lucida Method

This camera is based on the principle of optics and photography. It is suitable for reduction of large maps especially wall maps. The original map is hanged on the wall in a vertical plane, and its reduced image is transferred through a prism on a drawing sheet of paper placed in a horizontal position virtually below the prism. To get an uniform and sharp copy of map in a reduced form, it is very necessary that the original map should be well illuminated. The reduced image on the original can be viewed through the prism. The eye of prism should be in the centre of the map. It should not have any movement while taking the image of the map, otherwise it may be distorted. The required degree of enlargement or reduction is got by adjusting the distances of the original and the drawing paper with respect to the prism if the distance from the drawing paper is more than the distance from the prism to the original map, it will lead to reduction, and if the distance is less from the prism to the original map, it will lead to enlargement.

3.4 CONCLUSION

The enlargement and reduction of maps is related to the scale of maps. It is that technique by which the maps are reproduced proportionately as per our requirement. The methods, by which this procedure can be adopted are known as photographical, cartographical and instrumental. Photographical methods depend on the use of photo camera and photostat machines. These techniques depend on the expertise of cameramen and handling of photostat machine. Cartographical and instrumental methods are followed by the geography person himself. The measurement of squares and similar triangles are easily made by the person concerned. These are the easiest and simplified methods. The instrumental methods need the acquaintance of the person concerned to handle the pantograph, ediograph.

These are quite expensive and time consuming ways to enlarge or reduce the maps and because of that, these are not so popular.

3.5 SUMMARY

The original map may be reduced or enlarged on any size. This is possible with the change in its scale. We intend to show more details in the map, and if the map is of small size, it can be enlarged with the help of certain methods and vice versa. If map is of large size and it is to be incorporated in a book or magazine, it can be reduced in the required size. The methods can be put into three categories by which the maps may be put in the required size, according to scale. These methods are known as mechanical, cartographical and instrumental.

Photographical methods are based on the use of certain machines, which can change the size of map within no time. It is the simplest method. Photography is no doubt a costly affair, as photo cameras, primarily need much investment, but such cameras can be used by a photographer in other purposes also. The camera takes the photo image of the map. It captures all the objects shown on the map. This photo image enlarged or reduced on the photo paper, gives the true picture of details of the original map. This process takes less time. It is a costlier affair. The use of digital cameras and mobile cameras has increased the utility of this technique.

Photostat machines are also based on camera device technique. These days, it is very popular. An original map is reduced or enlarged in no time. It is cheap also. It can enlarge a small size map into parts, which can be joined together very easily. It is a boon to researchers and students.

Cartographical methods are based on the geometrical figure of squares and similar triangles. In square method, the original map is covered by the grid of squares of suitable size. The arm of the square is measured, and this length of the arm is the base to determine the size of the required map. The arm of the required map is ratio of denominator of original map and denominator of R.F. of new map multiplied by the length of arm of the square of original map. The number of squares remains the same, but their size is reduced or enlarged according to our scale. The similar triangle method is applicable on such maps which are mainly in linear shape such as river or transport line. This triangle has all its angles of 60^0, and the size of the triangle or the base of the triangle is calculated on the same formula as is of square method.

The instruments which are basically designed for the change in the scale of original map are known as pantograph, eidograph and camera lucida. Pantograph is based on the principle of similar triangles. It gives good results in the reduction of original map in comparison of its enlargement. This instrument has four brass arms. It moves on castors and has fulcrum in one big arm on its left side. It has needle point in one arm and tracing point in another arm. These points are interchangeable. At the time of reduction the needle point is put on big arm and the tracing point or pencil point on the small arm. This position is reversed at the time of enlargement. So, it has two methods erect and reverse method.

Eidograph is constructed with two parallel bars, with one support. It is also based on the principle of similar triangles. The camera Lucida is based on the principle of optics and photography. It is suitable for the reduction of wall maps.

3.6 GLOSSARY

Reduction	Smaller than the original
Enlargement	Larger than the original
Photograph	A record of behavior of light with the object
Photographical	Photo taken by standard or digital camera
Photostate	A copy of the map with the help of photo camera machine
Square	All the four arms of the equal length
Grid of square	Graticule of squares
Denominator of R.F	Ground distance
Similar triangle	All three angles of the same value i.e 60^0
Pantograph	Parallelogram
Pantograph	A framework of four tabular bars
Castor	Wheels
Erect method	To reduce the map by pantograph
Reverse method	To enlarge the map by pantograph
Eidograph	An instrument of two parallel bars and one central bar
Fulcrum	A triangular weight
Camera Lucida	Reduces wall maps with the help of prism

3.7 ANSWER TO CHECK YOUR PROGRESS

1. Enlargement and reduction of maps is related to scale.
2. The size of map can be changed by so many times preferable two, three or four times.
3. Reduction of map may delete the details of certain objects.
4. Enlargement of map is helpful in addition of certain details.
5. Photographical, cartographical and instrumental are three methods to change the scale of maps.
6. Photographical methods are of two types- photography and photostat.
7. Photography is done by standard or digital cameras.
8. Photography is capable of giving the high degree of precision.
9. Photography gives positive and negative prints both.
10. Photography takes very little time in the processing.
11. Photostatis done by photostat machine.
12. Photostat machine is a camera like device.

13. The original map in the machine is placed vertically below the prism.
14. The prism transfers the image to a sensitized photostat paper.
15. The photostat machine can enlarge or reduce the original image or map.
16. Photostat can give a number of copies within no time.
17. Photostat is the cheapest method.
18. Cartographical methods are of two types – squares & triangles.
19. Cartographical methods are based on geometrical figures.
20. Square method is the most reliable and accurate method.
21. In square method, the map is covered by a grid of squares of same size.
22. The size of squares is determined by the formula, and it is proportionate to the size of original map.
23. The number of squares remains the same, either the map is enlarged or reduced.
24. Square method is based on the length of arm as all the four arms have equal length.
25. Similar triangle method is based on triangle.
26. Similar triangle method is just similar to square method.
27. In similar triangle method the length of one arm of a triangle is calculated on the basis of formula.
28. In this triangle method, the inside of a triangle is divided into the grid of squares.
29. The squares in the triangle are drawn by dividing the base line into equal parts.
30. The square in the triangle helps in the transfer of the object.
31. Instrumental methods are known as pantograph, eidograph and camera Lucida.
32. Pantograph is an instrument of four parallel bars.
33. It is fixed by a fulcrum on the table.
34. It is mounted on small wheels also known as castors.
35. It is more appropriate for the reduction of maps.
36. The tracer point and pencil point are inter changeable.
37. The reduction and enlargement is done according to graduated marks on the parallel bars.
38. In erect method, the original map in erect form as a enlargement map.
39. In reverse method the original map in reverse form as a reduced map.
40. Eidograph is an instrument of two parallel bars.
41. The working of eidograph is just similar to pantograph.
42. In eidograph, the fulcrum, pencil point and tracer point are put in one straight line.
43. Camera Lucida is based on the principles of optics and photography.
44. Camera Lucida transfers the image of map on horizontal plane.
45. Camera Lucida is suitable to reduce the wall maps.
46. Camera Lucida has the original map in the vertical form and transfers its image on a horizontal sheet of paper.

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3.10 TERMINAL QUESTIONS

1. What do you mean by enlargement and reduction of maps? Explain.
2. Why the enlargement and reduction of original map is necessary? Justify it.
3. Discuss the methods of enlargement and reduction of maps.
4. Discuss the photographical methods in detail.
5. Explain the process of photographical method.
6. Discuss the importance of photostat technique.
7. Explain in detail the square method.
8. Elaborate the similar triangle method. How it is useful?
9. Discuss the formula used in square method.
10. Which method is suitable for reduction and enlargement of linear maps? Give example also.
11. A map is on the scale of 1:40 change it on R.F 1:20 and 1:80 with the help of square method.
12. A river is drawn on a map with scale 1:1000. Enlarge it on the scale of 1:500 with the help of similar triangle method.
13. A map of India is drawn on a scale of 1:10,00000 and the size of a square is 1 cm. Reduce it on the scale of 1:20,00000.
14. The base of a triangle is 5 cm and a road is drawn on that base. Draw it on the triangles of 2.5 cm and 8 cm.

BLOCK-2
REPRESANTATION OF PHYSICAL DATA

UNIT-IV: METHODS OF SHOWING RELIEF

4.1 *OBJECTIVES*

After studying this unit, you will be able to-

- Understand different methods used for representation of relief features.
- Understand the development of qualitative methods landforms and landscapes on the earth surface in recognizing typical landform patterns in the selected areas.
- Understand slope and gradient of the area concerned with the help of these methods.
- Understand the development of mathematical or quantitative methods based on mathematical inputs.
- Find out the advancement in the methods of studying relief features in the recent past. In GIS environment techniques are used to prepare three-dimensional features of the earth surface.

4.2 INTRODUCTION

To identify and map the different relief features of the earth surface has always been a challenge for geographers especially cartographers. Every method has its merits and demerits and there is always a scope left to find out a new method. The need to map the different features may be made for a variety of reasons. The systematic observation of the earth surface, interpreting of the relief features of different parts of the earth surface, their implementation in various field areas and their representation accordingly is a significant part of geographical studies

In this unit, you will study about relief, which has been widely studied, analyzed and interpreted by generations of geographers. The word includes one of the most obvious irregularities of the earth's surface, altitude, the third dimension of geographical space. Present day relief of any part of the earth surface is the result of the dynamic processes active in that particular part of the earth surface. It is also necessary for you to understand that though the word relief is much older, development of geomorphology in the nineteenth century led towards not only the description and analysis of landforms but also showing the landforms of different size, shape and height with more accuracy and effective manner. As a result, different methods to show relief features or topography of different parts of the earth surface developed faster in different parts of the globe.

The term topography originated in ancient Greece and continued in ancient Rome as the detailed description of a place. The word comes from the Greek words as topos, which means, "place" and graphia, which means "writing". In classical literature, this refers to writing about a place or places. In Britain and in Europe in general, the word topography is still sometimes used in its original sense. Here, in this unit, we are more interested in explaining relief as well as the methods, which show relief in geographical studies. For this, it is necessary for you to know all the possible ways to understand the relief features as not only they are at present but also how they were in the past and how they can change in the future. If we go through past studies, we can find a common interest starting related with the mapping of relief or topographic surveys and mapping started for defence purposes. The

earliest detailed in the United States were made by the “Topographical Bureau of the Army,′′ formed during the1812 war which later on in 1938 became the Corps of topographical Engineers. After the U. S. Geological Survey assumed the work of national mapping in 1978, the term topographical remained as a general term for detailed surveys and mapping programs, and adopted by most other nations as standard. In France De la Noë, a topographer and a lieutenant colonel published his work on the "forms of terrain" and, in this way contributed to the development of cartography for military usages. Detailed military surveys in Britain (beginning in the late eighteenth century) were called Ordnance Surveys, and this term was used into the 20th century as generic for topographic surveys and maps. In the 20th century, the term topography started to describe surface description in other fields too. Drastic changes came with the twenty first century computer cartography, GIS, and more and more work is being done for improvement in accuracy in this field all over the globe. You must have understood up to now that studying the different relief features is an essential part of understanding geography. In this reference you must also know that a high plateau may have a high altitude but a low relief while mountains in the coastal areas may have only a modest altitude but great relief. In simpler words, in geographical studies, understanding relief features is very important. The horizontal and vertical dimensions of the earth surface referred as terrain have its impact on different aspects of human life. Because of this reason, it has been a major topic of interest for geographers. Understanding the terrain of an area enables the understanding the boundaries of drainage basins, water and sediment flow in channels. Understanding relief also supports soil conservation in agricultural areas. Contour farming leads towards sustainable agriculture in hill slopes. The relief of that particular area up to a great extent determines changes in weather and determination of climatic regions. Two areas geographically close to each other may differ radically in precipitation levels or timing because of differences in elevation or a rain shadow effect. In aviation, precise knowledge of differences in elevation is required. Terrain will also affect range and performance of radars and terrestrial radio navigation systems. Not only this, a mountainous terrain or hilly region can have its impact the implementation of a new aerodrome and the orientation of its runways. Detailed terrain studies can provide details of surface water flow and distribution of water bodies over the given area. Some of these examples may be helpful for you to realize the significance of understanding and mapping relief features while studying geography. In most of geographical studies, topographic maps are widely used for showing relief. Over a large area, it can affect water and climatic patterns. In this way, we can understand the significance of relief features and different methods for mapping them from the beginning of map making up to now.

4.3 *MEANING OF RELIEF*

All of you know that the earth features are different in elevation. The definition of relief is complex because it requires reference to several parameters. It is indeed at once the expression of altitude, of slope, and of form, while at the same time reflecting the relationships that exist between these different elements. There is a Chinese proverb that expresses this very well: if there were no mountain, the plains would not be seen. Indeed, associating relief solely with high altitude zones is reductive; even if slope, shape and altitude

are most prominent in mountainous regions but areas comparatively plain parts of the earth surface also have different relief features. Thus, you must have understood that all portions of the terrestrial surface have relief. In simpler way, we can say that the difference in between the elevation of the highest and lowest points above the mean sea level is relief. In geography, relief refers to the highest and lowest elevation points of an area. For those studying geography and want to understand relief, identifying different relief features and showing them on maps is equally important .We can say that:

- Mountains and ridges are the highest elevation points above the earth surface.
- Valleys and other low-lying points are the lowest ones.

To understand the topography of an area, first one must know about relief. Local relief refers specifically to the quantitative measurement of vertical elevation change in a landscape. It normally refers to a limited area. Since few areas have a consistence elevation in their topography, a relief map represents the increase and decrease in elevation. These classify landscapes by scale, from enormous ocean basins and continents down to local hills, spurs, cliffs, valleys, gorges and river terraces.

In order to study different earth features in a systematic way, geographers have divided landforms into three orders of relief as :

- The first order landforms include huge continental platforms and ocean basins.
- The second order of relief includes continental masses, mountain masses, plateaus, plains and lowlands.
- The third order of relief includes individual peaks, cliffs, valleys, hills, spurs, gorges, caves, moraines, cirques, ripples, beaches and numerous others.

The different types of relief result from the geodynamics of the globe visible as fractures, faults, earthquakes volcanoes, river erosion, glacial erosion, wind erosion etc. The sum of all these processes enables an understanding of what should be attributed to one or other type of geodynamic, what relates to primitive forms and what to derived forms. Present-day reconstitutions of paleo-climates, the quantification of different processes, and the understanding of time scales in the elaboration of forms and formations, all provide insight into the history and origins of characteristics we can observe today. The many aspects of the study of relief has led researchers, and in particular geographers, to make a series of distinctions.

4.4 *METHODS OF SHOWING RELIEF*

Representation of relief features on the plain paper has always been a challenge because there is still scope remaining to find out an ideal solution. In the beginning, topographic survey information was based upon the notes of surveyors. Delineation of boundary used to derive from local cadastral mapping. Other local sources were also used to derive naming and details of the area. However, in the latter stages of surveying, errors and contradictions were resolved for map making. As the art of map making developed over the years, different ways

of showing relief features on the maps were developed too. The surface of the earth, which is represented through maps, has its limitations because-

- The features of the earth, which show relief, are three-dimensional
- We show the location of features in two-dimensional space mostly as you have seen when you go through map reading
- Now, with the help of modern computer cartography, the three dimensional quality of the earth surface can be visualized up to a great extent

You must understand that the best way to show various relief features on maps with more accuracy has yet to be found .The greatest challenge for modern mapmakers is to produce maps which not only picture the relief forms but accurately portray it quantitatively as well too. Methods of showing relief features largely depend upon the scale of a map.

According to scale, maps are divided into:

- large scale maps
- Small scale maps.

You must know the basic differences in between these two types of maps. We can say that:

(i) Smaller areas with accurately shown relief features are known as large-scale maps .The large-scale maps show the nature and characteristics of relief features more precisely in a map while

(ii) Larger areas, which show fewer details, are known as the small-scale maps. On small-scale maps, all the relief features are generalized.

How do we show a particular relief feature depends largely on our purpose. Why is it important to show that particular relief feature at a given place at a given point of time? These questions obviously strike in the mind of a person when he or she uses a particular method for the representation of relief features. The development of different methods and techniques indicate the long-term process, which is the result of the efforts of countless people who are trying to improve the methods of representing the relief features through their long journey from hachure lines up to digital elevation models and topological modeling.So far, varieties of approaches in different or combined forms are used to represent relief features on the earth surface. In the early 18th century, hachuring was replaced with a scientific form of hill shading. Hill shading resembles a light and shadow effect. Valleys and the sides of mountains appear as though they are cast in shadow. This is a visually striking method, which is ideal for providing an overall view of the relief of an area. Hill shading, however, does not show height, which means that it, is no more accurate than hachuring. Spot heights are used to show the exact height of the land at a particular point. Spot heights are depicted using a dot (or triangle) and a corresponding number, which represents the altitude (height above sea level) at that point. While spot heights provide accuracy in elevation, they do not provide much information about the shape of the land. This is why they are often used in conjunction with hill shading, layer tinting and contour lines. It depends on the time, accessibility purpose and study area that which method has to be used. You can better

understand the development of the methods and techniques in the representation of relief features as follows:

4.4.1 Pictorial Representation

These are the primary methods used for the representation of relief from the very beginning when the art of map making was in initial stage. With the help of simple curves, and drawings relief features were shown. In 1503, a French thinker De Vinci started an effort with drawing small hill shaped features. After nearly one and a half century, a resident of Switzerland, Gygers made a successful effort by drawing, lines resembling hachures with shading. Slowly, efforts started all over Europe to develop such methods.As you can understand, visible effects are dominant in such type of processes. Hachures, hill shading, layer shading and tinting are some of these methods.

4.4.1.1 Hachure

The hachure line method is for depicting relief (invented by Saxon Major Lehman) and is adopted for most of the military surveys in the nineteenth century.The small lines drawn down the slopes in the direction of the steepest gradient are known as Hachure. The earth features including mountains, hills, terraces, and other landforms having height could be easily marked with the help of hachure lines. Besides this, drawing these lines requires great patience and very hard work. Qualitative and relative representation of earth features the method whichcannot determine accurate height of the points or places and exact information regarding the slope and slope values.

Fig. 4.1 Hachure lines

The thickness of the lines determines the slope. You can clearly identify the slope by seeing the thick and thin lines (Figure-4.1). Where you see the thicker lines drawn on the map, you can understand that the area has greater slope while the thinner lines on the map show the gentle slope areas. Completely white colour represents plain areas. In the areas of gentle slope, the hachure lines are less dark. The areas of steep slope (more than 45°), are shown with black colour.

4.4.1.2 Hill shading and layer colouring

You must know that hill shading, a technique borrowed from artists, appearance of a map by creating the illusion of depth. The method of hill shading is based on the hypothesis that light is thrown upon the area. You may also know the fact that light thrown from any side records the shadows that might fall over an area on a particular map (Fig.4.2). The vertical light slopes appear darker as they occupy larger areas. In most of the maps prepared light come from the northwestern side. If one assumes so, the southeast sides of hills away from the light are shown dark and the tops of hills and lower slopes are shaded lightly, and plains are left without shading.

Layer colouring, as you can see in figure 4.3is a method used to show areas of different elevation with certain colours. While spot heights show the heights of some certain points, to provide an overall image that conveyed height a technique called Layer colouring was developed.

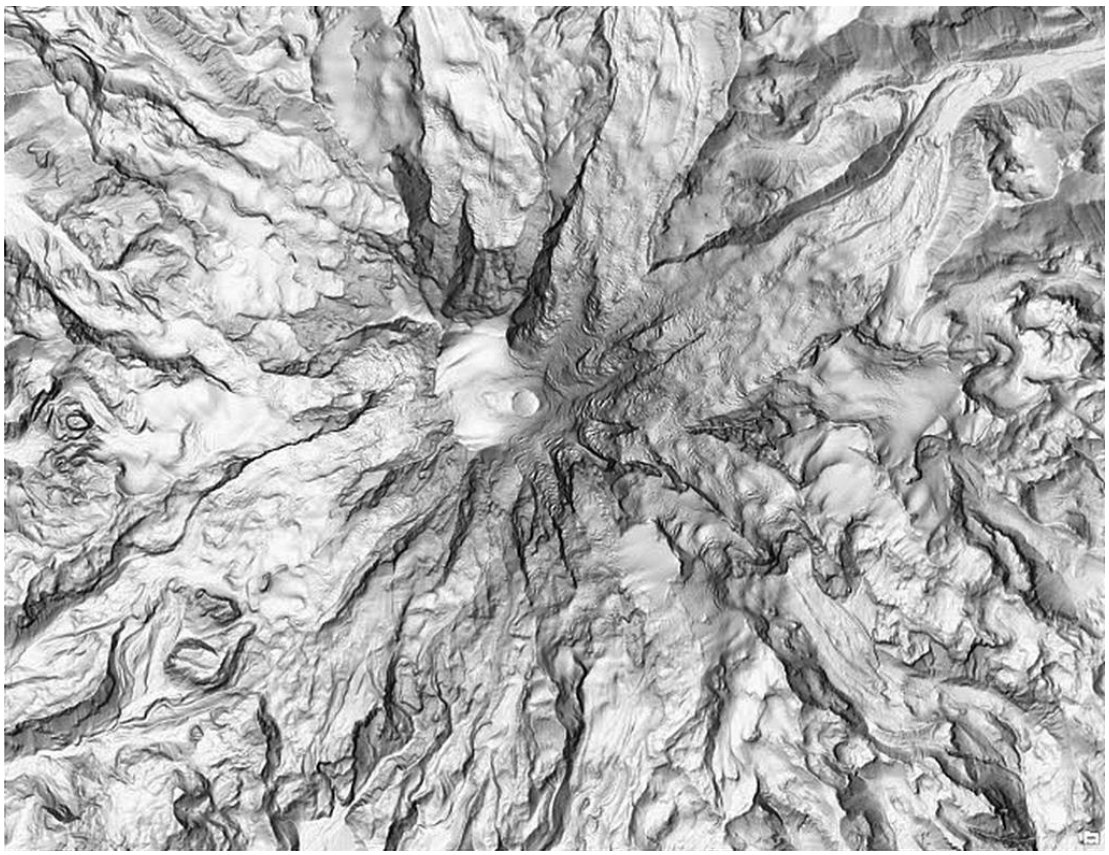

Fig. 4.2 Hill Shading

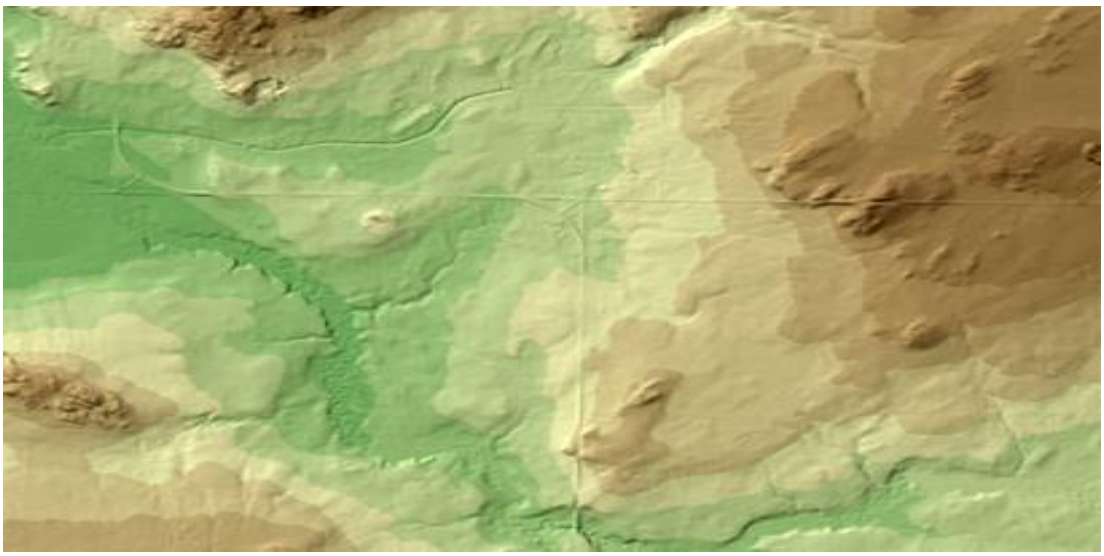

Fig. 4.3 Layer coloring

4.4.2 Quantitative or Mathematical Methods

With the development of cartography, search for better methods for representation of relief features continued. In the eighteenth century, the efforts started from France. These days these methods have become very popular in representation of relief. In these methods the spot heights are used for determination of heights of a particular place or area. Using spot heights interpolation of contours is possible which helps in representing relief with more accuracy. Some of the mathematical methods used in showing relief are as follows:

4.4.2.1Spot heights

Spot heights mark the exact height of a particular point or places.

- This exact point on a map with an elevation recorded with the help of vertical datum.
- You can call it a standardized geodetic reference point.
- The datum is normally the mean sea level (MSL) that can be used in cartography. Spot heights provide accuracy in elevation.

They also provide more information about the surfaces in between the contours. A number preceded by a dot presents these. In Figure 4.4, you can see part of a contour map in which the highest top (spot height) is 245 meters. They represent absolute heights because they are marked with careful determination and precise calculations relative to the standard datum line. As you must have understood their significance regarding the exact location and height of any particular place, they are alone themselves less significant in showing the relief features of a particular area or region. Therefore, used with the combination of other methods.

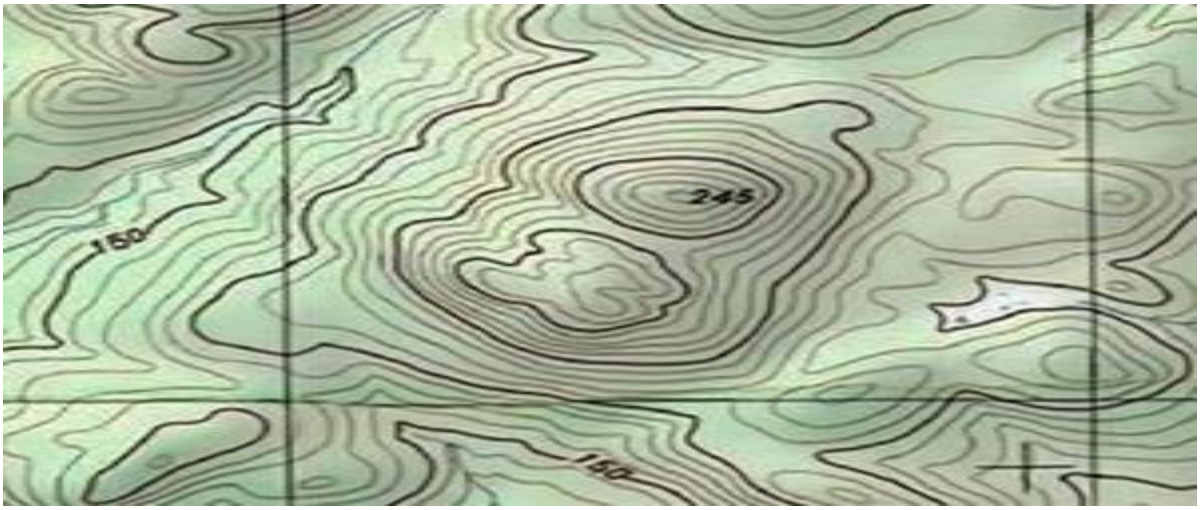

Fig. 4.4: Spot heights

4.4.2.2Bench Marks

The term Benchmark is an item used to mark a point as an elevation reference. They are:

- Frequently, bronze or aluminum disks are set in stone or concrete, or
- On rods deep into the earth to provide a stable elevation point.

A government agency or private survey firm typically places benchmarks, and many governments maintain a register of these marks so that the records are available to all. These records are usually in the form of a geographically searchable database (computer or map-based), with links to sketches, diagrams, photos of the marks and any other technical details. Government agencies that place and maintain records of benchmarks include sometimes, 'BM.' or Bench Marks is written within them as shown in Figure4.5.

Fig. 4.5 City of Toronto benchmark disk in Canada.

4.4.2.3 Trigonometric-Point Method

In this method, base stations are established in the area at some selected distances. At these stations, spot heights are marked with triangles. These stations can have distances of several kilometers. The curvature of the earth has also kept in mind when these stations are established.

4.4.2.4Contours

A contour is a line drawn on the map through all the places situated at the same height above the Mean Sea Level. With having a look on the given contour map, slope of that particular area can be determined. If the contour lines are far apart, the slope of the area is gentle.

Fig. 4.6 Contour lines

In Figure 4.6, you can see the contour lines with a contour interval of 50 meters. As the contour lines come closer to each other the slope becomes steeper. Wherever the contour lines are very close, it is clear that there is a steep slope or the area is a hilly region.

With the help of contour lines, exact slope angles can also be determined. This can be made possible with the help of vertical angles and horizontal distances between two points marked on a particular map. The contour lines are drawn at a certain interval. Normally, for Survey of India Topographical sheets with a scale of 1/50000 the contour lines are at the interval of 20 meters. You can also notice a bold line at 100 meters interval in the Topographical sheets published by Survey of India. The contour lines drawn on maps also clearly help to identify relief features such as river valleys, hilltops, cols knolls etc. However, it is not possible to show places having less height than the contour interval or lower relief areas on the map with the help of contour lines still contours are one of the best methods to show the relief features. With the help of contour lines; it is possible to draw cross section which shows an area in a more realistic way. With the help of a cross-section on a contour map, you can draw a diagram which can show the particular landscape in a realistic manner.

4.4.2.5 Slopes and gradients

You can find the slope in between the two contour lines. First you will have to find the horizontal distance between them. Suppose there are two points, say; a and b., (Figure4.7.) as follows:

- Find the horizontal ground distance.
- Lay a ruler crossing exactly perpendicular to the contour lines and measure the distance.
- Convert the distance to meters.
- After doing this; find the rise or vertical distance.
- Identify the elevation of the first and the last contour line on your line.
- Subtract one from the other to find the rise in meters. Calculate the percent slope or the degrees slope using the equations given below.

Vertical distance/ Horizontal distance × 100= % slope

Vertical distance/ Horizontal distance (Tan) = slope degree

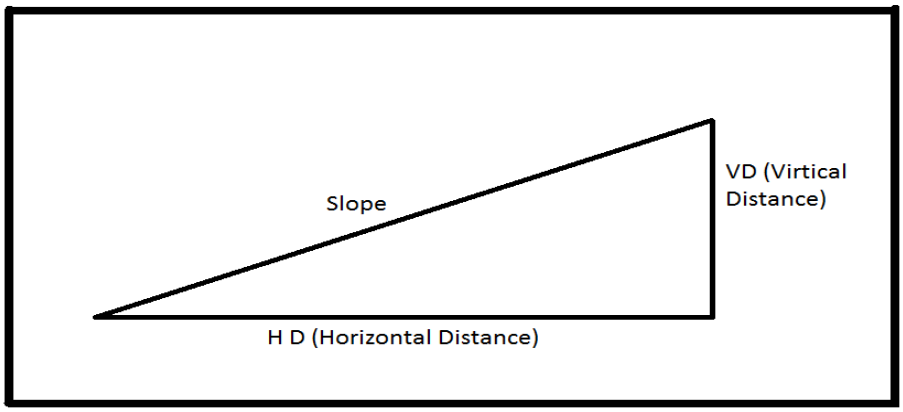

Fig. 4.7 slopes

Further, you can prepare a slope map using GIS technique .you can see a slope map of tehri reservior(Figure 4.8) .The slope map has been prepared 1n which the slope of the reservior area has been divided into five categories.You can easily visualize the terrain of the reservior area. This types of maps can be further used for landuse planning and management.

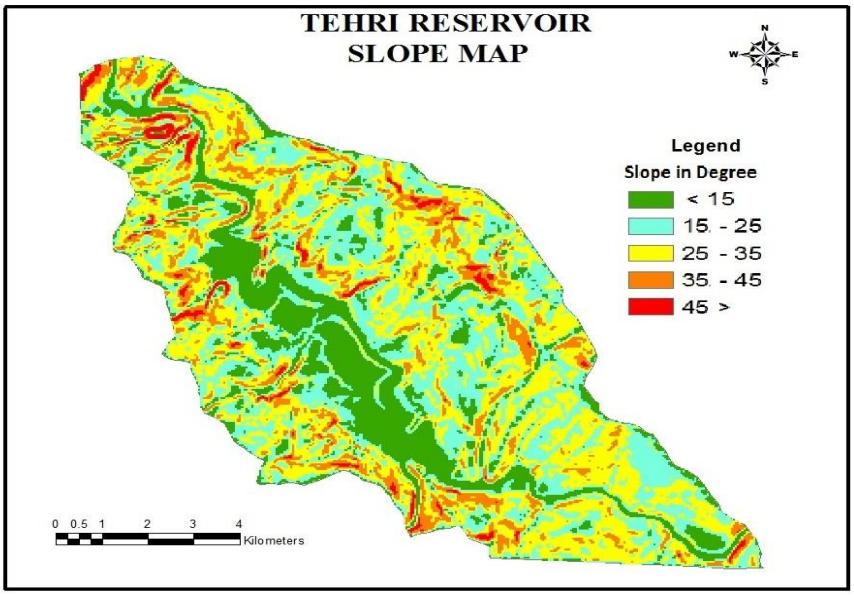

Fig. 4.8 Slope map of Tehri Reservoir

You can also show the relative relief of a landscape unit with the help of contours. Relief representation is now possible with the help of GIS techniques .The given map shows the relative relief of the Khanda Gad watershed in the mountainous region of the Himalayas (Figure 4.9).

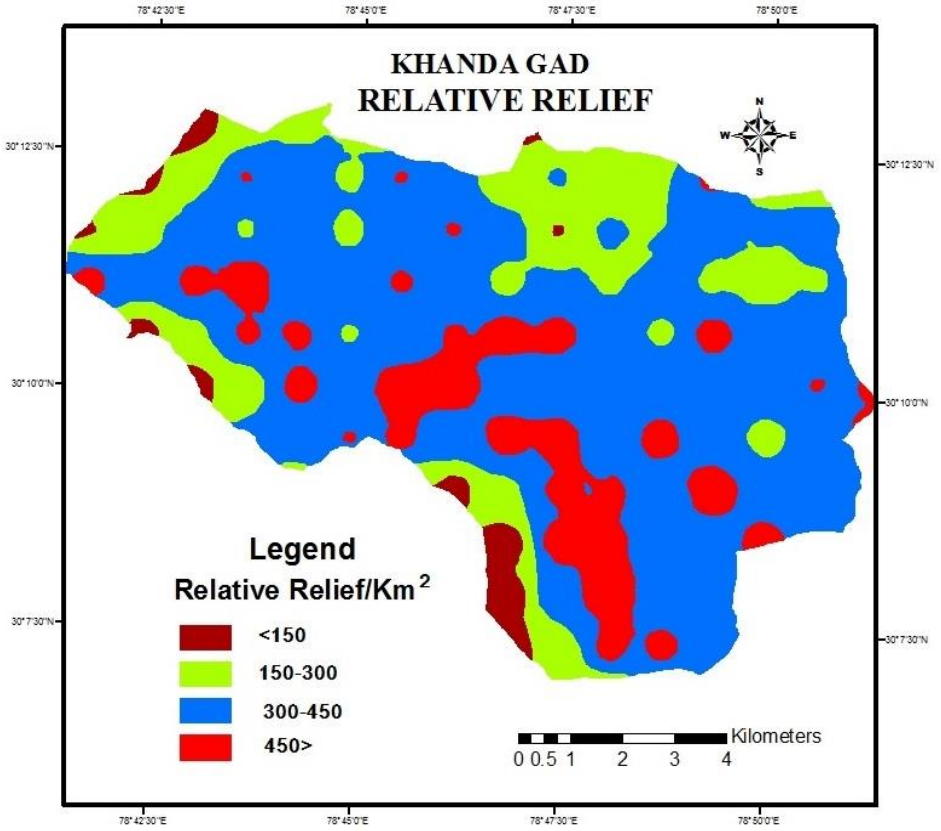

Fig. 4.9 Relative relief map of Khanda Gad watershed

4.4.3 Mixed methods

In modern times, map making is not possible with the help of a single method. The modern techniques are often used in conjunction with hill shading, layer tinting and contour lines. With the advancement of computer based technologies in the modern times, representation of relief features has become much easier. Still, the other advanced techniques somehow rely upon basic mapping techniques in preparing maps to solve specific problems related to representation of relief features to some extent. A combination of field survey and lab-work using advanced computer cartography can be more useful as you can see in the following methods:

4.4.3.1 Layer shading and tinting

This is the method in map-making by colouring the required area with combination of some contour lines. This method is applicable mostly to small-scale maps as these are generalized largely.

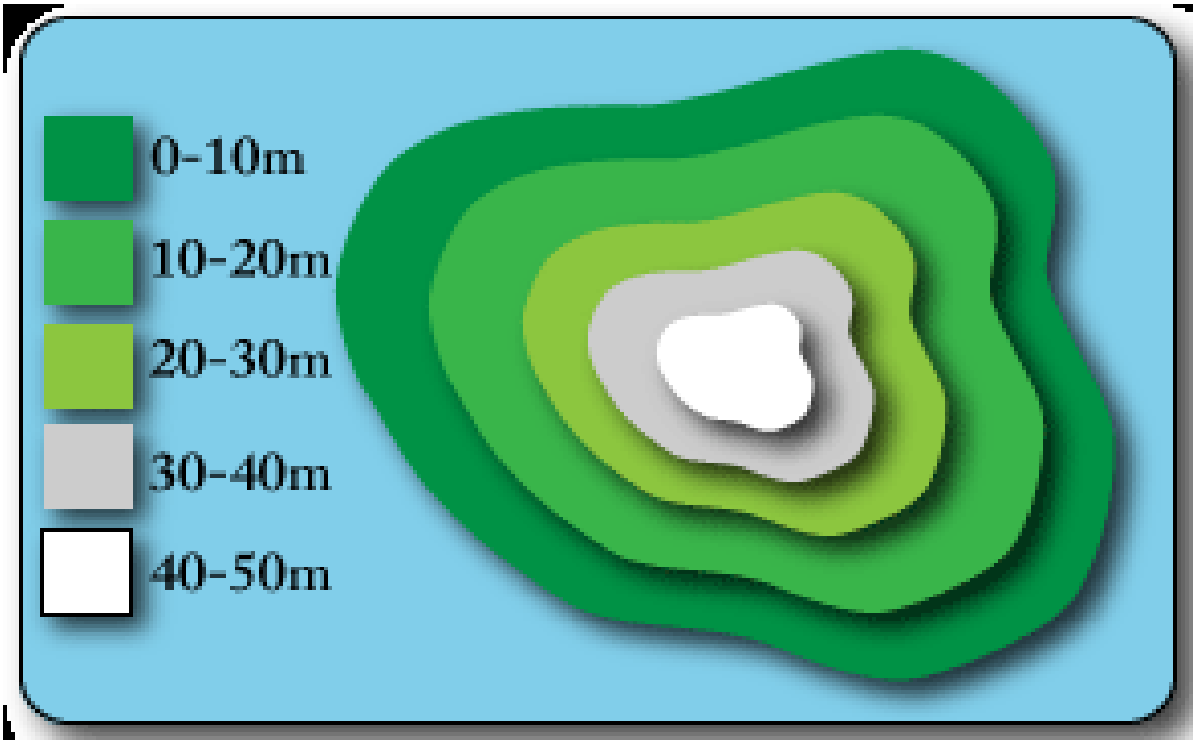

Fig. 4.10 Layershading

After drawing a few contour lines, in between which the intervals increase progressively with an increase in height. You can better understand it with the help of Figure 6, which shows :

- Contours for 0-10 meters, 10-20 meters, 20-30 meters, 30-40 meters, 40-50 meters show layers with the help of different colours shown in the index.
- With the help of this method, the whole map is divided into belts.
- These belts are coloured on the basis that one is looking at the area from above and the colours are chosen accordingly.
- Low areas are supposed to be less warm and normally coloured with green and the higher are assumed to be warmer and are coloured in white or brown.

This method is though popular but it is not accurate. Let us understand how this method has its demerits:

- Colours chosen to show comparatively plain areas are shown with the help of green colour in the map.
- Green colour is normally associated with forest cover so it may cause confusion while studying details of the map.
- Arid and desert areas are generally located in low altitudinal zones. You may understand the point how one may confuse when these deserts are shown with green colour because of low attitudes while there is no vegetation at all in these arid regions

The method is used by news print media to distinguish the physical and cultural features of different parts of the earth surface and report easily about the transport system, art culture or any other activity related with space and time.

Fig. 4.11

4.4.3.2 Computer Cartography

In modern times these techniques are slowly replacing the older methods of map making. Some of the modern computers mapping techniques are used in the depiction of relief these days. These are based on GIS and Remote sensing techniques. With the help of advanced computer based cartography and use of aerial and satellite imagery are being used in producing good quality maps which can show relief features in an attractive manner for visualization of the terrain more clearly and effectively. In Figure4.11 you can see a picture which is prepared with the help of satellite imagery and GIS technique.In this picture Spot 1 is a moraine,which had created a block where a basin formed and allowed the build-up of water. The local people call it teh Chorabari Tal. Spot 2 is where water flowed through the breached moraine and Spot 3 has water overtopping the moraine on the other side as well. Spot 4 indicated heavy erosion, suggesting that the flow carried a huge volume of water. The dark patch to the right of Spot 5 suggests the formation of a new depression, which could have turned into a small-sized lake because of the heavy rainfall.Thus with the help of satellite imagery and field data collection,possible steps can be taken to assess the damage due to di saster which took place at Kedarnath temple,Uttarakhand in the recent past.

The digital elevation model (DEM) is a raster-based digital dataset of the topography of all or part of the Earth surface. DEMs may be derived from existing paper maps and survey data, or they may be generated from satellite or other remotely sensed radar or sonar data.These are based on GIS and computer mapping techniques. You can see a Digital Terrain Model of

Takoli Gad watershed (Figure 4.12) which shows the location of North Almora Thrust clearly in an attractive manner.

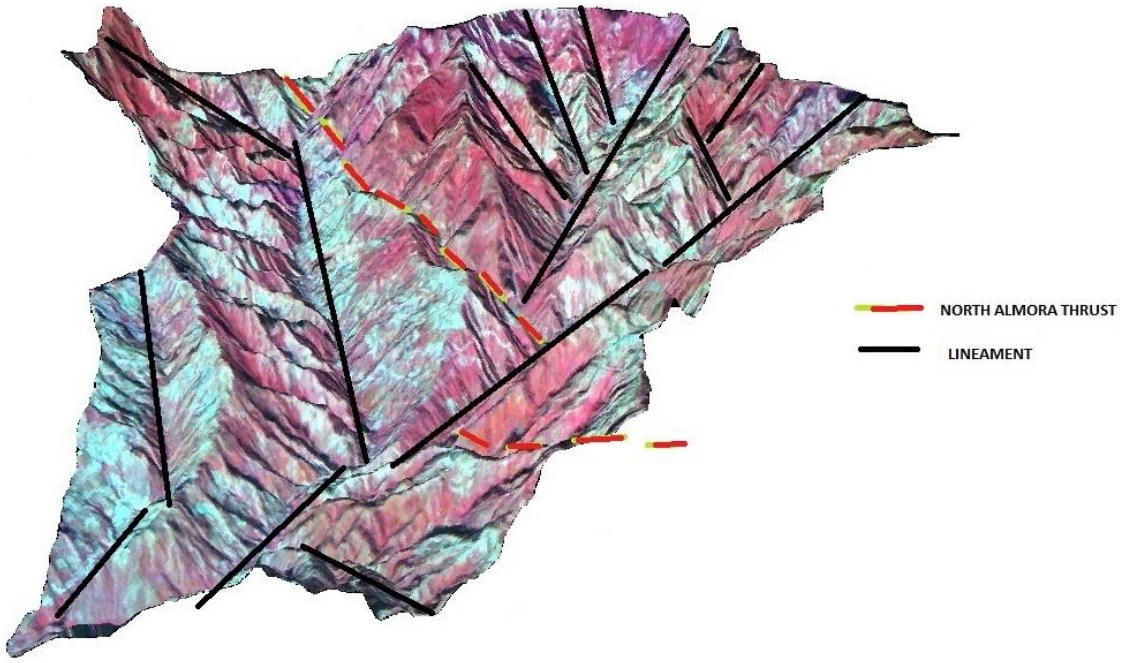

Fig. 4.12 Digital Terrain Model of Takoli Gad watershed

Photogrammetry is a measurement technique used to identify not only relief features but to depict land use and land cover of a particular area. Three dimensions of an object can be determined by the measurements made in two or more photographic images taken starting from different positions normally from different passes of an aerial photography flight. With the help of two common points identified on an image, a line of sight can be built from the location of the camera. The intersection of its rays or triangulation determines the relative three-dimensional position of the point. Further, known control points can give these relative positions absolute values.

4.5 CONCLUSION

As all of us know, relief has its impact on every phase of human life and largely determines its suitability for human beings. To show the irregularities of the earth surface in plane paper has always been a challenge for geographers especially cartographers. The need to map the different topographic features may be made for a variety of reasons. The start was from military surveying planning.

You must have understood up to now that Relief representation is very important for people studying geography because elevation of the land in conjunction with information about the slope and shape is very useful for them. Studying contour map may be further useful for geography students interested in understanding the earth features, which are different in elevation all over the globe in a better way with help of regional or site-specific physical characteristics including their height, types of slope characteristics etc.

The significance of representation of relief features in multiple field areas such as mapping of hazardousness or risk zones, slope instability, flood zones, watershed management and land use planning which may help in monitoring of the related processes active in different landscapes and landforms is understood by researchers and scientists in different field areas. With the application of modern tools and techniques, it has been possible up to a great extent now to show different forms of terrain with GIS. Terrain is commonly modeled either using vector triangulated irregular network (TIN) or raster image.

Combination of Remote sensing, aerial and satellite imagery photogrammetry, satellite radar mapping are been employed for complex mapping needs of the present times. These techniques are not only helpful in representation of relief features but also can help solving many practical problems in geomorphology, hydrology, disaster management and environmental planning.

4.6*SUMMARY*

Representation of relief features on maps has always been a challenge because there is always a scope remaining to find out an ideal solution. From the notes of surveyors and local sources in the beginning, the art of map making developed over the years and different ways of showing relief features on the maps were developed too. The surface of the earth, which is represented through maps, has its limitations. Representation of relief and slope analysis started with the small lines drawn down the slopes in the direction of the steepest gradient. These are known as Hachure. These lines could not determine accurate height of the points or places and exact information regarding the slope and slope values. Contour lines were invented later to solve this problem. With the help of contour lines exact slope angles can also be determined. This can be made possible with the help of vertical angles and horizontal distances between two points marked on a particular map. The contours are drawn at regular intervals. To show different relief features of the earth surface, "topographic maps′′ are often used as base maps to show relief features for different purposes. Different features are marked in such maps. Spot height is an exact point on a map with an elevation recorded above a given datum which is normally the mean sea level. Bench Marks are used to mark a point as an elevation reference. In the map making process, pictorial presentation, hill shading, layer shading and tinting were developed through years. With the help of advanced computer based cartography and use of aerial and, satellite imagery, aerial photography, photogrammetry good quality maps are being produced which can show relief features in an attractive manner for visualization of the terrain more clearly and effectively. The digital elevation model (DEM) is a raster-based digital dataset of the topography of all or part of the Earth surface. DEMs may be derived from existing topographic maps and survey data, or they may be generated from new satellite or other remotely sensed radar or sonar data. These are based on GIS and remote sensing techniques. However, contours are one of the most significant medium for the representation of relief features of the earth surface and all the other advanced techniques somehow rely upon contour maps or topographic maps to solve specific problems related to representation of relief features to some extent.

4.7 *GLOSSARY*

Hachure: A short line used for shading and denoting surfaces in relief (as in map drawing) and drawn in the direction of slope.

Hill shading: A shaded relief (levels of gray) on a map, just to indicate relative slopes, mountain ridges, not absolute height.

Layer shading: Layer shading, or layer colouring, is just a way to show elevation changes on a map. It is used like contour lines on maps that show larger areas, like whole countries.

Photogrammetry: The use of photography in surveying and mapping to ascertain measurements between objects.

Triangulated irregular network (TIN): A digital data structure used in a geographic information system (GIS) for the representation of a surface.

Digital elevation model (DEM):A is a digital or 3D representation of a terrain's surface — commonly for a planet (including Earth), moon, or asteroid — created from terrain elevation data.

Geographic Information System (GIS): A system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.

Relative relief: Difference between summit level, the highest altitude for a given area, and base level, lowest altitude for a given area.

Drainage pattern: A pattern formed by the streams, rivers, and lakes in a particular drainage basin. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land.

4.8 *ANSWER TO CHECK YOUR PROGRESS*

4.8.1(Self check Questions)

1. What do you understand by relief?
2. In which country did the term topography originates?
3. In which type of geographical studies does study of relief helps us significantly?
4. Why mapping relief is important for geographers?
5. Why showing the irregularities of the earth surface in plane paper has always been a challenge for geographers?
6. Which processes are responsible for the different types of relief features over the earth surface?
7. Which are the highest relief features?
8. What is local relief?
9. Fill in the blanks with appropriate words from below.

i) Earth features are .....in elevation

ii) Geographers have divided land forms into..... Orders of relief.

iii) Methods of showing relief largely depend upon the .....of the map.
iv) The ……..maps show the earth features more precisely.
v) All portions of the terrestrial surface have..... relief, scale, different, three, large-scale.

10. What are hachures?

11. What is a contour?

12 Define digital elevation model (DEM).

4.8.2: (Answers to self-check Questions)

1. Relief means Difference in elevation .This is one of the most obvious irregularities of the earth's surface, altitude, the third dimension of geographical space.
2. The term topography originated in ancient Greece and continued in ancient Rome as the detailed description of a place.
3. Study of relief help us significantly in agricultural activities including contour farming, which leads towards sustainable agriculture in hill slopes. The relief of that particular area up to a great extent determines changes in weather and determination of climatic regions. Apart from this, relief determines many activities related to development of human society.
4. Studying relief is important for geographers because the horizontal and vertical dimensions of the earth surface. It have its impact on different aspects of human life. Over a large area, relief can affect water and climatic patterns that are part of geographical studies. That is why it has been a major topic of interest for geographers.
5. The surface of the earth is three dimensional having length, width and height; while maps have only two dimensions (length and width).Therefore, showing the irregularities of the earth surface in plane paper has always been a challenge for geographers.
6. The complex combined effect of the dynamic processes active in that particular part of the earth surface are responsible for the different types of relief features over the earth surface
7. Mountains and ridges are typically the highest elevation points.
8. Local relief refers specifically to the quantitative measurement of vertical elevation change in a limited area.
9. i) Earth features are <u>different</u> in elevation
   ii) Geographers have divided landforms into <u>three</u> orders of relief.
   iii) Methods of showing relief largely depend upon the <u>scale</u> of the map.
   iv) The <u>large-scale</u> maps show the different earth features more precisely.
   v) All portions of the terrestrial surface have <u>relief</u>.
10. Hachures are the small lines drawn down the slopes in the direction of the steepest gradient.
11. A contour is a line drawn on the map through all the places situated at the same height above the Mean Sea Level.

12. The digital elevation model (DEM) is a raster-based digital dataset of the topography of all or part of the Earth surface.

4.9 REFERENCES

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4.10 *SUGGESTED READING*

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4.11 *TERMINAL QUESTIONS*

1. Define spot heights and benchmarks.
2. What is the role of hill shading in the representation of relief?
3. What are quantitative techniques? Define their role in the representation of relief.
4. Which relief features on the earth surface do the contour lines clearly identify on maps?
5. What is Layer colouring method?
6. How this method is applicable in the representation of relief?
7. Can you find the slope of an area with contour lines? Explain.
8. What are computers mapping techniques. Define their role in relief representation.
9. Explain Photogrammetry as a technique of cartography.
10. What is the significance of relief representation for geographers?

UNIT- V REPRESENTATION OF RELIEF FEATURES BY CONTOURS

5.1 OBJECTIVES

This chapter explains how representation of different relief features is possible with the help of contour lines of any known surface.

After studying this chapter, learners will be able;

- To understand different types of slope and their specific characteristics
- To show a specific landscape in a realistic way
- To understand the significance of contour lines in GIS environment where they can be used to prepare three-dimensional model of the earth surface

5.2 INTRODUCTION

The combined effects of endogenetic and exogenetic processes are continuously changing the earth surface. The slope of the surface also changes accordingly. The varied and complex slopes of the earth surface are easy to represent with the help of contour lines. Fluvial, pluvial, glacial, arid and coastal landforms are of different shapes and sizes and you must understand that because of these differences their contours are different too. Contour lines are lines drawn on a map connecting points of equal elevation. These lines are necessary to show relief features in any type of maps. Before the invention of contour lines, the hachure line method for depicting relief was used in representation of relief. The method invented by Saxon Major Lehman and was adopted for most of the military surveys in the nineteenth century .These small lines drawn down the slopes in the direction of the steepest gradient showed the earth features including mountains, hills, terraces, and other landforms having height. Drawing these lines required great patience and very-very hard work. Qualitative and relative representation of earth features the method could not determine accurate height of the points or places and exact information regarding the slope and slope values. The invention of contour lines solved this problem, as they were able to represent relief in a more scientific manner. These lines were first drawn on maps by a Dutch cartographer named Krukvees. It took about seventy years to become popular. These lines represented relief in quantitative terms and this was the major advantage of these lines. This means that if you physically follow a contour line, elevation would remain constant. Thus, the lines showing elevation and shape of the terrain of a particular part of the earth surface, known as contour lines connected the places of equal elevation. Imagine yourself walking along a contour line. You are walking along the same elevation.

To illustrate relief features of the area of interest, contour lines have significance for students studying geography. These lines show the gradient very clearly. In order to keep things simple, topographic maps show all the contour lines elevations only. Though contours are significant features of a topographical map, these maps also include man-made features such as settlements such as settlements and roads. Therefore, these lines are evenly spaced apart. We call this spacing the contour interval. As with all types of isolines, when contour lines are close together, they represent a steep slope, whereas when lines are far from each other, they represent a gradual slope. Every fifth or tenth contour starting at sea level is an index contour. This is a heavier line and labeled. Each topographic map uses a contour

interval, or equidistance, (the distance in elevation between contour lines) appropriate for that area. While flat area maps show a 5-meter contour interval, stepped terrain may have a 20-meter or more contour interval.

For example, if your map uses a 10 meter contour interval, you will see contour lines for every10 meters of elevation -- lines at 0, 10, 20, 30, 40, and so on. Different maps use different intervals, depending on the topography. If, for example, the general terrain is quite elevated, the map might run at 20- to 30 meter intervals. This makes it easier to read the map -- too many contour lines would be difficult to work with. Look in the margin of your map to find out its contour interval.

Topographic maps perfectly and precisely show contour lines. If you look on them at a distance of 1 meter, you will see crest and valleys. With the help of contour lines, exact slope angles can also be determined. This is possible with the help of vertical angles and horizontal distances between two points marked on a particular map. The contour lines drawn on maps also clearly help to identify relief features such as river valleys, hilltops, cols knolls etc. However, places having less height than the contour interval or lower relief areas are not much clear on maps. Still contours are one of the best methods to show the relief features.

With some practice and imagination, you can easily identify the hilltops and valleys in your study area. Unlike the simple topographic map used above, real topographic maps have many contour lines. It is not possible to label the elevation of each contour line. The contour lines are drawn at a certain interval. To make the map easier to read every fifth contour line vertically is an index contour. Darker brown lines on the map show Index contours. These contour lines are usually labelled. Normally, for Survey of India Topographical sheets with a scale of 1/50000 the contour lines are drawn at the interval of 20 meters. You can also notice a bold line at 100 meters interval in the Topographical sheets published by Survey of India. The contour interval chosen for a map depends on the topography in the mapped area. In areas with high relief the contour interval is usually larger to prevent the map from having too many contour lines, which would make the map difficult to read. In this unit, you will learn the different techniques used to represent relief with the help of contour lines.

The art of map making developed over the years. Different ways of showing relief features on the maps developed through a long passage of time. The surface of the earth, which is represented through maps, has its limitations. The features of the earth, which show relief, are three-dimensional and our maps must depict it as such but we show the location of features in two-dimensional space mostly as you have seen when you go through map reading. Though with the help of modern computer cartography, the three dimensional quality of the earth surface can be visualized up to a great extent.

The greatest challenge for modern map makers is to produce maps which not only picture the relief forms but accurately portray it quantitatively as well too. You must understand that the best way to show various relief features on maps with more accuracy has yet to be found. Methods of showing relief features largely depend upon the scale of a map. According to scale, maps can be broadly divided into large scale and small scale maps. You must know the basic differences in between these two types of maps. The large-scale maps play a vital role in the representation of landscapes and landforms. They determine the

drainage pattern and account for the transformation of terrain. Thus, they have influence upon human activities in the form of land use patterns, irrigation networks, transport, communication and many others.

With the help of contour lines; it is possible to draw cross section which shows an area in a more realistic way. A cross section shows a cut view or side view of a landscape. It shows the landscape as it would appear if it were sliced open, like cutting a large piece of cake in half. The diagrams below show how to draw a cross section.

5.2.1 Drawing a cross-section

With the help of a cross-section (Figure 5.1) on a contour map, you can draw a diagram, which can show the particular landscape in a realistic manner. In the figure, you can see the line of the section as a-b. Along the line of the section, place the edge of a piece of paper. Mark on the paper the start a and finish b. carefully make the points where each contour crosses the paper. After doing this, you have to number their heights.

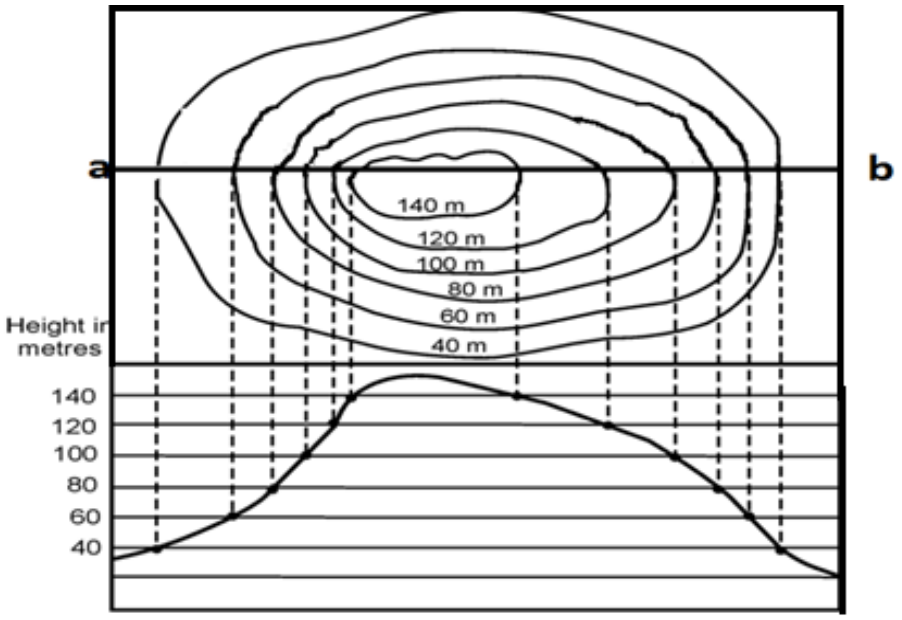

Fig. 5.1

In the present case, the height varies in between <40 and >140 meters. You will have to decide a scale for your section. Do not use a ruler. Notice that the slope of the hill is different in both the sides. Choose the scale in such a way that shows the features clearly. Mark with small dots to show the heights of the contours and position of other features.

You can find the slope in between the two contour lines as follows :

- Find the horizontal distance between them.
- Lay a ruler crossing exactly perpendicular to the contour lines and measure the distance.
- Convert the distance into meters.
- Find the rise or vertical distance.
- Identify the first and last contour line on your line.

- Subtract one from the other to find the rise in meters.
- Calculate the percent slope or the degrees slope using the equations given below.

Vertical distance/ Horizontal distance × 100=% slope

Vertical distance/ Horizontal distance (Tan) = slope°

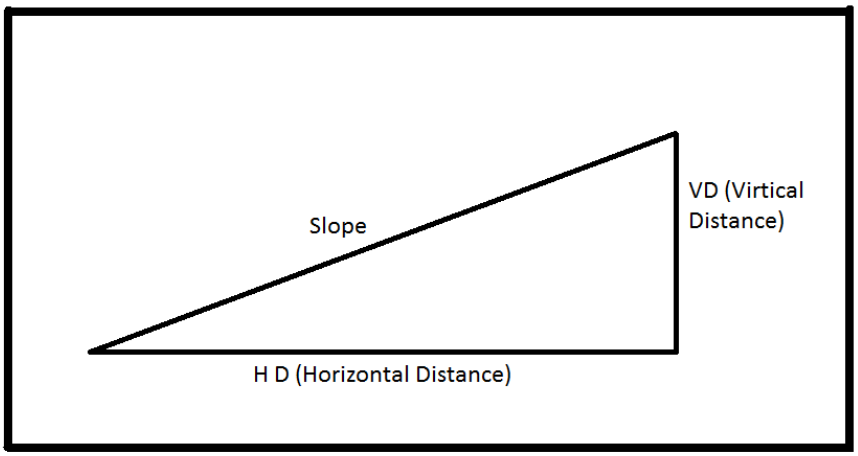

Fig. 5.2 finding slopes

5.3 *MAJOR RELIEF FEATURES*

The delineation of major relief features in map of an area by means of contour lines that represent elevation values; each such line passes through points of the same elevation. The method is not wholly objective because two investigators may produce somewhat different maps whenever interpolation between data points is necessary for construction of the contours. Different forms and patterns of relief can be represented by contour lines in an effective and useful manner. In the case of pointed hills, the contours are nearly circular and at equal distances from one another. The contours with the highest height values are in the middle. In the case of a flat-topped hill, the inner two or three contours will be close together. The innermost contour has the highest value, but encloses a larger, oval area. Widely spaced contour indicates flat surface. Closely spaced contour indicates steep ground. Equally spaced contour indicates uniform slope.

Irregular contours indicate uneven surface. Approximately concentric closed contours with decreasing values towards centre indicate a pond. Approximately concentric closed contours with increasing values towards centre indicate hills. Contour lines with U-shape with convexity towards lower ground indicate ridge. Contour lines with V-shaped with convexity towards higher ground indicate valley. A spur is formed between two river valleys. In the case of a river valley, the contour value increases to the outer side and decreases down towards the inner side, where the riverbed is. In the case of a spur, the higher number of

contour is to the inner side and the value or number of the contour decreases down towards the outer side of the spur.

You should also know that contour lines generally do not meet or intersect each other. If contour lines are meeting in some portion, it shows existence of a vertical cliff. If contour lines cross each other, it shows existence of overhanging cliffs or a cave.

You will find it useful to obtain the topographical map of your area and do some exercises related with representation of relief features with the help of contours. The contour lines marked on topographic maps help to make you recognize the relief features easily after practicing. The information stored in the maps in the form of contour lines will make you understand some of the significant relief features more clearly. You will learn how to represent the major relief features in this unit.

5.3.1 Conical Hill

A conical hill is a hill rounded at the base and rises up to a sharp peak like a cone. You can see a conical hill in Figure 5.3 where you can see how this type of hill shown with the help of contour lines. The base of the hill shows rounded shape while the peak is quite sharp.

Conical hills or mountains occur in different shapes.These hills are not always geometrically shaped cones. Some are more tower-shaped or have an asymmetric curve on one side.

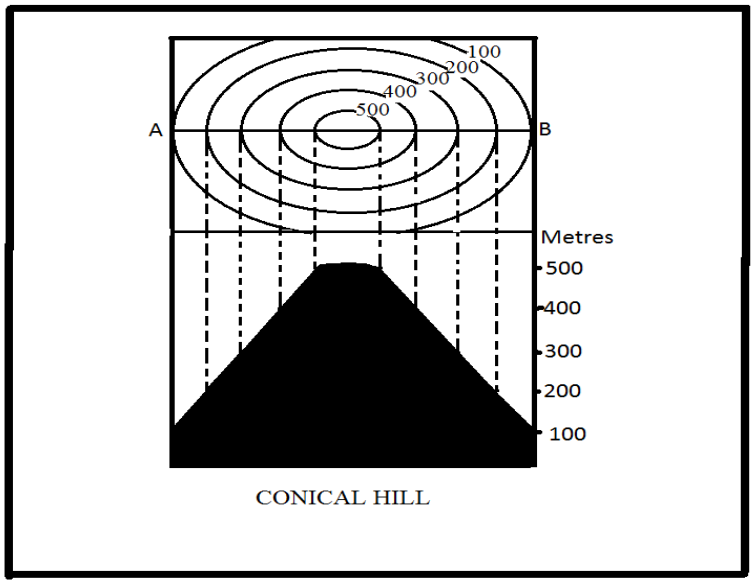

Fig. 5.3

Typically, however, they have a circular base and smooth sides with a gradient of up to 30°. Such conical mountains are found in all volcanically formed areas of the world such as the Bohemain Central Uplands in the Czech Republic the Rhon in Germany or the Massif Central in France.

5.3.2 Plateaus

Plateaus make up about45 percent of the Earth's land surface. Plateau is an elevated, comparatively level expanse of land A Pat land plateau or Pat is the local name for lava capped Mesas in Chotanagpur plateau (specifically in Western Ranchi Plateau region).a. In

Figure 5.4, you can see how the contours of a plateau when they are closely spaced as there are a steep slope and broad top.

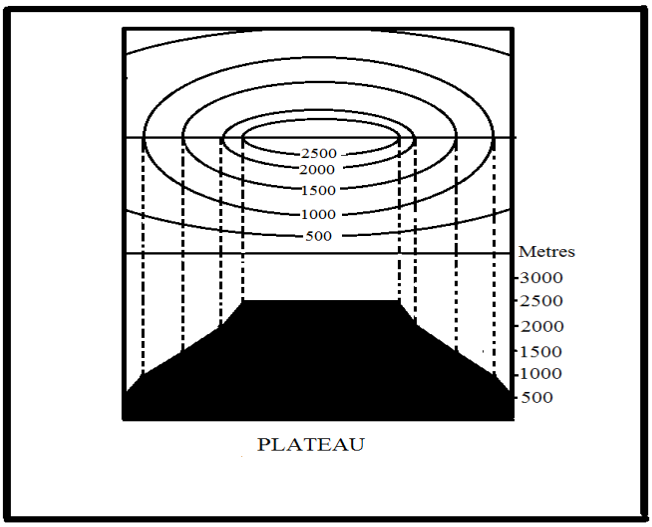

Fig. 5.4

5.3.3Saddle

In geographical terms, a saddle point is a low point in a range of hills or a pass between two mountain peaks or a gap in a ridge. It can also be recognized as a gap or a dip in a ridge crest. Alternative names include gap, notch and col. In the image (Figure 5.5), you can see a saddle in between the two elevated surfaces.

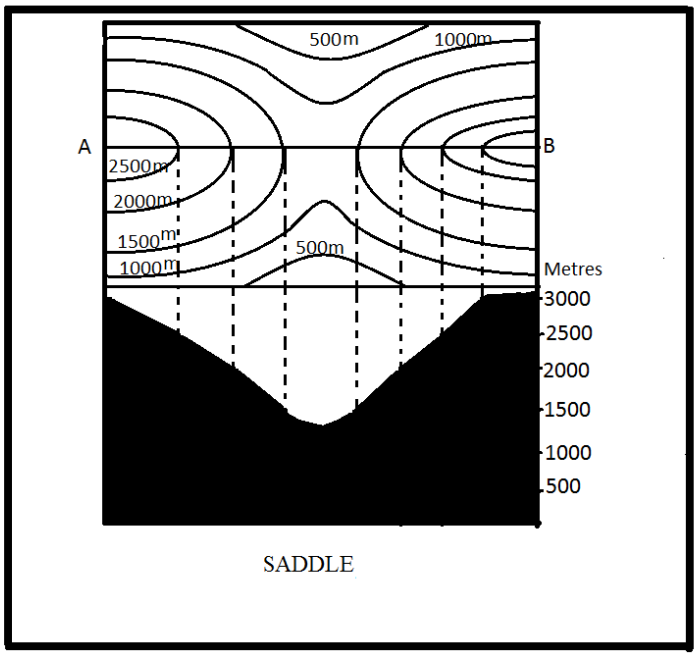

Fig. 5.5

5.3.4 Undulating Slope

Outward bulges irregularly mark an undulating slope and inward bends. Such slopes are very common in nature. In this type of slope, the gradient changes after short distances. Therefore, some parts of the slopes may be convex while some other part may be concave. Accordingly, the contours are widely placed at some places and close together at others. In Figure 5.6, you can see that the western part of the selected area has steep slope while the eastern part has gradual slope.

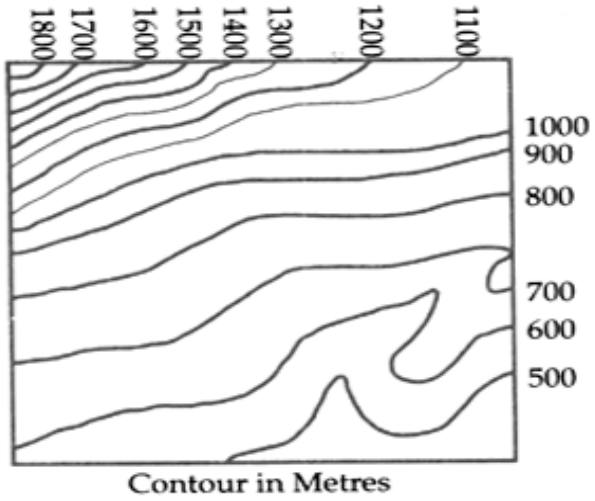

Fig. 5.6 Undulating Slope

5.3.5 Concave Slope

A concave slope is marked by an inward bend on a relief feature. The slope is less at the foot but more at the top. Contour lines are, therefore drawn comparatively far apart at the foot and close together at the top. In the concave slope, the distance in between the contour lines goes on decreasing as the numerical value of the contours (height) increases. In Figure 5.7,you can see concave slope drawn with the help of contour lines.

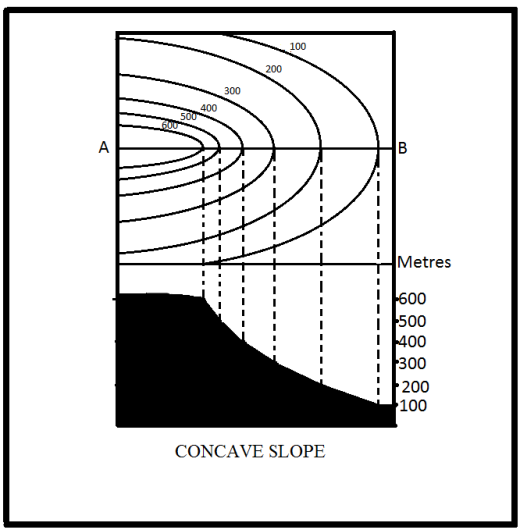

Fig. 5.7

5.3.6 Convex Slope

An outward bulge marks a convex slope. At the foot, the slope rises more steeply while less steeply or more gently at the top. The contour lines, which represent the convex slope, are, therefore close together at the foot and are comparatively further apart at the top.

As the height increases, the distance between the contour lines increases. A convex a slope characterizes dome-like hill or a narrow steeped wall valley. In Figure 5.8, you can see that as we move downwards, the contour lines become closer to each other.

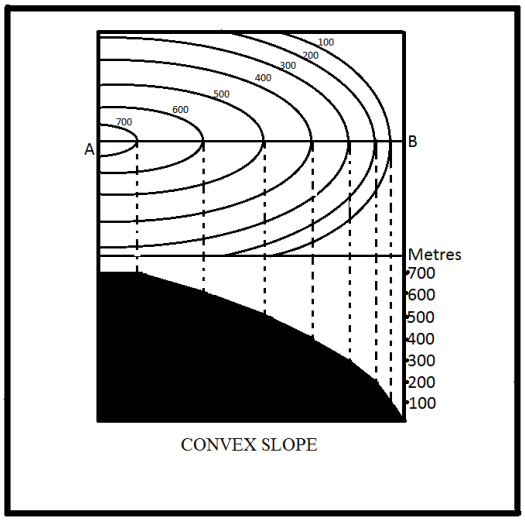

Fig. 5.8

5.3.7 Cliffs

Cliff is a vertical, or near vertical, rock exposure. Cliffs are common in mountainous regions, near coasts, escarpments and along rivers. Cliffs are usually formed by rock that is resistant to erosion and weathering. This is due to the processes of erosion and weathering that produce them. Figure 5.9 shows a vertical cliff where many contours join each other.You can see in the figure clearly that contour lines are converging because of steep slope.

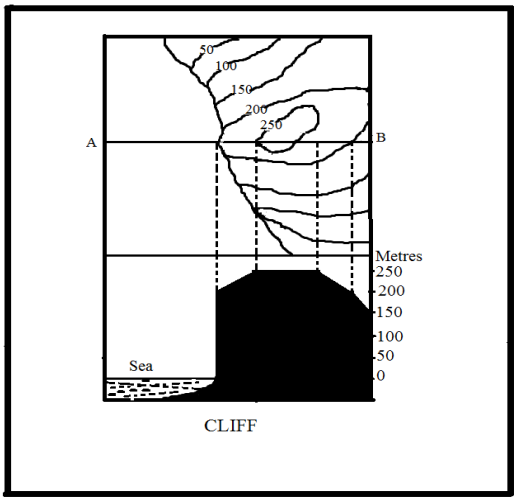

Fig. 5.9

Sedimentary rocks most likely to form cliffs include sandstone, limestone, chalk and dolomite. Igneous rocks such as granite and basalt often form cliffs. Where two or three contour lines lie together, there is a perpendicular cliff. This occurs in mountainous regions. Nanga Parbat's Rupal Face, which rises approximately 4,600 meters, or 15,000 feet, above its base, is the highest cliff in the world. Since the height is vertical, a number of contour lines meet at the same point.

5.3.8 Waterfall

Waterfalls are commonly formed in the upper course of the river. At these times the channel is often narrow and deep. In a waterfall, the river plunges suddenly downwards along a vertical slope. There is vertical height which means that a wide difference in elevation occurs at the same point. Therefore; the contour lines cross the river at the same point .Contours showing waterfall meet each other as the slope is too steep to show them apart. The vertical height is found by multiplying the contour interval by a number one less than the contours passing through that point. When the river courses over resistant bedrock, erosion happens slowly, while downstream the erosion occurs more rapidly. As the watercourse increases its velocity at the edge of the waterfall, it plucks material from the riverbed. Waterfalls and rapids are characteristic features of a "V" shaped young valley. In figure 5.10, you can see clearly how contours meet at a point where the slope is steep.

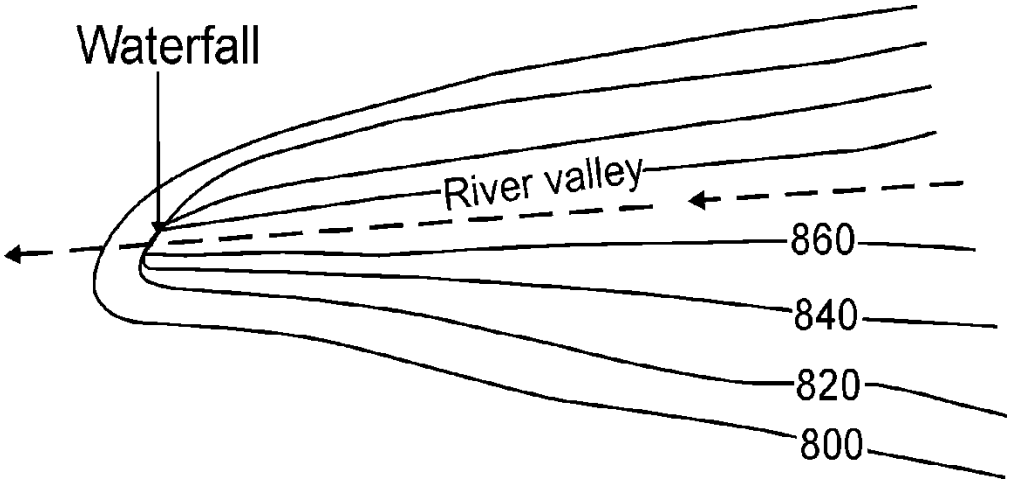

Fig. 5.10 Waterfall

5.3.9 U shaped valley

The process of glaciations normally forms U shaped valleys. They are characteristic of mountain glaciations in particular. They have a characteristic U shape, with steep, straight sides and a flat bottom. It has a broad bed. Along the valley side the slope rises gradually first and then steeply. The contour lines, which show such a valley, are quiet close together when their numerical value is large. Lower contours on the other hand are, far apart. Thus, as you can clearly understand with the help of Figure 5.11, which shows a U shaped valley where contours are close to each other near, the sides but far apart near the valley.

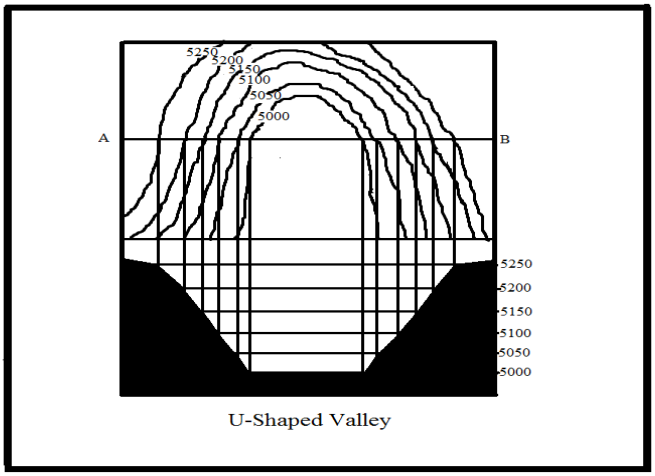

Fig. 5.11

5.3.10 Hanging valley

A hanging valley is also a U shaped valley. A hanging valley is a tributary valley to the main valley. The floors of the tributary valleys erode and deepen at a slower rate than the floor of the main valley, so the difference between the depths of the two valleys steadily increases over time. The tributaries are high above the main valley, hanging on the edges, their rivers and streams entering the main valley by either a series of small waterfalls or a single impressive fall.

5.3.11 Lakes

A lake is a body of water surrounded by land. Lakes vary greatly in size. Lakes contain about ninety percent of surface water found on earth (not including oceans).Lake vary greatly in area, depth, altitude, salinity and other characteristics. They may be small or quiet big. Their water may be sweet or saline though most of the lakes are freshwater lakes. Most of the lakes are situated on the land surface above the sea level, but exceptions are there such as Dead Sea and Caspian Sea. Figure 5.12 shows Contours for Lake. The contour interval is 20 meters. In the figure, you can see that as the depth of the lake increases, the value of the contours decreases.

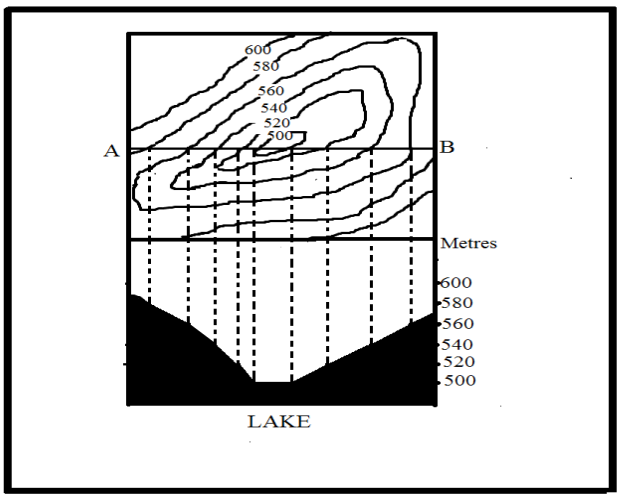

Fig. 5.12 Contours for Lake

5.4 CONCLUSION

Contour lines help to understand the shape of the land surface in a quicker and easier form. The contour lines on a topographic map are in fact the brown lines, which represent an imaginary line on the ground along which all points are at the same elevation. Contour lines also show the shape of features on the terrain. To identify and map the different relief features of the earth surface has always been a challenge for geographers especially cartographers. Every method has its merits and demerits and there is always a scope left to find out a new method. The need to show different features in a map may be very important for a variety of reasons.

The systematic observation of the earth surface, interpreting of the relief features of different parts of the earth surface, their implementation in various field areas and their representation accordingly is a significant part of geographical studies. Given a series of surveyed data points and their elevations, one can construct a contour map of any known surface. Contour maps are extremely useful for geography students. Contours make it possible to measure the height of the mountains, depth of the oceans and steepness of slopes. The numbers featured on each line, represent the exact height of the land at points along that line. Contours give information about the slope weather it is flat, undulating or mountainous. By reading contour lines, you can be able to measure the steepness of a hill, the height of a mountain, and even the depth of a lake or ocean. Where the contour lines are close together, there is steep slope.

You must have understood up to now that the close lines mean the elevation is changing rapidly; those are steep places. In a cliff or waterfall, a number of contour lines meet at the same point.You have studied in the unit that where the contour lines are far apart, it means that the elevation is not changing much; those are flat places. The landforms have extremes between steep and flat and contours are the medium that can represent the three-dimensional surface of the earth in maps effectively. Contours help us to solve some specific purposes such as site selection for engineering projects, finding routes for communication between different places, to ascertain the indivisibility of stations as well as to ascertain the profile of ground surface along any direction. They can also help mark a suitable route for a given gradient. In addition to topography, there are scores of geophysical, geochemical, meteorological, sociological, and other variables mapped routinely by the method. Finding out the nature of the ground with the contours are extremely useful in civil engineering studies. Intervisibility of any two points can be found by drawing profile of the ground along a line can be found with the help of contours. Catchment area and hence quantity of water flow at any point of a river can be found with the help of contour lines. From the contours, it is possible to determine the capacity of a reservoir. Thus, study of contours and representation of earth features with contours is not only important for geographers and geologists but for scientists and engineers having multiple interests beneficial for the society. Representation of landforms is a challenging problem, besides advanced computer based cartographic techniques that are comparatively easier and time saving largely. The availability of plotting devices in recent years has permitted mapping by computer, which reduce the effect of human bias on the final product.

5.5 SUMMARY

In this unit, you learned the significance of contour lines, which connect points that are the same height above sea level. Most commonly found on topographic maps, contour lines are particularly useful, since they accurately depict the height, shape and slope of a landscape. More generally, a contour line for a function of two variables is a curve connecting points where the function has the same particular value. Either contour lines curved, straight or a mixture of both lines, describe the intersection of a real or hypothetical surface with one or more horizontal planes. The configuration of these contours allows map-readers to infer relative gradient of a parameter and estimate that parameter at specific places. The patterns created by the lines show the shape of the land.

By studying this unit, you may have become more familiar with the patterns used to represent different relief features with the help of contours. You also identify different types of landforms with these lines. In this unit, you learned the significance of contour lines which not only represent landforms and landscapes in an effective manner but also individual relief features as well. Most commonly found on topographic maps, contour lines are particularly useful, since they accurately depict the height, shape and slope of a landscape. In this unit, you have studied how to depict some major relief features with the help of contour lines.

You must have understood up to now that a conical hill is a hill rounded at the base and rise up to a sharp peak like a cone. Contours of a plateau are closely spaced at the sides with a broad top .Contours of a saddle show a gap in between the contours in the middle of two elevated surfaces. In undulating slopes, the contours are widely placed at some places and close together at others. A concave slope is marked by an inward bend on a relief feature. The distance in between the contour lines goes on decreasing as the numerical value of the contours increases in such slopes. The contour lines, which represent the convex slope, are, therefore close together at the foot and are comparatively further apart at the top. The contour lines, which show such a valley, are quiet close together when their numerical value is large. Lower contours on the other hand are, far apart. A hanging valley is also a U shaped valley.

A lake is a water body surrounded by land. Contour lines generally do not meet or intersect each other. If contour lines are meeting in some portion, it shows existence of a vertical cliff .By studying this unit you may have become more familiar with the patterns used to represent different relief features with the help of contours. You also must immediately identify different types of landforms with these lines. Once we know how to determine the elevation of the unmarked contour lines we should be able to determine or at least estimate the elevation of any point on the map.

5.6 GLOSSARY

Landforms: Natural features of the landscape such as valleys, plateaus, mountains, loess, glaciers or sand dunes.

Isolines: A line on a map, chart, or graph connecting points of equal value.

Tributary - A tributary is a freshwater stream that feeds into a larger stream or river. The larger, or parent, river is called the mainstream.

Converging contours: A little horizontal distance on steep slopes between points greatly different in height, contour lines indicating such terrain are close together.

Sedimentary rocks: Sedimentary rocks are types of rock that are formed by the deposition and subsequent cementation of that material at the Earth's surface and within bodies of water.

Undulating slope: A slope of land full of ups and down is undulating.

Velocity: An important concept in kinematics that describes the motion of bodies.

Cliff: a vertical, or near vertical, rock exposure

Intervisibility: The distance at which a given standard object can be seen and identified with the unaided eye

Perpendicular: The relationship between two lines which meet at a right angle (90 degrees).
Three-dimensional surfaces: Relief of the earth surface which has width, length and height

5.7 *ANSWER TO CHECK YOUR PROGRESS*

5.7.1 (Self-check Questions)

1. Define contour lines.
2. What is index contour?
3. How can exact slope angles be determined with the help of contour lines?
4. Which types of slope show the contours far apart?
5. What is a saddle?
6. Describe contours along a cliff.
7. Explain contour settings of concave slopes.
8. What is undulating slope?
9. Where is a 'U' shaped valley formed?
10. What are the major advantages of describing relief with contours?

5.7.2 (Answers to self-check Questions)

1. Lines drawn on a map connecting points of equal elevation are called contour lines.
2. Every fifth contour line vertically shown by darker brown lines on the topographic map is an index contour.
3. Exact slope angles can be determined with contour lines with the help of vertical angles and horizontal distances between two points marked on a particular map.
4. When contour lines are far from each other, they represent a gradual slope.
5. A saddle is a low point in a range of hills or a pass between two mountain peaks or a gap in a ridge. It is also called a gap, notch and col.
6. A cliff is a vertical, or near vertical, rock exposure where many contour lines lay together.
7. In the concave slope the contour lines are, therefore drawn comparatively far apart at the foot and close together at the top.

8. In undulating slope, there is irregular gradient that changes after short distances. Therefore, some parts of the slopes may be convex while some other part may be concave.
9. The process of glaciations normally forms 'U' shaped valleys. Therefore, they are normally found in mountainous regions where there is plenty of snow.
10. Contours make it possible to measure the height of the mountains, depth of the oceans and steepness of slopes. Apart from this, these lines give information about the slope weather it is flat, undulating or mountainous.

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5.10 TERMINAL QUESTIONS

1. Define contour lines.
2. What are the uses of contour lines?
3. What is the best method of representing the relief features and why?
5. What is index contour?
6. How can exact slope angles be determined with the help of contour lines?
7. Which types of slope do the contours show when they are far apart?
8. What is a saddle?
9. Describe contours along a cliff.
10. Explain contour settings of concave slopes.
11. What is undulating slope?
12. Explain 'U' shaped valleys.
13. What are the major advantages of describing relief with contours?
14. Write down the differences in between concave and convex slopes.
15. Explain similarities between the cliff and waterfall.
16. How can you recognize a saddle in a topographic map?
17. How do contours help map-readers?
18. What does the difference in between the contour lines show?
19. What do you understand by converging contours?
20. What type of contours do you see in the hanging valleys?
21. Which type of maps commonly shows contour lines?

UNIT IV REPRESENTATION OF CLIMATIC DATA

6.1 OBJECTIVES

After realizing the significance of climatic data, the objectives of the present chapter will make you capable;

- To identify changes in the atmosphere and represent the results through appropriate methods of various weather phenomena.
- To understand weather phenomena and resultant climate changes in a better and effective manner
- To understand, how to represent data related to temperature, wind, humidity, and rainfall, as well as other atmospheric factors that describe the local weather and climate.
- Understand the interrelationships of these elements in different parts of the earth surface

6.2 INTRODUCTION

Climate of any particular place or country is the topic of interest for geographers all over the world. Scientific studies in the past few decades provide information that the global climate is changing in a way that it may challenge the survival of human beings. The pattern of human life in any particular region is largely dependent upon the type of climate of that particular region. Because of global warming the spectrum of world geography, economy and society will obviously change. Therefore, the changing climatic patterns all over the world are matter of concern for scientists and researchers in different parts of the globe today. For proper understanding of climatic conditions all over the world or a place or region within it, it is necessary for us to understand what is meant by the term weather. Weather is simply the current state of the atmosphere at a specific location at any given point in time. You know very well the fact that some places are dry, some are wet, some are hot, some are cold, and rest are different having a complex combination of different types of weather.

You can find out what the weather is like where you live by looking out the window or by stepping outside. In your daily life, you often use this term by asking a relative or friend about the weather conditions of his or her place. Weather refers to temperature, humidity, cloudiness, visibility, different forms of precipitation, and the wind's direction and speed. To understand better, you must know that the above-mentioned five factors determine the state and condition of the atmosphere and, therefore, influence and determine the weather. Each place on Earth has weather. However, weather typically varies in different places on the Earth surface. Scientists who study the weather collect information from different places on Earth and come up with averages, or typical types of weather, for a particular place. They include day-to-day state of the atmosphere in a region and its variations. The difference between weather and climate, which students often confuse, is, therefore very simple. Weather tells you about the atmospheric conditions at any given moments Real-time measurements of pressure, temperature, wind speed and direction, humidity, precipitation, cloud cover, and other variables. Thus, you can define weather as the day-to-day state of the atmosphere, and its short-term (minutes to weeks) variation.

You can directly feel the impact of weather in your daily lives and analyze its impact on a wide range of subjects including the social and economic well being of human beings in the place where they live. If you are planning for a tour or outing the first question you ask to yourself is about the weather conditions of the place you are going to visit so that you may carry your luggage accordingly. Now, let us know what climate is. Climate is statistical weather information that describes the variation of weather at a given place for a specified interval. Thus, you can say that climate includes weather conditions for a given location over a period. Climate determines mean values of weather elements over a fairly wider territory and a longer period. In popular usage, climate represents the synthesis of weather; more formally, it is the weather of a locality averaged over some period (usually 30 years), plus statistics of weather extremes. Thus, they are both used interchangeably sometimes but differ in terms of the length of time they measure and what trends affect them. The climatic conditions of a region are directly involved in determining the environment of that particular area including flora and fauna. Climate also has its impact on the houses people live, the clothes they wear and up to some extent the recreation opportunities of that particular area.

Analyzing climatic information involves seeking patterns, relationships, and connections. As you analyze and interpret information, meaningful patterns or processes emerge. After this, you can synthesize your observations into coherent explanations. During the process, it would be useful for you to note associations and similarities between areas, recognize patterns, and draw inferences from maps, graphs, diagrams, tables, and other sources. Using basic statistics, you will be able to look for trends, relationships, and sequences. Climatic analysis involves various processes. It is sometimes difficult to separate the processes involved in organizing climatic information from the procedures used in analyzing it; the two processes go on simultaneously in many cases. But in other instances, analysis follows the manipulation of raw data into an easily understood and usable form. However, interpretations of climatic data involve the use and development of spatial climatic data. Meteorological warnings and forecasts are very significant for the people and should be disseminated in a proper way, if they are to be of value to users. Different types of graphs and diagrams are used to represent weather conditions and climatic data. Rapid developments in technology, however has its significant impact in the area of graphics. On the one hand, developments in computer technology enable production of a vast array of graphic material, and on the other hand, need of formal training to produce expertise in graphics and training individuals with capabilities which can help in the representation of climatic data with computer cartography. With the information provided for a certain time in a certain area, trained personals can guide more efficiently and help to develop graphics to suit the unique needs and circumstances of a particular area. Thus, from the very beginning up to now, we will discuss some of the important climatic diagrams in this unit.

6.3 REPRESENTATION OF WEATHER–DATA

The weather describes the atmospheric conditions at a specific place at a specific point in time. Climatic conditions of a particular place on the earth surface or the planet as a whole is determined by collecting meteorological data, real-time measurements of atmospheric pressure, temperature, wind speed and direction, humidity, precipitation, cloud cover, and

other variables. After knowing weather statistics for over periods of 30 years, you can determine the climate of your region.

Weather generally includes sunshine, rain, cloud cover, winds, hail, snow, sleet, freezing rain, flooding, blizzards, ice storms, thunderstorms, steady rains from a cold front or warm front, excessive heat, heat waves and more. Major weather phenomena are as follows-

- The first and most significant factor that determines weather is temperature. Temperature is measured using a thermometer in degrees Fahrenheit or Celsius.
- The second factor is air pressure that includes the amount of pressure exerted by the air in a particular air mass. Air pressure is also called barometric pressure because it is measured using a barometer and commonly measured in inches of mercury.
- The third factor that can determine the weather is if a place is experiencing humidity. Humidity is a measure of the water content of the air mass.

Weather instruments are used to take measurements of temperature, wind, humidity, and rainfall, as well as other atmospheric factors that describe the local weather and climate. Different types of instruments are used to measure different parameters and there are many types to choose from. The variables measured with these types of instruments are wind speed and direction, pressure, humidity, temperature, and precipitation, including rain and snow. For representation of weather- data it is necessary to view certain parameters in certain places. The user can define the month or season and place of interest. The weather data including past weather conditions and long term averages can be used for representation through various methods. Some of the methods with the help of which you can represent these data are given below:

6.3.1 Wind Rose Diagram

Wind rose is a graphic tool used by meteorologists. It was included on maps before the development of the compass rose. You can see a medieval wind rose diagram in the picture (Figure 6.1) which helped to let the reader know in which directions the 8 major winds (and sometimes 8 half winds and 16 quarter winds) blew within the plan view. No differentiation was made between cardinal directions and the winds which blew from said directions. North was depicted with a fleur de lis, while east was shown as a Christian cross to indicate the direction as seen in figure 1. With changing times, improvements were made to clearly show the speed and direction of the flowing wind. Wind rose is designed to show the frequency and direction of the wind at a weather station for a given time. The wind direction indicates the direction the wind is coming from. The number of wind directions and wind speed classes can change as required. For a better understanding we can say that it is a graphic tool used at meteorological stations. It gives a succinct view of the distribution of speed and direction of wind distributed at a particular location. Historically, wind roses were predecessors of the compass rose (found on maps), as there was no differentiation between a cardinal direction and the wind which blew from such a direction. At present, using a polar coordinate system of gridding, the frequency of winds over a time plotted by wind direction, with colour bands showing wind speed ranges. The direction of the longest spoke shows the wind direction with the greatest frequency.

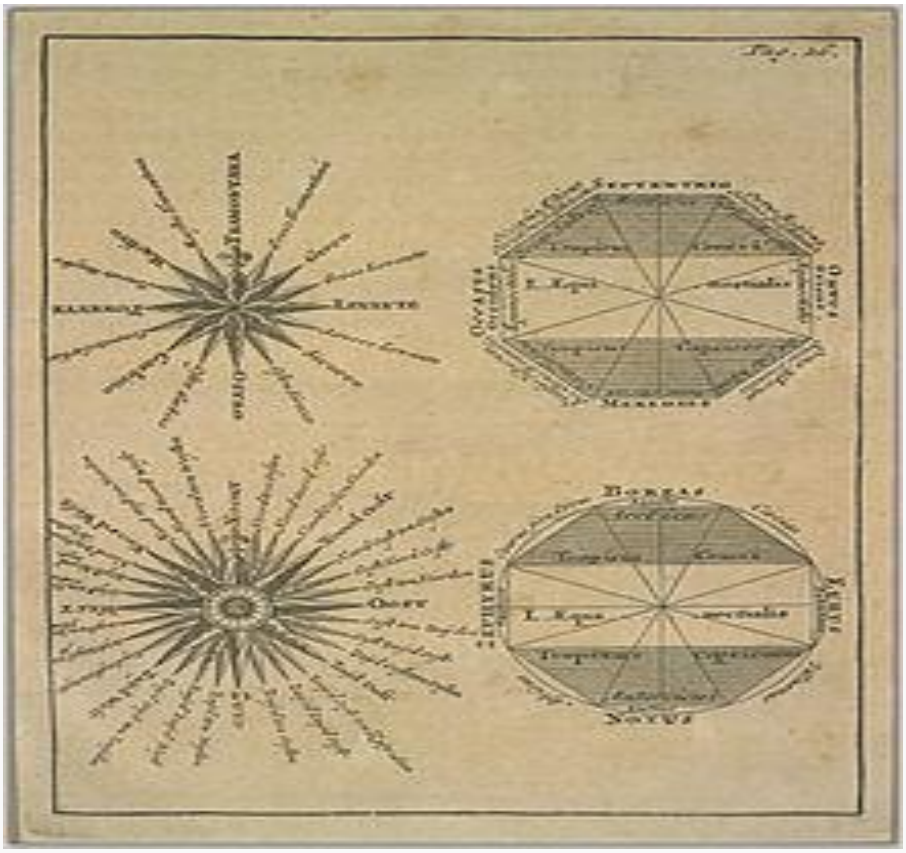


Fig. 6.1A medieval wind rose

The modern wind rose diagram shows the frequency of winds blowing from particular directions over a specific period. The length of each 'spoke' around the circle is related to the frequency of the wind from a particular direction per unit time. Each concentric circle represents a different frequency, emanating from zero at the centre to increasing frequencies at the outer circles. A wind rose plot may contain additional information, in that each spoke is broken down into colour-coded bands that show wind speed ranges. Wind roses typically use 16 cardinal directions, such as-

- North (N), NNE, NE, etc.
- They may be subdivided into as many as 32 directions.

Wind roses angle measurement in degrees as following

- North corresponds to 0°/360°
- East to 90°
- South to 180° and
- West to 270°.

The diagram (Figure6.2.) shows speed of the wind flowing at different directions. The speed of the flowing wind towards different directions is measured in meters /second. Different colures of the spokes indicate towards the variations of wind speed that shows that the maximum speed of wind in the diagram is 15.50 m/second in the diagram .The circle in the centre indicates calm winds. Winds were calm 3.6 % of the time.

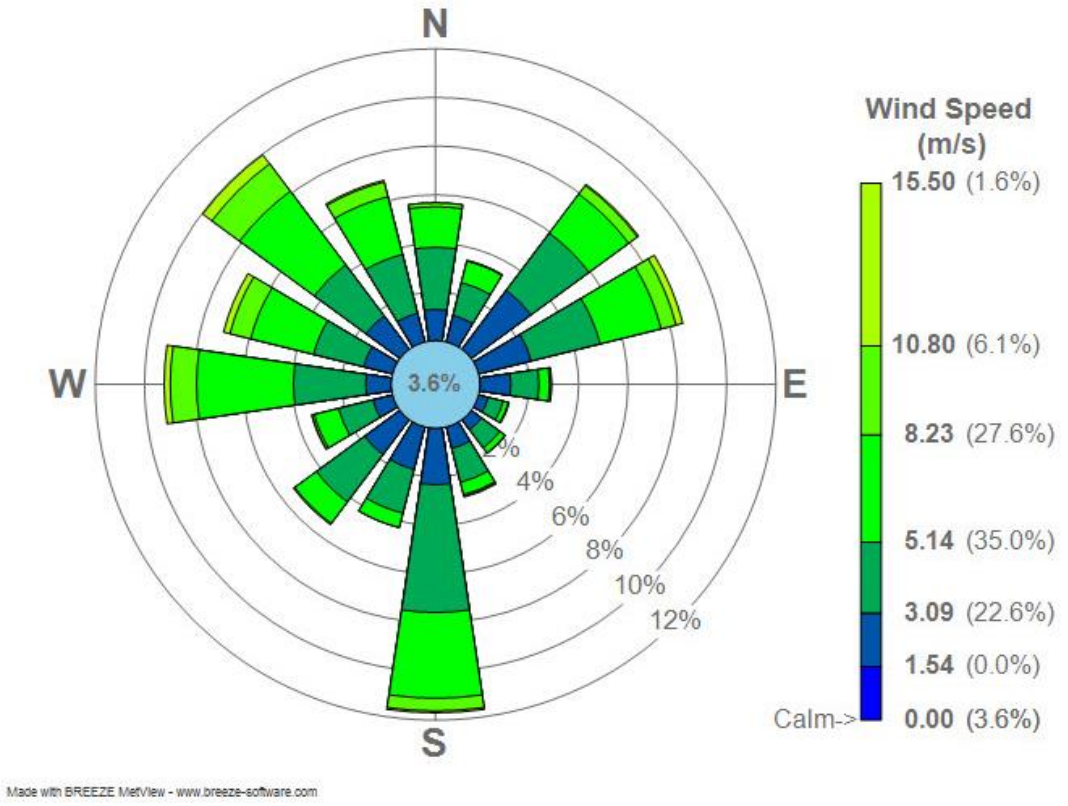


Fig. 6.2: A Modern Wind rose diagram

Compiling of wind rose is one of the preliminary steps taken in constructing airport runways as aircrafts typically perform their best take-offs and landing points into the wind. Below is a sample wind rose from December 6th - 7th from the Timber Weather Station.

The header identifies the weather station. In the example above, it is the Timber station at the Yellowstone Club. It displays the last 25 hours of data covering the date and time range shown on the upper right. A summary of average wind direction, average wind speed, and peak gust is given on the right as well.

The most important data is displayed by each "spoke." The length of each "spoke" tells the frequency of wind coming from a particular direction. In this case 72% of the given time (25 hrs), winds blew from the W. 24% of that time, winds blew from the WSW.

To determine wind speed frequency is a little more difficult. Wind speeds are indicated by colour. If a "spoke" is mostly one colour, then winds blew mostly at the wind speed denoted by that colour. In this case, 56% of the time, winds blew from the W at 5-15 mph. For the red section of the "spoke" which indicates winds at 15-25, you have to do a little math. The red section is between 72% and 56%. Subtract these two numbers and you get 16%. This means winds blew from the W at 15-25 mph for 16% of the time. The circle in the centre indicates calm winds. Winds were calm 0% of the time.

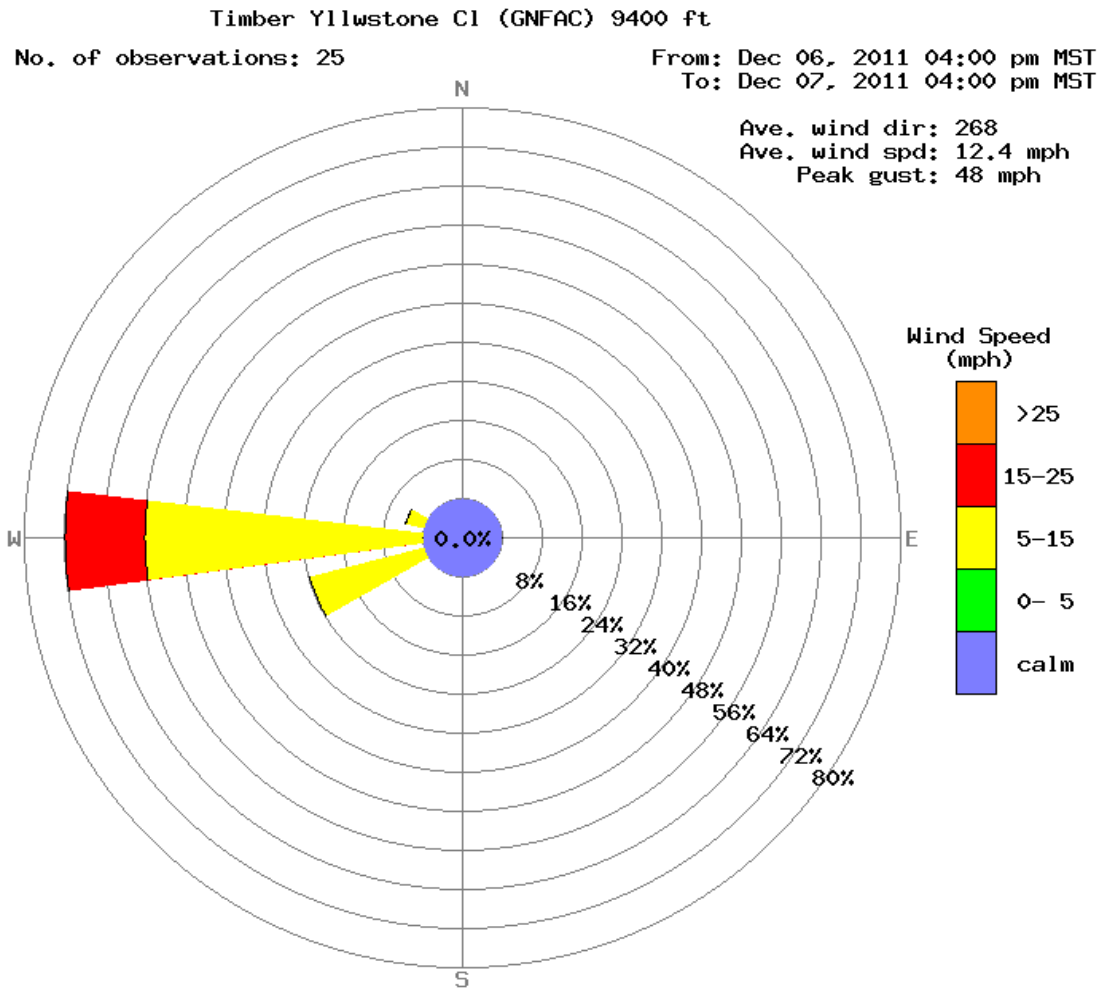


Fig. 6.3 Wind rose diagram for Timber station, Yellowstone Club

6.3.2 Rainfall dispersion diagram

Dispersion diagrams display the main patterns in the distribution of data. The graph shows each value plotted as an individual point against a vertical scale. It shows the range of data and the distribution of each piece of data within that range. It therefore enables comparison of the degree of bunching of two sets of data.

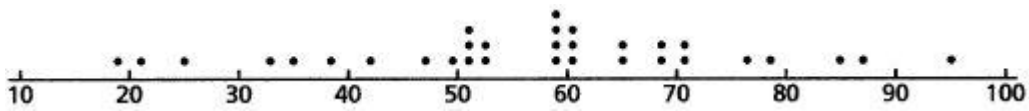


Figure -6.4:Dispersion diagrams

They are useful in presenting

- Maximum,
- Minimum

- Median
- Lower Quartile
- Upper Quartile

Rainfall Dispersion graphs display the main pattern in the distribution of rainfall data. The graph shows each value plotted as an individual point against a vertical scale.

Rainfall dispersion diagrams are drawn with the help of long-term meteorological data. To draw rainfall dispersion diagrams, first you will have to arrange all the data in ascending order. After arranging the data in such a way, you will be able to know the maximum and minimum amount of rainfall in every month. After that, you will calculate the median, lower quartile and upper quartile with the help of the formula given below.

Median=N+1/2th number

Lower quartile= N+1/4th number

Upper quartile= 3(N+1)/4th number

In the formula's given above 'N' value denotes the number of total given years for which data have been obtained. For ten years of meteorological data of Hapur, the maximum, minimum, median, lower quartile and upper quartile have been calculated for every month and the rainfall dispersion diagram (Figure 6.5) was drawn.

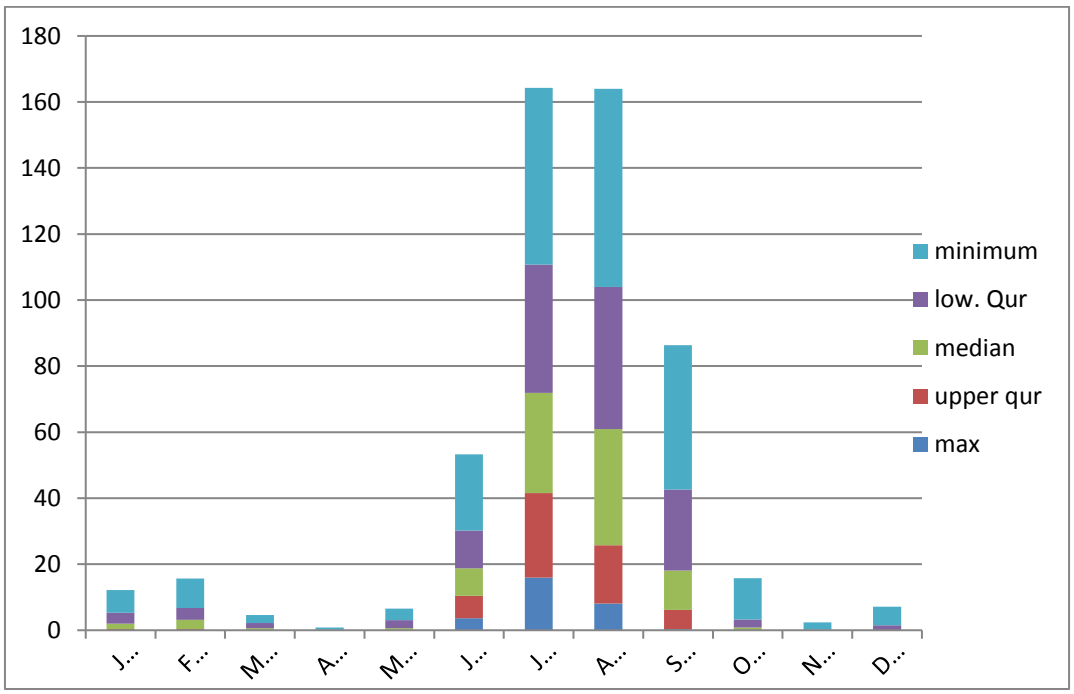
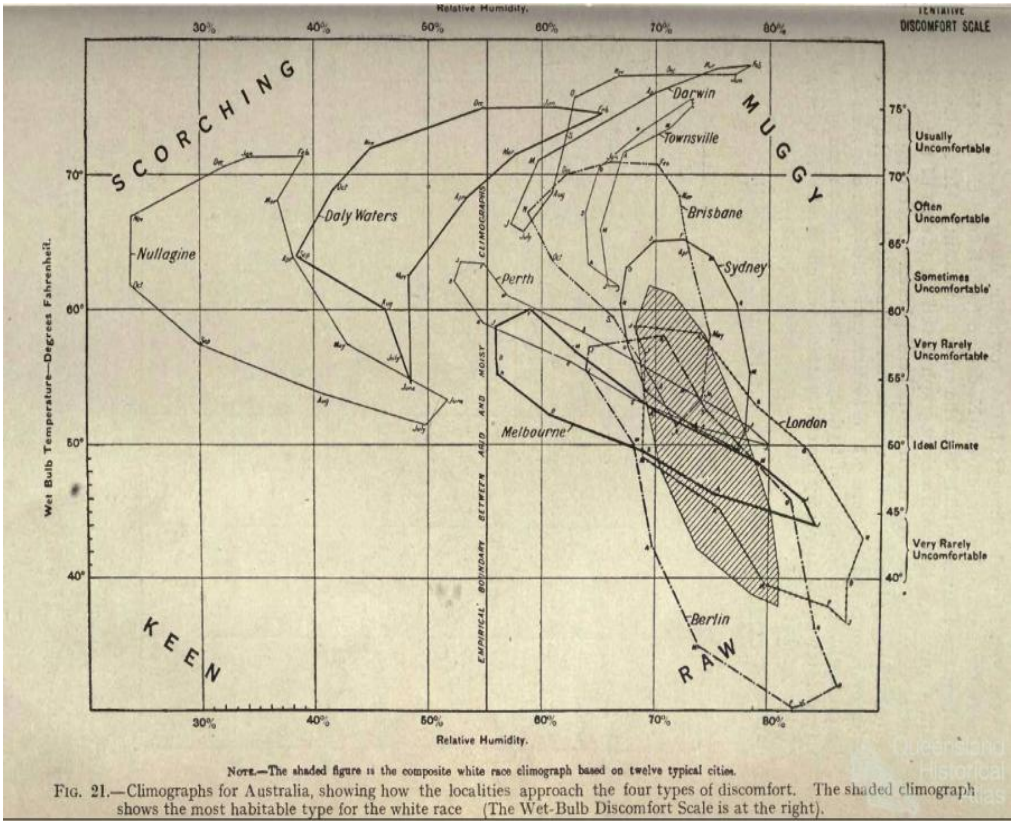


Fig. 6.5 Rainfall dispersion diagrams

6.3.3 Climograph

A graphical representation of basic parameters of climate (precipitation and temperature), which is monthly average at a certain location is known as climograph. It is

used for a quick-view of the climate of a particular location. According to Monkhouse and Wilkinson "AClimograph or climagraph or climagram is a diagram in which the data for the elements of climate at any one station are plotted against one another''. In this way, you can say that a climograph is representing two climatic variables monthly means one as the abscissae and the other as the ordinates. The resultant twelve sided figure provides the general index of the climate of a particular station.



Note.—The shaded figure is the composite white race climograph based on twelve typical cities.

Fig. 21.—Climographs for Australia, showing how the localities approach the four types of discomfort. The shaded climograph shows the most habitable type for the white race (The Wet-Bulb Discomfort Scale is at the right).

Fig. 6.6Climograph by Griffith Taylor

Taylor's climograph represents wet –bulb temperatures (from 10°F-90°F) as ordinates and relative humidity (from20% to 100%) as abscissae. Each of the twelve points showing wet bulb temperatures and relative humidity for individual months is marked by initial letters of the month. The four corners N.W., N.E., S.W. and S.E. are marked as Scorching, Muggy, Keen and Raw respectively. They are very useful for comparative studies in climates, because they provide general climatic index, which can be understood at a glance.

Thus, a climograph also represents at least two elements of climate (temperature and rainfall, temperature and humidity) at one time. In 1918, Kuipan constructed climographs with the help of highest and lowest recorded temperatures in the warm and cold months giving a scientific base to the world climatic divisions. J.B.Laile used the average monthly data to construct such graphs. One form of representation uses an overlapped combination of a bar and line chart used to show the climate of a place over a 12-month period.

Another method uses a common horizontal axis while different vertical axis. Here both the precipitation and temperature are shown in bar charts. This method has an advantage that the range of temperature (average of minimum and maximum temperatures) can be shown, rather than just the average temperature.

Climographs display temperatures in a clear and concise manner; however they may be misinterpreted when used in inappropriate situations. For this reason, it is important that they are utilized in a reasonable situation.

The climograph as developed by Dr. Griffith Taylor, but in a modified form in which data for air temperature and relative humidity are used in place of those for wet-bulb temperature and relative humidity, is believed to be useful in many ways beyond the simple showing of monthly averages of climatic conditions as heretofore. Thus, starting from the nineteenth century, climographs have been modified by numerous scientists all over the world. You can understand it clearly with the help of the example given below:

Example: Draw a climograph of Jodhpur with the help of following data:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet-bulb temperature (°C)	14	16	15	19	18	25	25	25	24	20	16	15
Relative humidity (%)	27	39	23	22	28	43	49	55	48	21	14	26

Choose suitable scales to represent relative humidity along the X-axis and wet bulb temperature along the Y-axis. Draw the co-ordinates of 27 %(relative humidity) and 14°c. (wet bulb temperature) to mark the point ‘J’for January for Jodhpur. Similarly, mark the remaining eleven points. The twelve-sided polygon so obtained is the climograph of Jodhpur. Now write down Scorching, Muggy, Keen and Raw in their respective corners.

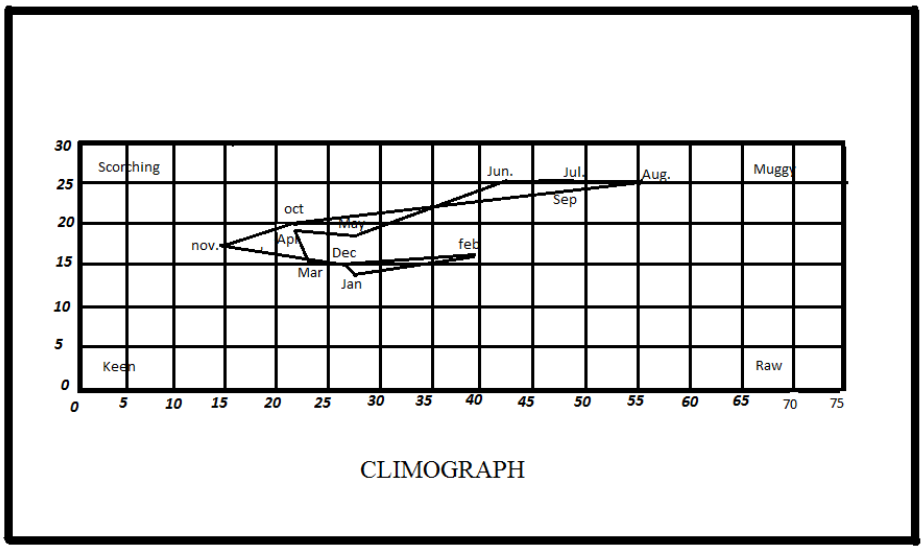


Fig. 6.7 Climograph

6.3.4 Hythergraph

A plotted graph showing the relationships between precipitation and temperature is known as Hythergraph. This type of graph was first invented by Griffith Taylor in 1916.The Hyther graph as devised by G.Taylor is just like the climograph as defined by Raisz,Foster and Huntington. As explained in the climograph the twelve monthly points are the temperature rainfall ratio in the hythergraph too. Temperature is plotted along the vertical coordinate and rainfall along the horizontal coordinate .The hither graph denotes the impact of evaporation in the earth surface and the actual availability of underground water in a particular place. During the period of high temperatures, even with sufficient amount of rainfall received the actual availability of water is low because of higher amount of evaporation. In the hythergraph presented by Griffith Taylor, limit of temperature and rainfall has not been given while in similar type of climograph Foster has included the maximum and minimum limits of temperature and rainfall.You can understand the significance of hythergraph with the following example :

Example: Draw hythergraph for Meerut with the help of following data :

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average monthly temperature (°c)	14	16	22	28	31	32	30	29	27	24	18	14
Average monthly rainfall (cm.)	3	2	2	1	2	7	19	20	12	1	2	2

Choose suitable scales to represent rainfall along the X-axis and temperature along the Y-axis. Draw the coordinates of average monthly rainfall (3cm.) and average monthly temperature (14°c.)to mark the point 'Jan' for January. Similarly, mark the remaining eleven points Feb., Mar., Apr etc.. The twelve-sided figure so obtained is the hythergraph for Meerut.

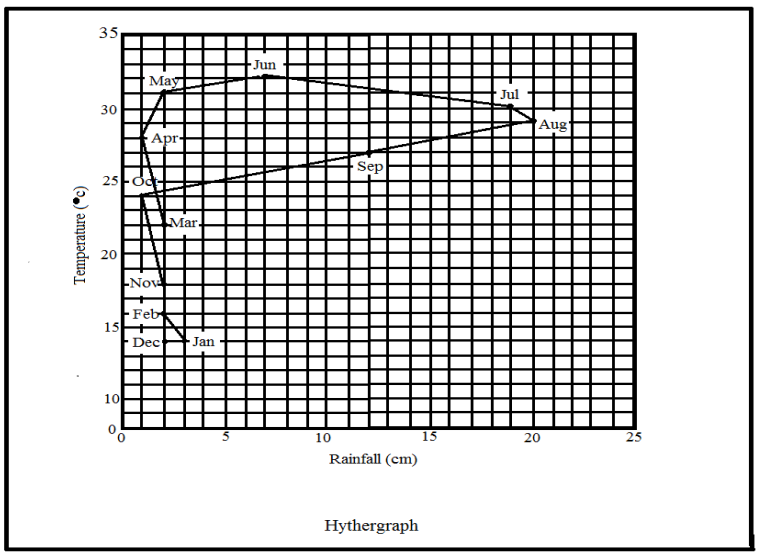


Fig. 6.9

Their major purpose is to provide general climatic differences, which occur in different parts of the earth surface and effect human life in various ways. They are much superior to the other combined rainfall and temperature graphs because they help a quick understanding of the relationship between varying atmospheric conditions. Moreover, they are also well suited for comparative studies.

6.4 CONCLUSION

Climate describes the average conditions of a place expected at given time .A region's climate is generated by the climate system, which has five components: atmosphere, hydrosphere, land surface, and biosphere. If you measure weather data calculate and analyze weather statistics over a long period, you will be able to understand the climatic conditions of that particular area. Temperature, rainfall, cloud cover, winds, hail, snow, flooding, blizzards, ice storms, thunderstorms, steady rains from a cold front or warm front, excessive heat, heat waves and more are the weather components that vary from place to place and time to time. In a long period, their impact upon the earth surface is well known as climatic variations. Representation of climatic data related to different regions such as hills, plateaus and plains have to be determined region-to-region and place to place.

Today, as you all know, the world is facing several challenges due to global warming and climate change. There are strong evidences, which indicate that, an increase in the mean maximum as well as minimum air and oceanic temperature, which is leading to widespread melting of glaciers, and rising sea levels. The increasing frequency and magnitude of disasters occurring due to climate change are posing threat to lives and livelihood at local level and; of course has its impact all over the earth. The Representation of these data is very important for you to understand. This may help you in a practical way to easily recognize the different climatic components and their changes along time at a particular place on earth or all over the globe. This may also help the communities adapt the challenges like soil erosion, land degradation, frequent flooding and rising sea levels. All the factors responsible for climate change need careful observations, continuous monitoring of climatic inputs, and research. This is only possible with data analysis and representation of the collected data bank.

Therefore, it is the requirement of the present hour to represent the collected data bank in a presentable manner to make it applicable in the areas concerned. With modern technology developing rapidly, the issue is no longer how to spread the information, but how to do it in the most efficient way. You must have understood up to now that collected data bank through different meteorological stations if represented through specific methods can help to compare them easily. This may help to deal with the problems related with changes in climatic conditions in general and the extreme weather conditions at different places around the world in particular that are matter of concern for scientists all over the world. The changes in the climate are at such a fast pace that many plants and animal species would vanish from the earth surface. By Identifying changes in the atmosphere and show the impact

of human caused greenhouse gas emissions and other processes that are responsible for the same.

You must have understood up to now that the changing climatic conditions at different places all over the world requires continuous monitoring of weather data and representing them in a better way to make them useful for the poor people which are the most vulnerable to changing weather and climatic conditions. To show elements and processes of climatic in different parts of the earth surface so that they can be further used for solving multiple problems. Illustration of climatic data may help policy makers to make appropriate decisions immediately. Representation of weather- data accordingly may help in developing new ways of farming that support a healthy environment to minimize climatic impacts and create a better quality of life for farmers. Continuous monitoring and analysis of meteorological inputs can further be used for modelling. These methods may help policy makers to make appropriate decisions immediately.

6.5 SUMMARY

You learned in this unit that the average weather conditions at a specific place at a given time are known as climate. A region's climate is generated by the climate system, which has five components: atmosphere, hydrosphere, cryosphere, land surface and biosphere. Climate may include precipitation, temperature, humidity, sunshine, and wind velocity, phenomena such as fog, frost, and hail storms over a long period of time. Different types of instruments are used to measure different parameters. Weather stations collect meteorological information with the help of these instruments. These data can be analyzed and plotted through various methods and techniques. You have learned the methods which are very significant for representations of major components of climate .Thus; some of the methods included in this unit will help you to understand the weather phenomena which collectively represent climate in a better way. These are wind speed and direction, distribution of rainfall at a particular place at a certain period, varied temperatures, their interrelationships in a clear and concise manner and ultimately how they have their impact upon each other and on human beings in different parts of the earth surface. Thus, you must have understood up to now that all these methods are an initial part in understanding meteorological as well as climatic components up to a great extent.

Wind rose, a graphic tool used by meteorologists, was included on maps before the development of the compass rose. With the help of this diagram in order to let the reader was able to know which directions the 8 major winds blew within the plan view. Able to give more precise information, the modern wind rose diagram shows the frequency of winds blowing from particular directions over a specific period. The length of each ‘spoke’ around the circle is related to the frequency of the wind from a particular direction per unit time. In the rainfall dispersion diagrams graphs are used to display the main patterns in the distribution of data. The graph shows each value plotted as an individual point against a vertical scale. Drawn with the help of long term meteorological data, these diagrams predict the maximum, minimum, median, lower quartile and upper quartile .After arranging all the data in ascending order, you will be able to know the maximum and minimum amount of

rainfall in every month. After that, you will be able to represent your data with the rainfall dispersion graphs.

To view the general climatic view at a glance, including more than single climatic parameters, a climograph represents at least two elements of climate (temperature and rainfall, temperature and humidity) at a given point of time. In 1918, Kuipan constructed climographs with the help of highest and lowest recorded temperatures in the warm and cold months giving a scientific base to the world climatic divisions. A plotted graph showing Griffith Taylor first invented the relationships between precipitation and temperature in the early twentieth century. This type of graph is known as Hythergraph. It resembles first invented by Griffith Taylor in 1916.

The Hythergraph as devised by G.Taylor is just like the climograph as defined by Raisz, Foster and Huntington. However, the climographsand hythergraphs both represent the relationship between rainfall and temperature . Moreover, hythergraphs also include the wind speed and direction. They well suit for comparative studies.

Thus, in this unit ,you have learned to represent climatic data mainly temperature, rainfall, direction of wind with the help of different methods which are very significant in the studies related with climatic differences that can be noticed after a careful observation of the available data collected from different parts of the world. Furthermore, after studying this unit, you may be able to think of the changes humanity needs to adapt to a world where changing climatic patterns is a matter of deep concern. All the above mentioned methods discussed in the unit are to facilitate analysis and prediction in the field of weather and climatic variability and changes for use, benefit and value to society.

6.6 GLOSSARY

Predecessors: A thing that has been followed or replaced by another.

Atmosphere: The atmosphere is a mixture of nitrogen (78%), oxygen (21%), and other gases (1%) that surrounds Earth. High above the planet, the atmosphere is the home for many plants and animals.

Cryosphere: The cryosphere is the frozen water part of the Earth system. Beaufort Sea, north of Alaska. One part of the cryosphere is ice that is found in water. This includes frozen parts of the ocean, such as waters surrounding Antarctica and the Arctic.

Biosphere: The biosphere is the biological component of earth systems, which also include the lithosphere, hydrosphere, atmosphere and other "spheres" (e.g. cryosphere, anthrosphere, etc.). The biosphere includes all living organisms on earth, together with the dead organic matter produced by them.

Temperature: An objective comparative measure of hot or cold a quantity

Humidity: Humidity represents the amount of water vapour in the atmosphere or in a gas.

Precipitation : Rain, snow, sleet, or hail that falls to or condenses on the ground.

Meteorology : The interdisciplinary scientific study of the atmosphere.

Fog : A visible mass consisting of cloud water droplets or ice crystals suspended in the air at or near the Earth's surface. Fog can be considered a type of low-lying cloud and is heavily influenced by nearby bodies of water, topography, and wind conditions.

Frost : The coating or deposit of ice that may form in humid air in cold conditions, usually overnight.

Hail storms : Any thunderstorm which produce hails that reaches the ground is known as a hailstorm has a diameter of 5 millimetres (0.20 in) or more. Hailstones can grow to 15 centimetres (6 in) and weigh more than 0.5 kilograms (1.1 lb). Unlike ice pellets, hailstones are layered and can be irregular and clumped together.

Greenhouse gases : The primary greenhouse gases in Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone.

Blizzards : A severe snowstorm characterized by strong sustained winds of at least 35 mph (56 km/h) and lasting for a prolonged period of time—typically three hours or more.

Ice storms : A storm of freezing rain that leaves a coating of ice

Thunderstorms :A storm with thunder and lightning and typically also heavy rain or hail.

Cold front : The transition zone where a cold air mass is replacing a warmer air mass. Cold fronts generally move from northwest to southeast. The air behind a cold fronts is noticeably colder and drier than the air ahead of it.

Warm front : The transition zone where a warm air mass is replacing a cold air mass. Warm fronts generally move from southwest to northeast and the air behind a warm front is warmer and moister than the air ahead of it.

The median : A number that is halfway into the set. To find the median, the data should first be arranged in order from least to greatest.

The upper quartile : The median of the upper half of a data set. This is located by dividing the data set with the median and then dividing the upper half that remains with the median again, this median of the upper half being the upper quartile.

The lower quartile (Q1) : is the median of the lower half of the data set of the spatial climatic data.

Soil erosion : This is a naturally occurring process on all land. The agents of soil erosion are water and wind, each contributing a significant amount of soil loss each year.

Land degradation : A process in which the value of the biophysical environment is affected by a combination of human-induced processes acting upon the land. It is viewed as any change or disturbance to the land perceived to be deleterious or undesirable.

Scorching : high temperature (70°-80°F) and low relative Humidity (below40%)

Muggy : high temperature (70°-80°F) and high relative Humidity (over70%)

Keen :low temperature (below40°F) and low relative Humidity (below40%)

Raw : low temperature (below40°F) and high relative Humidity (over70%) becomes thinner until it gradually reaches space. It is divided into five layers. Most of the weather and clouds are found in the first layer.

Hydrosphere : The hydrosphere is the liquid water component of the Earth. It includes the oceans, seas, lakes, ponds, rivers and streams. The hydrospherecovers about 70% of the surface of the Earth.

6.7 ANSWER TO CHECK YOUR PROGRESS

6.7.1(Self-check Questions)

Q.1. What is climate?

Q.2. How can climate of a particular region are understood properly?

Q.3. How can you represent climatic data?

Q.4. What helps you to look for trends, relationships, and sequences in the available climatic data?

Q.5. Define 'weather'.

Q.6. What is a wind rose diagram?

Q.7. What is the significance of each "spoke″ in the wind rose diagram?

Q.8. Where are wind roses used as one of the preliminary steps taken in modern times?

Q.9. Who used climographs scientifically to divide the world into climatic divisions?

Q.10. What is the disadvantages of climographs?

Q.11. Who was the founder of hythergraph?

12. Fill in the blanks with the appropriate words given below
(Ordinates, ascending, plotted, graphic tool)

i) Temperature is..... along the vertical coordinate.

ii) Wind rose is a..... used basically by meteorologists

iii) Taylor's climograph represents wet –bulb temperatures as .....and relative humidity as abscissae.

iv) In the rainfall dispersion diagrams, first you will have to arrange all the data in .....order.

6.7.2(Answers to self-check Questions)

1. Climate is detailed statistical weather information that describes the variation of weather at a given place for a specified interval.
2. The climatic conditions all over the world or a place or region within it, can be understood with collection, analysis and representation of weather data of that particular place or region.
3. Climatic data can be represented with the help of different types of graphs and diagrams.

4. With the help of basic statistical techniques you can find out trends, relationships, and sequences in the available climatic data.
5. The atmospheric conditions at a specific place at a specific point in time are known as weather.
6. The diagram, which shows the frequency of winds blowing from particular directions over a specific period, is a wind rose diagram.
7. In the wind rose diagram the length of each "spoke" tells the frequency of wind coming from a particular direction.
8. Compiling of wind rose is one of the preliminary steps taken in constructing airport runways as aircrafts typically perform their best take-offs and landing points into the wind.
9. In 1918, Kuipan constructed climographs giving a scientific base to the world climatic divisions. In his division, highest and lowest recorded temperatures in the warm and cold months were used.
10. Though climographs display temperatures in a clear and concise manner but if not used in appropriate situations there are chances of misinterpretation. Therefore, it is necessary that they may be used in a reasonable situation.
11. Hythergraph was first invented by Griffith Taylor in 1916.
12. Fill in the blanks with the appropriate words given below

i) Temperature is<u>plotted</u> along the vertical coordinate.
ii) Wind rose is a <u>graphic</u> tool used basically by meteorologists
iii) Taylor's climograph represents wet –bulb temperatures as <u>ordinates</u> and relative humidity as abscissae.
iv) In the rainfall dispersion diagrams, first you will have to arrange all the data in <u>ascending</u> order.

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6.10 TERMINAL QUESTIONS

1. Define 'weather'.
2. What can be the first step towards understanding the climate of a particular region?
3. What is climate?
4. What helps you to look for trends, relationships, and sequences in the available climatic data?
5. How can you represent climatic data?.
6. Highlight the major factors that determine the state and condition of the atmosphere?
7. Explain meteorology. Tell the significance of meteorological data for the students studying geography?
8. What is the relationship in between weather and climate?
9. What is a wind rose diagram? Are modern wind rose diagrams different from the previous ones? Explain.
10. What is the significance of each "spoke′′ in the wind rose diagram?
11. Where do we use wind roses as one of the preliminary steps taken in modern times?
12. Who used climographs scientifically to divide the world into climatic divisions?
13. What is the disadvantage of climographs?
14. Who was the founder of hythergraph?
15. Fill in the blanks with the appropriate words given below
    (Ordinates, ascending, plotted, graphic tool)
    i) Temperature is..... along the vertical coordinate.
    ii)Wind rose is a..... used basically by meteorologists
    iii)Taylor's climograph represents wet –bulb temperatures as .....and relative humidity as abscissae.
    iv) In the rainfall dispersion diagrams, first you will have to arrange all the data in .....order.
17. Explain the changes in the modified form of climographs after Griffith Taylor.
18. In which senseare the words Scorching, Muggy, Keen and Raw used and by whom?
19. Explain dispersion graphs. How do these graphs represent rainfall?
20. What are hythergraphs? What do these types of graphs show?
21. Why is the representation of weather data included as a part of geographical studies?

UNIT–VII: WEATHER INSTRUMENTS

7.1 OBJECTIVES

This part of the study is to note and determine the changes in weather elements like temperature, air pressure, winds and rainfall. These elements affect the life and conditions of the people everywhere. Weather, because of its uncertainties has been our concern for many years. There is a necessity to have the observations of weather phenomena in a systematic way.

7.2 INTRODUCTION

Weather denotes the atmospheric conditions of weather elements at a particular place and time. The climate of a place is the overall conditions of temperature, pressure, winds, humidity, cloudiness and precipitation of a large area or region over a long period of time. All these are basic weather elements. A change in one weather element will, in turn, change some or all the others. Hence, on the basis of predominant weather elements weather conditions can be generalized. For instance, predicting weather a few days in advance may prove very useful to farmers, aviators, tourists, planners. This, at any rate is not a simple task. To do it accurately, we require a number of weather instruments devised especially for the purpose. These help us to take safety measures in advance.

The places, where weather conditions are continuously recorded are called weather stations. These stations are of three types – surface, upper air and space based observation stations. These are coordinated by the world meteorological organization (WMO), a specialized agency of the United Nation, headquarters at Geneva. We are here mainly concerned with the meteorological instruments of surface observations.

7.3 TYPE OF WEATHER INSTRUMENTS

The prediction of weather is not a simple task. To do it accurately, we require a number of weather instruments devised especially for the purpose. It is also necessary to know the use of these instruments. The elements of weather need different type of instruments. The temperature, air pressure, humidity, clouds, winds and rainfall are main elements and need the use of specialized weather instruments for accurate recording of weather data at certain interval.

7.3.1 Temperature Measuring Instruments

The knowledge of the temperature of freely moving air is the primary concern of weatherman, because it is responsible for a variety of weather changes. The instruments designed to measure accurately the changes in temperature is called a thermometer which literally means ‘heat measurer’. These are categorized into following types:-

(i) The simple Thermometer
(ii) Maximum and Minimum Thermometer
(iii) Thermograph

7.3.1.1 The Simple Thermometer

The design of a thermometer is based on the fact that any substance, whether solid, liquid or gas expands when heated are expanded in a particular manner. Generally, liquids are preferred. Liquid thermometers are smaller and easier to read and handle. It is a most common type. Mercury or alcohol is used as a thermometric liquid in standard thermometers. When the mercury heated, it expands more than the glass, and when cooled, it contracts more than the glass.

Temperature is indicated in degrees of Celsius and Fahrenheit. These are the two type of scales named after two scientists, who devised them. Fahrenheit scale was devised by Danial Fahrenheit in 1714. He was German physicist. The Celsius scale was devised by Anders Celsius in 1742. He was an Swedish Astrologist. This scale is mainly used in those countries, which have metric system. In our country, we use mainly the Celsius scale. In Celsius thermometer, the temperature of melting ice is marked 0ºC and that of boiling water 100°C, and the interval between the two is divided into 100 equal parts. On the Fahrenheit thermometer, the freezing and boiling points of water are graduated as 32°F and 212°F, respectively and the interval between them is divided into 180 equal parts. Therefore, one Celsius degree is equivalent to 1.8° Fahrenheit degrees. The following formula is used for the conversion from one scale to another:-

From Celsius to Fahrenheit

$$F = \left(C \times \frac{9}{5} \right) + 32 \text{ or } \frac{F - 32}{180} = \frac{C}{100}$$

From Fahrenheit to Celsius

$$C = \frac{F - 32}{5} \text{ or } \frac{C}{100} = \frac{F - 32}{180}$$

Example:

The normal temperature of the human body is 40°C. Convert it into Fahrenheit:-

- $\frac{F - 32}{180} = \frac{C}{100}$
- $\frac{F - 32}{180} = \frac{40}{100}$
- $F = \frac{40 \times 180}{100} + 32$
- F = 72 + 32 = 104°

The normal Temperature of the human body is 104°F, convert it into centigrade:

- $\frac{C}{100} = \frac{F - 32}{180}$

- $C = \frac{104 - 32}{180} \times 100$
- $C = \frac{72 \times 100}{180}$
- C = 40°C

In meteorology, the real air temperature is measured with the help of a thermometer placed in a sheltered place to protect it from direct sunshine or reflected radiant heat. The thermometer is placed inside a double walled wooden white painted box. This box is placed at a height of about a metre above the ground in an area. It should be away from the trees or walls of the buildings.

The thermometer consists of a narrow sealed glass tube of a small uniform bore sealed at one end with an expanded bulb at the other. The bulb and the lower part of the tube are filled with mercury. Fig. 7.1

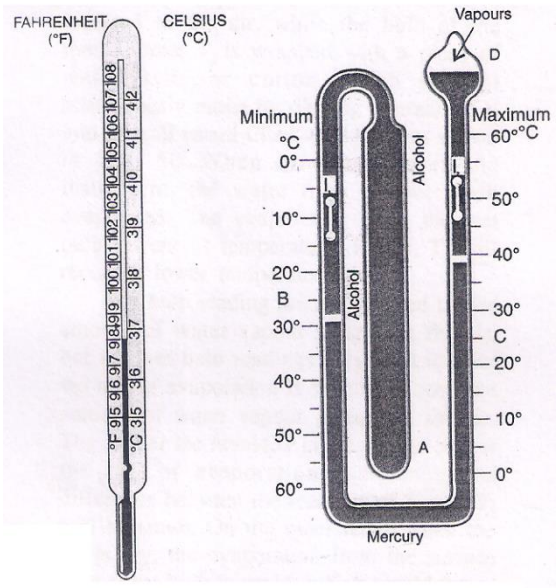

Fig 7.1 Clinical and Six's Maximum and Minimum Thermometer

7.3.1.2 Maximum and Minimum Thermometer

This is a combination of two thermometers. These register maximum and minimum temperatures. The purpose of this thermometer is to record the highest and the lowest temperatures occurring during a given period, preferably for twenty four hours.

The thermometer used for measuring the maximum and minimum temperature in a day is called the Six's Maximum and Minimum Thermometer. The maximum thermometer tube has mercury in it, while the minimum thermometer has alcohol in it, which does freeze easily.

This thermometer consists of a cylindrical glass bulb A connected to a U-shaped tube. B.C., which terminates in another bulb D as shown in Fig. 7.1. The lower part of BC contains mercury. The parts of the limbs B and C above the mercury surface and the bulbs A and D contain alcohol. This alcohol is known as thermometer liquid.

Above the mercury surface in each limb, there are two steel indices I_1 and I_2, each provided with a spring arrangement which keeps them pressed to the sides of the tube. To set the thermometric, each index is moved up or down the tube by a small horse-shoe-shaped magnet. This magnet brings I_1 and I_2 indices in contact with the mercury. This situation is defined as the setting of the thermometer. This shows that the thermometer now can be used for the reading.

Both limbs of B and C are graduated with the values of Celsius and Fahrenheit scales. The left limb A registers the minimum temperature with the scale of graduation running downwards from top. The right limb registers the maximum temperature with the graduations running upwards from the bottom. It means the value of scale decreases from bottom to top in minimum tube, while the value of scale increases from bottom to top in maximum tube.

The alcohol in the bulb 'A' expands with the rise in temperature, and it pushed down the mercury surface B. Naturally mercury rises in the limb 'C', and it pushes up the index I_2 when temperature falls the mercury level in C falls. In this situation the index I_2 remains at the same position. It doesn't come down. This results in the rise of mercury in B limb, and the index I_1 is pushed up until the temperature ceases to fall. Hence, the readings against the lower ends of the indices I_1 and I_2 give the minimum and maximum temperatures, respectively, reached during the period of observation.

After noting the readings of maximum and minimum temperatures, for the given period, generally for the last 24 hours, which is usually one date or day, the thermometer is again set-up with the help of the magnet. Both the indices I_1 and I_2 are brought again in contact with the mercury levels in both the limbs. It is practicised again to record both the temperatures of the following day. The readings of both the temperatures give us with the average and range of temperatures of the day.

Example : Suppose, a place has recorded 10°C as the minimum, and 40°C as the maximum temperature in that the case the:

Average Temperature of the day is : $\frac{\text{Maximum} + \text{Minimum}}{2}$

Here, $\frac{40°\text{C} + 10°\text{C}}{2} = \frac{50°\text{C}}{2} = 25°\text{C}$

The total of both the temperatures is divided by 2, as it has an addition or total of two temperatures.

Range of Temperature of the day : Maximum – Minimum

Here : 40°C – 10°C = 30°C

In metrological observatories the readings of temperature are taken at fixed intervals every day. Now-a-days separate thermometers are used for obtaining the maximum and minimum temperatures. In this case maximum thermometer contains mercury, whereas the minimum thermometer contains alcohol. Both, these thermometers are attached on single piece of wood. This is then defined as Rutherford's thermometer.

Thermograph: It is a self-recording instrument, and records the temperatures automatically and continuously. The values are noted on a graph paper. It has bimetallic strip, used as a reactor. This strip is made by two such metals, which have their different nature of thermal expansion. These strips have curvature shape, and are joined with the pen of the graph by applying levers. This graph not only records the maximum and minimum temperature of twenty four hours, but also records variations in the temperature during aforesaid period.

7.3.2 Humidity Measuring Instruments

Humidity is known as the amount of water Vapour in the atmosphere. The water vapour holding capacity of the air increases with the increase in temperature and decreases with the fall in temperature. The maximum and minimum amount of water vapour, the air can hold at given temperature is called vapour capacity. The amount of water vapour present in the air is expressed in terms of grams per cubic metre.

Humidity is expressed in two ways:

(i) **Absolute Humidity:** It is the weight of water vapour in a given volume of air at particular temperature

(ii) **Relative Humidity:** It is a ratio between the total capacity of the air for holding moisture under a given temperature and the actual amount of moisture being carried by it at the moment. It is expressed in percentage.

Example: The temperature of a sample of air is 35°C. It can hold 30 grams of moisture per kilogram. (It can be defined as maximum humidity) Suppose, it is 6 grams at the moment i.e. is the absolute humidity. The relative humidity at the temperature will be as follows:

$$\text{Relative Humidity} = \frac{\text{Absolute Humidity} \times 100}{\text{Maximum Humidity}} = \frac{\text{Actual Amount of coater vapour}}{\text{Vapour capacity of the air}}$$

$$= \frac{6 \times 100}{30} = 20\%$$

Thus, its relative humidity is 20 percent. The air at this temperature is said to be saturated when its relative humidity is 100 percent. Suppose, here in the above case, the moisture is increased more than 30 grams, which, the air will not be able to hold, and it will come out in the form of rain. Relative humidity is the touchstone of humidity of the air. It acquaints us with the present condition of air, that how much it is dry or humid.

The humidity of the place can be found out with the help of dry and wet bulb thermometer, Hygrograph and Hair hydrometer. Among these wet and Dry bulb thermometer is widely used for the purpose.

7.3.2.1 Wet and Dry-Bulb Thermometer

It is a simple instrument. It was devised by Manson, so it is also named as Manson's Hygrometer. It has two thermometers. Both of these are identical fixed to a wooden frame. The bulb of the thermometer (Dry) T_1 is kept uncovered and is exposed to the air, while the bulb of the thermometer T_2 is wrapped with a piece of wet Muslim or cotton which is kept continuously most by dipping a strand of it into a small vessel filled with water. (Fig.7.2). When air blows over the instrument, the water is evaporated from the wet bulb. This amount of evaporation affects the temperature of wet-built. More evaporation of T^2 thermometer will bring down the temperature and it will indicate the dryness of the air. If T^2 thermometer is affected by less evaporation, in that case the temperature will not go down. It will not have much difference with T_1 thermometer.

Dry-bulb reading is not affected by the amount of water vapour present in the air, whereas the wet-bulb reading will vary with it since the rate of evaporation is dependent upon the amount of water vapour present in the air. If the air is more humid, it will slower the rate of evaporation, and hence, the difference between the readings of T_1 and T_2 will be small. On the otherhand, when the air is dry, the evaporation from the surface of wet-bulb is rapid, it would lower down its temperature and the difference between the two readings would be large. Hence, the difference of the readings of T_1 and T_2 determines the humidity of the atmosphere. The larger the difference, more is the arid air. The small the difference, less is the arid air. In case, if both the thermometers T_1 and T_2 have not any difference in the temperature, it means the air is fully humid or saturated. In that condition, the atmosphere will soon have rains.

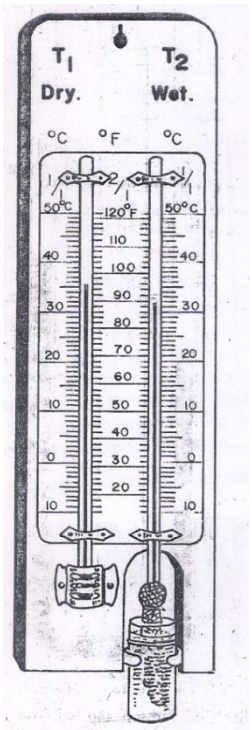

Fig. 7.2 Wet and Dry Bulb Thermometer

For Example:

- If dry-bulb temperature is 20°C and wet-bulb temperature is 18°C, it denotes the humid air.
- If dry-bulb temperature is 20°C and wet-bulb temperature is 5°C, it denotes the dry air.

The amount of humidity can be determined with the help of a table known as Relative Humidity Table No. 1.

Dry-bulb temperature (°C)	Difference between wet-bulb and dry-bulb temperatures (°C)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	81	64	46	29	13															
2	84	68	52	37	22	7														
4	85	71	57	43	29	16														
6	86	73	60	48	35	24	11													
8	87	75	63	51	40	29	19	8												
10	88	77	66	55	44	34	24	15	6											
12	89	78	68	58	48	39	29	21	12											
14	90	79	70	60	51	42	34	26	18	10										
16	90	81	71	63	54	46	38	30	23	15	8									
18	91	82	73	65	57	49	41	34	27	20	14	7								
20	91	83	74	66	59	51	44	37	31	24	18	12	6							
22	92	83	76	68	61	54	47	40	34	28	22	17	11	6						
24	92	84	77	69	62	56	49	43	37	31	26	20	15	10	5					
26	92	85	78	71	64	58	51	46	40	34	29	24	19	14	10	5				
28	93	85	78	72	65	59	53	48	42	37	32	27	22	18	13	9	5			
30	93	86	79	73	67	61	55	50	44	39	35	30	25	21	17	13	9	5		
32	93	86	80	74	68	62	57	51	46	41	37	32	28	24	20	16	12	9	5	
34	93	87	81	75	69	63	58	53	48	43	39	35	30	28	23	19	15	12	8	5

Precautions for the use of the thermometer

1. The vessel of wet-bulb should be filled with distilled water.
2. The cotton cloth should be changes at least once in a month.
3. The thermometer should not be exposed to direct sunshine.
4. It should be housed in a shelter place.
5. The wood on which T_1 and T_2 thermometer are attached should be painted white.
6. It should be kept at such site, from where the air has free movement.
7. It is kept at a height of about a metre and placed away from buildings in an area not enclosed by walls or trees

Hygrograph: It is a self-recording instrument. It is an advanced form of hair hygrometer. Its built is just identical to thermometer. It also indicates its measurements on a graph paper.

7.3.3 Atmospheric Pressure: Measuring Instruments

Air pressure is an important element of weather and is measured in inch or millibar. It is defined as the pressure exerted by the atmosphere on an unit area.

It is well known that air has weight and that it exerts great pressure on the earth's surface. It is observed that sea level, in normal conditions, has the pressure of air 14.7Lb (pounds) on every square inch or 1.03 kg. per sq. cm. As a result of the constant movement of air, the changes in temperature and the variation in its vapour content, the weight of the air above any point is continuously changed. Therefore, like temperature, atmospheric pressure also has variations with time and space. It is an important feature of weather study. It helps in forecasting as it has very close relationship with other weather elements.

The instrument designed to measure atmospheric pressure is called a barometer. These are mainly of two types – (i) Aneroid barometer and (ii) Fortin's Barometer.

7.3.3.1 Aneroid Barometer: It is a very common instrument, used for the measurement of atmospheric pressure. It has derived its name from Greek word, aneros (a – not, neros-moisture), meaning without liquid. It was invented by Lucien Vidie in 1843. It has a circular shape like a time watch.

It consists of a corrugated metal box made of silver or some similar thin alloy, sealed completely. The chamber is air tight and has vacuum inside. Inside the box, there is a spring pressing lid upwards against the pressure of the atmosphere. When the pressure of the atmosphere from outside increases, it pushes the lid downwards and when the pressure of the atmosphere is less outside the lid is pushed upwards by the spring. This relative movement of lid results in the rotation of the needle on the dial that indicates the atmospheric pressure. (Fig. 7.3)

This barometer can easily be transported. So, it has special significance in aviation and mountaineering. The dial of the barometer has the indication of certain weather elements like vary stormy rainfall, change, fair, very dry. It is now very common in use. It is very easy to note the variations is pressure from the instrument.

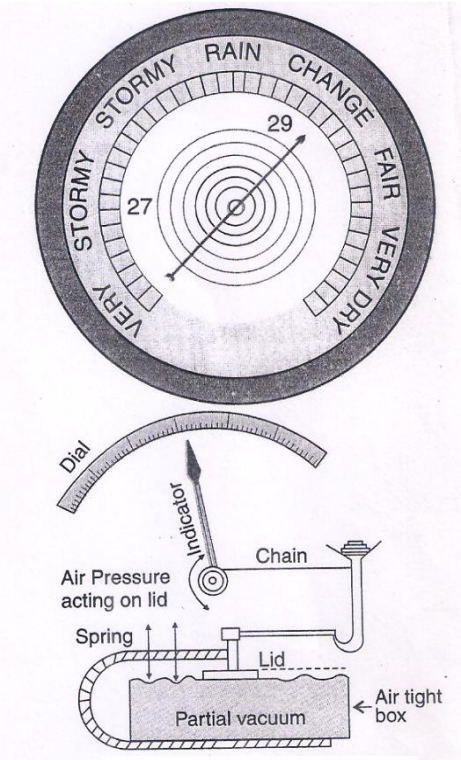

Fig. 7.3 Aneroid Barometer

7.3.3.2 Fortin's Barometer: This is known as Mercury Barometer. It was devised by **Evangelista Torricelli** in 1643. He was the disciple of Galileo of Italy. Though it is costly instrument, but the measurement of air pressure is quite easy. It is based on a simple principle as explained here:-

Principle: It can easily be followed by a simple experiment. Take a thick glass tube of uniform bore. It should be a metre long. Fill it with mercury close the mouth of the tube with

a finger, then invert and immerse its open end in a cup of mercury without allowing air to enter in the tube and then remove the finger. The mercury will flow out of the tube into the cup and stand at a definite height above the level of the liquid in the cup. This is because the weight of the column of mercury in the tube, above the surface of the mercury in the cup is balanced by the weight of the air column of an indefinite height exerted as pressure upon an equal cross-section of the liquid surface. The height of the column of mercury in the tube, therefore, becomes the measure of the pressure of air. The height of the column is graduated in millimeters or in inches. (Fig. 7.4)

Fortin's barometer is generally used by metrological observatories. It consists of a vertical glass tube, filled with mercury. The upper end of the tube is closed and the bottom open. The open end of this tube is inverted into a cistern of mercury. This cistern has a flexible bottom with an adjusting screw (s) to bring the mercury level in the cistern to a fixed point before taking reading.

With the decrease in pressure, some of the mercury flows out of the tube into the cistern. While with the increase, some of the mercury in the cistern flows into the tube. Therefore, to provide a fixed point above which the height of the column may be measured, an ivory index 'I' is fixed to the top of the cistern. The zero of the scale corresponds to the tip of the ivory index which points down vertically.

The barometer tube is encased in a brass tube, AB, for protection, and the scales indicating centimeters, inches or millibars of air pressure are inscribed on it. It has a slit, through which the mercury level in the tube can be easily seen.

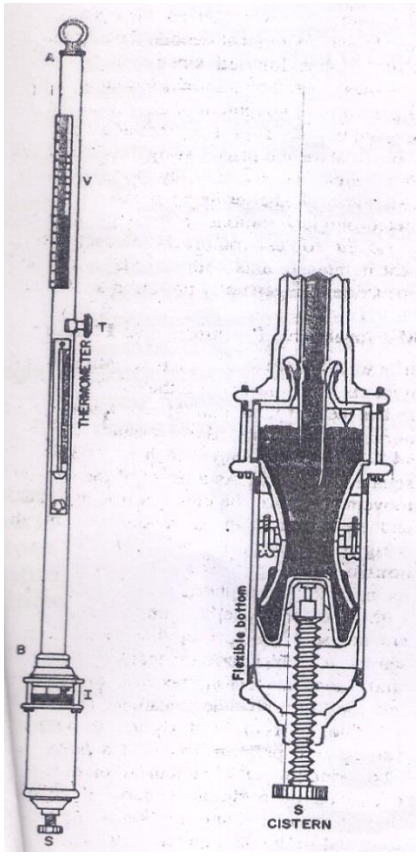

Fig. 7.4 Fortin's Barometer

The instrument is provided with a vernier scale. 'V' which slides in the slit. Its position is adjusted by means of the screw 'T'. There is a brass plate attached to the vernier and is behind the barometer tube. The lower edge of this brass plate and the lower edge of the vernier are in the same horizontal line and they move together when 'T' works. There is also an attached thermometer. It helps us to make the correction for every pressure reading.

Precautions for its use: It needs certain adjustments before the reading is taken :

(i) The mercury level in the cistern should be made to just touch the tip of 'I'.

(ii) The zero of 'V' should be made to coincide with the surface of the mercury in the tube.

Barograph: It is a self-recording instrument to measure the air-pressure. The reading can be noted from the graph paper which has its connection with levers of the instrument.

Unit Measures of Pressure:

There are mainly two major units to measure air pressure-one is Inch scale and the second is Bar Scale.

1000 millibar = 75 centimeter = 29.53 inches = 1 Bar

7.3.4 Instruments of Wind Observation

Wind is another basic weather element. The Horizontal movement of air is called wind, which always blows from high pressure to low pressure areas. Two basic measurements about wind need to be observed with care namely (i) Direction , (ii) Speed.

7.4.4.1 Wind Direction: Our main directions are North, East, South and West. These are cardinal points. These directions of the wind are determined by means of a **wind vane**. The wind vane always points to the direction of wind. This vane is a revolving plate. This plate is perfectly balanced on a rod. There are ball bearings on which it turns smoothly without frictions, so that it responds even to a slight blow of wind. In a simplest form, the vane has a light thin metallic or wooden structure having a pointed end known as arrow (made of heavy metal) and a broad end called the tail (Fig.7.5)

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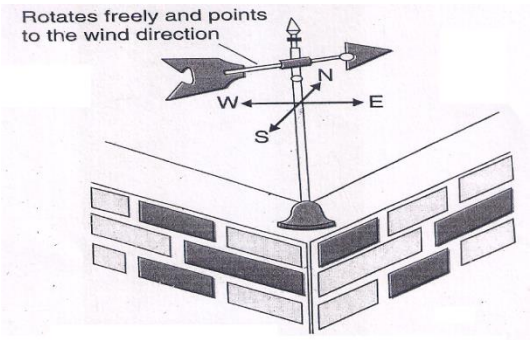
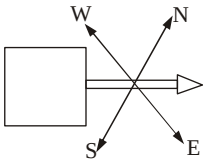


Fig. 7.5 Wind Vane

The arrow always points towards the direction from which the wind blows and the tail helps in keeping the point of the vane nosed into, or towards the source of the wind. Below the vane, the vertical rod carries a cross indicating the four main directions. For example, the arrow of the vane indicating towards North direction, it means that the winds are blowing from north to south. In this case, the winds will be named as northern winds. If supposed, the

arrow has its direction towards south direction, it means that the winds are blowing from south to north direction

It is to be kept in mind that the arrow indicates the direction of the prevailing wind. The wind flows from what direction is called as windward direction and the wind is moving to that direction is called as Leeward direction.



It indicates north east direction.

If the wind is moving from North, it will be named as North wind and suppose it is blowing from east to west, in that case it will be defined as Eastern winds. Here, eastern side is windward side and western side is leeward side.

Wind Speed: Wind speed is measured by an instrument called Anemometer. An Anemometer is an instrument used for measuring the wind velocity. This wind speed indicator consists of three or less commonly four hemispherical cups attached by horizontal arms to vertical spindle.

These cups start to rotate with the blowing of winds. These cups spin in horizontal direction. The rotary motion of horizontal arms, in turn, cause the vertical spindle to rotate. At the bottom of the spindle, there is a mechanical device which records the number of its revolution. These revolutions indicate the velocity of the wind.

7.4.4.2 The anemometer: It is sometimes electrically connected to a dial inside the weather station. This dial indicates the speed of wind in kilometers or miles or knots (nautical miles) per hour. The rotation of the cups depends on speed of wind. If the wind is blowing with a high speed, in that situation, these cups will rotate with a great speed. It means the rotation of cups is an indication of wind speed. (Fig. 7.6)

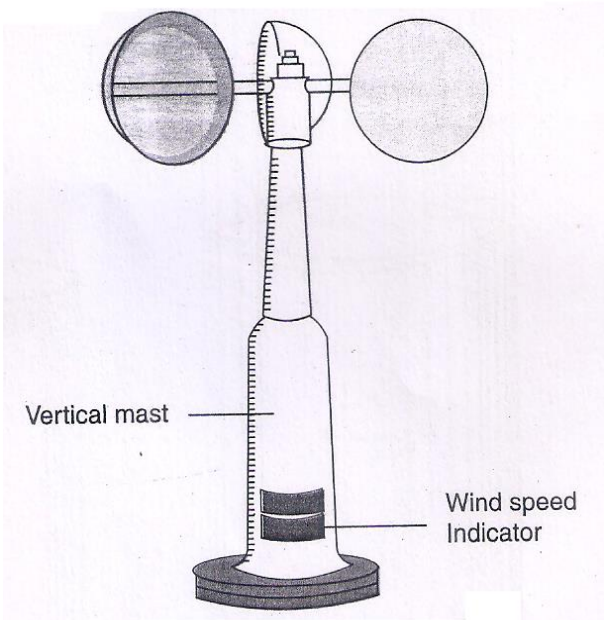


Fig. 7.6 Anemometer

It we mark that smoke is rising vertically, it means that there is hardly any speed of the wind. It can be said that wind is calm. Sometimes if we feel that it is quite difficult to move on the road, the wind speed in such cases is more than 40 kms. per hour. In a storm, when trees get uprooted, the wind speed is more than 100 kms. per hour.

Precautions in its use :

(i) The wind instruments should be placed at such points, which must be free from the interference of local hindrances.

(ii) These should be placed in open space, where the air movement is quite without any obstacle.

(iii) It should be placed at high objects.

The anemometer is also known as Robinson's cup Anemometer as because it was devised by Robinson.

Anemograph: It is a self-recording instrument. It is mainly used by observation. All the changes in the speed of wind are recorded on the graph.

7.4.5 Rain Measuring Instruments

Rainfall is such a weather element which depends on the relative humidity of atmosphere, direction of winds and air pressure conditions. When the air is fully saturated, then with the fall in temperature, the water vapour presents in the moist air start to convert into water drops due to condensation. This process helps in the formation of clouds and thus the water drops start to fall in the form of rain. At this juncture, if the air temperature with a great fall reached near to freezing point, in such situation the water drops are converted into snow, and when it falls it is called as snowfall.

7.4.5.1 The instrument used to measure the amount of rainfall is known as Rain Gauge. It is a simple instrument and consists four parts:

i. **Outer Cane:** It is a metal cylinder

ii. **Inner Cane:** This cane is made by copper metal. This circular cane is fitted accurately in the outer cane. The rain water is collected in it.

iii. **Funnel :** The outer cane has a circular funnel on its mouth. It helps in the collection of water of each drop. Its circumference is equal to the circumference of the base of the receiving bottle.

iv. **Graduated Cylinder:** This is a measuring Jar, which is graduated in millimeter. The reading is taken every 24 hours at a fixed time of the day, generally 8.00 a.m. It shows the amount of rainfall in a given day. Suppose, if we measure one cm. rainfall in the last twenty four hours, it means that the entire surface must have a layer of one cm. water, with the condition that it should neither be evaporated or absorbed nor have any flow to other area. (Fig. 7.7)

Four accurate readings, the instrument should be exposed in an open and level area 30 cms. above the level of the ground to prevent splash. To allow free and unintercepted fall of raindrops in the rain gauge, it should be placed far away from trees, buildings, and other high

objects. Also it needs to be protected from stray animals as they are likely to overturn the rain gauge.

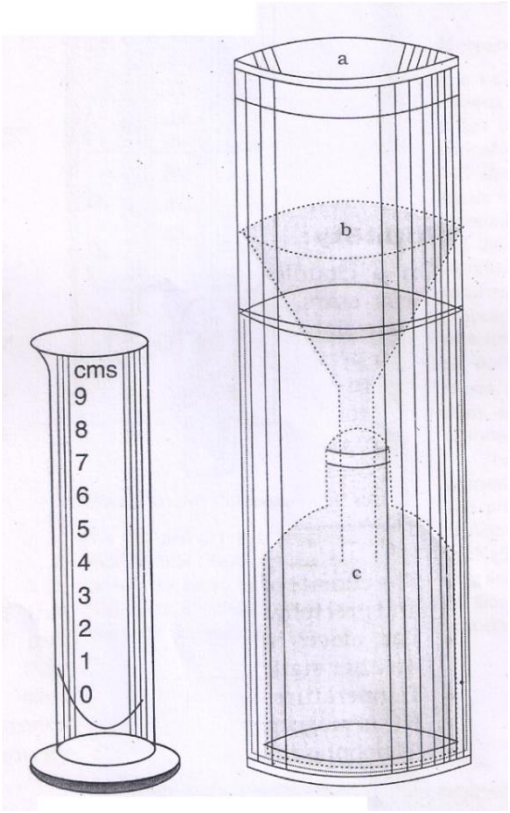


Fig. 7.7: Rain Gauge

7.4 CONCLUSION

It is quite necessary to use various weather instruments for the knowledge of weather elements. Weather is a changing phenomenon. The change is one element of weather brings the change in another element. With the help of certain weather instruments such change can be noted and defined. Their analysis helps us to take safety measures in advance.

7.5 SUMMARY

Temperature, air pressure, amount of rainfall, wind speed and wind direction, presence of water vapour in air, or dryness of the air, sky conditions, form of precipitation are main weather elements. Temperature is measured in Fahrenheit and Celsius units. Celsius is the most common. It has 0^0C as freezing point and 100°C as boiling point. Simple thermometer is used to measure the temperature of human body, mainly in Fahrenheit. Maximum and minimum thermometer is used to measure the lowest and highest temperatures of the day. It acquaints us with the mean, range of temperature of the day. It is of U-shaped and the temperature is indicated by lower point of steel indices. Thermograph is a self-recording instrument used mainly by big meteorological observatories.

Humidity denotes the amount of water vapour present in the atmosphere. The air can hold more water vapour, when it is heated more. It is expressed in the form of absolute, maximum and relative. Absolute humidity expresses the present water vapour of the air at a particular temperature. Maximum humidity means the water vapour holding capacity of the air at that temperature. Relative humidity is the ratio between both the humidity i.e. absolute and maximum. It is expressed in percentage. If it is 100, it means the air is full saturated or fully condensed. Dry and wet bulb thermometer is the main instrument to measure this weather element. The more difference between both the temperatures is an indication of low humid atmosphere, on the other hand, the low difference shows that the air is fully saturated. Hydrograph is a self-recording instrument.

Air pressure is closely related with the temperature. Cold air has heavy weight, and exerts high pressure. Warm air is light in weight, and reels low pressure. Aneroid Barometer is most common instrument. It entails weather condition like storm, change, smooth, rainy, dry and very dry. Fortin's barometer is a mercury barometer, and is generally used by metrological laboratories. Air pressure is measured in inches, millimeters and milibars.

Wind direction is examined by wind vane. Its arrow indicates the direction of wind. If it indicated towards east, it means that eastern winds are blowing. Wind speed is measured by anemometer. It measures the speed in km. per hour. Anemograph is a self-recording instrument used by meteorological laboratories.

Rain gauge is used to measure the amount of rainfall. It is a cylindrical shaped instrument. Rainfall is measured in inches, millimeter and cm. Certain precautions are necessary for its use.

7.6 GLOSSARY

Anemometer:	An instrument meant for measuring wind speed
Aneroid Barometer:	A portable instrument, commonly used for measuring atmospheric pressure.
Barometer:	An instrument for measuring atmospheric pressure.
Rain Gauge:	An instrument for measuring accurately the amount of rainfall at a given place over a fixed duration.
Wind Vane:	An instrument used for determining wind direction.
Water Vapour:	It is the moisture in the atmosphere. It condenses to form clouds and precipitates in the form of rain and snow.
Absolute Humidity:	It denotes the actual amount of water vapour in the air.
Relative Humidity:	It denotes the ratio between the actual amount of water vapour and the maximum amount of water vapour, the air can hold at that temperature. It is expressed in percentage.

Air:	Air is a mixture of gases.
Wind:	Moving air is known as wind.
Aneroid:	Without liquid, a portable instrument used for measuring atmospheric pressure.
Celsius and Fahrenheit	are the units to measure the temperature.
Mean Temperature:	It is the average temperature of the day, month or year.
Range of Temperature:	Difference between maximum and minimum thermometer
Humidity:	Presence of water vapour in the air

7.7 ANSWER TO CHECK YOUR PROGRESS

1. The direction and wind speed vary greatly because different parts of the earth rotate at different speeds.
2. Air moves from high pressure areas towards the low pressure areas.
3. The horizontal movements of air near the earth's surface is known as wind.
4. On a hot day, it feels cool under a fan- because of high temperature, we need cool air.
5. Fog usually disappear soon after sunrise- because of increase in temperature.
6. Dew is usually seen in the morning as because the night temperatures do not fall below 0°C
7. **Fill in the blanks:**

(a) A _____ is the self-recording instrument that measures air temperature.

(b) Aneroid barometer is an instrument that measures air _____

(c) Atmospheric Pressure is measured in _____

(d) A wet and dry bulb thermometer is also known as _____

(e) Celsius scale is the same as _____ scale.

(f) It is the passage of air _____ that makes the weather so variable.

(g) The small difference between dry and wet bulb thermometer readings indicate _____

(h) If no difference between the temperature of both the thermometer indicate.

(a) Thermograph (b) Air Pressure (c) Millibar or inch
(d) Hygrometer (e) Centigrade (f) Mass
(g) High humidity (h) Air is saturated

8. Match various elements of weather given in column a with the units in which they are measured in column B

Column 'A'		**Column 'B'**
1. Atmospheric Pressure	a.	Kilometers per hour
2. Wind Speed	b.	Millibars

3.	Relative humidity	c.	Degree of Celsius
4.	Rainfall	d.	Degree of Faherenite
5.	Temperature	e.	Percent
6.	Human body temperature	f.	Centimeters

1 (b), 2(a), 3(e), 4(f), 5(c), 6 (d)

9. Make correct pairs of the name of instruments in columns A and their uses in Column B.

	Column 'A'		**Column 'B'**
1.	Wet and Dry-bulb thermometer	a.	to find out wind speed
2.	Rain Gauge	b.	to find out wind direction
3.	Six thermometer	c.	to measure precipitation
4.	Aneroid barometer	d.	to find out humidity
5.	Wind vane	e.	to measure atmosphericpressure
6.	Anemometer	f.	to find out the maximum and minimum temperature of airfor a given period

1 (d), 2(c), 3(f), 4(e), 5(b), 6 (a)

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7.10 TERMINAL QUESTIONS

1. Define thermometer.
2. Define daily range of temperature.
3. What do you mean by atmospheric pressure? How is it measured?
4. What is the relation between temperature and pressure.
5. What is temperature? How is it measured?
6. Distinguish between-
   (a) Absolute and Relative humidity
   (b) Weather and climate
   (c) Mist and fog
   (d) Condensation and precipitation
7. What do you mean by wind vane?
8. How can humidity be expressed?
9. Define Rain- Gauge.
10. Define weather. Why should we study it?
11. Explain briefly or define the following terms-
    (a) Evaporation (b) Condensation (c) Precipitation
12. Give the name of six important weather instruments needed by you to record the data of all-weather elements.
13. What are the precautions to be taken in placing a rain gauge?
14. What are the precautions to be taken for the use of dry and wet-bulb thermometer?
15. Discuss the utility of aneroid barometer. What conditions of weather are indicated by it?
16. Explain the functioning of Fortin's barometer.
17. Which instrument is used to determine the direction of wind? Also explain the main directions.
18. Wind velocity is measured by which instrument? Explain.
19. How the rain is measured? Explain in detail.
20. How can you convert the Fahrenheit scale into Celsius scale? Discuss it with an example.

BLOCK-3

Weather Maps and Indian Topo-sheets

UNIT–VII: INTERPRETATION OF INDIAN WEATHER MAPS

8.1: OBJECTIVES

Weather and climate are subject of universal interest and they affect the life and conditions of people everywhere. The uncertainties of weather have been our concern for many years. These days, the changes in climate and issues of global warming are great concerns to us. Hence, it becomes necessary to acquaint ourselves with the changes in weather phenomena. It is possible only to have a systematic knowledge of weather map of an area. These maps give full information of all weather phenomena through which it is possible to predict more accurately the conditions of weather for a day, weeks, months or season. Forecast of monsoon, cyclonic storm, western disturbance, dust storm, snowfall are possible with the detailed analysis of day to day weather maps.

8.2 INTRODUCTION

Weather denotes the conditions of the atmosphere at a given place and time with respect to temperature, atmospheric pressure, humidity, precipitation, cloudiness and direction and velocity of winds. All these factors are known as weather elements. A change in one weather element will, in turn, change some or all the others. On the basis of predominant weather element weather conditions can be generalized by referring to them as rainy, sultry, cloudy, windy or sunny.

Weather forecasts help us to take safety measures in advance. The farmer can make more advantages of such weather predictions. Prediction of weather only a few hours a head may facilitate safe air flights. These are also very useful for navigators, fishermen, defence personnel, horticulturists; people connected with natural disasters and also the general public. It is for the benefit of all these people that weather bulletins are broadcast every day. This at any rate is not a simple test. To do it accurately the weatherman requires firstly the knowledge of weather instruments, devised especially for this purpose. The weather information thus collected; help us in the preparation of weather map of an area.

8.3 INTERPRETATION OF INDIAN WEATHER MAP

A weather map of the world or India shows the weather conditions of a stated time numerically or with the help of approved and listed metrological symbols. The need of weather maps was felt most by sailors for navigation purposes. In 1688 Edmund Halley published a weather map showing the trade winds and direction of prevailing monsoon. This map was rather a typical weather map as it recorded the weather condition over a period of time. Thus, it was necessary to develop such system, that within no time, the latest meteorological changes may be recorded and collected by the meteorological observatory.

The need of starting a Meteorological Service in India was first brought to the notice to the Government of India by the Asiatic Society of Bengal. The service was started by the Government in 1864 with headquarters at Shimla. After the first world war of 1914-18, this Department was expanded and the central office was shifted to Pune. The Indian Daily Weather Reports are published every day from this city.

In India there are more than 350 observing stations grouped into five categories:

(i) **Class I:** observatories are equipped with self-recording instruments and transmit data to the central observatory at Pune twice a day.

(ii) **Class II:** These are equipped with eye reading instruments. These telegraph weather messages twice daily.

(iii) **Class III:** These observatories send their observations to the forecasting centres only once a day.

(iv) **ClassIV:** These observatories record the data of temperature and rainfall and do not send massages daily.

(v) **Class V:** These observatories record the amount of rainfall once. They send the data at 8.00 a.m. daily. This amount indicates rainfall for the last twenty four hours, daily, if it is occurred.

Meteorological Observations

There are types of observatories by three means at Global level. These are follows. These function in coordination of WMO.

(i) **Surface Observatories:** These observatories are distributed all over the country and take observations according to globally coordinated time and spacing. They record elements like radiation, Ozone, atmospheric trace gases, pollution and atmospheric electricity.

(ii) **Upper Air Observatories-** These are large in number, and are scattered around the globe. They have balloon borne instruments for sensing different weather elements. Rockets are also used. They have radiosonde contain sensors. They use wireless massages and data for the analysis at the ground stations.

(iii) **Space Based Platforms or Observatories-** These are new powerful tool. They collect the information from artificial satellites. These are mainly geo-stationary satellites. In India INSAT and Meterosats are providing valuable observations of temperature, cloud cover, winds, cyclonic storm and other elements. These platforms take observation once a day over an area.

All the observation made by above means are used by our Central Meteorological station of Pune. A weather map of India is daily prepared and printed to depict various weather elements. Data is also collected on the ships playing on the India seas. We also collect information from weather observatories in Antarctica.

On the basis of all these meteorological observatories, Indian Meteorological Department of Pune publishes Indian Daily Weather Report two times in a day i.e. 8.30 a.m. and 5.00 P.m. (IST). This Report contains six pages. The first page has the description of the data of observation, and day, time 8.30 morning, brief summary of weather observation, forecast of weather for next two or three days and seismic Report. The lower side of this page has those Weather information observed by various ships with their location in Bay of Bengal and Arabian Sea.

Page No. 2, 3, 5 and 6 of this Report have a long table, which is composed in 23 columns, which give details the observation of our 210 meteorological observatories in code language. The first column has the name of the observation station. The columns 2 to 8 have the description of observations 5.30 p.m. of previous day. Ninth and tenth columns give the details of the present day observations of 8.30 a.m. The remaining columns have the details of the observation of last 24 hours, regarding to maximum temperature, minimum temperature, departure of temperature from the normal, amount of rainfall received during last 24 hours, total rainfall of the season. Departure from normal rainfall, normal annual rainfall.

The page no. four has one big size map of India along with two small maps in the lower part of the paper. This large map has the details of isobars, and different weather conditions with the help of symbols and codes. The small maps show the departure of maximum and minimum temperature from the normal.

Reading a Weather Map

Before proceeding to read the Indian Daily Weather Map one should get familiar with the various symbols used on such maps. The following points are to be described while reading the Weather map:

(i) Introductory Information.

(ii) Air Pressure: (a) Location of high bar, (b) location of low bar, (c) trend of isobars, (d) gradient of air-pressure.

(iii) Wind: (a) direction, (b) velocity.

(iv) Skycondition: (a) Cloud cover, (b) nature of the cloud, (c) other atmospheric phenomena.

(v) Precipitation: (a) general distribution, (b) special area of heavy precipitation, (c) amount of rainfall.

(vi) Sea- Conditions.

(vii) Departure of air pressure from normal.

(viii) Departure of temperature from normal.

1. **Introductory Information:**The preliminary information of weather report is date, day and time. the report is of which date and day, firstly it should be noted. The weather conditions are shown for time- (i) 830 HRS IST- 3.00 GMT (ii) 1730 HRS IST (1200 HRS GMT). The year is mentioned with Hindu SakSamvat.

2. **Air Pressure:**It is shown with the help of isobars. These lines join the places having equal pressure. Their interval is of 2 millibar. The value of each isobar is given on the map. Low pressure and High pressure areas are also marked. Their abbreviations are LP and HP. The trends of isobar indicate cyclonic or anti-cyclonic conditions. The space between two isobar helps in the examination of pressure gradient.

3. **Wind:** Wind speed and direction of winds are closely related with the distribution of air pressure. Areas with high pressure gradient have high wind speed. The relativity of air pressure indicates the wind direction. Winds blow from high pressure areas to low

pressure areas. The location of high and low pressure areas also indicates the direction of wind. Wind direction and wind speed are shown with the help of an arrow. The back part of the arrow indicates the wind direction. This back part has the lines, which are the symbol of wind speed.

On Indian weather map, the wind speed is shown in nautical miles (knot) per hour. Each half oblique line represents the speed of 5 knot, and the line of full length has the value of 10 knots. A complete triangle on the line indicates the speed of 50 knots. Generally 5 knots wind is known as light Breeze, 10 knots wind as Gentle Breeze, 15 knots wind as Moderate Breeze, and 50 knots wind as Strong Breeze. If it is more than 50 knot, its disastrous effects are increased.

4. **Sky Conditions:** On Indian weather maps an effort is made to show, that how much sky is covered with clouds. Sky conditions are shown with the help of a circle. The amount of cloud is shown by the shaded part of the circle. If the circle has not shade, it means that sky is clear. The following table explains the amount of cloud on the Indian weather map.

	Cloud Amount		**Cloud Amount**
	1/8 Sky Covered with Cloud		¾ Sky Covered with Cloud
	¼ Sky Covered with Cloud		7/8 Sky Covered with Cloud
	3/8 Sky Covered with Cloud		Overcast Sky
	½ Sky Covered with Cloud		Obscured Sky
	5/8 Sky Covered with Cloud		High Cloud

These circles are shown on the map, where, the observations have been made.

5. **Other Atmospheric Phenomena:** All those atmospheric changes, which affect the weather of place in any form, are shown with the help of certain symbols. Our weather map, mainly uses the following weather symbols, the details of which is as follows:

(i) Haze : The obscurity of the sky is produced by dust particles or smoke. The visibility is decreased. Area only upto a distance of 2 km. may be visible.

(ii) Mist : The obscurity of the sky is produced by condensed water particle. It also has the visibility upto a distance of 2 km.

(iii) Fog and Shallow Fog : Winter season, generally in morning the obscured conditions are produced due to two reasons:- Sometimes condensed water particles are hanged in huge quantity in the atmosphere, which makes visibility very poor. Sometimes it is so dense, that visibility upto a few metre becomes more difficult. It happens generally when the condensed water particles in the air are developed near to the ground surface. If it is less intense then it is defined as shallow fog. Dense fog cause many aviation and road accidents. Fog disappears with the increase in temperature as water is evaporated.

(iv) Hail: These are known as hail storm. More or less transparent, hails are hard pellets of ice of various shapes and sizes, which fall from Cumulonimbus clouds. These attain great size with the fall in temperature of condensed air. When the pellets (grains) are opaque white and vary in size between 2 to 5 mm in diameter, it is called soft hail. In case, the grains consist of a nucleus of soft hail covered with a thin layer of clear ice, it is called a small hail. Actually these are pellets of ice with thunderstorms.

Indian Weather Symbols

Symbol		Symbol	Phenomenon	Symbol	Phenomenon
∞	Haze	●	Rain	S→	Dust or sand Storm
=	Mist	▽	Shower	ξ	Dust Whirl
≡	Fog	✳	Snow	K	Thunderstorm
⁻⁻	Shallow Fog	↑→	Drifting Snow	▽	Squall
Δ	Hail	,	Drizzle	↘	Lightning

(v) Drizzle : When the condensed water in the clouds falls on the surface in the form of water droplets, it is called as drizzle. It is less intense rain.

(vi) Shower : When, suddenly clouds drops the water drops continually for a short period of time, then it is defined as shower. Generally, the sky is cleared after such temporary incidence.

(vii) Rain : When, water drops from the clouds, fall continuously and the size of these water drops is quite big, it is known as rain. It is the most common form of precipitation. Rain drops are 0.5 mm to 6.50 mm in diameter.

(viii)Squall : A blast of wind of higher velocity than average which rises suddenly and after lasting for a few minutes dies away comparatively suddenly. It is in real sense a sudden blast of wind. Sometimes, it may provide rain.

(ix) Frost : When the temperature of air falls below the freezing point and the water vapour is directly converted into crystals of ice. An accumulation of these crystals is called frost. It is seen ice on solid surface. It is found in those regions where the night temperature falls below 0^0C. It causes severe damage to plants. It can make roads slippery, dangerous to movement.

(x) Sleet: It is a mixture of rain and ice. It rains with snowfall. Such incidents are very common in cold regions. High mountain areas also experience, sometimes such mixture of rain.

(xi) Snow: It is a powdery mass of ice crystals. These ice crystals are spread on the surface in a layer. The thickness of the layer depends on the intensity of ice crystals. These crystals may fall singly or a number of them may combine to form large flakes.

(xii) Thunderstorm: When the winds move with a high speed, with lightening and thundering or roaring clouds, and provide heavy and sudden rain, known as thunderstorm. This is caused due to sudden change in atmospheric pressure conditions. At some occasions, they are also accompanied with hailstorms.

(xiii) Dust Devil: When the dust particles, suddenly rise in the circular form generate the form of dust devil. Winds go up speedily in circular form and carry dust particles upto a great height in the atmosphere. They also move horizontally as dust bowl. After such movement, these are automatically disappeared. Hot desert areas, experiences such atmospheric incidents.

(xiv) Drifting Snow : It is the movement of the snow. Its speed of movement depends on the slope of the surface and gravity of snow. The change in temperature has its impact on it.

(xv) Dew: It is a drops of water on cool, solid surfaces. It is found in regions where the night temperature does not fall below 0°C. It is beneficial to plants. It is not confined in only cold places. It also occurs in hot and humid regions. In deserts, the formation of dew is an important source of water for many plants and animals. It disappears with the increase in temperature.

6. **Precipitation :** Precipitation is classified according to its form in which it reaches the ground. The temperature of the air, both inside and outside the cloud determines whether the precipitation is rain, snow sleet, or hail.

   On Indian weather map, all these phenomena are shown by certain weather symbols, as discussed above. The amount of rainfall is gives on the map in the following form. This amount is printed near the circles showing sky conditions:

   — = 0.25 to 0.74 cms.

   I = 0.75 to 1.49 cm.s

   The amount of rainfall 2 cm. or more than 2 cmsis mentioned in figures near sky condition circles. This amount of rainfall in related with the last twenty four hours.

7. **Sea Conditions:** On India weather map, the conditions of sea wave movement is shown with certain abbreviations of English language. These symbols help us to assess the movement of sea water, that whether it is calm or it is notorious or disastrous.

   Following symbols are used on Indian weather map to show the sea condition of Arabian Sea, Bay of Bengal, and adjoining Indian Ocean. Such details are very useful to navigators, boat sailors, and fishermen, and also to coastal population.

   1. Cm. – CalmSea
   2. Sm – SmoothSea
   3. Sl. – SlightSea
   4. Mod – ModerateSea
   5. Ro. – RoughSea
   6. V.R.O. – Very Rough Sea
   7. Hi – HighSea
   8. V. Hi. – Very HighSea
   9. Ph. – Phenomenal

7. **Department of Air Pressure from Normal :** This feature of weather is shown on a small map printed below the main weather map. It shows the variation of air pressure from the normal, that it is high or less than the normal limit. This variation is shown by

the symbol of + Plus and – Minus. If it shows the variation in Minus, it denotes that the air pressure is below the normal limit, whereas, if it is in Plus, it indicates that air pressure is more than the expectation.

8. **Departure of Temperature from normal :** This is shown an two small maps, printed with the large weather map. One map shows the departure of temperature from the maximum limit and the another one departure of temperature from the minimum limit of temperature.

Weather Map Interpretation

Here, two weather maps have been interpreted in detail. One for the month of July and another for the month of January.

(A) July Weather Map

This weather map represents the weather conditions for the date 20 July, 1981, and corresponds to the time of 8.30 morning. It also indicates weather phenomena for the last twenty four hours. It is published by Indian Meteorological Department of Pune. This map also shows weather conditions of adjacent countries of India, i.e. Pakistan, Nepal, Bhutan, Bangladesh and Sri Lanka. (Fig. 8.2)

(i) Air Pressure: It is shown with the help of isobars. The main feature of air pressure is that it is high on seas than the land. Air pressure is on increase from the central part towards the southern part.

(a) **Low Pressure Areas :** Two such areas can be marked. One area is located on southern part of Pakistan. It is surrounded by a bar of 998 mb. It has much intensity in its south part is comparison of its north part. Another low pressure area is extended on central east India. Its location entails that it may further proceed towards west and north-west. It is surrounded by an isobar of 1000 mb.

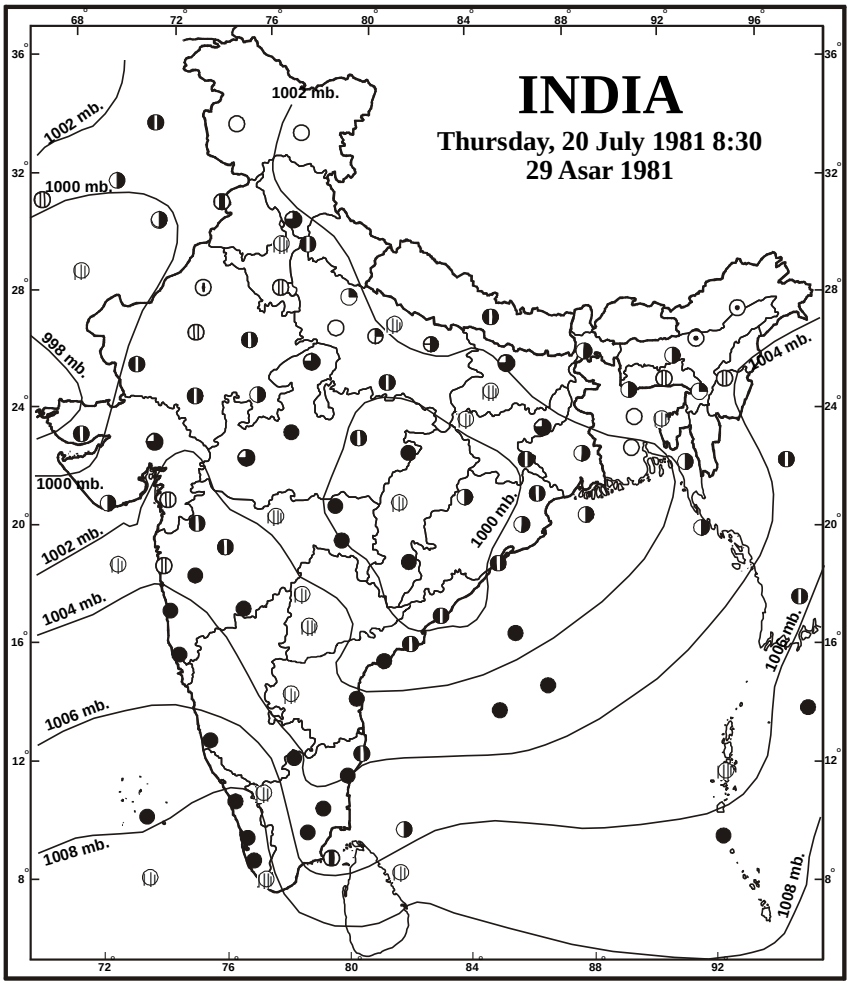

Fig. 8.2 India (Thursday, 20 July, 1981 (8.30 a.m. 29 Asar 1981)

(b) **High Pressure Area:** It is extended on Sea area. Arabian Sea has much high pressure than Bay of Bengal area. Arabia Sea High Pressure area has an isobar of 1008 mb. An High pressure area has developed on north-west boarder of Pakistan. It has air pressure 1002 mb which is Quite low than Arabian Sea High Pressure area. High Pressure is quite intense in the sea area.

(c) **Pressure Gradient:** South Indian has high pressure gradient. Here, isobars are very near to each other. On the other hand most central and north parts have low pressure gradient. The west and north parts rather have the absence of isobar. Pressure is on increase from north to south direction. ArabianSea has more gradient than Bay of Bengal.

(ii) Wind :

(a) **Direction :** Winds are blowing from Sea to land. Arabian Sea has South-west winds. These are blowing towards Western Ghat. In Bay of Bengal, winds are in south to north, and in north-west direction. In North-West of India, these have their direction towards Pakistan.

(b) **Velocity :** The speed of the wind on the sea is much faster than the land. The high pressure gradient has produced high speed winds in the area. The speed is between 5 to 15 knot in the sea area. The central and eastern parts of India have the wind speed less than 10 knot per hour.

(iii) Sky Conditions : Western and Eastern coast. Eastern and Central India are covered with clouds. The sky of north-central part is clear. South India sky is highly cloudy. Tripura, Mizoram, West Bengal and Terai Region have cloudy atmosphere. The sky of Odisha, and Andhra Pradesh is also covered with clouds.

(iv) Amount of Rainfall : Most Parts of India have received rainfall during the last 24 yours. Monsoon has been quite active in Kerala. The western Coasts, Lakshadweep have received heavy rain during the period. In Arabian Sea, Andaman-Nicobar islands are also in the grip of heavy rains. Odisha, lower Gangetic Plain, Central Madhya Pradesh, Chhatisgarh have also moderate rainfall. Hilly regions have also rainy atmosphere. Assam, Rajasthan, Punjab, Haryana and Western Uttar Pradesh have scattered rainfall or are dry. In Kerala, amount of rainfall is between 8 and 10 cm. Hyderabad has 6 cm. rainfall. In West Bengal it is 3 cm. in Birbhumi, Due to cyclonic depression. Chhatisgarh and west Odisha have enough rains.

(v) SeaCondition : Sea is quite smooth in Bay of Bengal. It is calm in PakStrait. It is rough on KeralaCoast. KonkanCoast has smooth and slight sea. North Arabian sea is smooth.

(vi) **Departure of temperature from normal :** The temperature in north-west India is below the normal. It is 8°C low than the normal in West Rajasthan. In Karnataka, Tamil Nadu it is also less than the normal. The remaining areas of the country have the temperature above the normal. Uttar Pradesh, Bihar, Jharkhand and West Bengal have the temperature 2°C high than the normal.

(vii) **Departure of air pressure from normal :** Two areas have developed of air pressure departure. The northern parts have air pressure above the normal. It is 4 millibar more than the normal in Himachal Pradesh, hilly areas and Pakistan. South India has air pressure below the normal limit. It is 2 millibar less than the normal on eastern coast.

(viii) **Weather Forecast :** Weather Department has predicted that Monsoon will make more progress in next few days. It will rain at all places. South Madhya Pradesh, Chhatisgarh, Telangana, AndhraCoast, KeralaCoast will receive heavy rainfall. Hilly areas may have heavy rainfall at few places.

(B) Winter Season Weather Map

This weather map shows weather conditions of India and its adjacent countries for the date 4 January 1993. The time is 8.30 a.m. It is published and printed by Indian Meteorological Department, Pune. (Fig. 8.3).

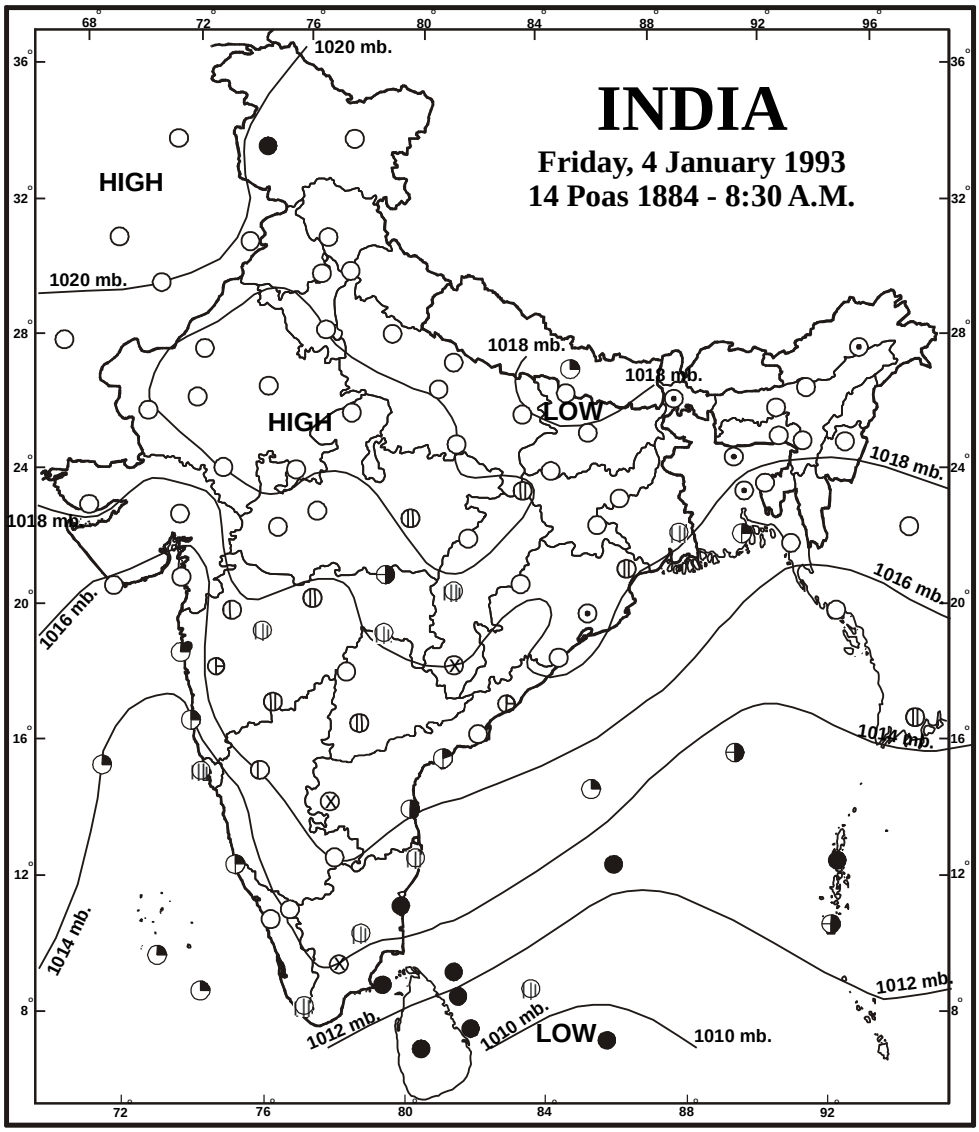

Fig. 8.2 India (Friday, 4 January, 1993 (8.30 a.m. 14 Poas 1884)

(i) **Air Pressure :**The pressure is on increase from south to north. This is the winter season, and it is quite natural that Indian ocean has low pressure than the Indian surface. Isobars have sufficient distance, giving evidence of normal air pressure conditions in the country.

(a) **High Pressure Area :** There are two areas of High Pressure. One is extended on Western India with a isobar of 1020 mb, and the another area is extended on Pakistan, also having an isobar of 1020 mb. Both seems to be interconnected to each other. Most parts of north India are having the air pressure between 1016 and 1020 mb. Isobars limiting high pressure area have sharp curves. These are not straight lines, reflecting high variations in the air pressure conditions.

(b) **Low Pressure Area :** Indian Ocean has the extension of low pressure area. It is surrounded by an isobar of 1010 mb. These isobars have their extension in V-shape. On

land, these are more shifted towards south. Whereas, in sea area, these have north ward trend. A low pressure area has also developed in Nepal, but Its intensity is not so low.

(c) **Pressure Gradient :** It is not so high. In South India, the isobar has the value of 1012 mb, whereas the North India has the extension of 1020 mb isobar. As a whole, South India has more pressure gradient than the north India. Eastern India has not much variation.

(ii) **Wind**

(a) **Direction :** Winds have variations in their direction in North India. These are moving from high pressure area to towards east, and north. In south India, their direction is from land to sea. In east, they have variation in direction.

(b) **Velocity :** In most part of India winds are quite calm. Their speed is more in south India. In north India, their speed is 5 to 10 knot. The wind speed is slow, because of low gradient in air pressure.

(iii) **Sky-Conditions :** Most parts of India have clear sky. Jammu Kashmir has clouds in its western part. In central and south India. Clouds are high. Eastern coast has cloudy sky. It has rainy conditions in Tamilnadu. ArabianIslands have also cloudy weather.

(iv) **Amount of Rainfall :** There is no rain in north India. Jammu-Kashmir state has showering in few areas. Eastern coast has also enjoyed little rain in the last 24 hours. Andaman Nicobar Islands have recorded 3.0 cm. rainfall.

(v) **Sea Condition :** The sea waves are smooth in Bay of Bengal. Arabian Sea, in its north part is calm, while its south part has slight and moderate conditions. The sea is smooth near Lakshadweep.

(vi) **Departure of temperature from normal :** The minimum temperature in north India is high than the normal. In South India it is also high than the normal. The Eastern India has recorded the temperature low than the normal. The maximum temperature is below the normal. It is high only in the sea area.

(vii) **Departure of air pressure from normal :** There is an increase in the air pressure in land area during the last 24 hours. It is more in central India. In South India air pressure has shown reduction. Sea area has also shown the fall in air pressure.

(viii) **Weather Forecast :** Meteorological Department has made this forecast that. South-east India may have more rains in the next 24 hours. Here, the rainfall may be accompanied lightning. North India will have dry atmosphere with calm air.

8.4 CONCLUSION

The study of weather is an important and interesting, as it affects our life in various ways. Weather denotes the conditions of atmosphere of a particular time. Its forecast makes us aware. Weather is shown by a map. So weather map is a map of weather conditions of a particular time of that area. Indian meteorological Department publishes Indian Daily

Weather Report. Its Report contains six pages, along with two maps. These represent for Indian standard time of 8.30 a.m. and 5.30 p.m. The morning weather map is very useful as it gives certain information for the last twenty four hours. These maps show air pressure, wind speed and wind direction, clearness of the sky, amount of cloud on the sky, amount of rainfall, certain important weather phenomena, movement of sea water, departure of temperature and air pressure from the normal. Weather forecasting is possible by the observation of all these weather phenomena.

8.5 SUMMARY

Weather is a state of atmosphere of a particular time. Its explanation depends on the observations of temperature, air pressure, sky condition, wind condition, and moisture. Such observation helps us in the forecast of weather. Our Indian Meteorological Department has made an attempt in this direction. It publishes daily weather maps of India, depicting weather conditions for 8.30 mornings. It is based on the observation and information received and collected from various laboratories, located in different parts of the country. These observatories are known as surface, upper air and space based.

Indian Weather Report consists six pages. It has two maps : one shows the weather conditions of the day at 8.30 a.m. gives the amount of rainfall for the last 24 hours. Another map depicts the weather conditions of the day at 5.30 p.m. It shows the changes in the weather have taken place during the last 9 hours. There are also given two small maps, showing the departure of maximum and minimum temperature and air pressure from the normal.

India weather map is studied with the help of certain symbols and codes. It has introductory information. i.e. time, day, data and year. Air pressure is shown by isobars. These are drawn with an interval of 2 millibar. Their shape, distance between two isobars entails us with changes in the weather. Their near location indicates much change instead of their distant location. High and Low Pressure areas are also marked on the Map. Their location acquaints us with the movement of winds, which are directly related to air pressure. Wind direction is indicated by an arrow. The back part of an arrow indicates that the winds are coming from that side. Wind speed is shown with the help of oblique lines on this arrow. Half oblique line is an indication of 5 knot per hour. One full oblique line is equal to 10 knot.

Sky conditions are shown by a circle. The shaded part of the circle indicates the amount of cloud. If it is full shaded, then it indicates that the sky is fully covered with the clouds. The other atmospheric phenomena are also shown with the help of approved symbols. These phenomena are haze, mist, fog, shallow fog, hail, drizzle, shower, rain, squall, frost, sleet, snow, thunderstorm, dust devil, drifting snow.

Amount of rainfall is given in cm. This indicates for the last twenty four hours. Sea waves are shown on the map. Sea is calm or it has notorious movement. The movement of sea water affects the fishing and navigation activities.

Department of temperature and air pressure from the normal also helps us to assess the weather conditions prevailed during the last twenty four hours. The departments of maximum

and minimum temperature from the normal are also explained. In this chapter, July and January weather maps have been discussed in detail as an example.

8.6 GLOSSARY

ISI	-	Indian Standard time
GMT	-	Greenwich Meridian Time
Observatory	-	A place of recording and maintenance of weather data.
Isobar	-	An imaginary line drawn on map joining places with equal barometric pressure
Millibar	-	It is equal to 1 Bar or 756 millimeter
Knot	-	Nautical Miles per hour, wind speed
Overcast	-	Sky is fully covered by clouds
Obscured	-	Un-cleared Sky
Weather Forecast	-	Protection with a reasonable amount of certainly about the conditions of weather that would prevail in the next 24 to 48 hour in a certain area.
Isotherm	-	Imaginary line drawn on a map joining places with equal temperature, reduced to seal level.
Departure	-	The variation of Maximum and minimum temperature from the normal.
Mean Sea Level(MSL)	-	The average height of the surface of the sea for all stages of the tide.
Variable	-	Any Characteristic which varies.
Cardinal Point	-	North, South, East and West are main Points or directions.

8.7 ANSWER TO CHECK YOUR PROGRESS

1. Weather is the statement of a particular time.
2. Climate is an assessment of a long period of weather conditions.
3. Weather map denotes the weather conditions of that area of a definite time.
4. Weather forecast help us to take safety measures in advance.
5. Indian weather maps are published by India Meteorological Department, Pune.
6. Indian weather maps are for 8.30 a.m. and 5.30 p.m.
7. Weather maps are based on three observations- surface, upper air and space based platforms.
8. Air pressure is shown by isobars and the units of scale ismillibar.
9. India weather map shows the location of High and Low pressure area.
10. Air pressure gradient is identified by the distances between the isobars.

11. Wind Speed is explained in nautical miles per hour.
12. Main wind directions are North, North-east, South, South-east, East, South, South-west, North-west.
13. Sky condition denotes that how much area of the sky is covered by clouds.
14. Overcast sky is fully cloudy sky.
15. Obscured sky has low visibility.
16. The intensity of visibility is represented by dew, haze, mist, shallow fog, and fog. These are the forms of condensation.
17. As a form of precipitation drizzle, shower, rain, sleet, snow conditions are shown on weather map of India.
18. Squall duststorm or thunderstorm, dust devil, represent the nature of wind movement and its velocity.
19. Drifting show indicates the movement of snow.
20. The conditions of sea helps us in fishing and navigation.
21. Make Correct Pairs of the following Weather phenomena :

	Column-A		**Column-B**
1.	Haze	a.	High intense of condensed water vapour
2.	Mist	b.	Water vapour fall in form of ice crystals
3.	Fog	c.	Water droplets on the surface
4.	Shallow Fog	d.	Obscured sky with dust particles
5.	Dew	e.	Obscured sky by condensed water particles
6.	Frost	f.	Less intense condensed water vapour

Answer : 1 (d), 2(e), 3(a), 4(f), 5(c), 6(b)

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8.10TERMINAL QUESTIONS

1. What do you mean by weather? Why should we study it.
2. What are the basic elements of weather?
3. What is a weather map?
4. Why and when the first weather map was produced?
5. Name the organization in India which records and monitors weather related data and information.
6. When Indian Meteorological Department was established. Explain its role in Weather forecasting.
7. Discuss how weather maps and charts are prepared and how are these useful to us?
8. Which organization in India records and monitors weather related data and information's?
9. What are three modes of meteorological observations used globally?
10. Discuss the weather map for the months of July and January.
11. Explain is detail those weather phenomena which are used by Indian Weather Map?
12. What do you mean by air pressure? How it is represented on the weather map of India?
13. How the amount of cloud is shown on Indian weather map? Explain.
14. How the movement of sea water is shown of weather map? Discuss.
15. What do you mean by the departure of air pressure and temperature? Discuss.

UNITIX TOPOGRAPHICAL MAPS OF INDIA

9.1 OBJECTIVES

The map is the most important tool of a geographer in the analysis and interpretation of various feature distributed on the surface of the earth. Maps are informative, analytical or perspective. Maps can serve a variety of purposes. Maps are defined as models of real world situations. Map reading, in actually, denotes the formation of a visual picture of the ground as depicted on the map. It requires a good deal of practice, and only a well-trained student in this art can visualize the correct picture of the area. Different physical and cultural features are well expressed by different symbols. The best way to familiar with the topography of a region, it is necessary to acquaint with the techniques of its reading. This is the main aim of this chapter.

9.2 INTRODUCTION

Topographical maps are the maps showing the natural landscape and cultural and elements of the area in much detail. These are primarily large scale maps and are based on the actual survey of the land. These are made on such scale that it is very easy to show roads, plan to settlement, contour lines and other details. They usually depict the detailed surface features as forests, rivers, lakes, and man-made features such as roads, railways, canals, and settlements.

Though the map is the tool of a geographer, but it is consulted by other people also. A traveller may simply need to know about the location of his destination, and route followed; while in military strategy one may require to detect all possible routes along which to military has to march. But the aim of geographer is quite different. He tries to identify the exact nature of topography depicted on the map. For this he has to study and note down carefully the main features, classify them in some order and then draw necessary conclusions from them. It is very necessary for him to have a comprehensive knowledge of physical geography as well as of human responses to natural environment. Obviously, this type of study is very useful to a student of geography in having a prosper grasp of the regional geography of an area. A good practice in the study of topographical maps will enable him to write a systematic geography of the area.

Topographical maps are prepared on a number of sheets since they are large scale maps. Each sheet gives the details of a part of the whole area. When the sheets are joined together, they form a map of the whole area. Thus, it becomes necessary to know about the topographical mapping of an area in our country.

9.3 TOPOGRAPHICAL MAPPING IN INDIA

In our country, topographical mapping is in the hands of government of India. Here, Survey of India Department was established by British Rule in 1767, and Major James Rennell was the first Surveyor General of India. This Department has made significant efforts in the preparation of topographical maps of India. Each and every corner of our country has been mapped on these large scale maps. The Department has prepared the maps of those areas also, which are highly inaccessible, and quite difficult.

In 1802, Colonel William Lambton was appointed Surveyor General of India. He started the mapping work in India with the help of triangulation method. He was succeeded by Sir George Everest. He made a number of improvement in the triangulation method. Thus, the triangulation method of survey is the product of both of these two Surveyor Generals. They covered the whole British India by a lattice of primary triangles. On the basis of one datum plane, they got success in the survey and preparation of topographical mapping of India and adjoining areas. Till 1905, this Department, prepared Revenue Survey Maps on the scale 16″ = 1 mile. Presently, these maps are prepared by concerned state governments of India.

Our Survey of India has now adopted Metric system since 1957. Previously our topographical maps were being published with the scale of 1 inch to 1 mile and 1 inch to 4 miles. At the moment, these maps are being published or have been transferred on the scale of 1:50,000 and 1:250,000. This work has now been successfully completed, and these maps are prepared with the help of modern and advanced techniques. Now Photographmatic Survey of technique has been adopted, and plane table Survey technique now has been fully discarded. This photographic technique is able to produce the details of the area concerned within no much time. National Remote Sensing Agency Hyderabad, Air Survey Co. Kolkata, and Directorate of Military Survey are helping in this matter of Survey of India. Aerial Photographs, Satellite imageries have been very useful in the preparation of these topographical maps with much details.

Nomenclature and Numbering of Topographical Maps of India

These maps of India are prepared on International Projection, as determined by International Mapping Committee. The numbering of toposheets is also based on the extent of India and adjacent countries. All maps of this series are prepared on the scale of 1:1,00,0000. These are called as one million map. Their index number is just like 63,64,65 and so on. Each map has the extension of an area 4° latitude and 4° longitude. The total number of toposheets in the world is 2222. Out of which 51 sheets partially or fully belong to our area. These maps have the number from 40 to 92. Among these 59 and 68 belong to Sri Lanka Region. (Fig. 9.1).

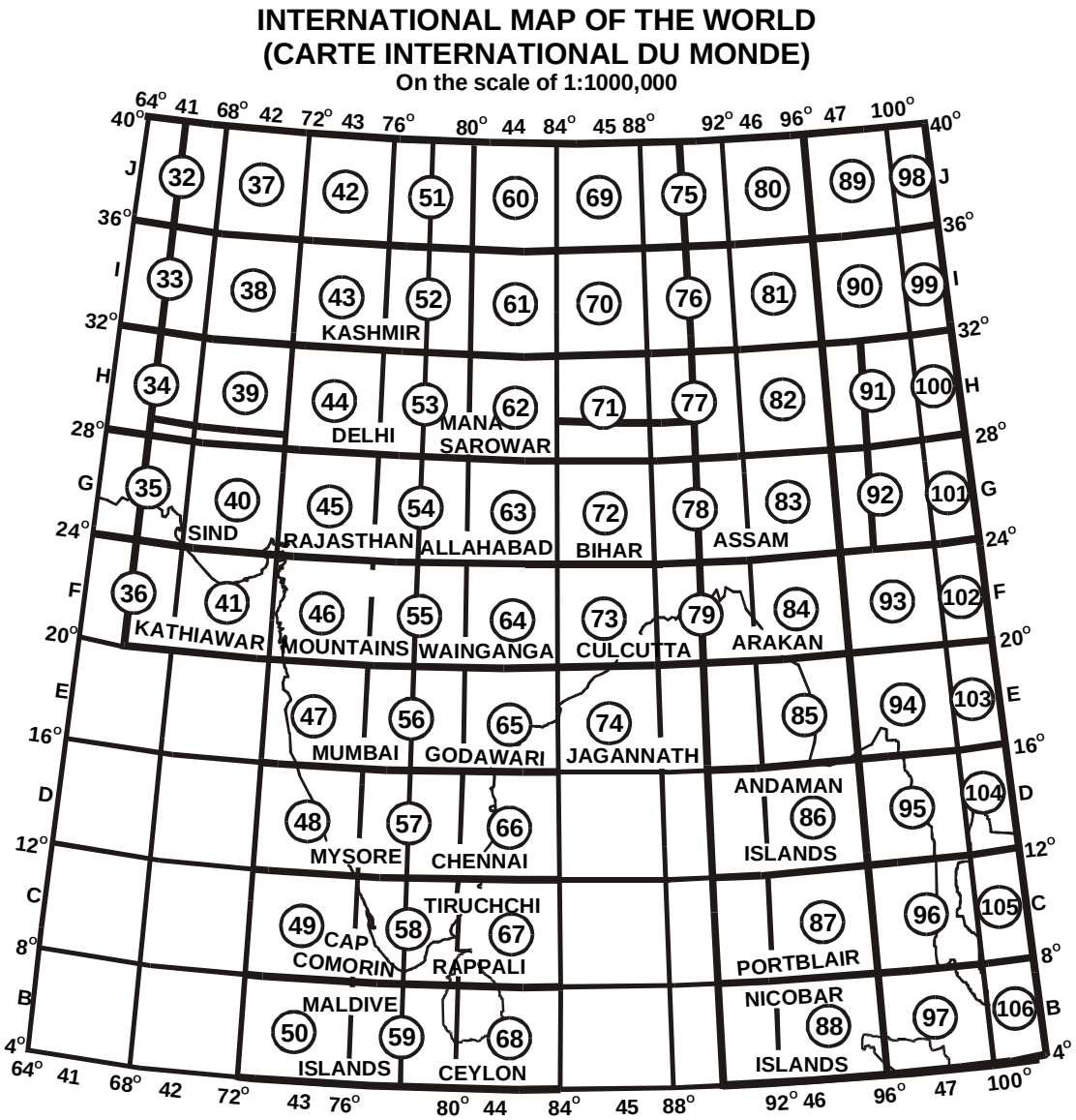

Fig. 9.1 International Map of the World

(I) Quarter Inch or Degree Sheet

These one million maps are divided into 16 sheets. These are defined as quarter inch (1 inch = 4 mile) or degree sheet of (1 cm. = 2.5 km or 1:250,000). After the division of this, inch sheet into 16 small sheets, each small sheet represents an area of 1°×1°. This is the one-fourth part of the 4^0x4^0 degree sheet, so these are also known as degree sheets. Their numbering is made by the use of 16 letters of English language, i.e. from A to P, these are named as shown in Fig. These letters are written in north to south direction. If suppose the number of degree sheet is 53, then the number of a degree sheet will be as 53A, 53B, 53C and so on. Thus, if the number of a degree sheet is 53k, it means, that it represents the area of 53 and occupies its area extended on 1°×1°, which is the sixteenth part of this million sheet (1 :M sheet) (Fig. 9.2(a)

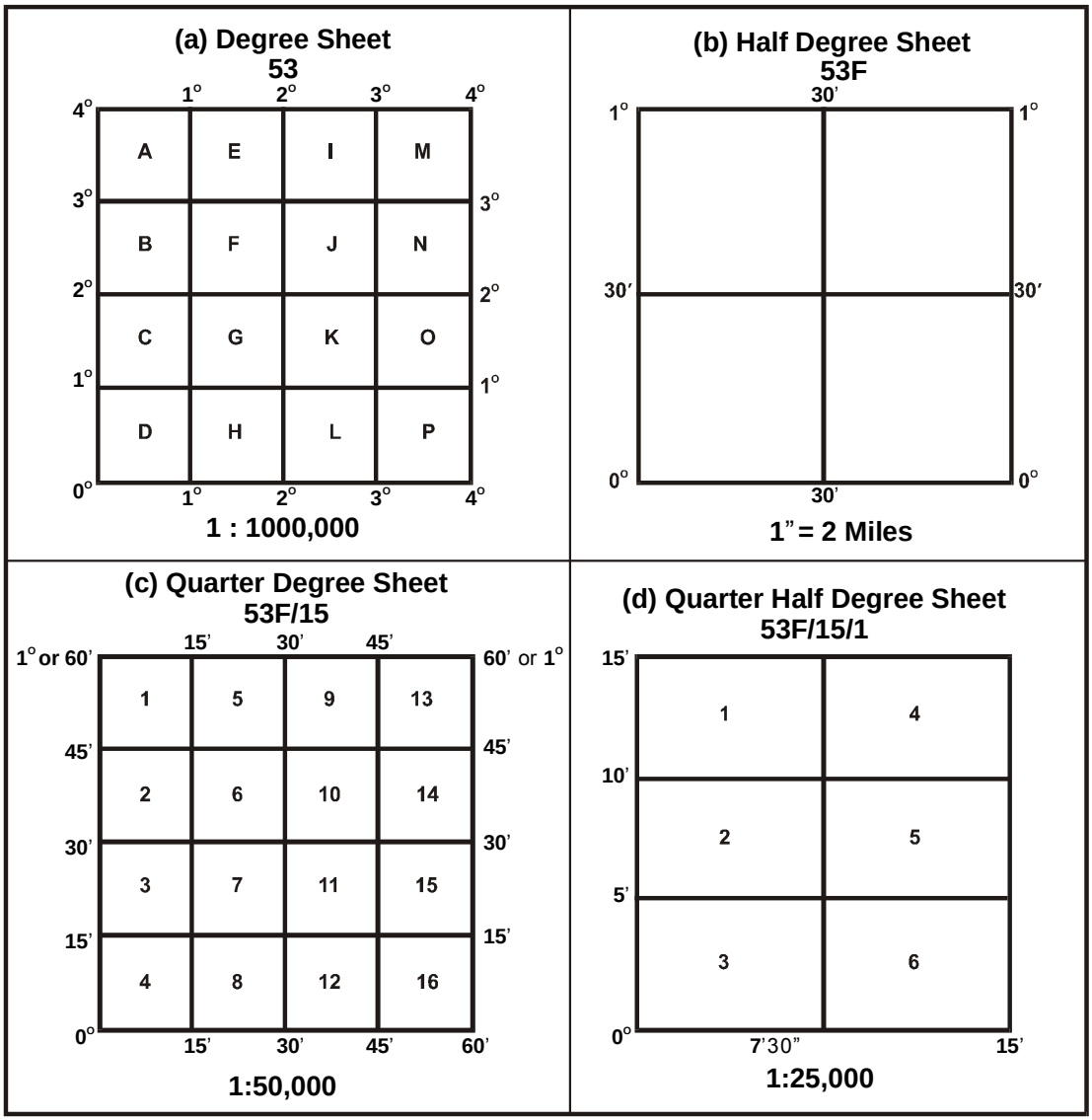

Fig. 9.2 Degree, Half Degree, Quarter Degree, Quarter Half Degree

(II) Half inch or Half Degree Sheet

One degree sheet is further divided into four equal parts. The scale of this half degree sheet is 1″inch =2 miles. It shows an extension of 30' × 30'. So these are named as half degree sheets. The nomenclature is made according to the direction of sources in half degree sheet. Here 53A NW, as shaded in the Fig. 9.2(b) represents North-West part of 53A sheet, our Survey of India Department has stopped the publication of these sheets.

(III) One Inch or Quarter Degree Sheet

One degree sheet (1°× 1°) is further divided into sixteen, equal parts. That is to say 'A' sheet, as an example is put into sixteen equal divisions and is named as 1 to 16. Each sheet is drawn on scale 1:50,000 and it represents an area of 15' × 15'. Here 53A/6, the shaded part will be named as one inch or quarter degree sheet. This sheet is very important, as it gives much details of the physical and cultural features of the area concerned. (Fig. 9.2(c).

Recently, Survey of India is busy in the preparation of toposheets of the scale 1:25,000. In this case quarter degree sheet is divided into six equal parts. Each sheet represents an area of 7'30'' latitude and 7'30″ longitude and is numbered by 1,2,3,4,5 and 6 and is named as. Suppose, if we 53A/6 sheet into six equal parts, it will be named as 53A/6/1, 53A/6/2, 53A/6/3, 53A/6/4, 53A/6/5, 53A/6/6 (Fig. 9.2(d). These are based on precise and detailed surveys. These are useful for the planning of a small area. These sheets are studied in much detail. In the next chapter, the method of their study is discussed in much details.

9.4 INDIA AND ADJACENT COUNTRIES SERIES

In this series, the maps of India and adjacent countries are prepared on the scale 1:1,000,000. Each map represents an area extended between 4^0 latitude and 4^0longitude. Thus, the area extended between 4^0 south latitude to 40^0 North latitude and 44^0 E longitude to 104^0 E longitude has been divided into 106 equal parts. This area includes the countries of whole Indian sub-continent i.e. Afghanistan, Pakistan, India, Sri Lanka, Nepal, Bhutan, Bangladesh and Myanmar and also countries of South-east Asia. Thyland, Vietnam, Cambodia and Laos. This gratitule has its extension on nearby area of China and Tibbet, Republics of South Russia such as Kazakhistan, Tajkistan, Uzbekistan.

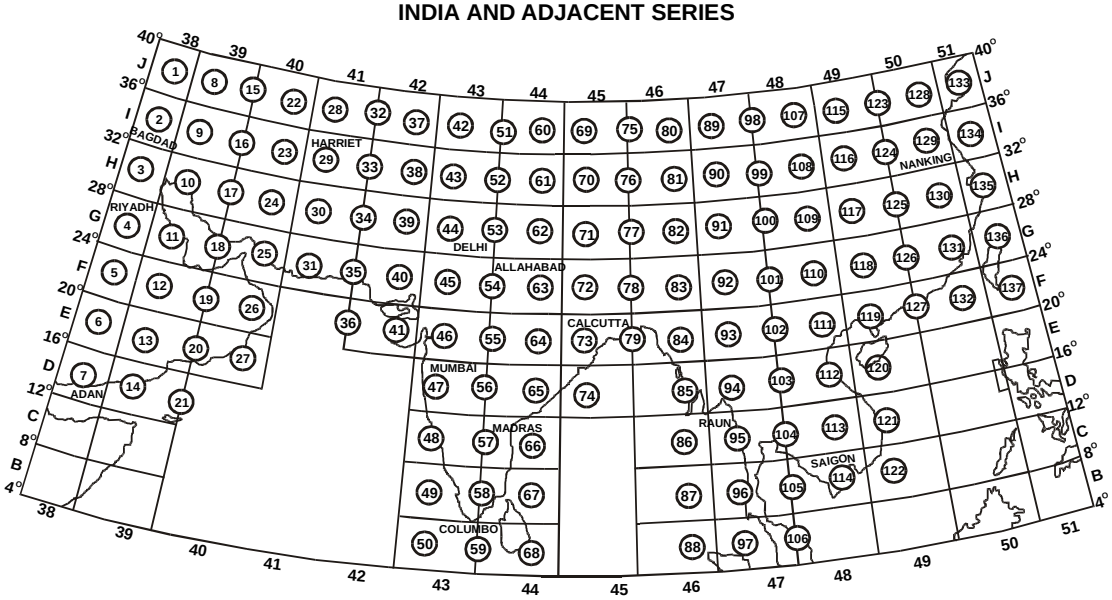

Fig. 9.3 India and adjacent Series.

All these 106 sheets have been numbered as from 1 to 106, and these are known as index numbers. The numbering is done serially i.e. from the left side to right side and from north to south side. The numbering starts from the north-west corner of the map and it goes first in south direction, as is shown on (Fig. 9.3). Sometimes these sheets are named on an important town, located in that sheet. For example, the sheet number 43,47,53 and 63 are named by the main town, located therein. (Fig. 9.3)

These are defined as Srinagar (43), Mumbai (47), Mysore (48), Allahabad (63). All the sheets of this series have these features. All the words and numbers are shown in black colour, water bodies and rivers in blue colour, roads in red colour. Presently, the publication of the maps of this series has been stopped. Our Survey Department has adopted this main division in the publication of one inch-half inch and quarter inch topo-sheets. The sheets of this series are also known as one million sheets.

9.5 INTERNATIONAL SERIES

This series includes the maps of whole world. A plan was prepared in the session of International Map Committee held at London in 1909. This plan was again considered in the conference of the committee, held Paris in 1913. It was decided that Polyconic projection should be modified. They modified it, and prepared new projection known as International Projection for the preparation of maps. The scale of these maps is 1:1,000,000 and thus these maps are known as one-million maps. Each sheet represents an area of 4° latitude and 6°longitude and thus, the whole world is covered by 2222 sheets, in accordance to this scheme. These sheets are as follows:-

Eighteen hundred sheets- are prepared for an area extended between 60°North to 60° South. Each sheet cover an area of 4° latitude and 6° longitude.

Four hundred twenty sheets- are prepared for an area extended between 60° to 88° latitudes in both the hemispheres. Each sheet covers an area of 4° latitude and 12°longitude.

Two sheets are prepared for Polar regions. These are spherical sheets. The centre of which is North Pole and South pole and the radius is 2° latitude. Each sheet covers an area of from 88^0 latitude to 90° (pole)

Thus, the total of all the above sheets is 2222. Survey Department of India has published all its topographical maps according to this international agreement. The maps of International Series are drawn according to the rules prescribed by the Cartographic division of U.N. Economic and Social Council. This series is also called as Carte International Du Monde.

Each map represents an area extended between 4° latitude and 6°longitude. As mentioned earlier, these maps are named as one million map. Fig. 8.1 shows the layout of maps of international series of India sub-continent. The map having an area in the north of equator are mentioned by N word with the number such as 43N, and the area extended in the south of equator are mentioned by ‘S’ word with the number such 43S.

9.6 CONCLUSIONS

Map is the tool of geographer. Topographical maps are large scale maps. These show various physical and cultural features in detail. These are consulted by the scholars of other discipline also. Survey of India prepares and publishes topographical maps of each and every

corner of the country in a systematic manner. These are based now on aerial photographs. In India, one inch, half inch and quarter inch map are prepared. Quarter inch maps with 1:50,000 scale are very useful. A new scheme of maps on 1:25,000 is in process. Our mapping system is in accordance of International Series.

9.7 SUMMARY

Map is a tool to acquaint us with the geographical features of an area. It is a reality of the earth surface particularly of that area. A geography student is also curious to know the techniques of the mechanization of topographical maps.

Topographical maps are large scale maps. These are prepared on the basis of detailed survey of the area. These are very useful to geographers, planners, politicians, demographers and persons of a number of other disciplines. Geography persons study the physical features of the area and as well as of human response to natural environment. These maps help us to write the systematic geography of the region.

Topographical map is a combination of number of sheets. Their mosaic presents the complete picture of the whole area. The mapping of these topographical maps is not an easy task.

It is done by Government of India. Our Survey Department, with its head office at Dehradun looks after this mapping work. These maps are now prepared in matrix system. These maps are prepared on the scale of 1:50,000 and 1:250,000 and 1:1,000,000. These are referred as quarter inch, one inch and four inch respectively. Their extension is 15'x 15', 1°× 1° and 4°× 4° latitudes and longitudes. A new series of 1:25,000 scale is now being published by the department, which will cover the whole India shortly.

These maps are numbered as per directive of international series. One million maps are given the number of such as 63,64,65 according to this series. Each map has an extension of $4^0 \times 4^0$. India and its nearby countries are covered by 51 sheets. These sheets are divided into 16 equal parts and each part has number from A to P. Suppose, the number of the sheet is 63, and if it is numbered as 63F. It denotes that this sheet covers an area of $1° \times 1°$ and is developed on the scale of 1:250,000. It is the sixteenth part of a million sheet. Half degree sheets, were previously in practice, but now, their publication has been stopped.

One degree sheet ($1° \times 1°$) is further divided into sixteen equal parts. These are numbered from 1 to 16. Suppose the number of such sheet is 63F/15. It means that it covers an area of 15′× 15′, and is on the scale of 1:50,000. These sheets are very useful for the detailed study of all type of geographical features. Survey Department also publishes now quarter degree sheets.

India and adjacent series prepares the maps of the countries of sub-continent. It covers an area extended between 4° south latitude to 40° North latitude and 44° E longitude to 104° E longitude. Thus, it has 106 sheets i.e. from 1 to 106. Certain Colour scheme is used on these maps to depict geographical features.

International Series cover the whole world. The maps of the series are prepared on international projection. The scale of the each map is 1:100,000 with an area of 4° latitude and 6°longitude. The whole world is covered by 2222 sheets. These are marked N and S according to their hemisphere location.

9.8 GLOSSARY

Topographic Map : A map of small areas drawn on a large scale, depicting detailed man-made and natural features.

9.9 ANSWER TO CHECK YOUR PROGRESS

1. Match the following:

	Column –A (Map)	**Column-B (Scale)**
i.	One degree map	a. 1:50,000
ii.	Four degree map	b. 1:250,000
iii.	One-fourth degree map	c. 1:25,000
iv.	One-eighth degree map	d. 1:100,000

Answer :i. (b), ii. (d), iii. (a), iv. (c)

Match the following pairs:

	Column –A	**Column-B**
i.	4°× 4°	a. 1:250,000
ii.	1°× 1°	b. 1:50,000
iii.	30′× 30′	c. 1:1,000,000
iv.	15′× 15′	d. 1:25,000
v.	7′30′′× 7′30′′	e. 1:125,000

Answer :i. (c), ii. (a), iii. (c), iv. (b), v. (d)

3. Map showing physical and cultural features are known topographical maps.
4. Topographical maps are large scale maps.
5. What type of scholar can study topographical maps in a proper way – A skilled and comprehensive knowledge person.
6. The headquarter of Survey of India is situated in Dehradun.
7. Present topographical maps are based on Aerial photograph and Remote sensing techniques.
8. If the number of a topographical map is 63, then the scale is 1:1,000,000.
9. If the number of a topographical map is 63K, then the scale is 1:250,000.
10. If the number of a topographical map is 63K/7, then the scale is 1:50,000.
11. If the number of a topographical map is 63K/7/2, then the scale is 1:25,000.
12. India and adjacent series covers an area of 4° South to 40° North latitude.

13. India and adjacent series covers Afghanistan, Pakistan, Nepal, Bhutan, Bangladesh, Sri Lanka, Myanmar and India.
14. India and Bhutan, Bangladesh, Sri Lanka, Myanmarhave 106 sheets.
15. International series has its maps on International Projection.
16. International series covers the whole world in 2222 sheets.
17. International series prepares 1800 sheets for an area 68^0 N to 68^0 south.
18. International series has 420 sheets for 60° to 88° N and S.
19. Two sheets for both the polar areas.

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9.12 TERMINALQUESTION

1. What are topographical maps?
2. Name the organization which publishes and prepares topographical maps of India.
3. Which are the commonly used scales for mapping our country used by survey of India?
4. What is meant by one million sheet?
5. Discuss the role of Survey of India in the preparation of toposheets.
6. Discuss the nomenclature and numbering system of topographical maps of India.
7. Explain India and adjacent countries series.
8. What do you mean by International Series of maps.

UNIT-X: INTERPRETATION OF TOPOSHEETS

10.1 OBJECTIVES

Geography is the study of places and complex relationship between people and their environment.

- It is main objective here to bring out the interconnection between people, places and things.
- The interpretation of topographical maps depends upon analysis of the various physical and cultural features, by putting them together. Their interpretation provides a wealth of information.
- Here, the main objective is to develop such skill, so that we may drive a number of useful information of area under study. It is also important to organize this information, and then these should be explained in association. An adequate skill is required for such interpretation.

10.2 INTRODUCTION

The understanding of surface features-physical and cultural both depends upon the ability to interpret topographical map. These maps are based on accurate surveys. They show a variety of landforms with carefully chosen conventional signs and symbols. These symbols are used to represent natural features like hills, valleys, slopes, forests, drainage, as well as man-made features like roads, railways, settlements, canals, agricultural farms, land use and so on.

Topographical map of an area is a combination of a number of topo-sheets, since these are large scale maps. Each sheet shows the features in details of a part of the whole area. These maps cannot be fully understood without the knowledge of symbols used therein to show different features. It is also to acquaint with the fact that the presence of one feature, indicates what type of relationship with the other feature or features. For example, if the area has dense forests, it means that it may be hilly area, it may have heavy rains, and it will have the presence of wild animals. In the same way, if there is a presence of a number of settlements, it will or may denote that the area is populous. It is full of means of livelihood, and has possible area for further development. So their study needs a practical skill that is developed through years of experience. It is possible only when we have full knowledge of all geographical aspects.

10.3PHYSICAL FEATURES

It is already mentioned, the understanding or reading of topographical map needs to acquaintance of oneself with the legend or key given in the map for identifying various physical and cultural features. These features are shown by conventional signs. These signs or symbols are traditional and are being used by the users based on the universally accepted formula. Their use has become our convention. In our country following conventional signs are being used by our Survey of India. So it becomes, necessary to acquaint with these symbols, before the interpretation of any topographical sheet. These symbols are put into two categories:

These are all natural features. These are listed below:

(A) Natural Water bodies, features and systems

1. **Stream :**It is a small river, or any flow of water.

2. **River :**It is a natural flow of water. It has its own identity.

3. **Tidal River :** Those are tidal river, where tide water flows.

4. **DryRiverBed :** The river has dry bed, with a narrow channel of water flow.

5. **Confluence:** It is the joining of two rivers, or to say the intersection of the tributary with the main river.

6. **Meanders:** These are loops and bends found in the middle course of river.

7. **Spring:**It is a flow of water which naturally appears on the earth's surface from beneath.

8. **Island:**Land surrounded by water on its all sides.

(B) Drainage Pattern

9. **Dendritic:**This resembles like a tree with its branches. This pattern is the product of uniform surface and flat relief. The tributaries join the main river at acute angles.

10. **Trellised:**It is a rectangular drainage pattern. It is developed where there are bands of alternately resistant and less: resistant rocks.

11. **Radial:**It is a spoke like pattern of rivers. It is developed in areas where is a conical hill or volcano. It radiates from a certain point.

(C) Vegetation and Forests

12. **Grass:**It indicates the pasture land. It indicates also the areas of insufficient rainfall.

13. **Palms:**It is found in desert and Coastal areas.

14. **Deciduous:**Most widespread vegetation of India.

15. **Swamp:**An area of land permanently filled with water. It has high water table.

16. **Scattered Vegetation:**The trees and scrubs are widely spaced.

17. **Dense forest:** Presence of trees more in number in a small area. They indicate a region of heavy rainfall.

18. **Reserved Forest:** These forests are not allowed to cut.

19. **Protected forest:** These are planted to function as shelter belts.

20. **Fire Line:** It is a 5 meter wide path in the forest area. It is a way to prevent forest fires from spreading.

(D) Representation of Nature of surface and heights

21. **Spot Height:** It is a height of a particular point or spot on the ground in meters. It is shown by a block dot.

22. **Relative Height:** It indicates the relative height from the nearby ground. It generally shows the height of a river bank on its sides. It may be the height of a dam, bridge, sand dune.

23. **Triangulated Height:** Its height is determined by trigonometry. The height is shown on map with a dot enclosed within a triangle.

24. **Bench Mark:** These are shown on a building as a permanent reference. It is a total of the height of the building and height of nearby ground from the mean sea level.

25. **Contour:**It is represented by a continuous line, joins the places of equal height above sea level.

26. **Form line:**These are shown by broken lines. These show the approximate heights and show the general pattern of the ground. They show the form of land, so these are known as form lines.

(E) Miscellaneous

27. **Sand Dunes:** These are mounds or hills of sand deposited by the action of wind.

28. **Mine:**A large excavation made into the earth to extract minerals.

10.4CULTURAL FEATURES

(A)Boundaries

1. **International boundary:** It is a line of bold dash and dot symbol in alternate form.
2. **State boundary:** It is a line of a series of light alternating dash and dot symbol, forms of border between states with a country.
3. **District boundary:** It is a line of a series of dashes, forms the border between the districts within a state.
4. **Tehsil boundary:** It is a line of a series of dots, form the border between the tehsil within a district.

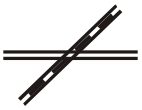
(B)Roads

5. **Metalled Road:** It is a tarred road. It is shown by a pair of two red parallel lines.
6. **Unmetalled Road:** It is untarred road. It is shown by a pair of red broken parallel lines.
7. **Path:** It is a narrow track made for the travel of man and animals. It is shown by a single red broken line.
8. **Cart Track:** It is a path broader than a pack track, made for the movement of bullock cart or horse cart. It is shown by a single red line.
9. **Footpath:** It is path made by man, usually in high steep regions. It is shown by a single line of dots.

(C)Railways

10. **Broad Gauge:** It is a distance of width between two rail line (patri). In broad gauge, the width is 1.69m. It is most useful.
11. **Metre Gauge:** The width between two rail patri is one meter.
12. **Narrow Gauge:** The width between two rail patri is 0.77m.

13. **Level Crossing:** Rail line crossing the road. Road crossing the Rail line.



14. Railway Station on Rail line.

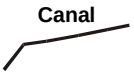
(D) Bridge and Tunnels

15. **Bridge:** It is an overhead structure to carry a road or rail line across a river.

16. **Railway line with Bridge:** Railway line is passed through a bridge. This bridge is constructed because of an obstacle of river, ponds, valleys,

(E) Water Bodies (Man Made)

17. **Canal:** It carries water taken out from river. It is man-made.



18. **Tank:** It stores the water in hallow. It may occur naturally sometime it may dry up.

19. **Pucca Well:** A bore made in the ground to reach the water table. Water is used for drinking, irrigation purpose.

20. **Brackish Well:** An unlined well, not having brick or stone walls.

21. **Tube well:** It is a deep bore dug into the ground, and the water is drawn out with the help of a pump.

22. **Dam:** This man made structure built across a river.

23. **Reservoir:** It is man:made or artificial feature. It is a perennial water body used to store water.

(F) Settlements:

24. Permanent Hut

25. Temporary Hut

26. Deserted town or village

27. **Nucleated Settlement:** Houses have close and near situation, and thus form compact and concentrated settlement. These are mainly located in fertile plain, with large population.

28. **Dispersed Settlement:** Houses have sparse or distant location.

29. **Linear Settlement:** Houses situated along road, or rail or river bank.

(G) Monuments, Buildings &Miscellaneous :

30. Fort

31. Temple

32. Church

33. Mosque

34. Tomb

35. Graves

36. Light House

37. Post Office ***PO***

38. Telephone Office ***TO***

39. Telephone line

40. Post and Telephone Office ***PTO***

41. Police Station ***PS***

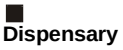
42. Dak Bungalow ***DB***

43. Inspection Bungalow ***IB***

44. Rest House ***RH***

45. Circuit House ***CH***

46. Aerodrome

47. Dispensary 

48. Kiln 

49. Battle field 

50. Camping Ground 

Topographical Map Reading and Interpretation

The interpretation topographical map depends on its keen and deep observation. It depends on the skill of the person concerned and also on the objective of the study. It is usually interpreted under the following heads:

1. Marginal information
2. Relief, drainage
3. Land use
4. Means of transport and communication
5. Human Settlements
6. Occupation

1. Marginal Information

These may be visualized in the following manner:

(i) The number of the toposheet- It gives an idea that as to which part of India it represents. For example toposheet number is 53G/9, 53G/10, 53F/15, 53F/16 shows part of Saharanpur and Haridwar districts. Knowing the extent of districts, it can be said, these are the part of western Uttar Pradesh and South Uttrakhand. It may be inferred that this area is fertile and populous.

(ii) Latitudinal and Longitudinal Extent- These indicate that in which part of the globe, the area is located.

- On a 4 degree topographic map, suppose 53G, it is extended in 4° latitudes and 4° longitudes.
- On a 15′× 15′ topographic map, suppose 53G/9, it is extended between $29^0$45’ 30^0N and 77°30′ to 77°45′ E. The lines are drawn with an interval of 15′ (minutes).

(iii) Scale: The scale is shown in representative fraction and also in linear scale. On a 15′toposheet, the scale is 1:50,000. This means that 1 cm on the map represents 500m on the ground.

(iv) Eastings and Northings : Along the margins of a toposheet, the eastings and northings values, in degrees are indicated. Each sheet has a grid of nine rectangles. Each grid shows the extent of 5′× 5′ area. It

helps us to define the eastern and northern location of the object in the grid.

(v) Direction of the True North and the Magnetic North variation: The longitude lines indicate True North. In the upper side of toposheet magnetic variation from true north with year is mentioned also.

(vi) Legend : At the bottom of the topographical map, a list of commonly used conventional signs and symbols are shown. This is the character of sheet.

(vii) Contour Interval : It is the difference in height between two consecutive contour lines. The sheet with scale 1:50,000 has the contour interval of 20 metres.

(2) Relief and Drainage

Relief i.e. the nature of surface and pattern of drainage are closely associated to each other. It is essential to note the highland areas and lowland areas. Slope is in which direction. What is the nature of slope.Highland areas have which type of landforms. What is the height of the area. Lowland areas have what nature of slope? Land is flat. What type of soils are present in the area?

Which are main rivers? Find out the name and their tributaries. Rivers are straight or meandering. Is there any prominent water divide in the region. Are there any peculiarities in the drainage system? The rivers have presence of water, or are dry. What is the relative height of river bank? It will entail us about the depth of river water. Discuss also the gradient of the prominent rivers.

(3) Landuse

It is an indication of economy of the area. The presence of canals, tanks and tube-wells is an indication of intensive use of the land for agriculture. Silt deposition by the rivers indicates that the land is very good for agriculture. The presence of flat land also indicates multiuse of land. It is also to note important ways in which the land is used. It also helps in determining possible major occupations or sources of livelihood of the people.

(4) Vegetation and Forests

The analysis of the types of vegetation provides possible clues about the climate and soil. Their presence also helps in the determination of nature of occupation. Presence of grassland is a feature of animal herding and animal based occupation like dairy and so on. Deciduous forests are most widespread vegetation of our country. Scattered scrub trees are an indication of low rain, and also an evidence of infertile land, only suitable for animal grazing. Dense forest indicates that area receives heavy rainfall and it is least

accessible. The presence of fire line also is an evidence of dense plant trees. If hill sides are lacking in vegetation, that it means the area is eroded by numerous streams.

(5) Means of Transport and Communication

The sheet shows all different means of transportation developed in the area. The presence of roads and railways is highly influenced by relief of the land. Roads can negotiate the steeper gradients but railways not. So roads can be marked in steeper areas.

The network of roads and railways is an indication of economic prosperity of the area. They indicate greater movement of passengers and goods. It is to be studied; the nature of roads, number of routes goes through the region. What are their destinations? How many over-bridges are there. Railways are of which gauge. They cross the tunnels, and bridges. They have embankments along rivers.

What types of communications are developed there? Telephone lines, Telephone office, Postal Services are to be visualized in the area.

(6) Settlements

The presence of settlements in the form of towns and villages reflect the economic and social development of the area. They determine the landuse of the area. The pattern of distribution, sites, functions of settlements are necessary to be examined. Settlements may have nucleated, dispersed or linear pattern. Settlements sites are of either natural or cultural importance. They have central location. The occupancy area of the settlement is an indication of its size and density. Congested shape indicates the inhabitance of more population.

Occupation of the area can also be identified. The presence of fertile and level land with irrigation facilities indicates the agriculture as a main occupation. Such land is shown in yellow colour. Forests indicate lumbering. Pastures are an evidence of cattle rearing. Fishing is inspired by the presence of plenty of rivers, tanks, reservoirs. Mines in the area have mining activities. Dense settlements near roads have industrial and trade activities. The presence of religious, natural beauty centres, hotels, indicates the activity of tourism in the area.

10.5CONCLUSION

The interpretation of topographical maps is a difficult task. Its analysis depends on the skill of the scholar, who can derive useful infomation. These maps entail physical and cultural features in very detail, which are useful for the geographical knowledge of the area. These features are shown by

conventional symbols. These symbols represent each and every detail, present in the toposheet of the area. Topographical maps are interpreted under the heads marginal information, relief, drainage, land use, means of transport and communication, human settlements and occupations of the people.

10.6MSUMMARY

Topographical maps are the directive of geography of an area. Their interpretation acquaints us with such information for which we do not need to have a visit of the area in the first instance. Topographical maps show a variety of landforms with carefully chosen conventional signs and symbols. A topographical map of an area is a combination of a number of toposheets. These are large scale maps and thus, show different features in much detail. The presence of one feature indicates its relations with the other features. The presence of dense net-work of roads is an evidence of populous settlements, more number of settlements, developed economy. Such observation can be made after a careful study of the toposheet.

Conventional signs are traditional sign, which are universally used and are acceptable by all disciplines. These can be put into two categories, physical and cultural features. Physical features are water bodies, drainage pattern, vegetation and forests, nature of surface and heights, and landforms. The main cultural features are administrative boundaries, roads and railways, bridge, tunnels, embankments, man-made water bodies, settlements, monuments, buildings.

Topographical maps, if studied systematically can yield a lot of information. These are interpreted in the heads of marginal information, relief, drainage, landuse, means of transport and communication, human settlements and occupations. Marginal information explain the number of toposheet, latitudinal and longitudinal extent, scale of the map, eastings and northings, direction of the true north and the magnetic north variation, legend and contour interval.

The study of Relief acquaints with the nature of surface, nature of slope. Drainage means the flow of main rivers and their tributaries their pattern of flow and depth of river water. Landuse is an indication of the economy of the area. The study of vegetation and forests give us possible clues about the climate and soil. Means of transport and communication include the pattern of roads, type of roads, over- bridges, rail line with their gauge characteristics. Their net-work indicates the economy of the area. Settlements in the form of villages and towns reflect the economic and social pattern of the area. Their presence affect the landuse and economy of the people of the area. The landuse pattern determines the occupation of the people.

10.7: GLOSSARY

Bench Mark : Exact height of specific points on prominent and durable material objects like rocks or buildings in the field. It is indicated by BM.

Contour : An imaginary line joining the places having equal elevation or altitude above mean sea level.

Contour Interval : It is between two successive contours. It is also known as vertical interval.

Drainage :A system of rivers or streams which drain all the rain water that fall in a region.

Grid : The network of latitudes and longitudes on the earth's surface.

Hachures : Small straight lines, running across the contours. These are shown by broken lines.

Land use : The use which is made by man of the surface of the land.

Legend :A description, explanation, table of symbols, and other information given on the map.

Magnetic North : The direction pointed to by the needle of the magnetic compass.

Relief : The variation of elevation from one place to another place. It is a collectivity of the land surface.

Spot Height : The exact height of a given spot. It is expressed in meters or feet.

True North : The direction towards which the North Pole of the earth points. It is also known as Geographic North.

Water Shed :A narrow elevated tract of ground separating water flowing in opposite directions.

Elevation : It refers to the height of the earth's surface above or below the sea level.

Inland Drainage :in where the rivers do not reach the sea.

10.8 ANSWER TO CHECK YOUR PROGRESS

1. The extent of 1:50,000 toposheet- 15'latitude & 15' longitude and the scale is 1cm = 500m.
2. Topographical Map is a combination of number of toposheets.
3. River is a natural flow of water.
4. Confluence is a meeting of two rivers.
5. Dendiritic, trellis and Radial are the patterns of drainage.
6. The presence of grassland is an indication of pastoral farming.
7. Dense forest indicates the moist and rainy climate.

8. Spot height is the exact height of a particular point.
9. Contour lines are lines of equal height based on actual surveys.
10. Sand dunes presence denotes the sandy and infertile soils.
11. Four type of administrative boundaries are shown international, state, tahsil and district.
12. Roads have a variety of metalled, unmetalled, footpath, Cart track.
13. Broad, metre and narrow are three main rail gauges.
14. Canal is a man-made river or flow of water.
15. Settlements are nucleated, dispersed and linear.
16. Sheet No. 53 G/9 inferences- 15′×15′ extent, 1:50,000 scale.
17. True North indicates towards North Pole.
18. Grid is a gratitule of latitudes and longitudes.
19. Magnetic variation is a deflection between magnetic north and true north.
20. Contour interval- Difference of height between two contours.
21. Landuse- the use of land for various purposes.
22. The dense network of transport is an indication of developed economy of the area.

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10.11TERMINAL QUESTIONS

1. What are contours?
2. What does the spacing of contours indicate?
3. What are conventional signs?
4. What is meant by layer contouring?
5. Write a short note on marginal information in Toposheets.
6. Explain what is meant by interpretation of toposheets. What information would you like to seek and how would you derive the information?
7. Discuss the importance of physical features as shown on toposheets.
8. Discuss the importance of cultural features as shown on toposheets
9. What is meant by Drainage Pattern with regard to flow of rivers?
10. Discuss different types of pattern of settlements.
11. How can you identify the occupations of the people in a particular topographical map?
12. Discuss the techniques for the interpretation of means of transport and communication.