Theme 7: Natural Resources

Prior Knowledge

It is recommended that you revise the following topics before you start working on these questions.

- Wind - uneven heating of the Earth, temperature and the movement of air
- Rain - rain gauge, weather prediction.

Climate in India

Like many other countries which are closer to the equator, India gets good rain as well as good heat, which provides a conducive environment for a variety of plants and animals to grow and prosper. The long coastline covering the land from three sides and the tall Himalayan range in the North creates a unique setup for a cycle of winds flowing from the sea to the land and back every year. It is this cycle which is responsible for the rains - the monsoon - in India. Monsoon drives the economy of India as agriculture is the major contributor to the Indian economy (about 20% to the total GDP) and employment (over 60%). Let us understand the phenomenon of the monsoon.

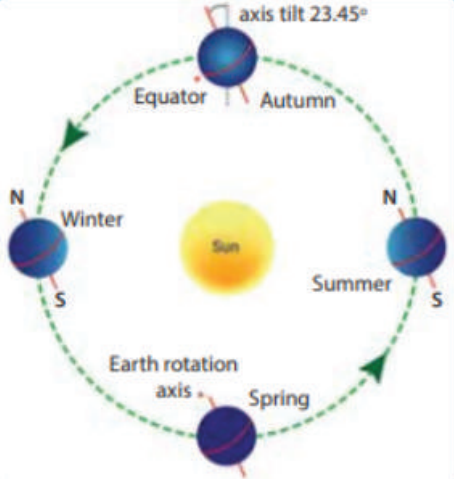


Fig. 7.1, Earth revolves around the Sun with a tilt in its spinning axis with respect to the orbital plane

As shown in Fig. 7.1, the Earth revolves around the Sun with a tilt in its spinning axis. [Note that the orbit is not as elliptical as it appears in the figure.] Because of this, it appears that the Sun begins to move towards the north (Uttarayana) and south (Dakshinayana) during the summer and winter solstice respectively. The Sun's rays falling at 90 degrees heats the surface more than the tilted rays, which is the main cause for the uneven heating of the Earth's surface. The uneven heating of the landmass and water bodies is the main drive for the seasonal winds, such as the monsoon and returning monsoon.

Case Study A - Monsoon & Returning Monsoon

India receives most of its rain from two seasonal winds - Southwest monsoon and Northeast monsoon. The southwest monsoon (commonly known as the monsoon) occurs from June to September and the northeast monsoon (often called the returning monsoon) occurs from October to December.

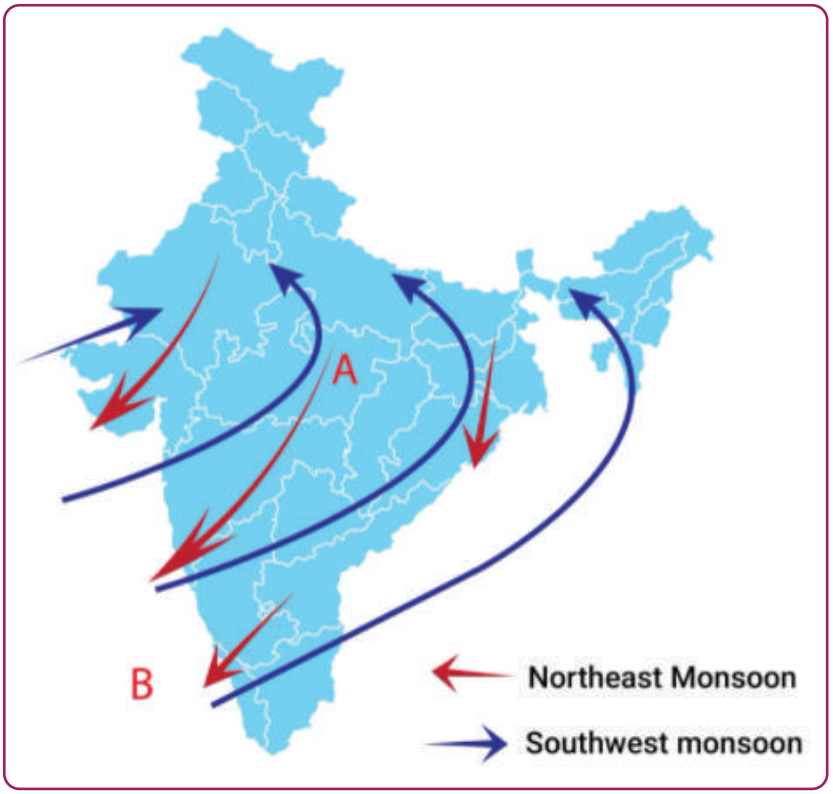


Fig. 7.2, Southwest monsoon (shown in blue) and Northeast monsoon (shown in red)

Fig. 7.2 shows the direction of movement of the southwest and northeast monsoon. The southwest monsoon is blowing from the sea to the land and hence it has more moisture compared to the northeast monsoon; which is blowing from the land towards the sea.

Question 1

Refer to Fig. 7.2 and predict the relative temperature of region A compared to region B.

i. Where is the temperature expected to be higher during the June-July period?

☐ Region A	☐ Region B

ii. Where is the temperature expected to be higher in October?

☐ Region A	☐ Region B

Question 2

Average rainfall data of India gets collected on an ongoing basis. The data of 30 years from 1961 to 1990 has been plotted in Fig. 7.3.

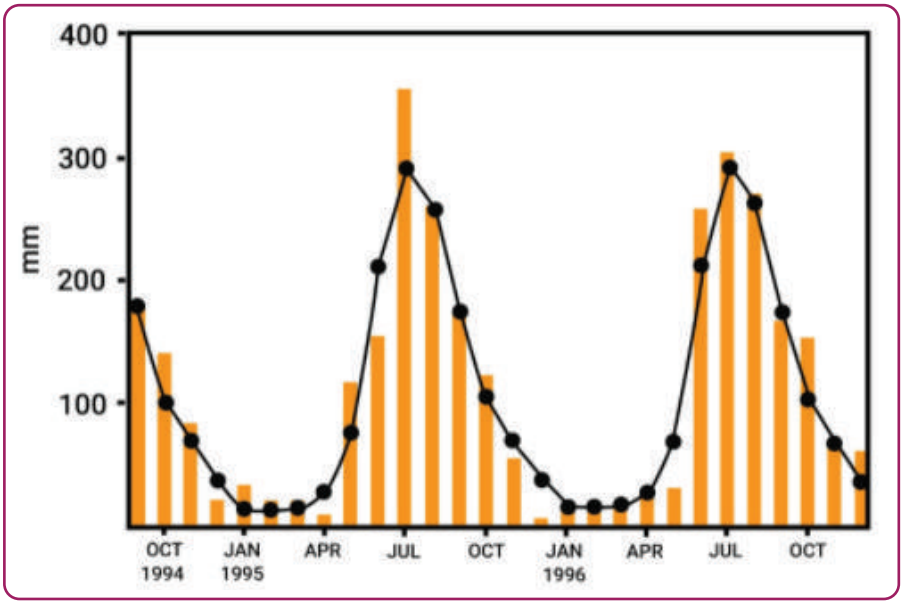


Fig. 7.3, A monthly time series of total precipitation (mm, bars), mean value of data from 1961 to 1990; Image & data sourced from Climate Prediction Centre, USA

Name the monsoon that influences more precipitation in India. What would be the reason behind this monsoon being more influential than the other? Write your answer in the space given below.

Answer

Case Study B - Wind & Temperature

As stated in the previous section, the unequal heating of the landmass leads to the movement of wind. When land gets heated, so does the air above it and as the warm air rises up, the pressure of air in that region goes down. On the other hand, the regions with lower temperature experience higher pressure of air. It is a difference in air pressure, which leads to its movement from a higher pressure region to lower. Fig. 7.4 shows the temperature and wind speed of India's coastal city, Mangalore, observed for a week in the month of May. The x-axis labels the time of the day at intervals of 6 hours in the 24-hour format.

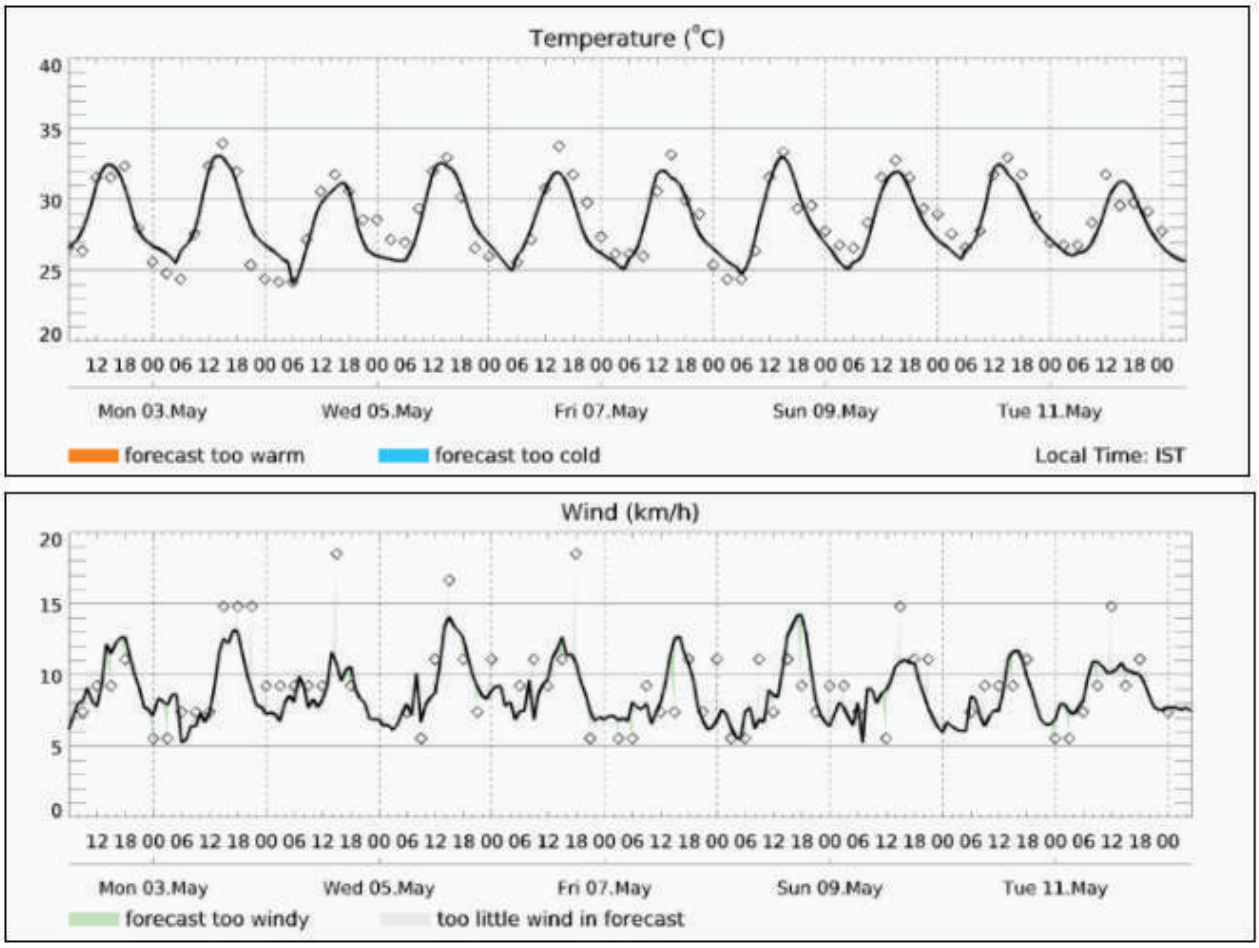


Fig. 7.4, Variation of temperature and wind during day and night time in a coastal region (Mangalore); Image and data sourced from Meteoblue, Switzerland

Question 3

Choose the statements that can be inferred from Fig. 7.4 about the wind speed and temperature of Mangalore during that one week. More than one statement may be true.

a. Wind speed increases and decreases with temperature

b. Wind speed decreases when the temperature increases and vice versa

c. There is no correlation between temperature and wind speed

d. The temperature of Mangalore increases at night time

e. The wind speed in Mangalore drops at night time

Write the options that are true, in the space provided.

Answer

Question 4

Land heats as well as cools down faster than water. In the data sample plotted in Fig. 7.4, during the time of the day when the wind speeds are the highest in Mangalore, which direction is the wind more likely to blow - sea to land or land to sea? Support your answer with appropriate arguments in the space provided.

Answer

Anemometer

As can be seen in the previous section, it is highly valuable to measure wind speeds to draw correlations and inferences related to climate and weather. It is also valuable for harnessing the wind energy. If one has to install an engine, like a windmill, which produces electricity from wind, one has to find out the region where wind blows at high speeds. Also, be it for the study of climate or for harnessing wind energy, it is also valuable to identify the direction in which wind blows during different times of the day, at different times of the year.

One of the instruments used to measure the wind speed and determine direction is called the anemometer. It was invented by an Italian architect during the Renaissance period. Leon Battista Alberti designed the first mechanical anemometer sometime around 1450. Let us look at a model of an anemometer and evaluate the features and limitations of its design.

Case Study C - Model of an Anemometer

The design of the model of an anemometer is shown here, using a few pictures and captions.

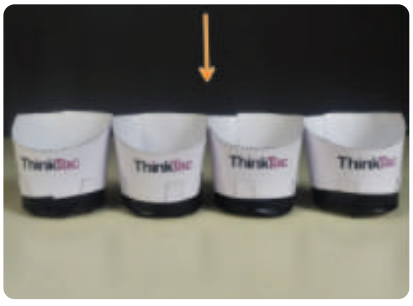


Fig. 7.5, Take four paper cups and cut along the curved line.

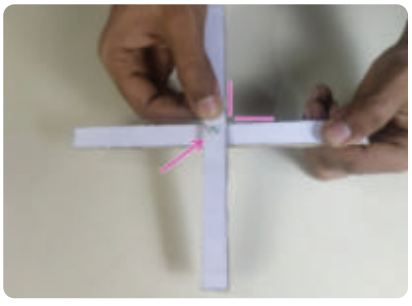


Fig. 7.6, A small stiff straw is inserted at the centre of the two cardboard strips such that the cardboard strips make a '+' sign.

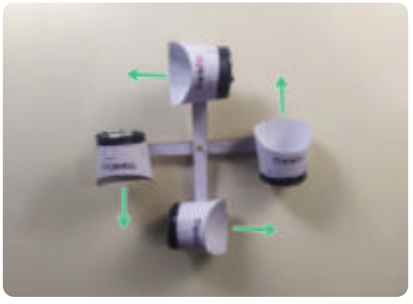


Fig. 7.7, Four paper cups are stuck on the arms of the cardboard strips such that the cut part of the paper cup is facing upwards.

Fig. 7.8, The cycle spoke fixed to a regular paper cup is inserted through a bead. The bead is glued approximately 3 cm from the top of the cycle spoke.

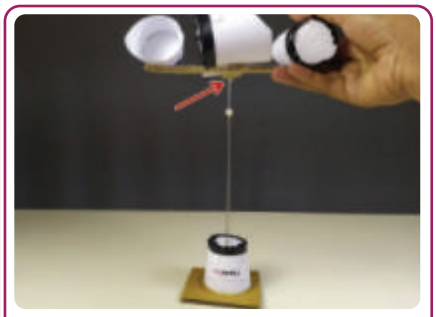


Fig. 7.9, The anemometer is assembled by inserting the cycle spoke through the straw fixed at the centre of the arms.

Fig. 7.10, The anemometer model is ready to record wind speed.

Question 5

Fig. 7.5 shows paper cups cut along a curved line. Choose the option that explains why the cuts are made in a curved line.

a. To capture wind coming from the side

b. To capture wind coming from the top

c. To decrease the mass of the setup

d. Without the curved cut, the setup won't rotate when the wind blows

Answer

Question 6

i. What is the role of the bead in the design of the model?

Answer

ii. Why do you think the cups should face the same direction?

Answer

iii. What would be the advantages of using four cups over using two cups?

Answer

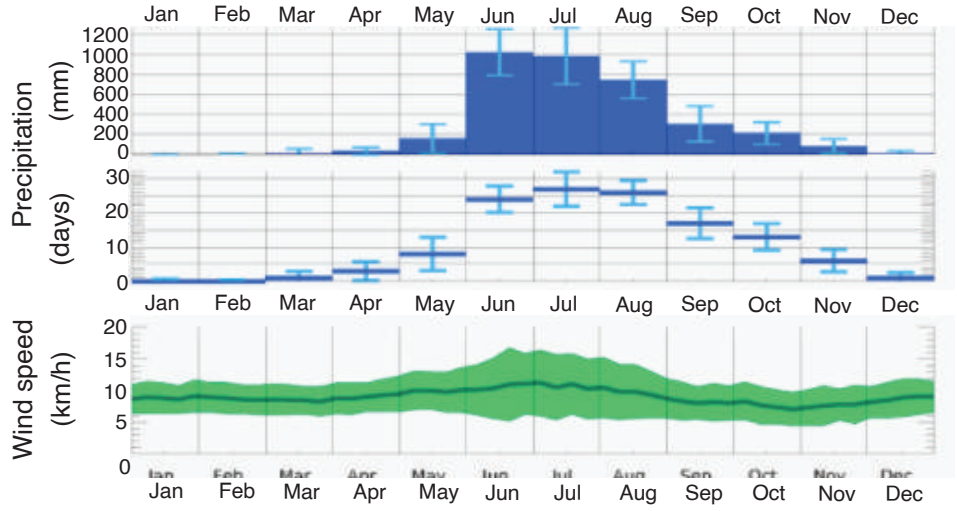
Question 7

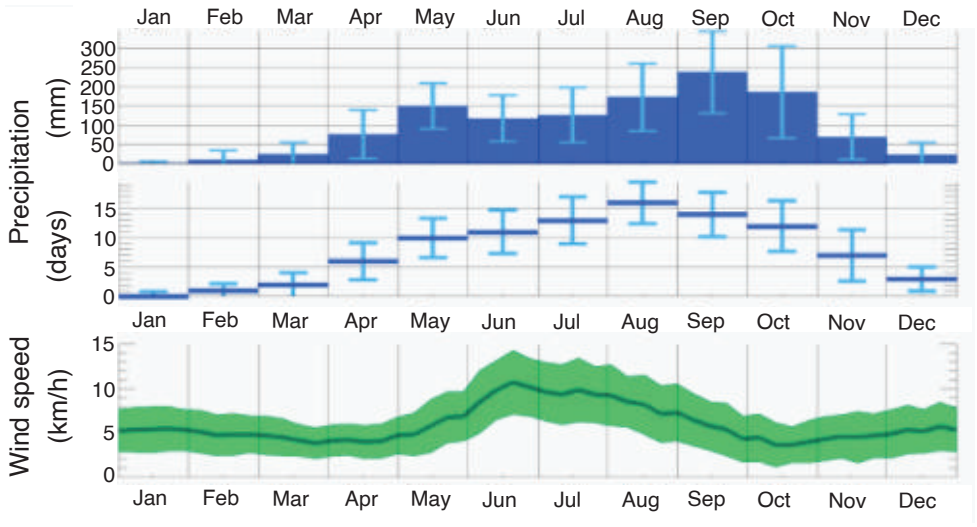
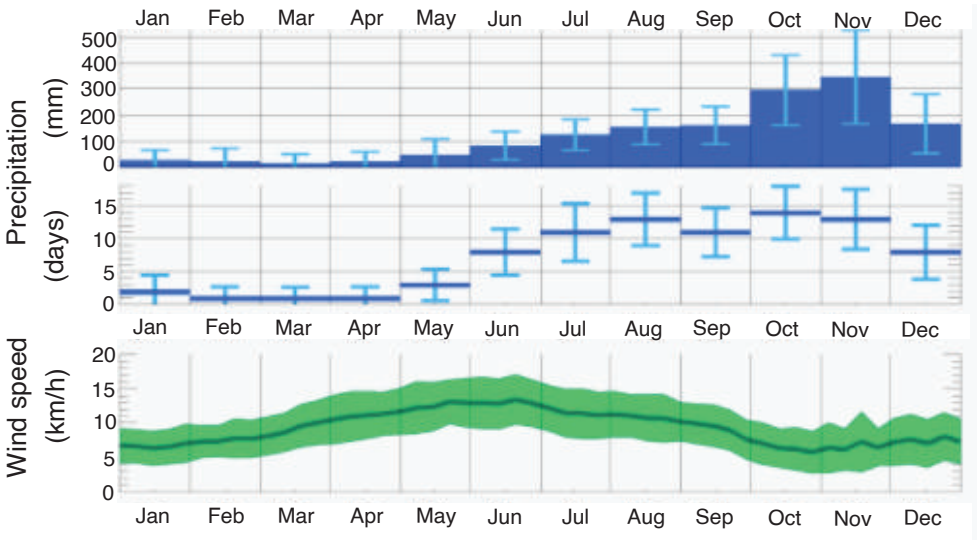
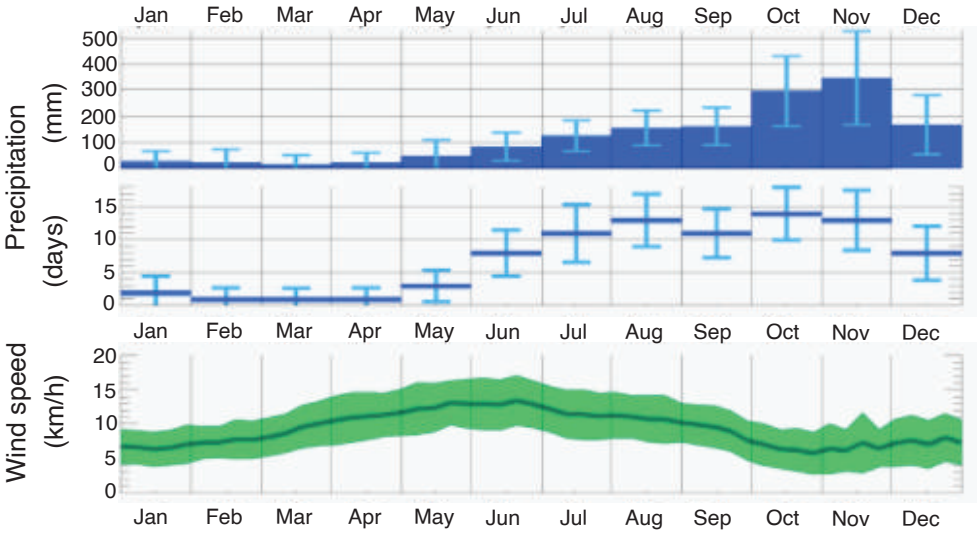
In the anemometer model, the wind entering the cups pushes the cups. This makes the four cups revolve around the cycle spoke (vertical axis). The faster the wind, the more will be the push, and hence more will be the number of revolutions per minute. Thus, wind speed can be measured by counting the number of revolutions per minute. To count the number of revolutions, one of the cups can be marked to use as a reference. However, during heavy wind, if the number of revolutions per minute is more than 600 (more than 10 revolutions per second), it is not possible to accurately count the revolutions using the human eye. Suggest changes/additions to the setup to make this feasible. Be specific with your response. Write your response in the space provided.

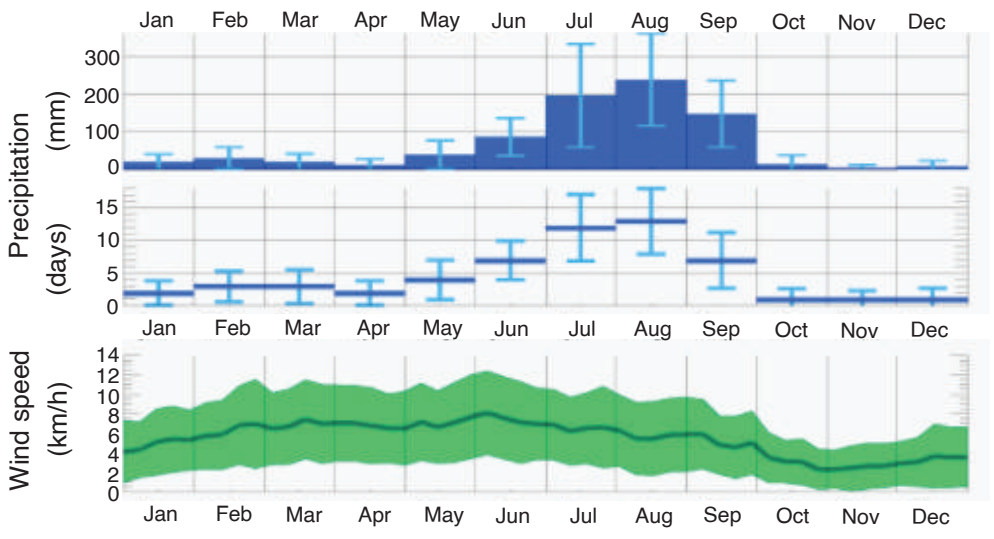
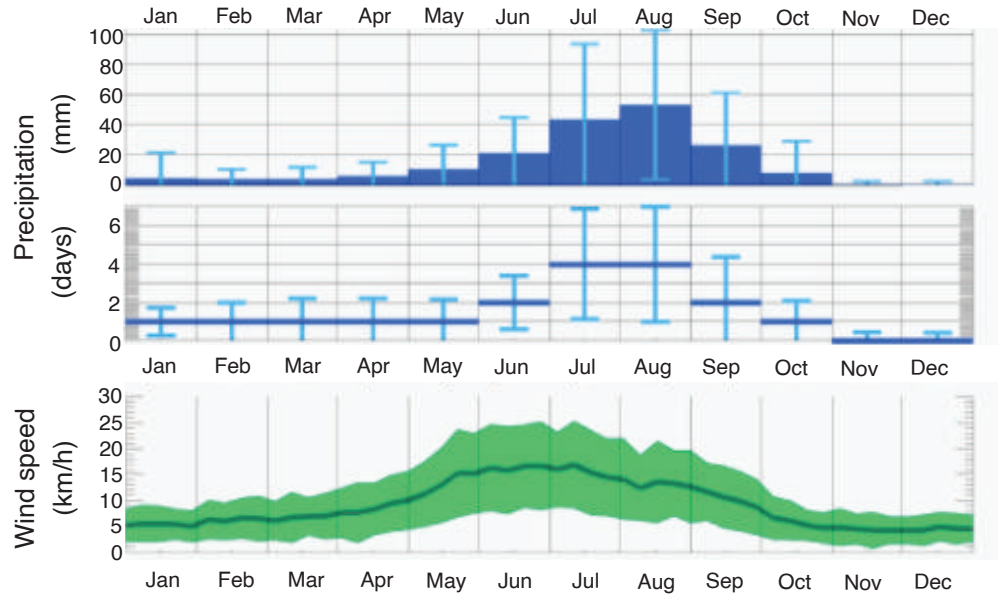
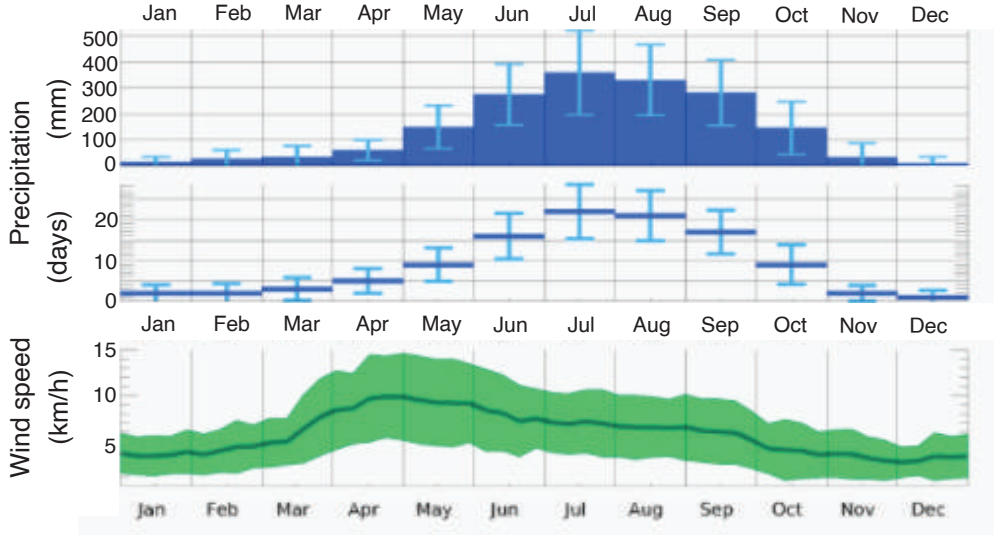
Answer

Case Study D - Wind Speed & Rainfall

In one of the previous sections, we correlated wind speed to temperature. Now let us look at some data to see if there is a correlation with rainfall as well. Images in Table 7.1 capture annual precipitation and wind speed of 9 cities of India observed from the closest weather station.

City	Graph showing precipitation and rainfall during a year
Mangalore	

Bengaluru	
Chennai	
Trivandrum	

New Delhi	
Jaisalmer	
Kolkata	

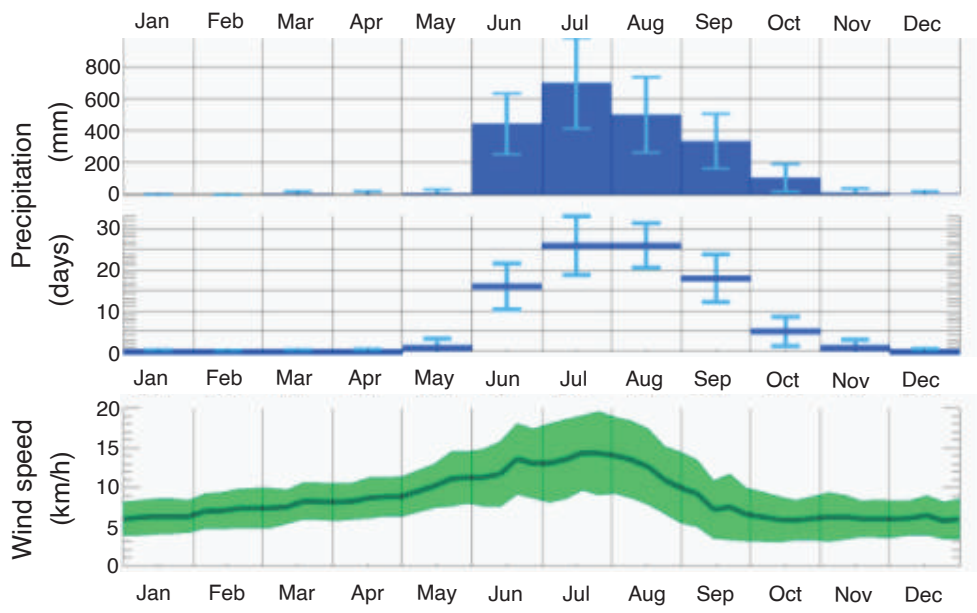
Mumbai	

Table 7.1, Precipitation and wind speed of different cities of India; Image and data sourced from Meteoblue, Switzerland

Question 8

Refer to Table 7.1 and answer the following questions in the space provided.

i. Name one station where the southwest monsoon is the primary source of rain.

Answer

ii. Name one station where the returning monsoon is the primary source of rain.

Answer

iii. Name one station which gets a significant amount of rain through both the monsoons.

Answer

Question 9

Based on the data in Table 7.1, name one station where the wind speed increases during the months when it rains.

Answer

Measuring Rainfall

A rain gauge is an important instrument that measures liquid precipitation that is measured in centimetres, or millimetres, to express the depth of rainfall on the surface of the Earth. It is used to monitor weather patterns, help farmers deal with drought and meteorologists prepare for natural disasters. Did you know that there are around 8000 rain gauges being used by meteorologists and hydrologists in the different states of India as of 2021? Let us find out why.

Fig. 7.11, Rain recorded in a Rain Gauge; Image by Bidgee via commons.wikimedia.org

You might have noticed that sometimes on a rainy day, you might experience rain as you step out of your house, however as you travel a few kilometres, there would be no rainfall at all. This is because the amount of rainfall experienced over a large area is not the same. For a country as large as India, where agriculture is its major industry, its economy is heavily dependent on rainfall. Hence, the Indian Meteorological Department (IMD) has issued guidelines to the State Governments to maintain a standard rain gauge network for accurate rainfall measurement. This includes providing advice on selecting the sites for rain gauge installation, methods of rainfall observation, reporting of the monthly rainfall data, and the analysis of the data extracted. The Symon rain gauge is the most commonly used rain gauge in India.

Case Study E - Rain Gauge

We have learnt about the model of an anemometer to measure wind speed. Let us now look at the model of a rain gauge, which is an instrument used for measuring the amount of rainfall in a region. A simple design of a rain gauge, using a cylindrical shaped syringe and a millimetre scale template, is explained in Fig. 7.12 to Fig. 7.15.

Fig. 7.12, The syringe is heated and then pressed on a flat surface to close the tip of the syringe.

Fig. 7.13, A millimetre scale template is pasted on the syringe such that the edge with the '0 mm' reading aligns with the edge close to the syringe's tip. The measuring unit of the rain gauge is ready.

Fig. 7.14, Mount the measuring unit of the rain gauge on any stand, such as a water-filled container.

Fig. 7.15, Fill the measuring unit with water up to '0 mm' before placing the rain gauge model to measure the rainfall.

Question 10

Will there be any difference in the accuracy of measurement of the rain gauge model if we vary the following parameters?

#	Parameter	Accuracy impacted?
i	Varying the diameter of the measuring unit (in the model, syringe is the measuring unit)	Yes/No
ii	Varying the height of the measuring unit	Yes/No
iii	Using a cone shaped vessel instead of a cylindrical shaped one	Yes/No

Write your answers with reasons in the space provided below.

i. _____

ii. _____

iii. _____

Question 11

Different rain gauges are mounted at different locations mentioned below. Choose the rain gauge that would give the most accurate answer.

a. Under a tree (one metre above ground level)

b. Under a tree (close to ground)

c. In an open area, like a terrace or ground (one metre above ground level)

d. In an open area, like a terrace or ground (close to the ground)

Answer

Question 12

In Fig. 7.15, the rain gauge is filled with water till the '0 mm' marking of the measuring unit. What would happen if you skip this step? Write your answer in the space provided below.

Answer

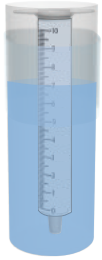
Exploration Pathway

DIY Anemometer

The speed of wind can be measured by an instrument called an Anemometer. Here, using some cardboard, a rubber base, a pencil and some paper cones, you make your very own anemometer. This can also be fitted with a Wind Vane, to determine the direction of the wind.

Matter - Heat Transfer

Heat transfer is the movement of thermal energy from one place/substance to another due to a difference in temperature. It can happen in 3 specific ways, and may be rapid (like heating a pan on the fire) or slow (like through a thermos flask). In this TACtivity, we build models with simple materials to understand the three forms of heat transfer - conduction, convection and radiation and the differences between them.



Rain Gauge Model

One of the simplest meteorological instruments to make is a rain gauge. Here, we paste a length scale vertically on a plastic syringe barrel, which can be used on your terrace or any open ground, to measure rainfall data. This can then be extrapolated to collect weekly, monthly, seasonal and annual rainfall data.

ThinkTac

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भारत
असतो मा सदगमय