In the last two chapters you have read about the landforms and the drainage of our country. These are the two of the three basic elements that one learns about the natural environment of any area. In this chapter you will learn about the third, that is, the atmospheric conditions that prevail over our country. Climate refers to the sum total of weather conditions and variations over a large area for a long period of time (more than thirty years). Weather refers to the state of the atmosphere over an area at any point of time. The elements of weather and climate are the same, i.e. temperature, atmospheric pressure, wind, humidity and precipitation. You may have observed that the weather conditions fluctuate very often even within a day. But there is some common pattern over a few weeks or months, i.e. days are cool or hot, windy or calm, cloudy or bright, and wet or dry. On the basis of the generalised monthly atmospheric conditions, the year is divided into seasons such as winter, summer or rainy seasons. The climate of India is described as the ‘monsoon’ type. In Asia, this type of climate is found mainly in the south and the southeast. Despite an overall unity in the general pattern, there are perceptible regional variations in climatic conditions within the country. Let us take two important elements – temperature and precipitation, and examine how they vary from place to place and season to season. In summer, the mercury occasionally touches 50°C in some parts of the Rajasthan desert, whereas it may be around 20°C in Pahalgam in Jammu and Kashmir. On a winter night, temperature at Drass in Jammu and Kashmir may be as low as minus 45°C. Thiruvananthapuram, on the other hand, may have a temperature of 22°C. Let us now look at precipitation. There are variations not only in the form and types of precipitation but also in its amount and the seasonal distribution. While precipitation is mostly in the form of snowfall in the upper parts of Himalayas, it rains over the rest of the country. The annual precipitation varies from over 400 cm in Meghalaya to less than 10 cm in Ladakh and western Rajasthan. Most parts of the country receive rainfall from June to September. But some parts like the Tamil Nadu coast gets a large portion of its rain during October and November. In general, coastal areas experience less contrasts in temperature conditions. Seasonal contrasts are more in the interior of the country. There is decrease in rainfall generally from east to west in the Northern Plains. These variations have given rise to variety in lives of people – in terms of the food they eat, the clothes they wear and also the kind of houses they live in. There are six major controls of the climate of any place. They are: latitude, altitude, pressure and wind system, distance from the sea (continentality), ocean currents and relief features. Due to the curvature of the earth, the amount of solar energy received varies according to latitude. As a result, air temperature generally decreases from the equator towards the poles. As one goes from the surface of the earth to higher altitudes, the atmosphere becomes less dense and temperature decreases. The hills are therefore cooler during summers. The pressure and wind system of any area depend on the latitude and altitude of the place. Thus it influences the temperature and rainfall pattern. The sea exerts a moderating influence on climate: As the distance from the sea increases, its moderating influence decreases and the people experience extreme weather conditions. This condition is known as continentality (i.e. very hot during summers and very cold during winters). Ocean currents along with onshore winds affect the climate of the coastal areas, For example, any coastal area with warm or cold currents flowing past it, will be warmed or cooled if the winds are onshore. Finally, relief too plays a major role in determining the climate of a place. High mountains act as barriers for cold or hot winds; they may also cause precipitation if they are high enough and lie in the path of rain-bearing winds. The leeward side of mountains remains relatively dry. The Tropic of Cancer passes through the middle of the country from the Rann of Kuchchh in the west to Mizoram in the east. Almost half of the country, lying south of the Tropic of Cancer, belongs to the tropical area. All the remaining area, north of the Tropic, lies in the sub-tropics. Therefore, India’s climate has characteristics of tropical as well as subtropical climates. India has mountains to the north, which have an average height of about 6,000 metres. India also has a vast coastal area where the maximum elevation is about 30 metres. The Himalayas prevent the cold winds from Central Asia from entering the subcontinent. It is because of these mountains that this subcontinent experiences comparatively milder winters as compared to central Asia. The climate and associated weather conditions in India are governed by the following atmospheric conditions: Pressure and surface winds; Upper air circulation; and Western cyclonic disturbances and troical cyclones. India lies in the region of north easterly winds. These winds originate from the subtropical high-pressure belt of the northern hemisphere. They blow southwards, get deflected to the right due to the Coriolis force, and move towards the equatorial low-pressure area. Generally, these winds carry little moisture as they originate and blow over land. Therefore, they bring little or no rain. Hence, India should have been an arid land, but it is not so. The pressure and wind conditions over India are unique. During winter, there is a high-pressure area north of the Himalayas. Cold dry winds blow from this region to the low-pressure areas over the oceans to the south. In summer, a low-pressure area develops over interior Asia, as well as, over northwestern India. This causes a complete reversal of the direction of winds during summer. Air moves from the high-pressure area over the southern Indian Ocean, in a south-easterly direction, crosses the equator, and turns right towards the low-pressure areas over the Indian subcontinent. These are known as the Southwest Monsoon winds. These winds blow over the warm oceans, gather moisture and bring widespread rainfall over the mainland of India. The upper air circulation in this region is dominated by a westerly flow. An important component of this flow is the jet stream. These jet streams are located approximately over 27°-30° north latitude, therefore, they are known as subtropical westerly jet streams. Over India, these jet streams blow south of the Himalayas, all through the year except in summer. The western cyclonic disturbances experienced in the north and north-western parts of the country are brought in by this westerly flow. In summer, the subtropical westerly jet stream moves north of the Himalayas with the apparent movement of the sun. An easterly jet stream, called the sub-tropical easterly jet stream blows over peninsular India, approximately over 14°N during the summer months. The climate of India is strongly influenced by monsoon winds. The sailors who came to India in historic times were one of the first to have noticed the phenomenon of the monsoon. They benefited from the reversal of the wind system as they came by sailing ships at the mercy of winds. The Arabs, who had also come to India as traders named this seasonal reversal of the wind system ‘monsoon’. The monsoons are experienced in the tropical area roughly between 20° N and 20° S. To understand the mechanism of the monsoons, the following facts are important. The differential heating and cooling of land and water creates low pressure on the landmass of India while the seas around experience comparatively high pressure. The shift of the position of Inter Tropical Convergence Zone (ITCZ) in summer, over the Ganga plain (this is the equatorial trough normally positioned about 5°N of the equator. It is also known as the monsoontrough during the monsoon season). The presence of the high-pressure area, east of Madagascar, approximately at 20°S over the Indian Ocean. The intensity and position of this high-pressure area affects the Indian Monsoon. The Tibetan plateau gets intensely heated during summer, which results in strong vertical air currents and the formation of low pressure over the plateau at about 9 km above sea level. The movement of the westerly jet stream to the north of the Himalayas and the presence of the tropical easterly jet stream over the Indian peninsula during summer. Apart from this, it has also been noticed that changes in the pressure conditions over the southern oceans also affect the monsoons. Normally when the tropical eastern south Pacific Ocean experiences high pressure, the tropical eastern Indian Ocean experiences low pressure. But in certain years, there is a reversal in the pressure conditions and the eastern Pacific has lower pressure in comparison to the eastern Indian Ocean. This periodic change in pressure conditions is known as the Southern Oscillation or SO. The difference in pressure over Tahiti (Pacific Ocean, 18°S/149°W) and Darwin in northern Australia (Indian Ocean, 12°30’S/131°E) is computed to predict the intensity of the monsoons. If the pressure differences were negative, it would mean below average and late monsoons. A feature connected with the SO is the El Nino phenomenon in which a warm ocean current that flows past the Peruvian Coast, in place of the cold Peruvian current, every 2 to 5 years. The changes in pressure conditions are connected to the El Nino. Hence, the phenomenon is referred to as ENSO (El Nino Southern Oscillations). The Monsoon, unlike the trades, are not steady winds but are pulsating in nature, affected by different atmospheric conditions encountered by it, on its way over the warm tropical seas. The duration of the monsoon is between 100- 120 days from early June to mid-September. Around the time of its arrival, the normal rainfall increases suddenly and continues constantly for several days. This is known as the ‘burst’ of the monsoon, and can be distinguished from the pre-monsoon showers. The monsoon arrives at the southern tip of the Indian peninsula generally by the first week of June. Subsequently, it proceeds into two – the Arabian Sea branch and the Bay of Bengal branch. The Arabian Sea branch reaches Mumbai about ten days later on approximately the 10th of June. This is a fairly rapid advance. The Bay of Bengal branch also advances rapidly and arrives in Assam in the first week of June. The lofty mountains causes the monsoon winds to deflect towards the west over the Ganga plains. By mid-June the Arabian Sea branch of the monsoon arrives over Saurashtra-Kuchchh and the central part of the country. The Arabian Sea and the Bay of Bengal branches of the monsoon merge over the northwestern part of the Ganga plains. Delhi generally receives the monsoon showers from the Bay of Bengal branch by the end of June (tentative date is 29th of June). By the first week of July, western Uttar Pradesh, Punjab, Haryana and eastern Rajasthan experience the monsoon. By mid-July, the monsoon reaches Himachal Pradesh and the rest of the country Withdrawal or the retreat of the monsoon is a more gradual process (Figure 4.4). The withdrawal of the monsoon begins in northwestern states of India by early September. By mid-October, it withdraws completely from the northern half of the peninsula. The withdrawal from the southern half of the peninsula is fairly rapid. By early December, the monsoon has withdrawn from the rest of the country. The islands receive the very first monsoon showers, progressively from south to north, from the last week of April to the first week of May. The withdrawal, takes place progressively from north to south from the first week of December to the first week of January. By this time the rest of the country is already under the influence of the winter monsoon. The monsoon type of climate is characterised by a distinct seasonal pattern. The weather conditions greatly change from one season to the other. These changes are particularly noticeable in the interior parts of the country. The coastal areas do not experience much variation in temperature though there is variation in rainfall pattern. Four main seasons can be identified in India – the cold weather season, the hot weather season, the advancing monsoon and the retreating monsoon with some regional variations. The cold weather season begins from mid- November in northern India and stays till February. December and January are the coldest months in the northern part of India. The temperature decreases from south to the north. The average temperature of Chennai, on the eastern coast, is between 24° – 25° Celsius, while in the northern plains, it ranges between 10°C and 15° Celsius. Days are warm and nights are cold. Frost is common in the north and the higher slopes of the Himalayas experience snowfall. During this season, the northeast trade winds prevail over the country. They blow from land to sea and hence, for most part of the country, it is a dry season. Some amount of rainfall occurs on the Tamil Nadu coast from these winds as, here they blow from sea to land. In the northern part of the country, a feeble high-pressure region develops, with light winds moving outwards from this area. Influenced by the relief, these winds blow through the Ganga valley from the west and the northwest. The weather is normally marked by clear sky, low temperatures and low humidity and feeble, variable winds. A characteristic feature of the cold weather season over the northern plains is the inflow of cyclonic disturbances from the west and the northwest. These low-pressure systems, originate over the Mediterranean Sea and western Asia and move into India, along with the westerly flow. They cause the much-needed winter rains over the plains and snowfall in the mountains. Although the total amount of winter rainfall locally known as ‘mahawat’ is small, they are of immense importance for the cultivation of ‘rabi’ crops. The peninsular region does not have a welldefined cold season. There is hardly any noticeable seasonal change in temperature pattern during winters due to the moderating influence of the sea. Due to the apparent northward movement of the sun, the global heat belt shifts northwards. As such, from March to May, it is hot weather season in India. The influence of the shifting of the heat belt can be seen clearly from temperature recordings taken during March-May at different latitudes. In March, the highest temperature is about 38° Celsius, recorded on the Deccan plateau. In April, temperatures in Gujarat and Madhya Pradesh are around 42° Celsius. In May, temperature of 45° Celsius is common in the northwestern parts of the country. In peninsular India, temperatures remain lower due to the moderating influence of the oceans. The summer months experience rising temperature and falling air pressure in the northern part of the country. Towards the end of May, an elongated low-pressure area develops in the region extending from the Thar Desert in the northwest to Patna and Chotanagpur plateau in the east and southeast. Circulation of air begins to set in around this trough. A striking feature of the hot weather season is the ‘loo’. These are strong, gusty, hot, dry winds blowing during the day over the north and northwestern India. Sometimes they even continue until late in the evening. Direct exposure to these winds may even prove to be fatal. Dust storms are very common during the month of May in northern India. These storms bring temporary relief as they lower the temperature and may bring light rain and cool breeze. This is also the season for localised thunderstorms, associated with violent winds, torrential downpours, often accompanied by hail. In West Bengal, these storms are known as the ‘Kaal Baisakhi’. Towards the close of the summer season, pre-monsoon showers are common especially, in Kerala and Karnataka. They help in the early ripening of mangoes, and are often referred to as ‘mango showers’. By early June, the low-pressure condition over the northern plains intensifies. It attracts, the trade winds of the southern hemisphere. These south-east trade winds originate over the warm subtropical areas of the southern oceans. They cross the equator and blow in a southwesterly direction entering the Indian peninsula as the south-west monsoon. As these winds blow over warm oceans, they bring abundant moisture to the subcontinent. These winds are strong and blow at an average velocity of 30 km per hour. With the exception of the extreme north-west, the monsoon winds cover the country in about a month. The inflow of the south-west monsoon into India brings about a total change in the weather. Early in the season, the windward side of the Western Ghats receives very heavy rainfall, more than 250 cm. The Deccan Plateau and parts of Madhya Pradesh also receive some amount of rain in spite of lying in the rain shadow area. The maximum rainfall of this season is received in the north-eastern part of the country. Mawsynram in the southern ranges of the Khasi Hills receives the highest average rainfall in the world. Rainfall in the Ganga valley decreases from the east to the west. Rajasthan and parts of Gujarat get scanty rainfall. Another phenomenon associated with the monsoon is its tendency to have ‘breaks’ in rainfall. Thus, it has wet and dry spells. In other words, the monsoon rains take place only for a few days at a time. They are interspersed with rainless intervals. These breaks in monsoon are related to the movement of the monsoon trough. For various reasons, the trough and its axis keep on moving northward or southward, which determines the spatial distribution of rainfall. When the axis of the monsoon trough lies over the plains, rainfall is good in these parts. On the other hand, whenever the axis shifts closer to the Himalayas, there are longer dry spells in the plains, and widespread rain occur in the mountainous catchment areas of the Himalayan rivers. These heavy rains bring in their wake, devastating floods causing damage to life and property in the plains. The frequency and intensity of tropical depressions too, determine the amount and duration of monsoon rains. These depressions form at the head of the Bay of Bengal and cross over to the mainland. The depressions follow the axis of the “monsoon trough of low pressure”. The monsoon is known for its uncertainties. The alternation of dry and wet spells vary in intensity, frequency and duration. While it causes heavy floods in one part, it may be responsible for droughts in the other. It is often irregular in its arrival and its retreat. Hence, it sometimes disturbs the farming schedule of millions of farmers all over the country. During October-November, with the apparent movement of the sun towards the south, the monsoon trough or the low-pressure trough over the northern plains becomes weaker. This is gradually replaced by a high-pressure system. The south-west monsoon winds weaken and start withdrawing gradually. By the beginning of October, the monsoon withdraws from the Northern Plains. The months of October-November form a period of transition from hot rainy season to dry winter conditions. The retreat of the monsoon is marked by clear skies and rise in temperature. While day temperatures are high, nights are cool and pleasant. The land is still moist. Owing to the conditions of high temperature and humidity, the weather becomes rather oppressive during the day. This is commonly known as ‘October heat’. In the second half of October, the mercury begins to fall rapidly in northern India. The low-pressure conditions, over northwestern India, get transferred to the Bay of Bengal by early November. This shift is associated with the occurrence of cyclonic depressions, which originate over the Andaman Sea. These cyclones generally cross the eastern coasts of India cause heavy and widespread rain. These tropical cyclones are often very destructive. The thickly populated deltas of the Godavari, the Krishna and the Kaveri are frequently struck by cyclones, which cause great damage to life and property. Sometimes, these cyclones arrive at the coasts of Odisha, West Bengal and Bangladesh. The bulk of the rainfall of the Coromandel Coast is derived from depressions and cyclones. Parts of western coast and northeastern India receive over about 400 cm of rainfall annually. However, it is less than 60 cm in western Rajasthan and adjoining parts of Gujarat, Haryana and Punjab. Rainfall is equally low in the interior of the Deccan plateau, and east of the Sahyadris. A third area of low precipitation is around Leh in Jammu and Kashmir. The rest of the country receives moderate rainfall. Snowfall is restricted to the Himalayan region. Owing to the nature of monsoons, the annual rainfall is highly variable from year to year. Variability is high in the regions of low rainfall, such as parts of Rajasthan, Gujarat and the leeward side of the Western Ghats. As such, while areas of high rainfall are liable to be affected by floods, areas of low rainfall are drought-prone. You have already known the way the Himalayas protect the subcontinent from extremely cold winds from central Asia. This enables northern India to have uniformly higher temperatures compared to other areas on the same latitudes. Similarly, the Peninsular plateau, under the influence of the sea from three sides, has moderate temperatures. Despite such moderating influences, there are great variations in the temperature conditions. Nevertheless, the unifying influence of the monsoon on the Indian subcontinent is quite perceptible. The seasonal alteration of the wind systems and the associated weather conditions provide a rhythmic cycle of seasons. Even the uncertainties of rain and uneven distribution are very much typical of the monsoons. The Indian landscape, its animal and plant life, its entire agricultural calendar and the life of the people, including their festivities, revolve around this phenomenon. Year after year, people of India from north to south and from east to west, eagerly await the arrival of the monsoon. These monsoon winds bind the whole country by providing water to set the agricultural activities in motion. The river valleys which carry this water also unite as a single river valley unit.