

Life in the Central Andes: Adapting to a Mountainous Region

13.1 Introduction

La Paz, Bolivia, is the highest big city in the world, sitting at 12,000 feet above sea level in the central Andes Mountains of South America. This high elevation can produce some odd effects. Golfers in La Paz can hit a golf ball much farther than they can at sea level. At a nearby ski resort, a skier may need to wear an oxygen tank to go skiing.

These effects are the result of thin air. The air is thinner at high elevations because the force of gravity pulls air downward, which means that there is less oxygen in the air at high elevations. This is why the skier in La Paz requires an oxygen tank. The thin air is also the reason a golf ball will travel farther at 12,000 feet. At that elevation, there is less air to cause friction on the ball and slow it down.

The people of La Paz are accustomed to living at high elevations. Like all of the people who live in the Andes Mountains, they have had to adapt to the effects of high elevation. The Andes include some of the highest mountain peaks in the world, with many of them rising much higher than La Paz. The various elevation levels in these mountains influence the way people live.

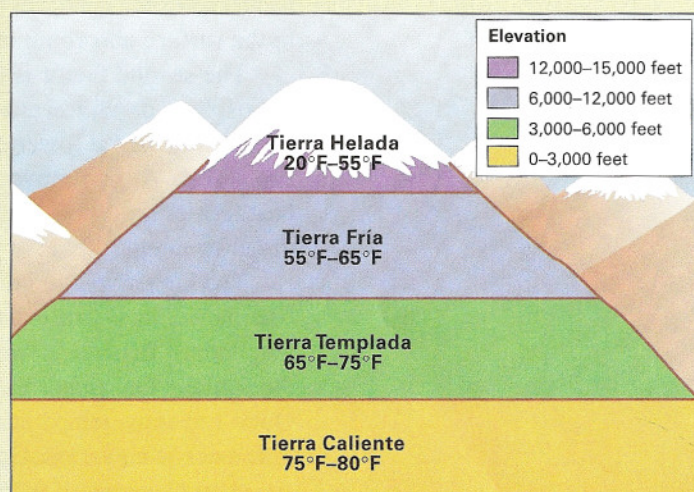
In this chapter, you will read about life in the central Andes. You will also learn about **altitudinal zonation**, a term that refers to the division of mountainous land into zones based on altitudes, or elevations. You will find out about the four main elevation zones in the Andes and how the people living there have adapted to each zone.

Essential Question

How do people adapt to living in a mountainous region?

This diagram represents the Andes Mountains of South America. Notice that the mountain is divided into four zones based on elevation. Each zone has its own range of temperatures. It also has its own distinct plant and animal life. The features of each zone influence how people live. Think about this diagram as you try to answer the Essential Question.

Graphic Organizer



13.2 The Geographic Setting

South America, the world's fourth largest continent, encompasses 12 countries and a wide range of environments. The continent has deserts, **tropical rainforests**, and several mountain ranges, with the greatest mountains being the Andes.

The Andes: Backbone of South America The Andes consist of several mountain ranges that are known in Spanish as *cordilleras*. These cordilleras form the longest chain of high mountains on Earth, stretching for approximately 4,500 miles from north to south, along the west coast of South America. The Andes have appropriately been nicknamed the backbone of South America.

The Andes Mountains pass through seven countries, featuring many different landscapes along the way. Some parts of the Andes are covered with dense forest, whereas other regions are rocky and bare. More than 50 mountains within the Andes reach elevations of more than 20,000 feet. These lofty peaks are always covered with snow and ice.

The Andes can be grouped in three sections. The northern Andes cross Venezuela and Colombia. The southern Andes run through Chile and Argentina. The central Andes cover Ecuador, Peru, and Bolivia. This chapter focuses on the central Andes.

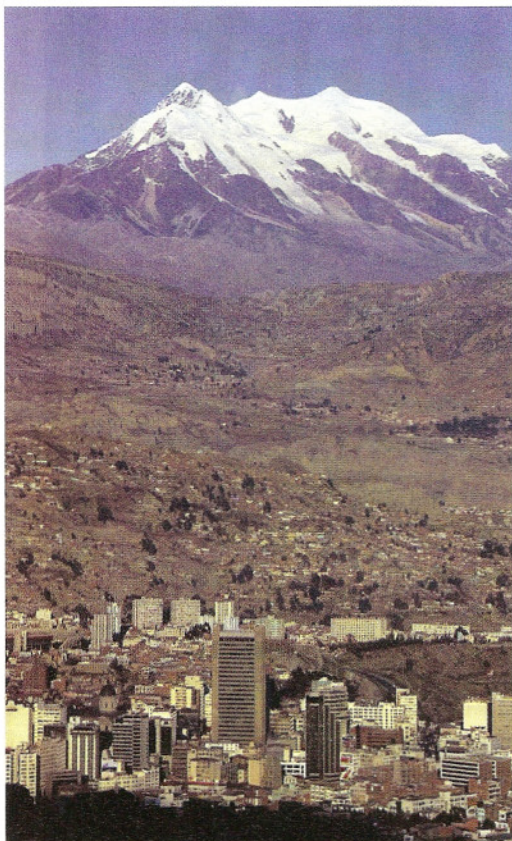
The Four Elevation Zones of the Andes In the introduction, you read about altitudinal zonation, learning that there are four main elevation zones in the Andes. These elevation zones are also called **climate zones** because elevation helps determine **climate**. The four elevation zones are illustrated in the diagram on the facing page.

The elevation zones in the Andes are known by their Spanish names. The lowest zone is called *tierra caliente*, or hot country. Above that is a zone known as *tierra templada*, or cool country. Next comes *tierra fría*, or cold country. The highest elevation zone is known as *tierra helada*, which means frost country.

The link between climate and elevation is based on two factors. The first factor is **solar energy**, which is the heat and light emitted by the sun. This energy from the sun warms Earth's surface. Some solar energy is also reflected by Earth back into the **atmosphere**, with the air closest to the surface absorbing most of the reflected heat.

The second factor is the force of gravity. Gravity pulls air in the atmosphere down toward Earth. As a result of this process, the air becomes denser at lower elevations. The denser the air, the more heat it can absorb. As you move higher, the air becomes thinner and holds less heat. For every 1,000-foot rise in elevation, the temperature of the air drops by around 3.5°F.

The higher you go in the Andes Mountains, the cooler the temperature becomes. This is true even in regions that are near the equator. For example, both of Ecuador's two largest cities, Guayaquil and Quito, lie near the equator. Guayaquil has an annual average temperature of 77°F, but Quito's average temperature is much cooler, just 55°F. The reason for the difference is elevation. Guayaquil is located at sea level, whereas Quito sits at an elevation of 9,350 feet. One city lies in *tierra caliente*, the other in *tierra fría*.



A Mountain City

La Paz, Bolivia, is the highest big city in the world. It is located at 12,000 feet in the heart of the Andes Mountains. The Andes run the length of South America. The only higher mountains in the world are the Himalayas of Asia. The people of the Andes have had to adapt to life at high elevations.

▶ Geotermis

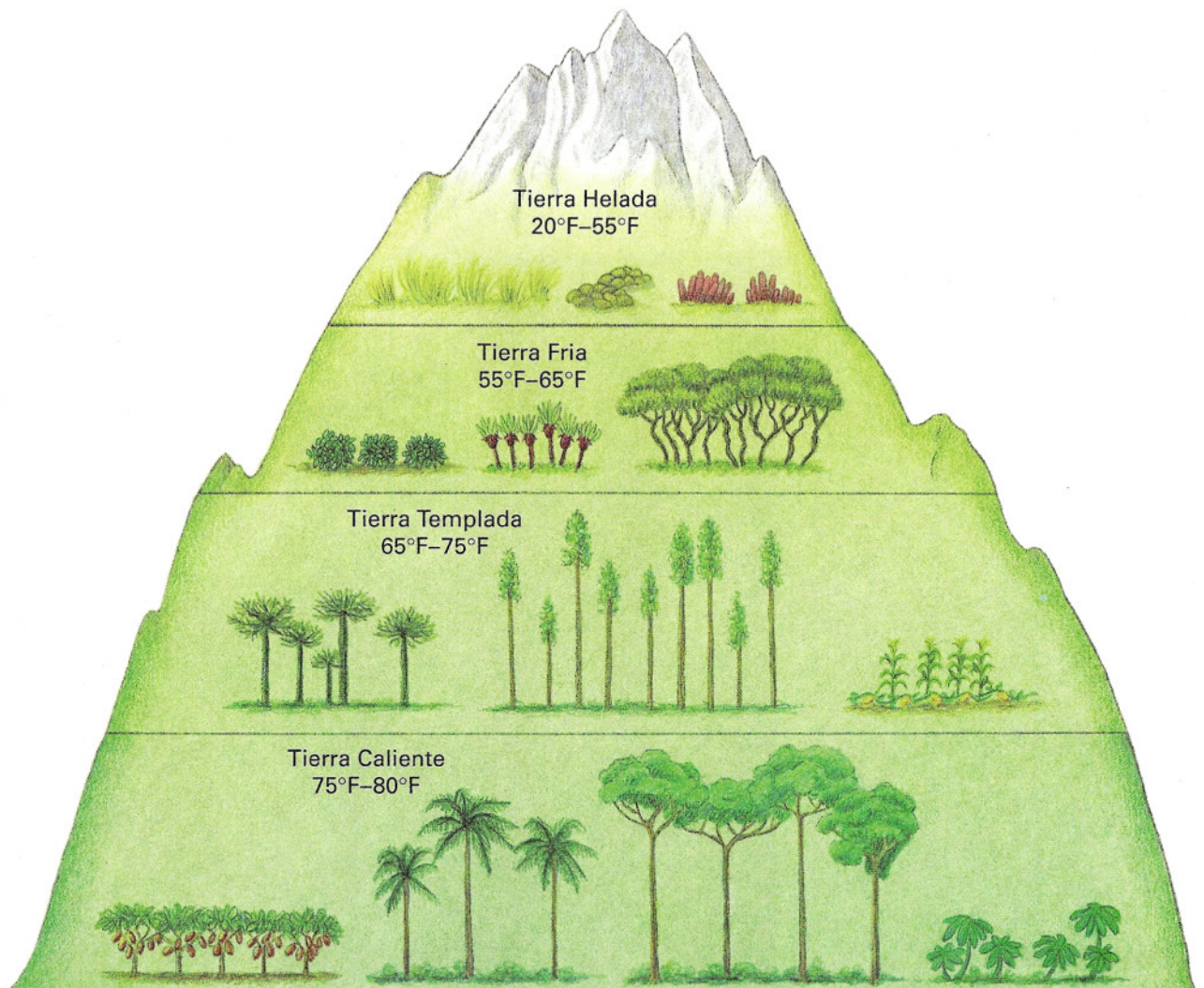
altitudinal zonation the division of land into zones based on elevation, which in turn helps determine climate and vegetation

snow line the lowest elevation on mountains where snow remains year-round

terracing the creation of flat areas on mountain slopes for the purpose of farming

tree line the highest elevation where trees grow on a mountain

vertical trade the trading of crops between lowland and highland areas



Altitudinal Zonation in the Andes

This diagram shows the four elevation zones of the Andes. Notice how the climate cools the higher you go. That's because the air gets thinner and holds less heat.

13.3 The Tropical Lowlands: Tierra Caliente

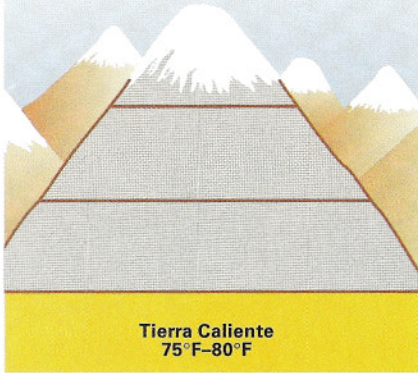
A worker is picking bananas on a plantation in Ecuador. The temperature is high, so he stops frequently to wipe the sweat from his brow. He also must watch out for spiders because tarantulas often hide within banana stalks. A tarantula bite may not be deadly, but it is extremely painful.

This banana plantation is located in the tierra caliente. Consisting mostly of tropical lowlands, this elevation zone lies at the foot of the Andes on both the eastern and western sides. People who live in the tierra caliente must adapt to a hot year-round climate.

Physical Characteristics The tierra caliente is the lowest of the four elevation zones of the Andes, extending from sea level to approximately 3,000 feet. The climate of this zone is generally hot and humid, with the average temperature ranging from 75°F to 80°F.

Broadleaf evergreen forests cover the eastern slopes of the Andes Mountains heading into the Amazon River Basin. On the western slopes of the Andes, the natural vegetation ranges from lush rainforests to **tropical grasslands**.

The Pacific coast of Peru is different. This area is also situated within the tropics, but it receives little rainfall. Here the land is mostly desert. Great sand dunes rise up in some places, whereas other parts are flat and rocky. Where there is water from rivers or streams, however, the vegetation is tropical.



Tierra Caliente
75°F-80°F

The Tierra Caliente

The tierra caliente is the lowest elevation zone in the central Andes. Conditions here are tropical. People dress in light clothing and live in houses open to the air. They also have to cope with tropical diseases like malaria.



Banana Plantation

Bananas thrive in the tierra caliente. They are grown on large plantations like this one. Many plantation workers are descended from Africans brought to South America as slaves.

Human Adaptations The tropical heat of the tierra caliente can make it an extremely difficult place to live. As a result, the area is less populated than the cooler, higher elevation zones. Some inhabitants are descended from the Africans who were brought by the Spanish to labor on large plantations as slaves. **Indigenous peoples** also live in some parts of the tropical rainforest.

People in this elevation zone have adapted to life within the tropics. Farmers plant crops that can do well in the heat, with some of the most common crops being bananas, rice, and sugarcane. People dress in light clothing, and they live in houses that are open to the cooling breezes. Their houses are often constructed of bamboo or wood, with palm-thatch roofs, and some houses have been raised on stilts to provide protection against flooding.

13.4 The Pleasant Uplands: Tierra Templada

In the rolling hills of Ecuador's tierra templada, gardeners are raising flowers, tending long rows of carnations, daisies, and roses. The flowers they grow will be shipped to buyers thousands of miles away. In fact, many of the roses enjoyed by Americans on Valentine's Day come from Ecuador because the mild weather of Ecuador provides the perfect climate for cultivating flowers.

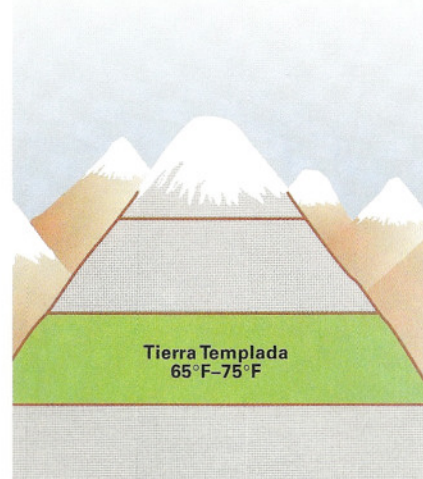
Physical Characteristics The tierra templada is the second elevation zone of the Andes. It lies between approximately 3,000 and 6,000 feet above sea level. At these elevations, the climate is **temperate**, with temperatures ranging from 65°F to 75°F, with rarely any frost. This pleasant weather lasts throughout the year, which is why people often call the tierra templada "the Land of Eternal Spring."

In this zone, the types of vegetation change with elevation. At the lower elevations, tropical plants such as palms, bamboo, and jungle vines are quite common. At the higher elevations, broadleaf evergreen forests are typical.

Human Adaptations The mild climate of the tierra templada makes it a good place to live. As a result, this elevation zone is more populated than the tierra caliente. Many of the people who live here are *mestizos*. Mestizos are a mixture of indigenous and European peoples. European cultural influences are strong within the tierra templada.

Farmers in this zone choose their crops based on elevation. At lower levels, they grow heat-loving crops, like bananas and oranges. Higher up, they grow corn, beans, and other vegetables. They also grow flowers for export. However, the main commercial crop of the tierra templada is coffee because the conditions here are ideal for growing high-quality coffee beans. Most of the coffee is grown on small farms, but there are also large coffee plantations.

People who live in the tierra templada have adapted their housing and dress to the comfortable climate. They live in solid homes made of concrete brick or plaster and covered with tile roofs. More well-off residents may live on large estates called *haciendas*. During the heat of the day, people wear light clothing, but they switch to warmer clothing for the cool mornings and evenings.



The Tierra Templada

The tierra templada is the second elevation zone in the Andes. It has a pleasant, springlike climate year-round. This mild weather appealed to European settlers. Some of the largest cities in Latin America are found here.



Flower Growing

Flowers like these roses are an important crop in the tierra templada. Most flowers are shipped to Europe and the United States. Flower prices rise and fall depending on events in those distant markets. Flowers are one of the first things people stop buying in hard times.

13.5 The Cool Highlands: Tierra Fra

A woman rises early in the highland city of Cuzco, Peru. This is tierra fría, and the morning air is cold. The woman puts on a warm sweater and shawl and heads off to the market to buy food, walking down ancient stone streets built by her ancestors, the Incas. A light frost on the stones makes them slippery, so she steps carefully. She is accustomed to life in the highlands.

Physical Characteristics Covering much of the central Andes Mountains, the tierra fría elevation zone lies between 6,000 and 12,000 feet. The average temperatures within this zone vary from 55°F to 65°F, but the nights are colder. At higher elevations, the temperatures often dip below freezing.

Mountains and valleys are the main physical features of the tierra fría elevation zone. The mountains are steep and rugged, but flat **basins** and **plateaus** can be found among the peaks.

A high plateau called the Altiplano lies at an average elevation of over 11,000 feet between Peru and Bolivia. This plateau contains Lake Titicaca, the world's highest **navigable lake**. A navigable lake is one that is large and deep enough for large boats. Lake Titicaca is rumored to hold hidden treasure, according to legends that say the Incas threw gold into the lake to protect it from the Spanish invaders.

Vegetation within the tierra fría depends partly on the amount of rainfall. In some places, enough precipitation occurs to support dense forests of pines and other **conifers**. In other places the land is so dry that only shrubs and grasses can survive there.

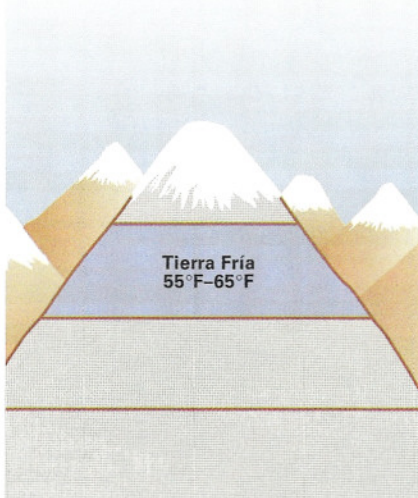
Elevation is another factor that affects what grows where. The **tree line** in the central Andes lies between 10,000 and 12,000 feet. The tree line is the highest elevation at which trees will grow.

Human Adaptations Approximately half the population of the central Andes are indigenous peoples. Most of these people live in the tierra fría. The two main indigenous groups are the Quechua and the Aymara. Both of these groups were once part of the mighty Inca Empire.

Over the centuries, the native peoples of the Andes have adapted to life at high elevations. They wear warm woolen clothes to protect themselves from the cold. They also build thick-walled houses out of stone or **adobe** brick. Even their bodies have adapted to high elevations, as they have developed larger lungs that can draw more oxygen from the thin mountain air.

Farmers have adapted their practices to the highland environment. They grow crops that do well at high elevations. These crops include potatoes, wheat, barley, corn, apples, and pears.

Farmers also use **terracing** to carve fields out of steep hillsides, building walls on the slopes and filling them in with soil to create flat land for planting. They irrigate these terraces with mountain streams. This method of farming goes back many centuries. The Incas used terracing to build a great civilization.



The Tierra Fría

The tierra fría reaches elevations of 12,000 feet. Many native peoples live in this zone. They have developed larger lungs to take in more oxygen from the thin air at these heights. Five hundred years ago, the centers of the Inca Empire were located here.

Market Day in Peru

The people at this market are wearing the dress of highland Indians. Highland markets are centers of vertical trade. Potatoes and wheat from the highlands are traded here for bananas and oranges from the lowlands.

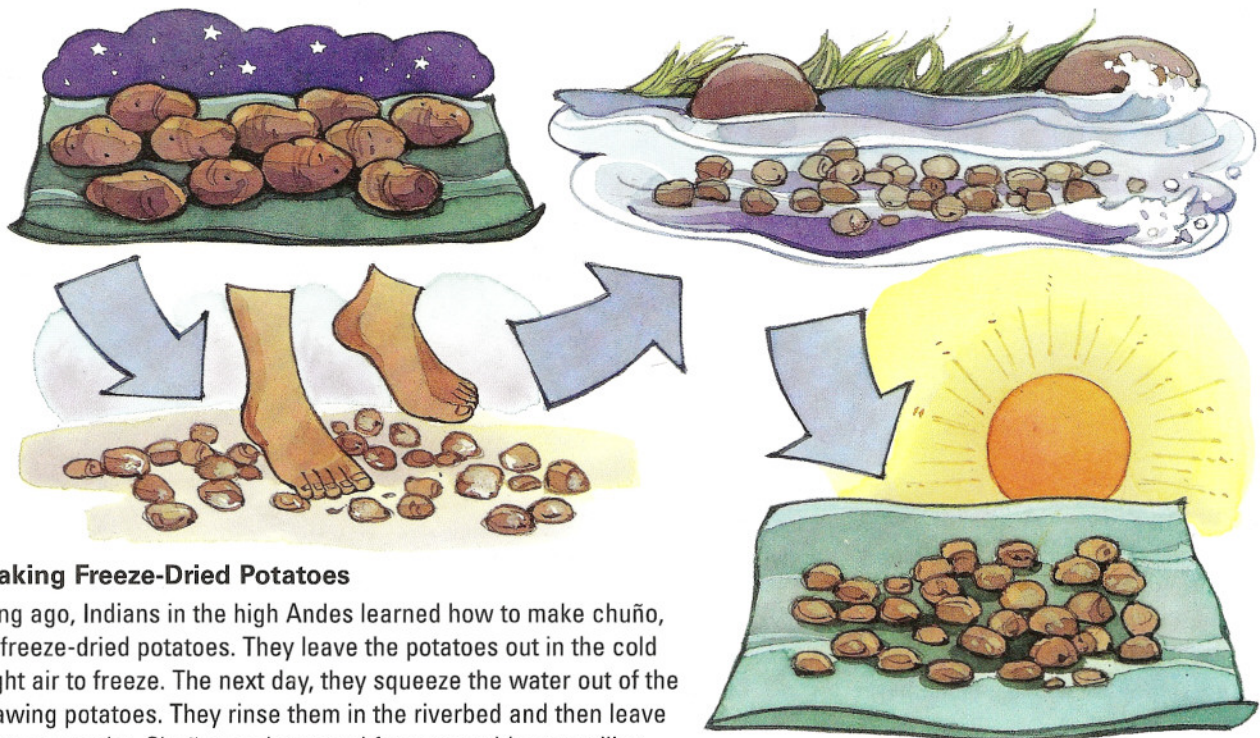




Inca Terraces

In the 1400s, the Incas created an advanced civilization in the Andes. These are the ruins of Machu Picchu, an Inca religious center in Peru. Notice the terraced fields at the edge of the city.

Another sign of adaptation to life at high elevations is **vertical trade**. This is the trade of farm products between the higher and lower elevation zones of the Andes Mountains. Highland farmers cannot grow crops from the lower zones, such as bananas, oranges, and tomatoes. Therefore, traders bring those products up to the highland markets. The traders also take highland crops, such as potatoes and wheat, down to the lowland markets. Through vertical trade, people who live in one elevation zone can have access to foods grown in other elevation zones. In this way, they are able to achieve a more balanced and varied diet.



Making Freeze-Dried Potatoes

Long ago, Indians in the high Andes learned how to make chuño, or freeze-dried potatoes. They leave the potatoes out in the cold night air to freeze. The next day, they squeeze the water out of the thawing potatoes. They rinse them in the riverbed and then leave them out to dry. Chuño can be stored for years without spoiling.

13.6 The Icy High Elevations: Tierra Helada

Every year, many Quechua Indians hike to a shrine in the mountains high above the city of Cuzco. They travel there to worship the *apus*, or mountain gods. “We make offerings to the mountains,” says one pilgrim, “asking them to send water for our crops and livestock.”

The shrine above Cuzco is set in the tierra helada, the highest elevation zone of the Andes. The pilgrims who make this journey have to be careful to walk slowly because the air is very thin. If people move too quickly at this high elevation, they can experience altitude sickness from a lack of oxygen. Altitude sickness can cause headaches, fatigue, shortness of breath, and nausea.

Physical Characteristics The tierra helada lies between 12,000 and 15,000 feet, with average temperatures varying from 20°F to 55°F. This is an extreme environment. The climate is very cold and windy. It often freezes at night, and snow falls at the higher elevations. At the upper edge of this zone lies the **snow line**, which is the elevation at which permanent snow and ice begin. Above the snow line, snow remains on the ground year-round.

Most of the tierra helada lies above the tree line, which means that trees are very rare in this elevation zone. The most common forms of plant life are low-lying shrubs and hardy grasses, which are found in **alpine** meadows called *paramos* or *punas*.

Human Adaptations The tierra helada is a challenging environment for humans, which is why relatively few people live at these extreme elevations. Most of the people who live here are indigenous peoples like the Quechua and the Aymara.

The Tierra Helada

The tierra helada is the highest zone of the central Andes. Conditions here can be harsh. The climate is cold, and vegetation is sparse. People grow hardy crops like quinoa, a grain that is rich in protein. They also work in mines. The mines of Bolivia were once among the richest in the world.

Spinning Wool

These highland women are spinning wool from an alpaca into yarn. The yarn will then be woven into cloth. Alpaca wool is finer and straighter than sheep wool. It is one of the best fibers for making soft, warm garments.



People have adapted to life in the tierra helada in various ways. As in the tierra fría, they dress in warm clothing. They plant the few crops that will grow at high elevations, including a native grain called *quinoa*, along with certain types of potatoes. They also raise llamas and alpacas, two types of animals that are related to the camel. Llamas and alpacas produce thick wool for blankets, bags, and clothing. Llamas also make good pack animals for transporting heavy loads across the mountains.

Some of the people who live in this elevation zone work in mines. The high Andes have many mineral deposits, including tin, lead, copper, and silver. Working conditions in the mines are quite dangerous, with many miners contracting lung disease or getting injured on the job. However, mining does provide one of the few sources of cash income in this harsh environment.

Above the Snow Line The highest part of the Andes lies just above the tierra helada. This area extends from the snow line to the tops of the tallest mountain peaks. In this cold and rocky region, snow and ice cover much of the land.

This part of the Andes is generally not inhabited, but it still plays a key role in Andean life. The reason is **glaciers**. These large ice fields cover the highest peaks in the Andes, storing large amounts of water above the snow line. In the summer, water from melting glaciers flows down to people living at lower elevations. Streams fed by these glaciers form a crucial part of the water supply.

Glaciers are very sensitive to changes in climate. They can grow or shrink, depending on the changes in temperature and precipitation that occur over time. If glaciers melt too fast, the result can be disastrous for the people who are living below them. “Glaciers don’t always behave nicely,” said a scientist who studies them. “Some glaciers have a nasty habit of storing up large amounts of water and then releasing it suddenly in a massive melt...which may involve floods, landslides, or avalanches.”

13.7 Beginning to Think Globally

In this chapter, you read about the four elevation zones in the central Andes Mountains. Each of these elevation zones has its own climate and vegetation. You have also learned how people have adapted to the conditions in each zone.

In other parts of the world, people have made different adaptations to mountain living. In general, however, relatively few people in the world live at high elevations because the conditions of life there are just too difficult.

In the future, mountains may become more attractive to people as places to live. There are signs that the world’s climate is getting warmer, and if this warming trend continues, life will change at higher elevations. For example, tree lines and snow lines are likely to rise. As mountains become warmer, more people may choose to live at higher elevations. At the same time, a warmer climate is likely to have a negative effect on mountain glaciers. Keep this in mind as you look at glaciers in the next section.



Shrinking Andes Glaciers

This satellite image shows a shrinking glacier in the Andes. There is still enough ice in this glacier to feed mountain streams year round. But if the glacier disappears, some of those streams may run dry part of the year.

13.8 Global Connections

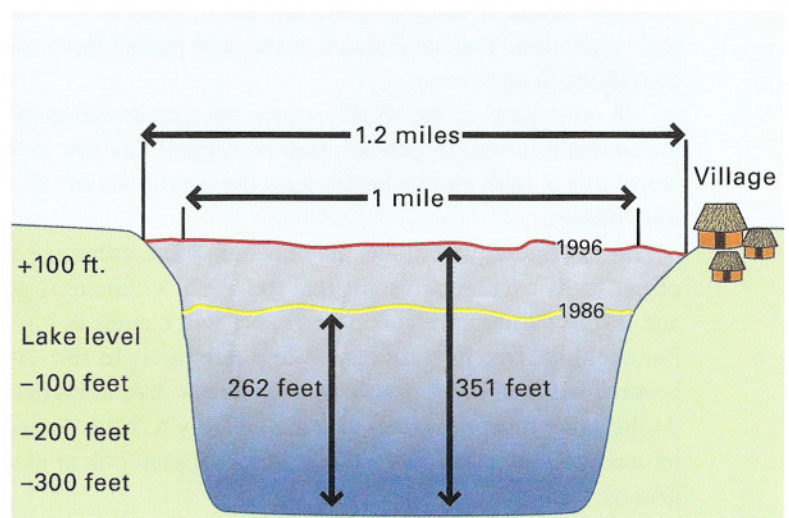
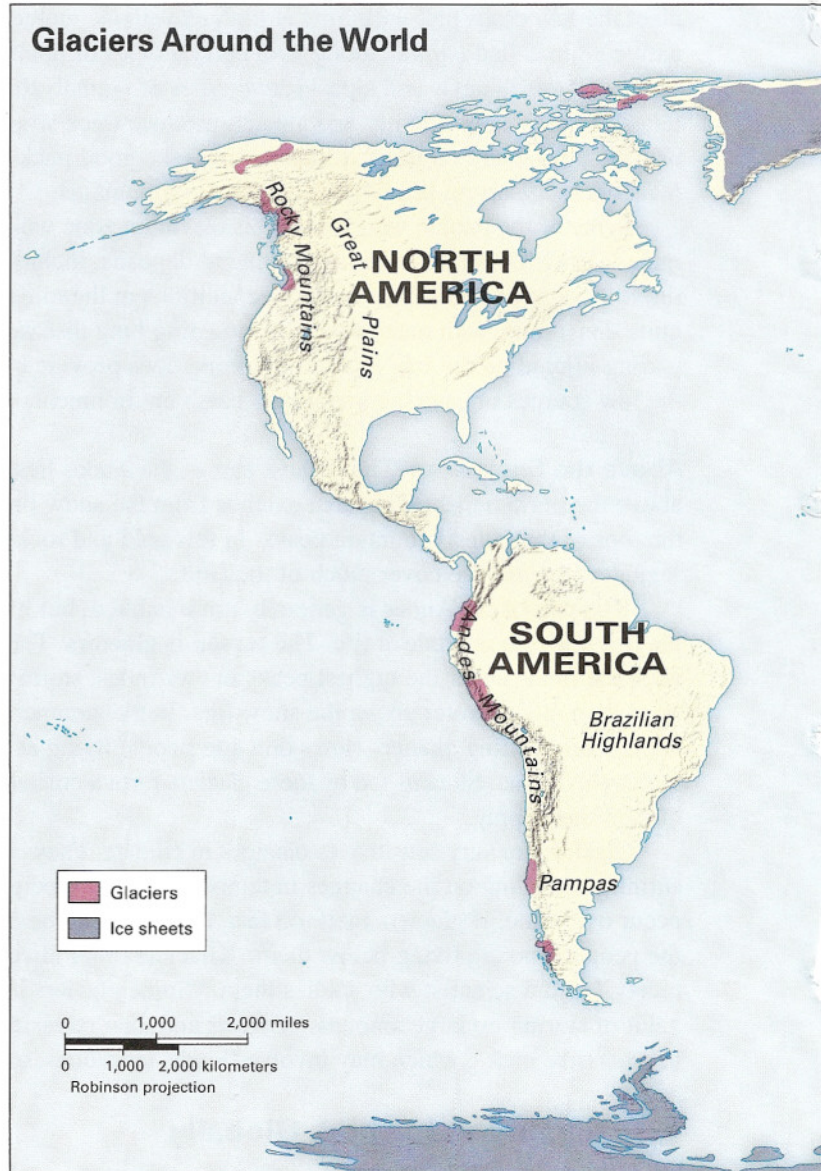
The map to the right shows glaciers around the world. There are about 160,000 glaciers worldwide today. Some of these glaciers are found in lowland cold areas such as Antarctica, whereas others have formed on high mountain peaks. Can you find examples of both lowland glaciers and mountain glaciers on the map?

What is happening to mountain glaciers around the world? Many mountain glaciers are retreating, or shrinking. Look at the image of the Gangotri Glacier, which is a mountain glacier that is located in the Himalayas. The lines on the photograph show how Gangotri Glacier has retreated over time. Not all glaciers are shrinking, however. Some are staying the same size or even expanding.

Why are some mountain glaciers retreating? Most scientists blame climate change for the shrinking of glaciers. These scientists say that Earth's climate has been slowly warming. These rising temperatures are causing glaciers to melt more than they have in the past. As their ice turns to water, the glaciers retreat.

What impact do retreating glaciers have on people living in mountainous regions?

Approximately 75 percent of the world's fresh water is frozen inside glaciers. When glaciers melt, they provide water for people to use. For example, the glaciers near Quito, Ecuador, supply about 80 percent of this South American city's water. If Quito's glaciers continue to shrink, they will provide less and less water to the city. "It's kind of like a bank account," said one scientist. "When you've withdrawn all the water, there isn't any more."





◀ **Lake Raphstreng Tsho**

This diagram shows changes in Raphstreng Tsho, a glacial lake in the Himalaya mountain range of Asia. As the glaciers that feed the lake melt, its water level rises. Between 1986 and 1996, the lake's water level rose by 89 feet.

Gangotri Glacier ▶

This satellite image shows the Gangotri Glacier in 2001. It is one of the largest glaciers in the Himalayas. The lines added to the image show how this glacier has shrunk since 1780.

