CHAPTER 3

Climates of India

kāle varṣhatu parjanyaha pṛiṭhivī sasyaśhālinī
deśhoyam kṣhobharahitah brāhmaṇāsantu nirbhayāh
May the rains be timely, may the Earth be lush with vegetation
May this country be free from turmoil, may good people be fearless!

– Subhāśhita



Fig. 3.1

The Big Questions

1. *What makes India's climate so diverse?*
2. *What are the monsoons? How are they formed?*
3. *What is the effect of climate on economy, culture and society?*
4. *How can understanding the climate help us to prepare for natural disasters?*
5. *What is climate change? What are its consequences?*

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Weather, Seasons and the Climate

'Climate' is a word people use in everyday conversations. But, quite often, what they really mean is 'weather', and not 'climate'. What's the difference? 'Weather' is what we experience every hour or day: it might be raining, or there could be bright sunshine, a lot of wind, etc. The weather keeps changing. Climate, on the other hand, is the pattern of weather an area or a region experiences over a long period of time — several decades at least. This pattern varies from region to region.

Before we come to the various types of climates, let us briefly stop to introduce seasons. Seasons occur as the Earth revolves around the Sun. Each season lasts for a few months and recurs every year. As we know, there are several seasons in the year — spring, summer, monsoon, autumn and winter — that occur in a cycle. Are seasons related to the weather or to the climate? The answer is: to both.

The weather changes with the season, that is, it can be dry and hot in the summer months, or humid and rainy during the monsoon. Further, the pattern of seasons in a region is closely connected with the climate. There are four main seasons across most regions of the world — spring, summer, autumn and winter. However, India receives rainfall during a specific period of the year — the 'rainy season' or monsoon — along with the other four.



Fig. 3.2

Traditionally, in many parts of India, the year is divided into six seasons or *ṛitus* — *vasanta* (spring), *grīṣhma* (summer), *varṣhā* (rainy season), *śharad* (autumn), *hemanta* (pre-winter), *śhiśhir* (winter). Specific rituals and festivals are associated with these six *ṛitus*, such as Vasanta Pañchamī or Śharad Pūrṇima.

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If we observe the world around us, we will notice that human, plant and animal life are in rhythm with the *ṛitus* or seasons. The crops we grow, the food we eat, the clothes we wear, and so on, change with the season. Depending on the region, some trees and shrubs bloom with the onset of *vasanta* or spring, in some places they shed their leaves or change their colour as *śharad* or autumn approaches and some animals develop thick fur in the cold winter months.

LET'S EXPLORE



- → Which are your favourite seasons? Write a short essay explaining your reasons.
- → Discuss in groups of three or four and find out whether there are specific events connected to the seasons in your region. Collect information about them—songs, feasts with specific types of food, practices in different seasons, etc. Document these and share your discoveries with your class.
- → Do you know which trees in your area change colours before the onset of winter? Are there trees that shed their leaves around this time? Why do you think this happens? Find out and document the local names of these trees.

Usually, the climate remains stable over long periods of time. However, scientists have been recording changes in the climates of the world in the recent decades. Studies show that many of these changes have been caused by human actions.

Let us recapitulate:

- Weather is what we experience from day to day—windy, rainy, hot, dry, etc.
- Seasons recur every year and the weather of a place is different in every season.
- Climate is the long-term pattern in a particular region. There are many types of climates in the world. We will now survey the main types found in India.

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Types of Climates in India

We have often seen how India is a land of diversity. This is equally true of its climate:

- In the north, the Himalayan mountains have an alpine climate with cold, snowy winters and cool summers (the word 'alpine' comes from the Alps, a mountain range of Europe). That's probably where you will see the thickest clothing in India!
- Lower in the Himalayas, and in many hilly areas of India, the climate is often said to be temperate, as the winters are moderately cold and the summers not too hot. That is where we find many 'hill stations', much frequented by people seeking relief from the heat in the plains below.



Fig. 3.3

- In the northern plains, the climate is subtropical, with very hot summers and cold winters. This is where most of India's wheat is grown.
- In the west, the Thar Desert has an arid climate featuring extremely hot days, cool nights, and very little rainfall. People there have had to develop unique ways to collect and save water.
- The western coastal strip receives heavy rainfall during monsoon months, creating a tropical wet climate, which is favourable to the growing of rice and spices.
- The central Deccan Plateau has a semi-arid climate with hot summers, mild winters and moderate rainfall during the rainy season.
- Eastern India and the southern peninsula experience a tropical climate with a mild winter and distinct wet and dry periods controlled by monsoon winds (more on them soon).

Note: You will understand later the meaning of the terms 'tropical' and 'subtropical', which are related to two special parallels of latitude called the 'tropics'.

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Factors Determining the Climate

What creates those different climates? There are many factors at work. Some are general ones — on the scale of the planet — while others are regional or even local. Let's examine a few.

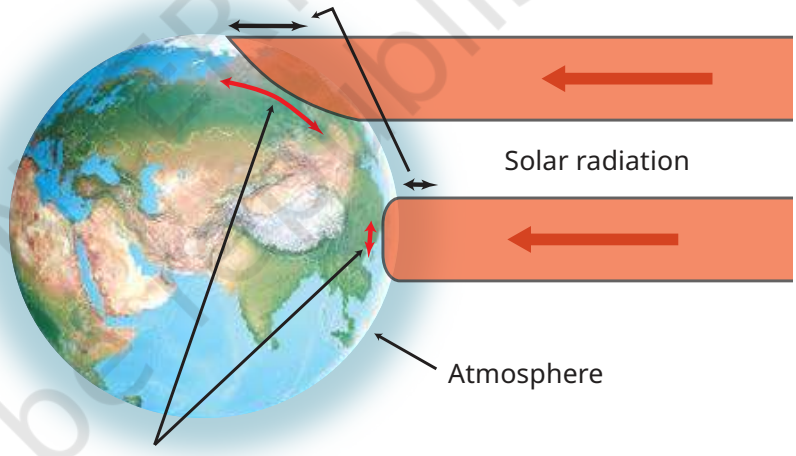
a) Latitude

LET'S REMEMBER



We studied about latitudes in Grade 6. Do you remember that latitudes measure the distance from the Equator, increasing as we move away from it (either northward or southward)? While the climate around the Equator is extremely hot, as the latitude increases it becomes temperate and then cold or frigid. Why is this so?

Places near the Equator, that is, at low latitudes, are warmer, while those near the poles (high latitudes) are colder. This happens due to the angle at which the sun's rays hit a particular area. At the Equator, the rays are nearly perpendicular, and so all their energy is focused on a smaller area of the Earth's surface. In the polar regions, the rays are inclined or oblique, and the energy is distributed over a larger surface. Moreover, they have to pass through more of the Earth's atmosphere, as the diagram shows, which further dissipates their energy. As a result, the polar regions receive less heat than the equatorial zone. We can see this in India too: Kanniyakumari and the Nicobar Islands being close to the Equator are warm or hot almost throughout the year, whereas places in the north, such as Srinagar, are much cooler.



At the equator exposure to the sun's rays is concentrated, but near the poles it is dispersed over a wide area

Fig. 3.4

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b) Altitude

We mentioned hill stations above, which are popular tourist centres because of their cooler climate. India has many including Munnar, Theni, Udhagamandalam (Ooty), Madikeri, Mahabaleshwar, Mount Abu, Shimla, Nainital, Darjeeling, Tawang, Shillong, etc. We know they are located at a higher altitude than the plains below, but how does that explain their cooler temperature? You will later learn the full answer in your Science classes.

To keep things simple for now, the temperature decreases as the altitude increases because:



Fig. 3.5

1. The atmospheric pressure, and therefore the air density, decreases as the altitude increases (as we saw in the chapter 'Understanding the Weather'), and as the air gets less dense, it gets cooler.
2. The sun heats the surface of the Earth, and so the farther away from the surface, the less hot the air will be. The Himalayas are so high that many peaks maintain a temperature below water's freezing point, keeping them covered in snow.

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LET'S EXPLORE



Udhagamandalam (Ooty) and Coimbatore are almost at the same latitude. The range of summer temperatures in Ooty is 10–25° while that in Coimbatore is 25–38°. Why do you think there is such a difference in temperature between these two places?

c) Proximity to the sea

Temperatures in coastal areas do not vary much; the summers are not too hot and the winters are not too cold. That is because the sea acts as a moderator for the temperature. This diagram sums up the phenomenon, and your Science textbook explains this further while discussing the heating and cooling of land and water in coastal regions. The result is that those regions tend to be more temperate. As you move inland from the coast, the temperatures get more extreme—summer temperatures will be higher and winter temperatures lower. For instance, Mumbai and Nagpur are located at a similar latitude, but Mumbai, being near the sea, has cooler summers (around 32°C) and milder winters (around 18°C), while Nagpur, away from the coast, experiences up to 44°C in summer and about 10°C in winter. As you can see, Mumbai's range of temperature (i.e. the difference between the maximum and the minimum) is about 14°C while the range at Nagpur reaches 34°C.

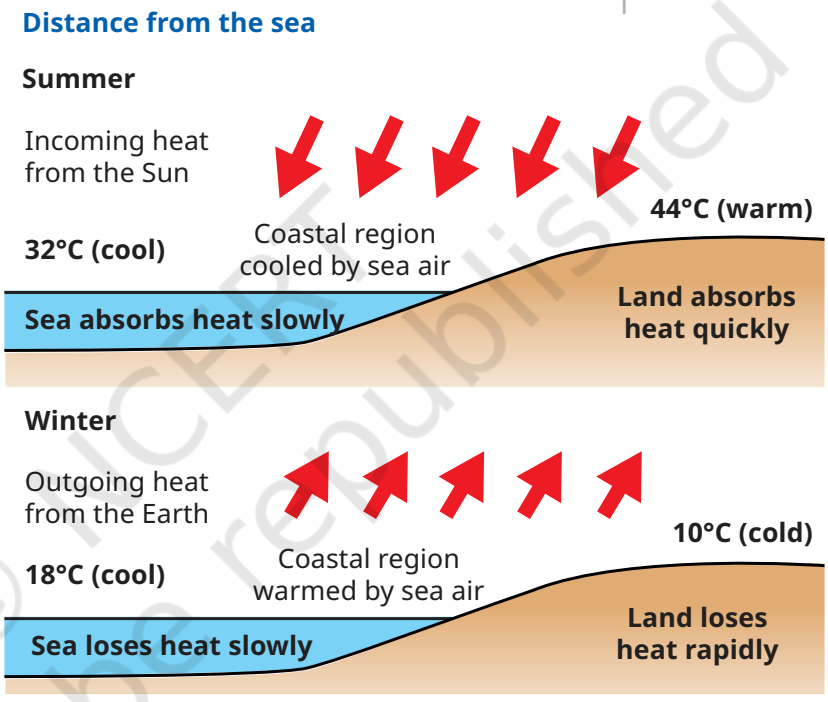


Fig. 3.6

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d) Winds

Wind can move masses of warmer or cooler air. States like Punjab, Haryana, Rajasthan and Madhya Pradesh often receive winds blowing from the west. Having travelled over the deserts of Arabia to Afghanistan, they bring dry and hot air that causes severe heat waves in summer. In winter cold winds from across the Himalayas creep into the Himalayan foothills, resulting in cold waves.

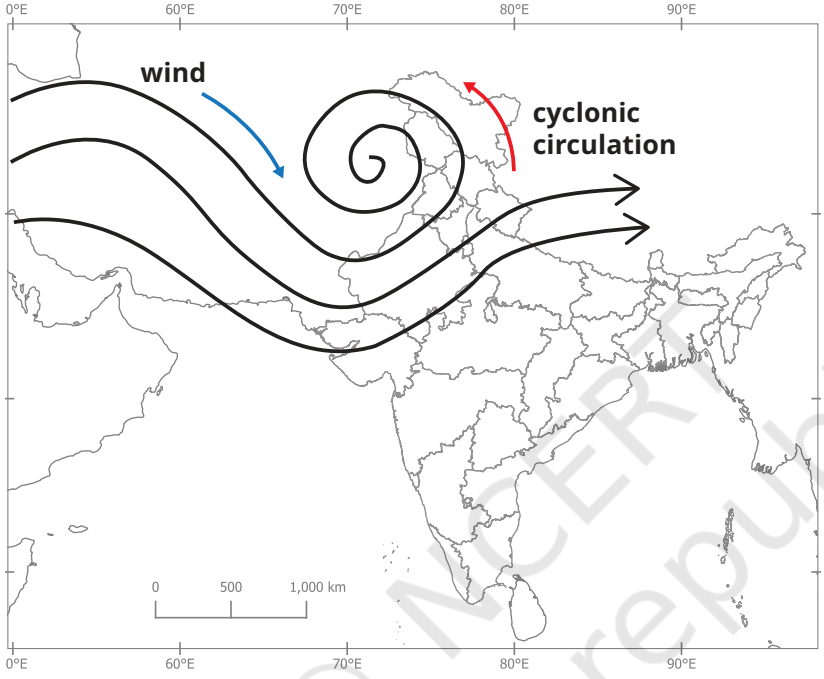


Fig. 3.7

Winds affect not only temperature, but also humidity, and in turn, precipitation. We saw dry winds coming from distant deserts; in contrast, winds coming from the sea bring moisture over the land, which may result in rainfall. We will soon see the case of the monsoon winds.



LET'S REMEMBER

In your Grade 6 Science textbook '*Curiosity*' you studied the water cycle! "The water from the ocean and the Earth's surface evaporates into the atmosphere as vapour and returns as rain, hail or snow...."

Topography: The totality of the physical surface features of an area. This may include mountains, hills, valleys, slopes, coasts, etc.

e) Topography

Finally, the **topography** of a region also plays an important role in determining its climate. For instance, the Himalayas and the Karakoram ranges protect, to some extent, the Indian

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subcontinent from the winds of the cold deserts of Central Asia. The nearly flat topography of the Thar desert, on the other hand, has nothing to protect it from hot and dry winds. In the next section, we will see the role of the Western Ghats in India's southwest monsoon.

Putting it all together...

The climate of any region is determined collectively by all the above factors. Describing the climate involves a description of the patterns of temperature, precipitation (rain or snowfall, occurrence of fog or mist) and wind conditions in a region over three decades or more.

A microclimate is a climate localised in a small area, which differs from the climate in the surrounding region. It has a unique pattern of temperature, humidity, precipitation, etc., in a small geographical area.



Fig. 3.8. Aravallis and urban heat islands

For instance, enclosed valleys and some forests have micro-climates of their own. So do 'urban heat islands', that is, some cities that have a large number of buildings and other concrete structures and very little vegetation; all this traps the heat and they are often much warmer than the surrounding region.

Microclimates can influence the local flora and fauna, the crops grown, and impact human health and well-being.

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The Monsoons

The monsoon season is central to life in India. During the monsoon months, the rivers fill up, the soil is soaked with water, crops grow and life thrives. Strictly speaking, the word 'monsoon', which comes from the Arabic word mausim, meaning 'season', refers to seasonal winds over a large area of the Indian Ocean and surrounding regions, including Australia, Africa and South Asia.

There is a yearly pattern to the monsoons. Their mechanism is complex, but based on the simple fact that land heats up or cools down faster than the ocean. Monsoons bring out the fundamental relationship between temperature, pressure and wind movement.

To put it simply, as summer begins, the Asian landmass heats up, creating a powerful low-pressure system over it. Since air always flows from high pressure to low pressure, winds are drawn from the cooler, high-pressure ocean towards the hot land. These ocean winds carry moisture that condenses over the warmer land and falls in the form of heavy monsoon rains. (That is why 'monsoon' commonly refers to the seasonal rains rather than the winds.)

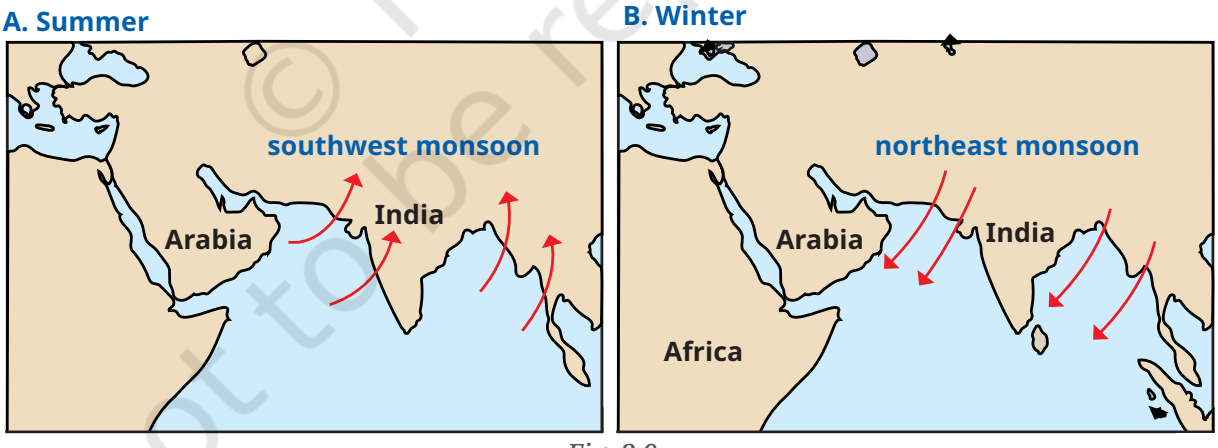


Fig. 3.9

The pattern reverses in winter, when the landmass cools down more rapidly than the ocean. Now the land has a high-pressure system while the ocean remains warmer with relatively lower pressure. This causes the winds to blow in the opposite direction — from the land towards the ocean — bringing dry conditions to much of Asia.

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Coming to India, the monsoon rains typically advance from the southern tip of India in early June, moving northward over several weeks until they cover the entire subcontinent by mid-July. It is not a smooth progression, though the Western Ghats (remember our brief survey of topography) act as a natural barrier; their western slopes receive much rainfall, while the Deccan plateau to the east receive less, and often with interruptions. This is commonly called the summer or southwest monsoon ('southwest' reflecting the direction the winds come from).

As winter approaches, the winds reverse and blow from the land to the ocean, as we just saw. These are dry winds that bring cold weather to south India, but a part of them, passing over the Bay of Bengal, collect some moisture and bring rainfall to parts of east and south India. This is called the winter or northeast monsoon.



DON'T MISS OUT

→ Mawsynram, located in Meghalaya, receives the highest average annual rainfall in the world, about 11,000 mm (which is the same as 11 metres!).



Fig. 3.10.

→ The monsoons have inspired many *ragās* in both Carnatic and Hindustani classical music. *Meghamalhār* and *amruthavarshini* are names of a couple of them.

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LET'S EXPLORE

Since the ability to predict the monsoon rainfall has been an important aspect of life in India, our ancestors observed Nature around them carefully. They developed local traditional knowledge through their experience. This traditional knowledge is an important heritage we must preserve. For example, fishermen on the Konkan coast predict the onset of the monsoon when fishes that normally stay under water are seen at the surface; in parts of southern India monsoon is said to arrive within 50 days after the Golden Shower tree (*Cassia fistula*) blossoms. Some communities also believe that when crows build their nests high on tree-tops, it indicates less rainfall, whereas if the nests are lower, rainfall is likely to be heavy. Make a list of such local knowledge about rain, fog, snow or hail in your area.

Climate and our Lives

Our lives are deeply connected with the climate and dependent on it. The impact of climate is visible in local cultures for instance, and India has many festivals associated with seasons and agricultural activities.



LET'S EXPLORE

Reach out to your grandparents or elders in your neighbourhood. Ask them about the traditional festivals and dances they remember from their childhood and youth, especially those related to agriculture and rain. What rituals did they participate in? Then organise a cultural fest with your friends. You can showcase some of the dances, songs and activities your elders shared with you. Whether it is a dance, harvest ritual, or a simple story about a prayer to rain gods, try to bring these traditions to life for your classmates.

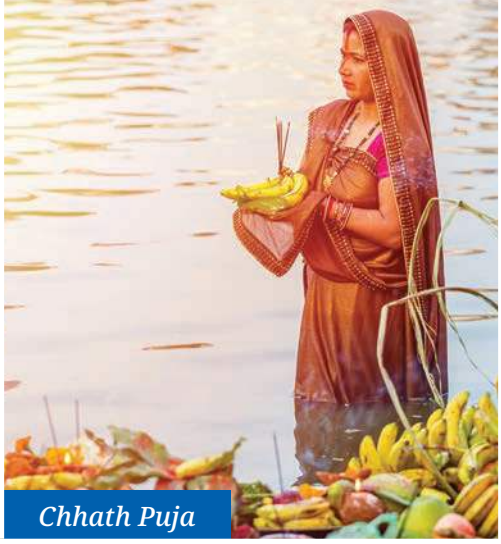
The climate also has a direct impact on the economy. For instance, you may have heard the phrase 'monsoon failure', which refers

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Bihu



Chhath Puja



Makar Sakranti



Baisakhi



Pongal



Awe Winter Festival



Hemis

Fig. 3.11



Losoong festival



Gudi Padwa

Lohri



Onam



to poor rainfall during the monsoon season; in such a case, the agriculture suffers, people (women, generally) have to walk long distances in search of water, and agricultural labourers are likely to migrate to the cities; food (grains, vegetables and fruits, to begin with) becomes costlier, fuelling inflation. Industrial activity also often depends on a predictable weather and the availability of water. The world over, we can easily detect such connections between the climate and socioeconomic conditions. Those conditions get especially strained when climate disasters strike.

Climates and Disasters

India's diverse weather patterns can bring about extreme conditions such as cyclones, floods, landslides and other such climate-related disasters. These events affect people's lives, disrupt agriculture, damage infrastructure and disturb local economies.

a) Cyclones

Every year, the Indian coastline, especially the eastern coast, witness several cyclones. In past years, some of them have been highly destructive, resulting in the loss of human and animal life, damaging property and infrastructure, uprooting trees and causing soil erosion. The India Meteorological Department (IMD) keeps track of coming cyclones and provides information on their formation, evolution, place of landing, etc.



DON'T MISS OUT



Fig. 3.12

The National Disaster Response Force (NDRF) is specially trained to respond to natural as well as human-made disasters. NDRF battalions are located at 12 different locations in India. The NDRF has played a key role in rescue and evacuation during disasters like cyclones, landslides and floods.

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How are cyclones formed? We saw that in some special situations, the atmospheric pressure near the sea becomes lower than the surrounding areas, creating a low-pressure system. This is an invitation to the air from surrounding areas to come into the low-pressure area, and the air from the sea moves in, bringing with it moisture and rain. When the low-pressure system is intense and the wind speeds are high, this may result in a cyclone.

As winds collect moisture, they form clouds and rotate inwards towards the centre of the depression. This centre, which is cloudless, is called 'the eye of the cyclone'.

THINK ABOUT IT

What are clouds? White lumps in the sky, you might say. But what are they made of? The answer is simple—water. But not just any water; clouds are masses of water droplets, ice crystals, or a mixture of both, that are suspended in the atmosphere.

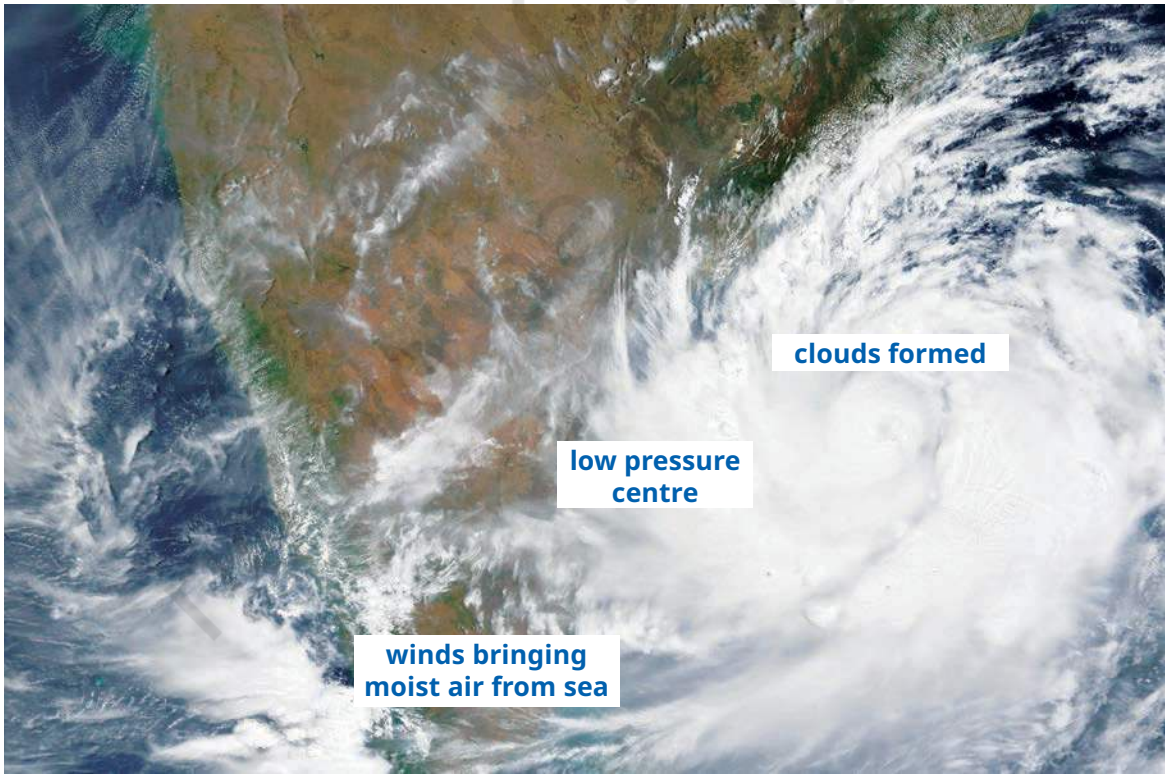


Fig. 3.13. Cyclone Fani

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Fig. 3.14. Eye of the storm

b) Floods

A flood occurs when water overflows into normally dry land. This could be due to heavy rainfall generating huge run-off water that the land cannot absorb, or due to excessive accumulation of water in bodies like rivers and lakes, until the water overflows or their banks are breached. Floods occur frequently during the monsoons. States such as Uttar Pradesh, Bihar, Kerala, Andhra Pradesh and Assam are particularly vulnerable to floods.



LET'S EXPLORE

Have you seen or read about floods? Look at the physical map of India. Discuss in pairs why you think floods occur in the areas mentioned above.

In the Himalayan regions, on the other hand, floods occur when glacial lakes overflow. Glacial lakes form a barrier of rocks and ice to hold their water, which often comes from melting glaciers. If the glaciers melt too fast (as is increasingly the case) or if there is too much rainfall, the build-up of pressure can cause the water

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Fig. 3.15

to break through the barrier — this is called a glacial burst and it often has devastating consequences for people and property.



DON'T MISS OUT

In 2013, Uttarakhand experienced a sudden glacial burst caused by continuous heavy rain over several days. Many landslides followed. Areas around one of India's important sacred sites, the Kedarnath temple, were completely destroyed. Several villages were washed away in the floods, along with many roads and bridges. Altogether about 6,000 people, many of them pilgrims, lost their lives.

Many cities experience flooding when there is heavy rainfall. This may be due to an overburdened drainage system or poorly planned construction encroaching on the waterways and blocking the flow of water. Besides, urban surfaces of concrete or asphalt do not allow water to be absorbed by the earth.

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c) Landslides

A landslide is the sudden collapse of rock, soil, or debris, often triggered by heavy rain, earthquakes or volcanic activity. Landslides are common in hilly and mountainous regions such as Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh, as well as the Western Ghats and hilly regions. These events often occur during the monsoon.

In those regions, the chances of landslides have increased due to human activities such as the cutting down of forests, building infrastructure without following approved methods and the construction of too many buildings that block the natural flow of water.

d) Forest fires

Forest fires are uncontrolled fires that spread rapidly across vegetation, often fuelled by dry climatic conditions, droughts or high winds. Human carelessness is another frequent cause. Forest fires are common in states with large forested or grassland areas such as Uttarakhand, Himachal Pradesh, Madhya Pradesh and Chhattisgarh, as well as mountain ranges such as the Western Ghats. Apart from destroying large areas of forest, fires harm wildlife, degrade the ecosystem, spoil the air quality and displace local communities. The consequences are therefore both environmental and economic.



LET'S EXPLORE

- → Observe Fig. 3.15. Describe the effects they may have on people, plants, animals and economic life.
- → In groups of four or five, identify in each of the above disasters the part of natural causes and the part of human causes. Compare your conclusions.
- → Discuss in the same groups series of preventive measures that could help avoid the above disasters.

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Climate Change

Climate change refers to significant, long-term changes in the climate. This may be on the scale of the planet or on a regional scale, and it involves shifts in temperature, precipitation and weather events. In past millennia (we can go back millions of years, in fact), natural processes drove climate change. Since the 19th century, however, climate change has been largely driven by human activities, particularly the burning of **fossil fuels**, deforestation, environmentally harmful industrial practices, and production and patterns of excessive or wasteful consumption.



Fig. 3.16

Fossil fuels: Sources of energy that were formed from the remains of plants and animals that died millions of years ago and were buried deep under layers of soil and rock or under the sea, where heat and pressure slowly turned them into coal, petroleum oil and natural gas.

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Why does the burning of fossil fuels affect the climate? In the Earth's natural carbon cycle, carbon dioxide (CO_2) and other gases are released gradually into the atmosphere and trap heat from the Sun. This natural 'greenhouse effect' warms Earth enough to support life. However, human activities like industry, transportation, and agriculture have released enormous amounts of these 'greenhouse gases' in just a few centuries. This sudden increase traps extra heat, causing rapid global warming and disrupting the climate patterns that plants, animals, and human societies have adapted to over thousands of years.

In India, rising temperatures are perceptible in many regions. Early in 2025, for instance, the country's average temperature was 1 to 3°C above normal, as a result of which the winter was much shorter and milder than usual. This affects not only agricultural production but also many small-scale industries. This is only one example showing how a warmer planet will present us with increasing challenges.

Understanding the relationship between the causes of climate change and disasters can help us to prepare better for these challenges. It also supports the need for more environment-friendly practices and building **resilience** and adaptation in communities. Governments worldwide, including India's, attempt to promote measures of climate **mitigation**, such as cutting down on greenhouse gas emissions, planting trees, boosting renewable energy and improving energy efficiency, promoting **sustainable** lifestyles, etc. But these often clash with a desire for economic growth and increased consumption.

Resilience: The capacity to withstand or recover quickly from difficulties.

Mitigation: The adoption of steps to help slow down global warming and reduce the causes of climate change.

Sustainable: Something which can be maintained over a long period of time.



Before we move on ...

- India's diverse climate is shaped by its geography, including mountains, deserts, and plateaus.
- Weather is short-term, seasons recur on a yearly basis, and climate reflects long-term patterns over decades.
- Factors such as latitude, altitude, proximity to the sea, wind and topography determine the climate.
- Monsoons are vital for agriculture, influencing crop cycles and livelihoods.

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- Climate is connected with cultural traditions, festivals, agriculture and economic activity.
- Understanding the climate helps prepare for natural disasters like floods and cyclones.
- Climate change leads to extremes of weather or temperature and can have severe consequences on the natural and human worlds.

Questions and activities

1. Match the climatic factors with their effects:

Column A	Column B
(1) Latitude	(a) Brings wet air to India during summer
(2) Altitude	(b) Creates different climates in the north and south
(3) Proximity to the ocean	(c) Keeps higher places cooler
(4) Monsoon winds	(d) Moderates the temperature

2. Answer the following questions:
   a) What is the difference between weather and climate?
   b) Why do places near the ocean have milder temperatures than places far away from it?
   c) What role do monsoon winds play in affecting India's climate?
   d) Why is Chennai warm or hot throughout the year, while Leh is cold?
3. Look at a map of India given at the end of this book. Identify the climate for these cities—Leh, Chennai, Delhi, Panaji and Jaipur.
   - Is the place near the sea, in the mountains, or in the desert?
   - How do these factors affect the climate there?

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4. Draw the monsoon cycle in summers and winters on a map of India.
    - Label where the winds blow in summer and winter
    - Show the direction of winds during the monsoon
5. Make a colourful poster showing festivals in India linked to farming and weather (e.g., Baisakhi, Onam). Add pictures or drawings of these festivals.
6. Imagine you are a farmer in India. Write a short diary entry about how you would prepare for the rainy season.
7. Identify a natural disaster (e.g., cyclone, flood, landslide, or forest fire) and write a short essay that includes the causes and impacts. Suggest actions that individuals, communities and the government can take to reduce the impact.

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