

Waiting for the Rains: The Effects of Monsoons in South Asia

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Introduction

Every June, all of India looks to the sky. When the rains come late, people begin to worry. Indian astrologers call this time of the year *rohini*—a time when hot, dry winds swirl dust across the parched plains. Women in rural areas might have to walk for miles in 115°F heat to the nearest water source, sometimes collapsing from heat exhaustion.

As one blazing day follows another, farmers throughout India pray for rain. Rain is critical for agriculture in India, which accounts for roughly 15 percent of the country's economy, and employs over half of the country's 1.3 billion population. Even animals in the region crave the rains, like the crocodiles of northern India. These animals can only lay their eggs in flooded, moist riverbanks.

Expectations build as the skies finally darken, heralding the arrival of **monsoons**. These strong and violent seasonal winds blow in from the ocean each summer, carrying clouds heavy with moisture. Almost all of the rain that South Asia receives each year is from these summer storms. Each year, the region celebrates as sheets of rain pound the dry land.

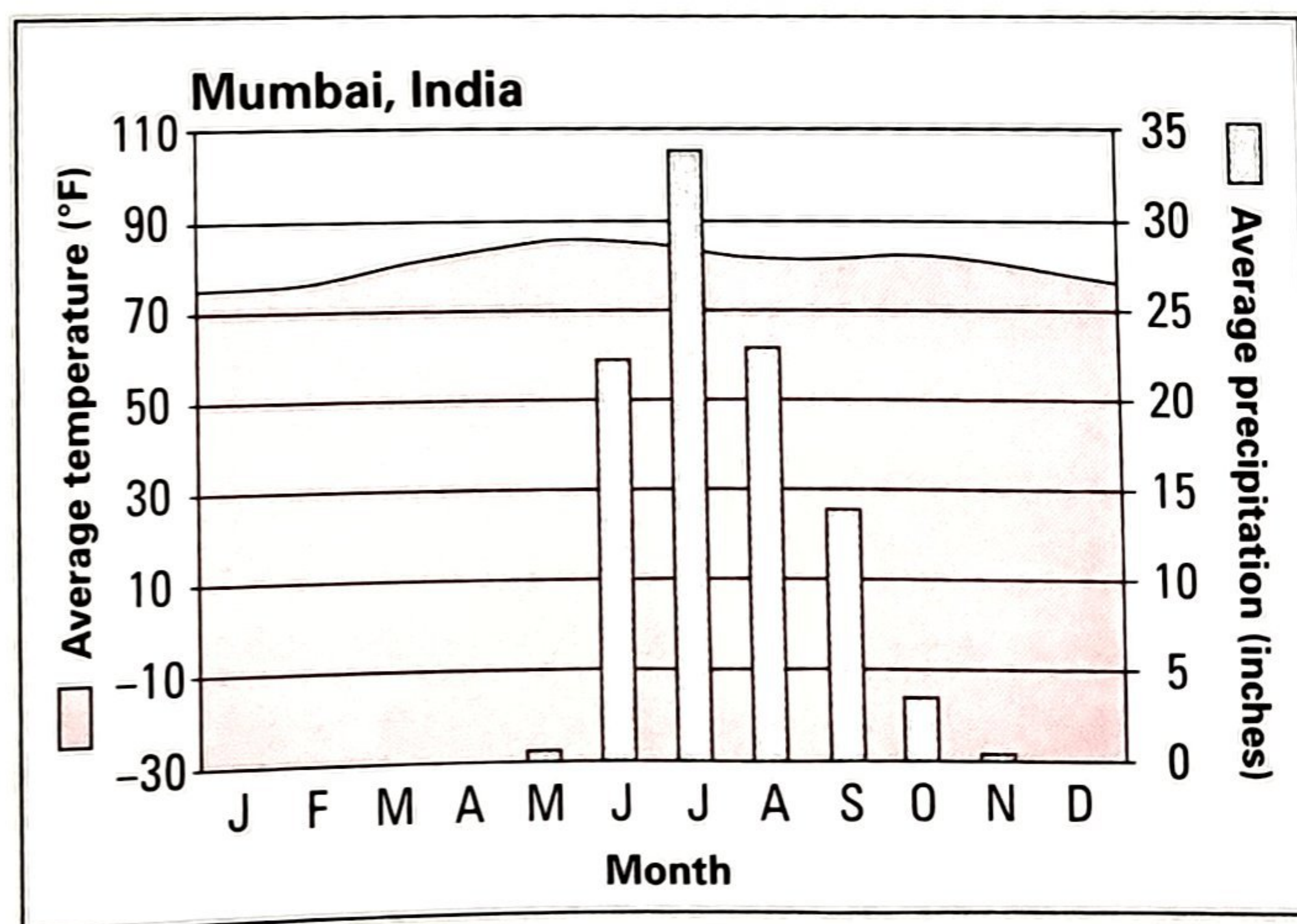
In this lesson, you will find out why the monsoons blow across South Asia each year, and you will explore how monsoons affect the **climate** of four cities in this **region**. Finally, you will discover how people in these cities adapt to waiting for the rains each year.

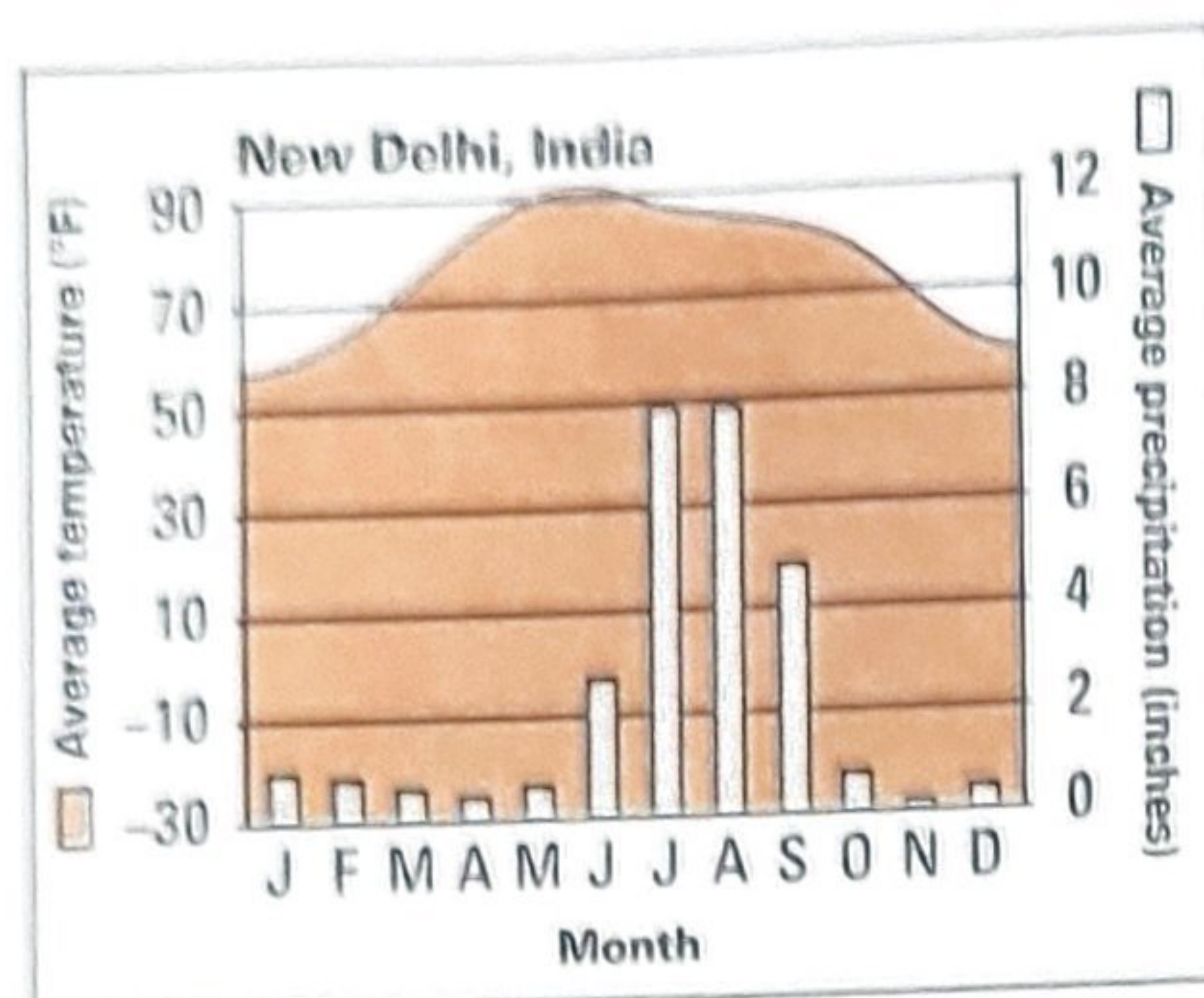
Essential Question

How does climate influence human activity in a region?

This climagraph shows average monthly temperatures and precipitation in the city of Mumbai, India. Notice the bars. They show the average precipitation for each month. Also notice the line. It shows average monthly temperatures in the city. Keep this climagraph in mind as you try to answer the Essential Question.

Graphic Organizer





New Delhi's Monsoon Climate

Monsoon winds affect the climate of New Delhi, the capital of India. The city sits on the edge of the Thar Desert in northern India. From October to May, it stays mostly cold and dry. During the summer monsoon months, rain can drench the city.

1. The Geographic Setting

South Asia juts out into the Indian Ocean like a giant triangle, forming a very large **peninsula** that is also known as the Indian subcontinent. The Himalaya mountain range cuts this subcontinent off from the rest of Central Asia. One out of every four people on Earth lives in South Asia. Most of them are farmers who annually anticipate the monsoons.

Changes in Atmospheric Pressure Create Monsoons Have you ever heard a weather forecaster mention areas of high or low pressure? These terms refer to high or low **atmospheric pressure**, which is the weight of the **atmosphere** pressing down upon the surface of Earth. Falling cool air creates areas of high pressure, while rising warm air creates areas of low pressure.

In a high-pressure area, cool air from the upper atmosphere presses down toward Earth's surface and, in the process, causes atmospheric pressure to increase. With this downward pressure, very little surface air can rise into the upper atmosphere to form clouds. High pressure generally means sunny days and no rain. The opposite happens within a low-pressure area, where warm surface air moves easily into the upper atmosphere. If this air is moist, it forms clouds that bring rain.

Air from high-pressure areas will naturally flow into low-pressure areas. This movement of air creates wind. During the spring and summer months, the air over the South Asian landmass warms up faster than the air over the Indian Ocean. As this hot air rises, it creates a low-pressure area. As a result, the cool, moist air that is over the Indian Ocean flows into the area of low pressure. This movement of air creates the summer monsoons.

During the fall and winter months, the air over South Asia cools and sinks, forming an area of high pressure. This high-pressure area keeps the moist air from the summer monsoons far out to sea. From October to March, only a small amount of rain falls throughout South Asia. During this long dry period, South Asians must manage dusty fields and dwindling water sources.

Mountain Ranges Create Rain Shadows Mountains affect where summer storms will drop their moisture. A mountain slope facing **upwind**, or against the direction of the monsoon winds, generally receives a large amount of rain. In contrast, a slope facing **downwind**, or in the same direction the wind is blowing, will receive far less rain. Geographers call the impact that mountains have on rainfall patterns the **orographic effect**.

The orographic effect works this way. When clouds blow up against mountains, the moist air rises up along the slopes of the mountains. As the air rises, it gradually cools. Since cooling air cannot hold as much moisture as warm air, the clouds release their moisture as **precipitation**—either rain or snow.

After the clouds have crossed over the mountains, little moisture remains in them. Consequently, people living on the downwind side of the mountains receive very little rainfall. This dry area is called a **rain shadow**. People living in a rain shadow have to adapt to life with little rain.

Geoterms

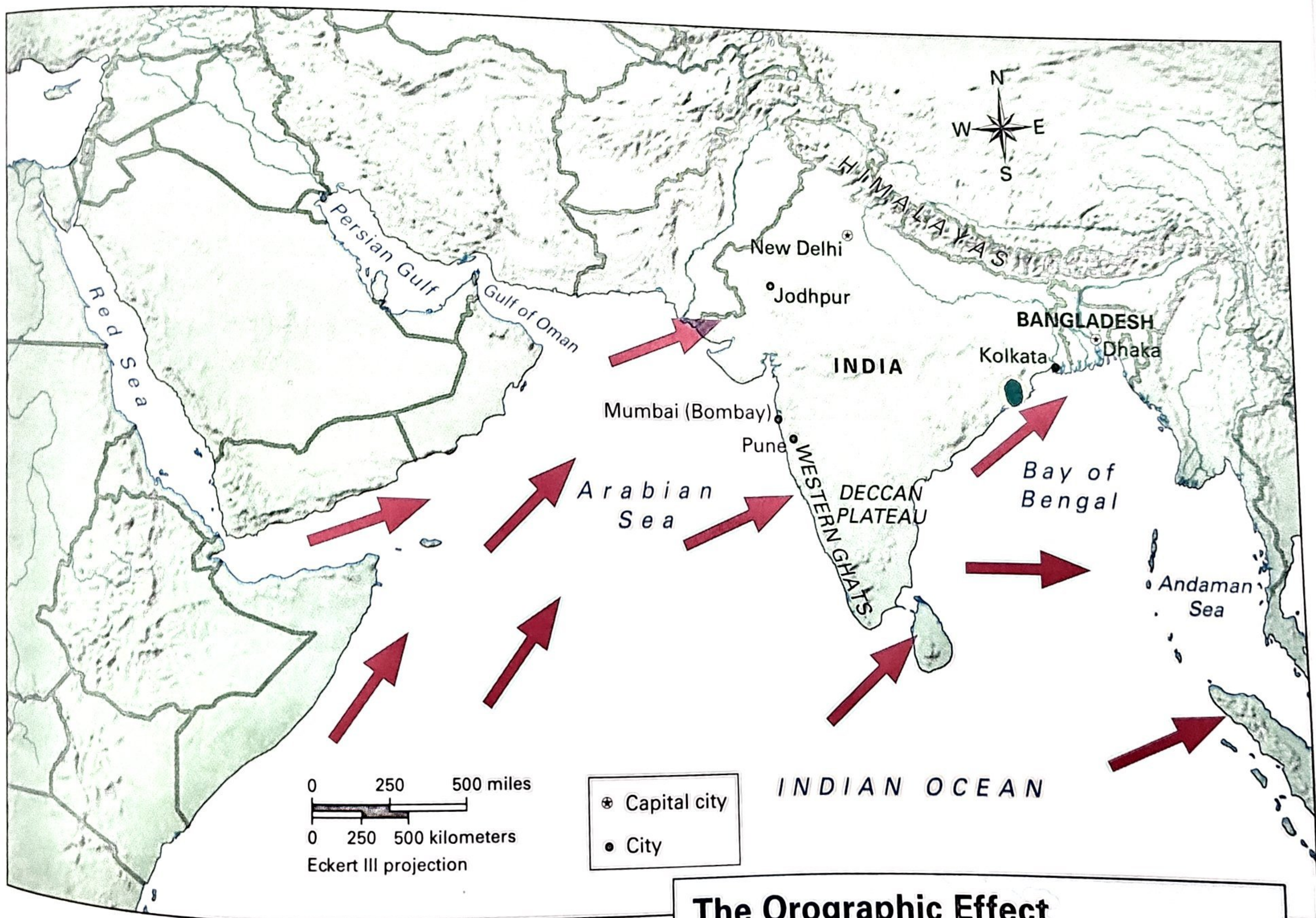
atmospheric pressure the weight of the atmosphere pressing down on any point of the surface of Earth. Air sinks in high-pressure areas, and few clouds form. Air rises in low-pressure areas to form clouds that produce rain.

monsoon a seasonal wind. Summer monsoon winds in South Asia usually bring rain to that region.

orographic effect the precipitation that occurs when moist air rises up the side of a mountain. As the air rises, it cools down and releases most of its moisture as rain or snow.

rain shadow a dry area on the downwind side of a mountain

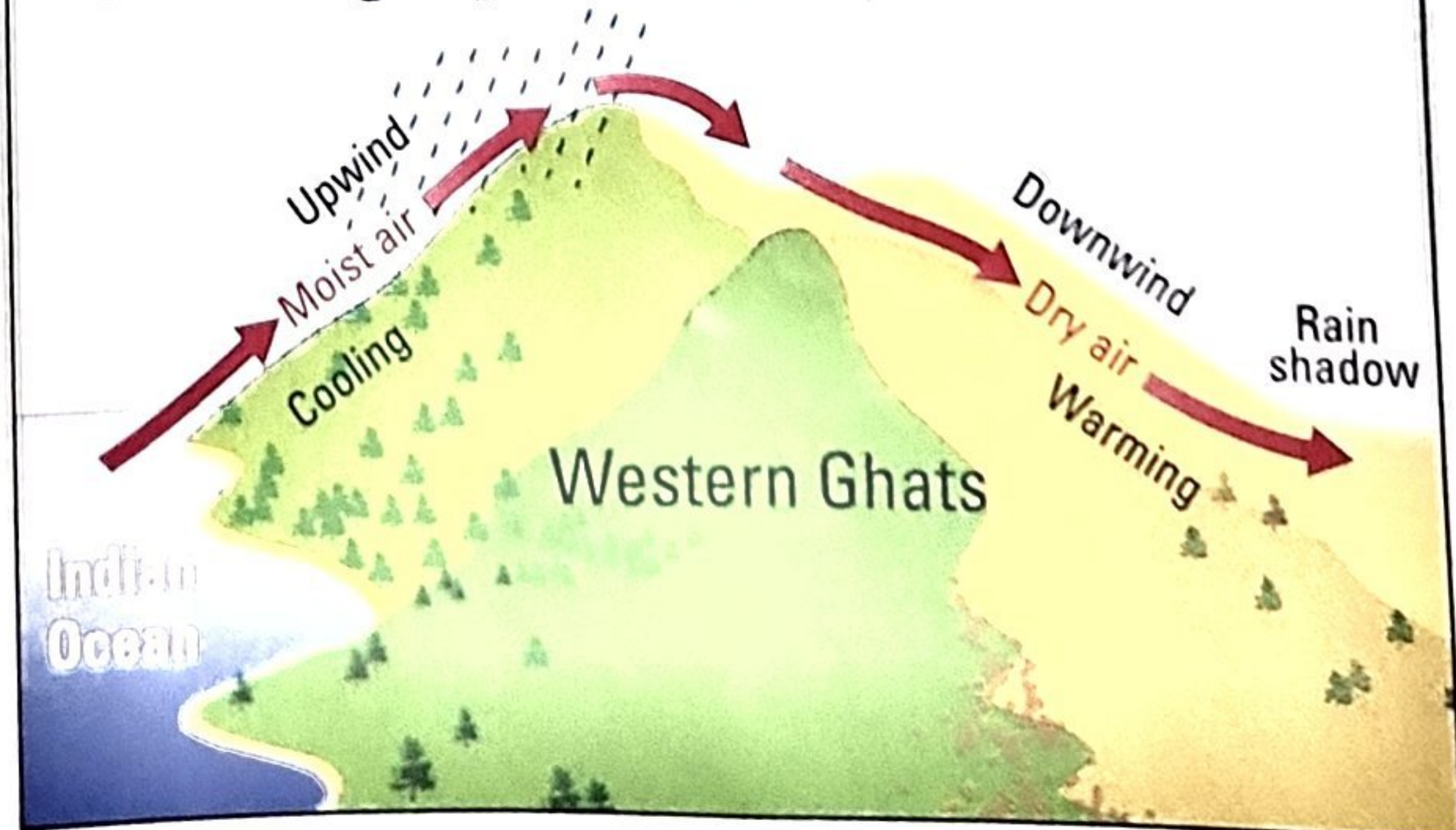
South Asia's Summer Monsoons



Monsoons and Mountains

Summer monsoon winds carry moist air from the Indian Ocean. These winds strike the Western Ghat mountain range in western India. As air rises, it cools and drops its moisture as rain. Cities on the upwind side of the mountains receive plenty of rainfall. Cities on the downwind side, in the rain shadow, receive relatively little.

The Orographic Effect



2. The Wet Months in Dhaka, Bangladesh

About 17 million people live in Dhaka, the capital city of Bangladesh. For the residents of Dhaka, the summer months can be difficult. In summer 1996, the homes of approximately 3 million people were flooded. Two years later, about 1,500 people perished during summer floods. Their deaths were attributed to everything from drowning to disease. In summer 2017, severe rains left much of Dhaka under water.

One of the World's Wettest Capitals Most of Bangladesh lies on a river **delta** that seldom rises more than 30 feet above sea level. Rice, a crop that grows best in warm, shallow water, thrives here. In the summer, monsoon rains often raise the rivers to dangerously high levels. When the rivers flood, it is difficult for rice crops to survive.

Dhaka, which is located in the center of Bangladesh, has one of the wettest climates on Earth. Up to 80 inches of rain falls there each year, with most of this rain coming during the summer months. From November to April, the weather is mostly dry.

Flooding is not Dhaka's only problem. In addition, Bangladesh is often pounded by **tropical cyclones**, otherwise known as hurricanes. Because Dhaka is situated at sea level, the city is often lashed by high winds and waves during these violent storms.

Life Depends on the Rains Bangladesh's economy depends on agriculture. Nearly half of the country's population farms the country's rich delta soil, relying on the monsoon rains to water their fields. When the summer rains are late, crops like rice, sugarcane, tea, and tobacco suffer. Sometimes the monsoons bring too much rain too quickly, flooding the fields. The deep water makes it impossible to plant and harvest the crops.

The city of Dhaka also suffers from too much rain. When the city's streets flood, car and bus traffic comes to a halt. Schools and businesses close down because no one can get to work. Meanwhile, floodwaters pollute the city's drinking water supply, creating conditions in which disease spreads rapidly. Children growing up in Dhaka learn that the same rains that cultivate life in the fields can also end life in the city.

Preparing for the Rain

The people of Dhaka expect flooding when the summer rains arrive. One way they have adapted is by raising their homes up on stilts. A raised home is not convenient most of the year, when everything has to be carried up and down stairs or ladders. During the flooding months, however, raised homes can save lives.





The Blue City Beneath the Fort

The Mehrangarh Fort was built in 1459. It sits on a tall hill overlooking Jodhpur. Because the buildings of this city are painted blue, Jodhpur has earned the nickname the Blue City.

3. The Dry Months of Jodhpur, India

The Mehrangarh Fort rises out of the **desert** like a towering giant, looking down on the “Blue City” of Jodhpur, India. The city gets its nickname from the fact that most of the houses are painted blue. Some people say that this color is used to keep away mosquitoes or termites. In July 2002, nearly half of Jodhpur’s crops could not be planted because the summer monsoons were late, starting the worst **drought** in more than 40 years.

A City on the Edge of a Desert Jodhpur sits at the eastern edge of the Thar Desert in northern India. This region is a leading producer of cattle, spices, and grains. It has a typically **semiarid** climate, with hot, dry weather throughout most of the year.

The people living in and around Jodhpur are accustomed to their semiarid climate. In most years, the city receives less than 20 inches of rain. The average temperatures do not drop below 60°F, even in the winter. Summer monsoons bring much-needed rains from June to September.

Water Is a Critical Resource Approximately half of the people living in Jodhpur work in agriculture, but farming is difficult in this dry region. The desert soil requires a great amount of water to produce crops, and farmers depend on the monsoons for that water. Every year, people wonder how much rain will come and when will it arrive.

The rains come late in some years. Sometimes too little rain falls, resulting in crop failures and shortages of drinking water. Families that run out of food sometimes survive by eating *samas*, a wild grass. As people grow weak from hunger, disease spreads more easily.

The people of Jodhpur have learned to adapt to their semiarid climate. In addition to growing crops, many farmers raise livestock, which can survive on native plants when crops fail. To conserve water, some farmers have begun to use drip irrigation, in which water drips directly onto a plant’s roots. With the use of this irrigation method, little water is wasted as **runoff** or to **evaporation**. This careful use of water makes sense in Jodhpur, where every drop counts.



The Dry Plains Near Jodhpur

Water is a luxury in the area around Jodhpur. Women must sometimes walk miles in scorching heat to fetch drinking water for their families. Wind can pick up the thin dust on the arid plains, creating dust storms. These dust storms are common before the summer monsoons.

Life Continues Despite Floods
Monsoon rains often fill the streets of Kolkata. Buses and cars can't drive through flooded streets, but rickshaws can. A rickshaw is a small cart with two or three wheels. It is pulled by someone who walks or bicycles in front of it. Rickshaw drivers are highly valued during the summer monsoon season.



4. Waiting for the Rains in Kolkata, India

Kolkata is a city of contrasts that has been described as both the “City of Joy” and the “Dying City.” Its modern skyscrapers tower over the muddy Hooghly River, which is a branch of the Ganges River. When the monsoons come during the month of June, the river floods. After a rain shower or two, Kolkata finds itself knee-deep, or even neck-deep, in water.

Wet Summers and Dry Winters Around 12 million people call Kolkata home. About one-third of the city's residents live in **slums**.

The city's winters are dry and pleasant, with moderate winds blowing in from the north. From June to September, the winds shift directions, as the moist monsoon air blows in from the Indian Ocean. The monsoons can dump nearly 50 inches of rain on the city in only four months, and temperatures can soar to 100°F. In this way, these summer rains present a great challenge to the people of Kolkata.

Monsoon Rains Begin and End Life Kolkata floods easily. The city's old canals overflow quickly when rainwater fills the streets, and buses and taxis can't navigate the flooded roads. Children must wade to school through waist-high water and spend the day in wet clothing. Nevertheless, the monsoon rains are welcome because the farmers need the rain to water their crops. The rains also provide relief from the sticky summer heat.

Kolkata has found ways to deal with the summer floods. In the past, a system of canals drained floodwater out of the city. This system was later abandoned in favor of modern streets and sewers, but when too much rain falls, garbage clogs the old canals. Standing water in the flooded streets breeds mosquitoes. Diseases that are carried by mosquitoes, such as malaria, then spread quickly, causing people to get sick or die.

Today, officials in Kolkata are working to rebuild the city's antiquated canals to help with the flooding. Sewer lines are being repaired so that they can carry more water during storms. The city is also working to keep the river clear of debris so that more water can drain downstream during heavy rains.

5. Living in the Rain Shadow: Pune, India

The city of Pune, located on the Deccan Plateau in western India, is less than 100 miles from Mumbai—a short two-hour drive. Yet, Mumbai receives at least 70 inches of rain during the summer monsoons. In contrast, precipitation in Pune often totals less than 30 inches for the entire year.

A Year-Round Dry Climate Between Mumbai and Pune lies part of a mountain range known as the Western Ghats. As the monsoon winds rise up the slopes of these mountains, the air cools and releases its moisture. By the time the monsoon winds reach the downwind side of the mountains, the air retains very little moisture.

Pune sits in a rain shadow on the opposite side of the Western Ghats from Mumbai. While the coastal city of Mumbai must prepare for heavy rain, Pune is spared from flooding. For the majority of the year, the air is dry and pleasant, and the monsoons bring welcome rains from about June to September.

Limited Rainfall Makes Water Precious The people of Pune have learned to survive with little water. Farmers here raise sugarcane, a crop that requires large quantities of water. They also plant crops that are more drought resistant, such as sugar beets.

Pune has also tried to increase its rainfall with **cloud seeding**, a process that involves dispersing chemicals into the air in order to cause rain. Rain falls when the water vapor in clouds condenses into droplets, which form around tiny specks of ice in the air. Under the appropriate conditions, clouds can be seeded to encourage this condensation to occur. Usually, this seeding is accomplished by spraying the clouds from the air with tiny amounts of either silver iodide or dry ice. The hope is that water droplets will form around these “seeds.”

It is difficult to determine the effectiveness of cloud seeding in the Pune region because no one knows the amount of rain that might have fallen without seeding. However, for people living in a rain shadow, the possibility for more rain makes seeding worth the expense.

Summary

In this lesson, you learned how monsoons affect the climate of South Asia. The differences in atmospheric pressure between the land and sea cause the summer monsoons, and these winds bring both welcome rain and deadly floods to coastal cities. The orographic effect also shapes the climate of this region. Cities on the downwind sides of mountains often lie in a rain shadow. Unlike their coastal cousins, the people in these cities must adapt to limited rainfall.

Other regions also have monsoons. From November to March, for example, northern Australia braces for its monsoon season. Monsoons hit the West African coast from June to September. In Arizona, monsoon rains arrive in the middle of summer, as moist air from the Gulf of Mexico blows inland.

Wherever people live, the climate will affect their activities. Think about this as you examine the variety of climates around the world in the next section.



Living in a Rain Shadow

Pune lies in a rain shadow. Farmers in the area can grow crops like rice only if monsoon rains are plentiful. In these paddy fields near Pune, people work to cultivate rice, aided by the monsoon rains.