UNIT 12

REPRESENTATION OF CLIMATIC DATA

Structure

12.1 INTRODUCTION

You have read climatology in the course on 'Physical Geography' in your First Semester. You might have seen various diagrams and maps namely isotherm, isobar, line and bar diagram and wind rose etc. Just imagine a situation where you will be provided with monthly data for temperature and rainfall of ten places for thirty years, it would be difficult for you to compare and interpret the data. However, the same data is represented through multiple line diagrams. We are sure that it would be easier for you to comprehend, compare and interpret. Therefore, we say visualization is one of the effective methods of representation of data in general and climatic data in particular.

In this unit, we will discuss about representation of climatic data through diagrams namely climograph, hythergraph, ergograph and wind rose. Like

previous units, we will explain concept and its uses along with one example and steps involved in the construction of such diagrams. Once you complete this unit, you would understand the steps of construction, utility and application of these climatic diagrams.

In the next unit i.e. Unit-13, we will discuss about representation of climatic data through maps. We will also explain in detail about representation methods of geographical data in Unit-14.

Expected Learning Outcomes

After studying this unit, you should be able to:

- identify appropriate diagrams for representing varied climatic data;
- describe concepts, methods of construction and their uses; and
- represent climatic data through appropriate diagrams.

12.2 ELEMENTS OF CLIMATIC DATA

Before discussing about the representation of climatic data, we should know the elements of climate on which data is gathered. If you remember, we watch it on the television, listen it on the radio, read it in the newspapers where it is presented in the form of weather report. Today you can also see it in your mobile phone. Generally, it presents weather condition of past 24 hours and predicts what would happen in the next 24 hours or more. In that weather bulletin particularly in newspapers and television, many a time, it is supplemented by satellite image and diagrams. We are sure that till now, you might have recollected all the weather or climatic elements we are talking about. If not, then please read it from newspaper, listen to news bulletin or watch it from television and revisit the Unit on “Elements of Weather and Climate” which you have already read in the First Semester Course on “Physical Geography”.

Most of the weather reports present five major elements of weather namely temperature, pressure, wind flow, humidity and precipitation. Some aspects of these five elements are shown in diagrams like line diagram, bar diagram, wind flow diagram etc., and some of them are presented in the maps like isotherm and isobar etc. We will discuss about the representation of climatic data through diagrams in this unit. Representation in the form of isotherm, isobar, and pressure gradient will be taken up in the next Unit 13 titled “Weather Maps”.

Let us now discuss in brief about the five climatic elements as mentioned above.

(i) **Temperature**: The most significant factor that determines weather is temperature. Temperature is measured using a thermometer in degrees Fahrenheit or Celsius. We generally represent all sorts of variations starting from diurnal i.e. in a day, monthly, annual and over a longer period of time. This provides you the maximum, minimum, range and average temperature of different places on the globe.

(ii) **Pressure**: Air pressure or simply we can say pressure has a direct relationship with temperature. It 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. You might have seen in weather reports, it has been depicted in terms of areas of high pressure and low pressure.

(iii) **Humidity**: Humidity is also another important factor that determines the weather of a place. Humidity is a measure of the water content present in the air mass. It plays a vital role in weather formation and agricultural activities etc

(iv) **Precipitation**: You have read various forms of precipitation namely snow, rain, hailstorm and drizzle etc. As you know, it is one of the essential elements for survival of the planet earth in general and survival of plants, animals and human beings in specific. We generally measure amount of rainfall in a place by using rain gauge.

(v) **Wind**: As you know temperature and pressure are the major determinants of wind flow. Wind speed and direction, gives you an idea about wind patterns of a particular place. If you remember while presenting a report about cyclonic storm, the reporter describes the wind speed as well as direction. This type of data we present through wind rose diagrams.

After knowing the elements of climate related data, let us discuss briefly about the instruments used for collecting above mentioned weather related data. Different types of instruments are used to measure different parameters. As you already know that thermometer is used for measuring temperature, barometer for pressure, anemometer for measuring wind velocity etc. Today, we have automated weather station (AWS's) in which these instruments are found at one place and as name suggests weather phenomena are recorded automatically. You will read more about this in the next unit. Once data is recorded, these data have to be gathered and communicated to different stakeholders like farmers, policy makers and general public etc. for different purposes. While communicating this huge data, we take the help of certain diagrams to make communication more effective and easily understandable. What exactly we want to see out of this huge data? We look for trends, patterns and relationships. Once we understand these three processes, it would be easy for us and respective stakeholders to draw inferences from such graphs and diagrams.

There are certain diagrams which are general in nature and represent various types of data including climatic data. Examples are line diagram, bar diagram, combined line and bar diagram etc. We will discuss about these diagrams in Unit 14. But there are certain diagrams which were developed for depicting climatic data exclusively. Examples of such diagrams are climograph, hythergraph, ergograph, wind rose and star diagrams etc. We will discuss about these exclusive diagrams in the next Sections.

Before that, let us know what we have learnt so far, by answering the questions as given below.

SAQ 1

Fill in the blanks with suitable words.

(i) Weather bulletin in newspaper and television, many a time is supplemented by _____ and _____.

(ii) Weather phenomena of a place are recorded automatically by _____.

(iii) Communicating huge data with the help of diagrams make communication more _____ and _____.

12.3 REPRESENTATION OF CLIMATIC DATA THROUGH DIAGRAMS

As mentioned above, we will discuss only those diagrams which are exclusively used for representing climatic data. While doing so, we can define the month or season and place of interest used for representation of the weather phenomena. The weather data including past weather conditions and long-term averages can be used for representation through various diagrams. Some of the diagrams with the help of which you can represent these data are given below:

1. Climograph
2. Hythergraph
3. Ergograph
4. Wind rose and Star diagram

Let us discuss these diagrams, their uses and steps involved in the construction with one example each.

12.3.1 Climograph

Climograph or climogram is nothing but the short form of climatological diagram. ***This is a twelve sided polygon that represents selected two climatic elements of a particular station against one another.*** This twelve sided polygon or climograph was constructed by taking wet bulb temperature and relative humidity as indicators for representing climatic condition of a place.

This was first conceived by J. Ball in 1910 and later expanded and improved by Leighly (1926), USDA (1941), and Taylor (1949). This diagram was also extensively used by Koeppen to summarize variations in world climatic conditions while developing his classification of climatic regions (you have already read it in a Unit of third block titled ‘climatology’ in first semester

course). If we look at the history behind the construction of climograph, it was also used to identify the places on the basis of scale of habitability or hospitability for white settlers in the tropic regions.

As mentioned above, the sole purpose for which Griffith Taylor constructed climograph was to identify the places in tropical area that were suitable or hospitable for white settlers. That is why he coined four special terminologies for four distinct climatic conditions. These four terms are always mentioned in the four corners of the climograph. These terms are raw, muggy, scorching and keen and are marked in South East, North East, North West and South West corners of a climograph respectively. Let us discuss each term along with its specified parameters like wet bulb temperature and relative humidity as well as the climatic conditions which it represents. These are as follows:

(i) **Raw**: Wet bulb temperature below 40 degree Fahrenheit (4.4 degree celsius) and relative humidity over 70 percent. Therefore, raw represents **cold and moist condition**.

(ii) **Muggy**: Wet bulb temperature over 60 degrees Fahrenheit (15.5 degree celsius) and relative humidity over 70 percent. Therefore, muggy represents **hot and humid condition**.

(iii) **Scorching**: Wet bulb temperature over 60 degree Fahrenheit (15.5 degree celsius) and relative humidity below 40 percent. Therefore, scorching represents **hot and dry condition**.

(iv) **Keen**: Wet bulb temperature below 40 degree Fahrenheit (4.4 degree celsius) and relative humidity below 40 percent. Therefore, keen represents **cold and dry condition**.

Griffith Taylor has also constructed the scale of discomfort based on his experience gained from the plotting of climograph for different places across the globe.

Scale of Discomfort by Griffith Taylor

Griffith Taylor's Scale of Discomfort was divided into six categories. These are as follows:

1. 40 degree Fahrenheit – 45 degree Fahrenheit represent **very rarely uncomfortable.**
2. 45 degree Fahrenheit – 55 degree Fahrenheit represents **ideal condition.**
3. 55 degree Fahrenheit – 60 degree Fahrenheit represents **very rarely uncomfortable.**
4. 60 degree Fahrenheit – 65 degree Fahrenheit represents **sometimes uncomfortable.**
5. 65 degree Fahrenheit – 70 degree Fahrenheit represents **often uncomfortable.**
6. 70 degree Fahrenheit – 75 degree Fahrenheit represents **usually uncomfortable.**

The location of this twelve sided figure in the graph also gives us the idea about the climatic condition of that particular place. How is it possible? This is possible because each corner depicts a particular type of climatic condition. For example, if the climograph is located in the north western corner of a graph, it indicates hot and dry conditions. This also indicates that particular place is situated in arid or semi-arid areas.

Apart from the position of climograph, the shape of climograph is also helpful in identifying the nature of climate. Some of the prominent shape and its associated climate are given below.

(i) A **spindle shaped** climograph shows **dry continental type of climate.**

(ii) **North East to South West diagonally** oriented climograph represents **monsoon type of climate.**

(iii) **North West to South East diagonally** oriented climograph represents **Mediterranean type of climate.**

(iv) Climograph which is **fully spread** represents the **British type of Climate**.

Let us discuss methods of construction of climograph with the help of an example given below. You will also be provided with more exercises in the Practical Manual in integrated laboratory course, BGGCL 134.

Example 1: Draw a Climograph of Kolkata representing the below given data in table.

Months	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Wet - Bulb Temp (in degree Fahren-heit	64.8	68.5	70.5	78.1	82.9	82.3	80.8	80.7	80.0	78.0	68.9	68.4
Relative Humidity (in percent)	40	44	38	38	57	69	81	79	75	72	48	48

Steps involved in the construction of Climograph are as follows:

(i) Draw X-axis and Y-axis on a graph sheet as OX and OY respectively. Mark Relative Humidity (RH) in the X-axis and Wet-Bulb Temperature in Y-axis. As you have already studied in the Course on Physical Geography, Wet-Bulb Temperature is either in Degree Celsius or Degree Fahrenheit (^oC or ^oF) and Relative Humidity is in percentage (%).

(ii) The Wet-Bulb Temperature is plotted in Y-axis, graduated from -10 ^oF to 90 ^oF while the relative humidity is plotted along the X-axis graduated from 20% to 100%. Do you know why this fixed value is taken into consideration? As mentioned earlier, in this graph, mean monthly values

of Wet-Bulb Temperature are plotted against those of Relative Humidity on a fixed frame as devised by Taylor to show the physiological effects of climate on human beings.

(iii) To represent above said two climatic indicators in X-axis and Y-axis, we have to select a suitable scale. You have already learnt about different types of scales in Unit 3, Block 1 of this course. In this case, we have selected a scale of 1 CM = 10^0 F for Wet Bulb Temperature and 1CM = 10 % for Relative Humidity.

(iv) Once we selected the scale and mark the X-axis and Y-axis accordingly, try to plot 12 points which represents Relative Humidity and Wet-Bulb Temperature of 12 months of the year. How to do it? For example, to get the points for the month of January, you have to draw perpendiculars from 6.5 cm (64.8/10) and 4.0 (40/10) that represents Relative Humidity and Wet-Bulb Temperature for the month of January. The point of intersection of these perpendiculars will show the position of point representing the values of January month. Mark the letter 'J' at this point.

(v) In a similar manner, plot other points representing the remaining eleven months and mark their names in similar way as suggested in the previous paragraph. Each month is represented by a letter symbol. In this case, the symbols are generally represented by first letter of their names written in capital letters. For example, September would be represented by the letter 'S' whereas October would be represented by the letter 'O' and so on.

(vi) Join all the 12 points sequentially with the help of a scale and complete the 12 sided polygonal figure. When you will complete the exercise, your climograph would look like the diagram as given below (see Fig. 12.1). Write down the words 'Raw', 'Muggy', 'Scorching' and 'Keen' in four corners of the diagram as explained earlier.

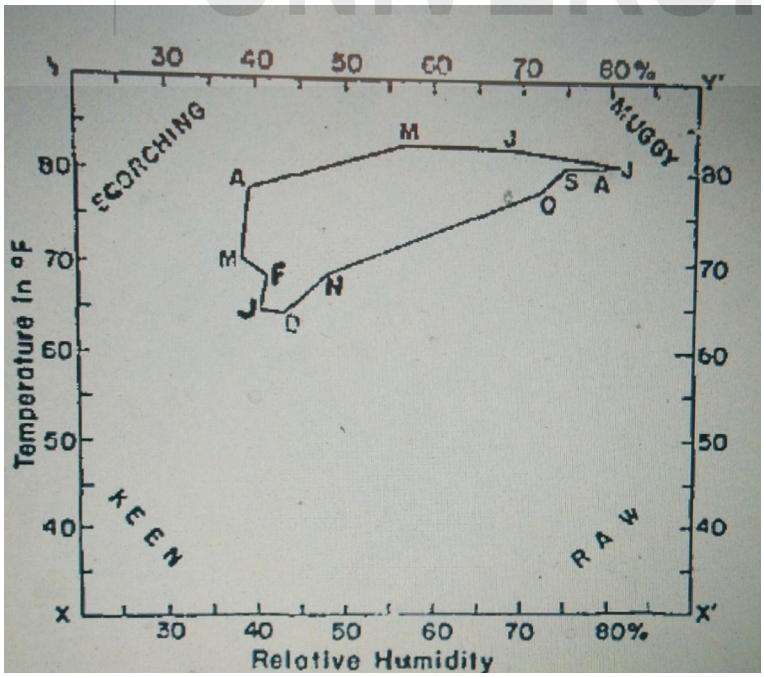

Fig. 12.1: Climograph of Kolkata.

12.3.2 Hythergraph

Hythergraph is another form of climatological diagram. This diagram was first devised by Griffith Taylor. Like climograph, hythergraph also represents climatic condition of a particular place. Then the question that automatically might be arising in your mind is that then why another diagram for the same purpose? As you know, climate of a particular place is determined by various weather elements like temperature, pressure and precipitation etc. In a two dimensional diagram, we cannot plot more than two variables. Therefore, various climatic diagrams were developed by using combination of any two suitable variables.

The only difference between climograph and hythergraph is of the indicators. If you remember correctly, in climograph relative humidity is plotted in X axis whereas wet bulb temperature is plotted in Y axis. In the case of hythergraph, rainfall is plotted in X axis whereas temperature is plotted in Y axis. Therefore, **hythergraph is also another twelve sided polygon that represents mean monthly temperature and rainfall of a particular selected station against one another.** Secondly, unlike climograph, the propounder of this diagram did not coin any term for representing climatic conditions.

Construction of a hythergraph is similar to climograph. Let us understand the construction of a hythergraph by solving the below given exercise.

Example 2: Draw a Hythergraph of Delhi representing the below given data in table.

Months	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temperature (in Celsius)	14	17	23	29	34	34	31	30	29	26	20	16
Rainfall (in mm)	25	22	17	7	8	65	211	173	150	31	1	5

Steps involved in the construction of Hythergraph are as follows:

(i) Draw X-axis and Y-axis on a graph paper as OX and OY respectively. Mark mean monthly rainfall on the X-axis and mean monthly temperature on the Y-axis.

(ii) To represent above said two climatic indicators in X-axis and Y-axis, we have to select a suitable scale. In this case, we have selected a scale of 1 CM = 3^0 C Temperature and 1CM =10 mm for rainfall.

(iii) Once we selected the scale and mark the X-axis and Y-axis accordingly, try to plot 12 points which represents mean monthly rainfall and mean monthly temperature of 12 months of the year. How to do it? For example, to get the points for the month of January, you have to draw perpendiculars from 4.7(14/3) and 2.5 (25/10) that represents the values of temperature and rainfall for the month of January. The point of intersection of these perpendiculars will show the position of point representing the month of January. Mark the letter 'J' at this point.

(iv) In a similar manner, plot other points representing the remaining eleven months and mark their names in similar way as suggested in the previous paragraph. Each month is represented by a letter symbol. In this case, the symbols are generally represented by first letter of their names written in capital letters as you have done in climograph. Join all the 12 points sequentially with the help of a scale and complete the 12 sided polygonal figure. When you will complete the exercise, your hythergraph would look like the diagram as given below (see Fig. 12.2).

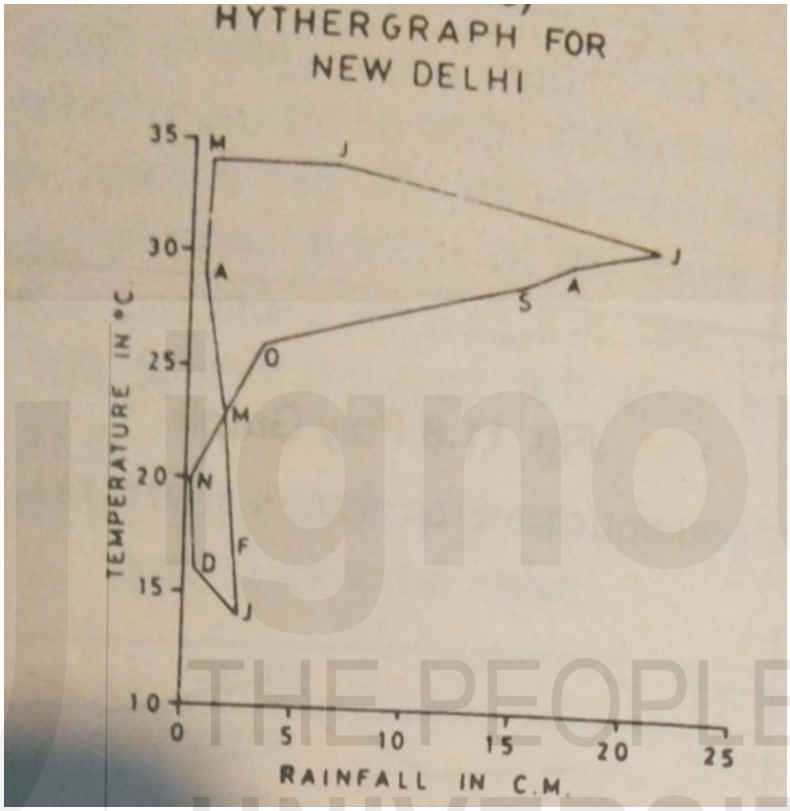

Fig. 12.2: Hythergraph of Delhi.

SAQ 2

Match the two columns.

Shape	**Climatic Condition**
A) Spindle	i) Monsoon
B) Diagonal (North East-South West)	ii) Continental
C) Fully Spread	iii) Mediterranean
D) Diagonal (North West-South East)	iv) British Type

12.3.3 Ergograph

The word ergo was derived from Greek word *erogon* which means work. There are certain economic activities that are performed during different periods of the year or in a particular season. Therefore, ergograph depicts economic activities performed during different seasons of the year along with

area or production. This was developed by Arthur Geddes. This graph also contains associated weather phenomena that favour a particular type of economic activities. Till now, you might have realized that this diagram depicts multiple variables.

Let us explain this with an example. In India, crops are grown in different seasons and are known as *Rabi, Kharif and Zaid*. Rabi crops like wheat are grown in winter months, rice is mainly a kharif crop grown during the hot and wet seasons and crops like sugarcane requires ten months from sowing to harvesting. When we prepare ergograph of a particular place, we represent weather along with the area utilized for growing crops. Mostly two to three elements of weather we depict are temperature, humidity and rainfall. This is because these two elements of weather have direct relationship with growing of crops.

In this diagram, we use combination of three types of statistical diagrams. Temperature and humidity are represented by line and rainfall is depicted through bar. The third dimension representing cultivated area is presented in the form of rectangular diagram.

However, Arthur Geddes and A. G. Oglive prepared circular ergograph to depict the continuous rhythm of activities performed in different seasons throughout the year. Here, we will construct an ergograph as suggested in the first case.

Let us understand the processes involved in the construction of ergograph through an example.

Example 3: Draw an Ergograph of Ambala representing the below given data in table.

Months	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temperature (in Celsius)	13	16	22	27	29	31	30	29	28	27	19	14
Rainfall (in mm)	29	57	7	10	12	58	297	296	195	11	6	8

Net Acreage of various Crops along with their growing season

Crops	Growing Season	Net Sown Area (in hectares)
Rice	May to October	1422
Wheat	November to April	2530.5
Cotton	June to December	668.5
Sugarcane	March to December	114.9

Steps involved in the construction of Hythergraph are as follows:

(i) Draw X-axis and Y-axis on a graph paper as OX and OY. In X-axis, we represent twelve months and in Y-axis we represent temperature and rainfall. Area covered under different crops will be shown through rectangular diagram and placed below the graph. We will discuss it in detail while discussing about its construction steps.

(ii) To represent above said two climatic indicators in X-axis and Y-axis, we have to select a suitable scale. In this case, we have selected a scale of 1 cm = 3^0 C temperature and 1cm = 20 mm for rainfall.

(iii) As temperature is a continuous data, it is represented through line diagram and rainfall is a discrete data, it is normally represented through bar diagram. Plot the points for temperature of each month after converting it according to scale. Once you mark the twelve points for the twelve months, join them with free hand and complete the line diagram. Similarly, convert the data related to rainfall according to the scale and construct twelve bars representing twelve months of a year.

(iv) As mentioned above, area would be represented through rectangular diagram. The formula for calculating area is as follows:

Area = Length x Breadth

Like temperature and rainfall, we have to fix a scale for area of production. Let us assume 1 cm = 10,000 hectare.

By doing so, we will get the value for area to be represented in the graph. In our map, length is already derived. Can you identify how it is derived? It is very simple. If one month is shown by 1cm, then six months would be shown by 6 cm, 10 months by 10 cm and so on. Once we obtain the value for area and length, we can easily calculate the breadth or width of a rectangle (Breadth=Area/Length).

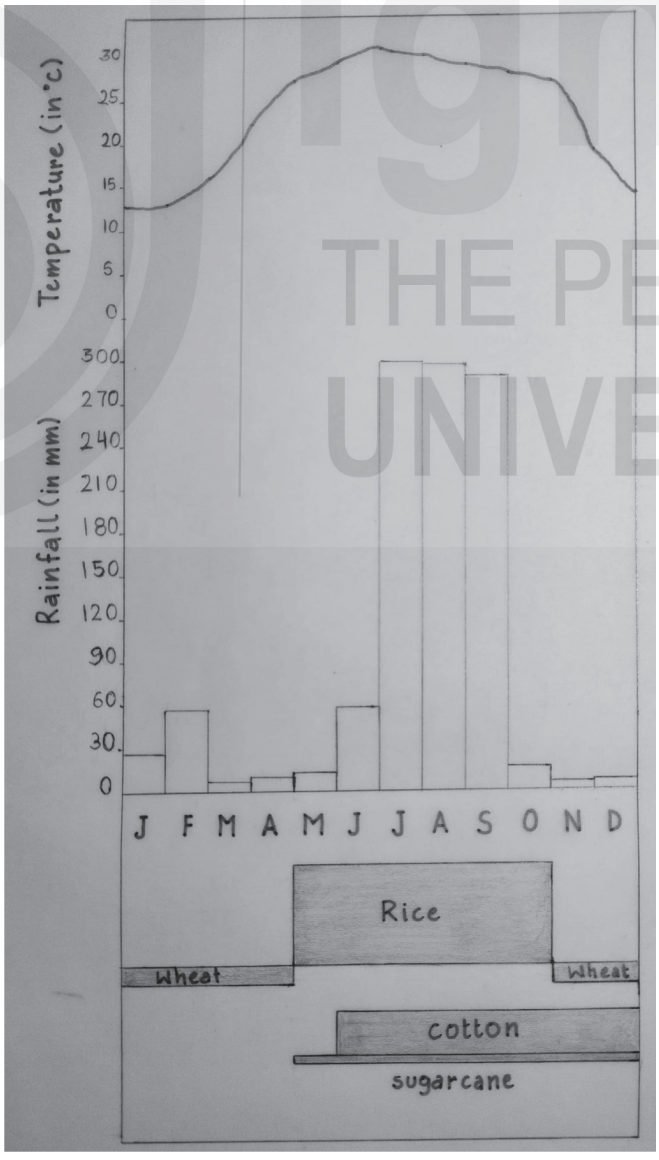

Fig. 12.3: Ergograph of Ambala.

(i) After obtaining all the values, we will construct rectangular diagram to represent the area. When you will complete the exercise, your ergograph would look like the diagram as given below (see Fig. 12.3).

12.3.4 Wind Rose or Star Diagram

This diagram is also known as star diagram or direction diagram. It's because this diagram looks like a star in which the light emanates from the centre to all the directions. As you know, there are sixteen directions – four cardinal or primary directions and twelve secondary directions. Therefore, in a wind rose, maximum sixteen lines can be drawn from the centre representing corresponding sixteen directions (see Fig. 12.4).

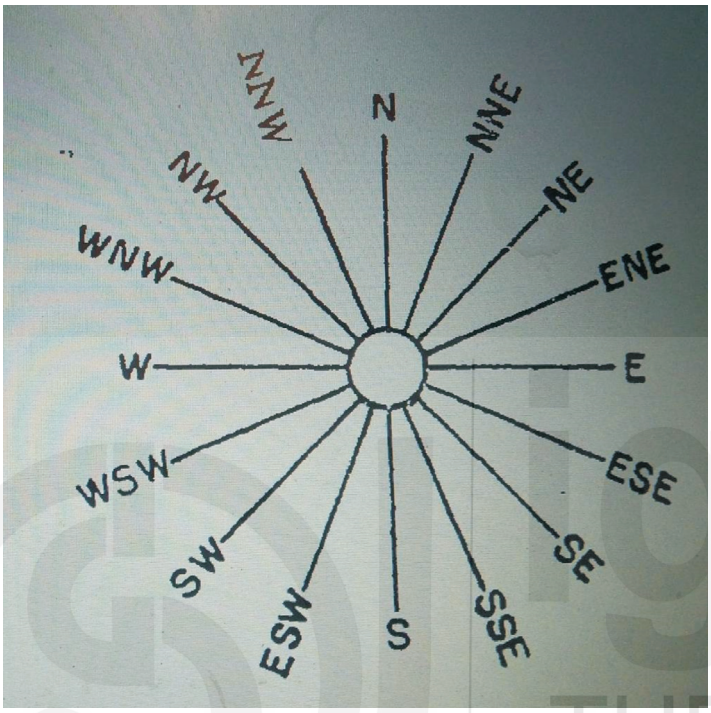

Fig. 12.4 Four cardinal and twelve secondary directions.

The length of each line would be proportionate to the quantity it represents. So, each ray will represent the number of hours or days, the wind blows from the corresponding direction in a particular period. But there are some hours or days (as the case may be) when the wind is calm. These calm periods are generally shown by drawing a small circle at the centre and writing the number within the circle. After all the lines are drawn, the end points of all the lines are joined. This closed diagram is known as star diagram.

Like other cases, let us understand the process of constructing wind rose through the below given exercise.

Example 4: Draw a Wind Rose of Bengaluru representing the below given data in table.

Wind Direction	North	North East	East	South East	South	West	South West	North West
No. of Days	14	25	64	14	13	109	37	24

Steps involved in the construction of Wind Rose are as follows:

1. Draw a small circle having radius of 1 cm. There is no strict rule for it. It can be little bigger also. The basic purpose of drawing the circle is to write the number of calm days inside the circle.

2. Draw a horizontal straight line that passes through the centre representing east-west direction. Similarly, draw a vertical straight line bisecting horizontal line which would represent north and south direction. Needless to say, that this vertical line will also pass through the centre. These two lines will represent four cardinal directions.

3. To find out the rest of four secondary directions i.e. north east, south east, north west and south west, bisect all the cardinal directions associated with it. For example, to derive north east, bisect the area between north and east at 45 degree angle and draw the straight line. Derive rest of three secondary directions in a similar manner.

4. To decide the length of all the eight lines drawn, we have to choose a scale. In this exercise, let us assume 1cm = 10 days. Accordingly, let us calculate length to represent wind flow in all directions. For example, the length for the north direction would be 1.4 cm whereas for east, it would be 6.4 cm. Calculate for the rest of the six directions accordingly.

5. Once we draw the eight lines according to the scale, join the tip of each line by drawing straight lines with the help of a scale and complete the diagram. When you will complete the exercise, your diagram would look like the diagram as given below (see Fig. 12.5).

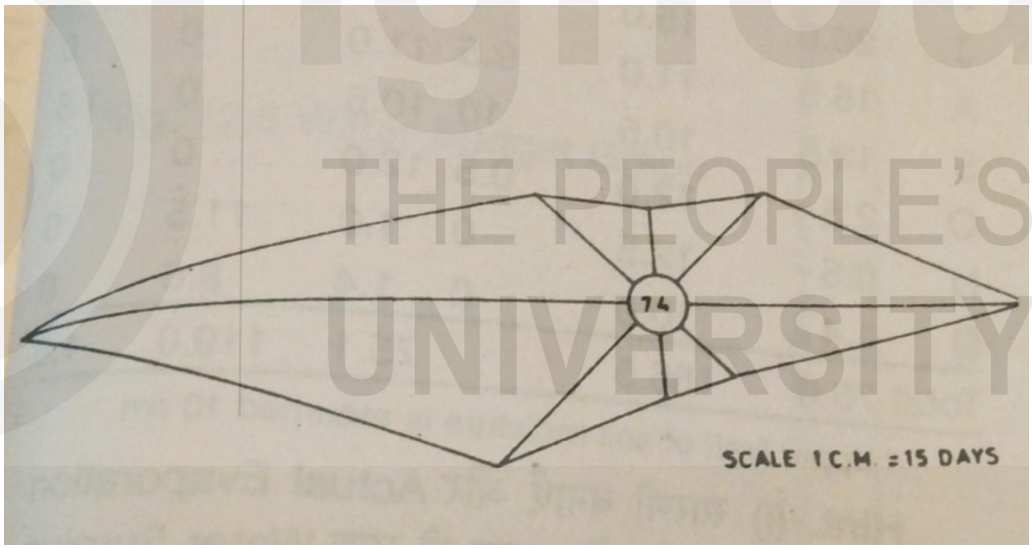

Fig. 12.5: Wind rose diagram of bengaluru.

SAQ 3

Which of the following statements are true and which are false.

(i) Ergograph was developed for the first time by Griffith Taylor.

(ii) The word ergo was derived from Greek word *erogon* which means work.

(iii) In a wind rose, maximum twelve lines can be drawn from the centre representing corresponding four cardinal and eight secondary directions.

(iv) In wind rose diagram, calm period is generally shown by drawing a small circle at the centre and writing the number within the circle.

12.4 SUMMARY

In this unit, you have studied so far:

- Climatic elements namely temperature, pressure, humidity, precipitation etc. are represented through maps and diagrams. Some of the methods used for representation of climatic data are wind rose, star diagram, climograph, hythergraph and ergograph.
- Climograph or climogram is a twelve sided polygon that represents selected two climatic elements of a particular place against one another. This twelve sided polygon or climograph was constructed by taking wet bulb temperature and relative humidity as indicators for representing climatic condition of a place.
- This was first conceived by J. Ball in 1910 and later improved by Leighly (1926), USDA (1941), and Taylor (1949). This diagram was also extensively used by Koeppen to summarize variations in world climatic conditions.
- Hythergraph is another form of climatological diagram. This diagram was first devised by Griffith Taylor. Like climograph, hythergraph also represent climatic condition of a particular place. Hythergraph is also another twelve sided polygon that represents mean monthly temperature and rainfall of a particular station against one another.
- The word ergo was derived from Greek word *erogon* which means work. Therefore, ergograph depicts economic activities performed during different parts of the year along with area or production. This was developed by Arthur Geddes. Arthur Geddes and A. G. Oglive prepared circular ergograph to depict the continuous rhythm of activities performed in different seasons throughout the year.
- Wind rose is also known as star diagram or direction diagram. It's because this diagram looks like a star in which the light emanates from the centre to all the directions. Each ray will represent the number of hours or days, the wind blows from the corresponding direction in a particular period.

12.5 TERMINAL QUESTIONS

1. What is a Climograph? Who used climographs scientifically to divide the world into climatic regions? Describe the 'Scale of Discomfort' developed by Griffith Taylor.
2. Who was the founder of hythergraph? What are the similarities and dissimilarities between hythergraph and climograph?
3. What is an ergograph? Describe the purpose of an ergograph.
4. What is a wind rose? What is the significance of each "spoke" in the wind rose? How do we represent calm days in wind rose?

12.6 ANSWERS

Self Assessment Questions (SAQ)

1. (i) Satellite image, diagrams

   (ii) Automated weather station

   (i) Effective, easily understandable

2. A - ii; B - i, C - iv; D - iii

3. (i) False

   (ii) True

   (iii) False

   (iv) True

Terminal Questions

1. Your answer should include all the key points like meaning and terminologies with reference to Climograph systematically as explained in the Section 12.3.1.

2. In order to answer this question, you should highlight the key differences between the two by referring to the Section 12.3.2.

3. Your answer should briefly describe the ergograph and highlight its main purpose. Refer to the Section 12.3.3.

4. Your answer should briefly incorporate the meaning, significance and highlight the importance of calm days in a wind rose diagram. Refer to the Section 12.3.4.

12.7 REFERENCES/SUGGESTED FURTHER READING

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