

Life in the Central Andes: Adapting to a Mountainous Region

13.1 Introduction

La Paz, Bolivia, is the highest big city in the world. It sits 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 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. That means there's less oxygen in the air at high elevations. This is why the skier in La Paz needs an oxygen tank. It's also why a golf ball travels farther at 12,000 feet. There is less air to cause friction on the ball and slow it down.

The people of La Paz are used to living at high elevations. Like all peoples of the Andes, they have had to adapt to the effects of elevation. The Andes include some of the highest mountain peaks in the world. Many of these peaks rise much higher than La Paz. The various elevation levels in these mountains influence the way people live.

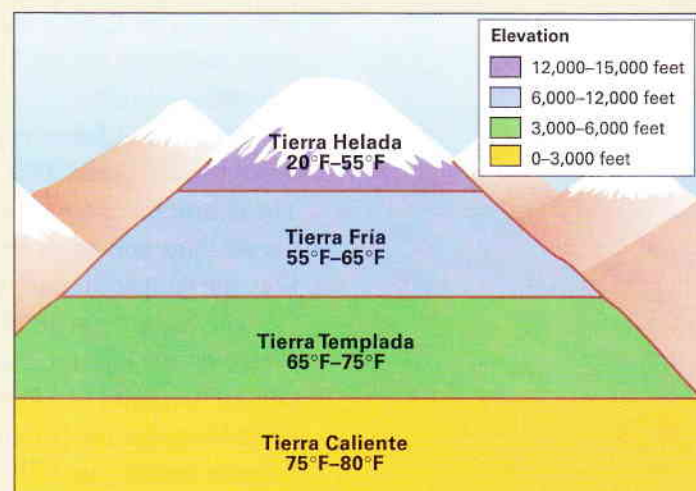
In this chapter, you will read about life in the central Andes. You will also learn about **altitudinal zonation**. This term refers to the division of mountainous land into zones based on altitudes, or elevations. You will find out about the four main elevation zones in the Andes and how the people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





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.

13.2 The Geographic Setting

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

The Andes: Backbone of South America The Andes are made up of several mountain ranges called *cordilleras*. These cordilleras form the longest chain of high mountains on Earth. The Andes stretch for 4,500 miles down the west coast of South America. They are sometimes called the backbone of South America.

The Andes pass through seven countries. Along the way they feature many different landscapes. Some parts of the Andes are covered with dense forest. Others are rocky and bare. More than 50 peaks in 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. You learned that there are four main elevation zones in the Andes. These zones are also called **climate zones** because elevation helps determine **climate**. The four elevation zones are shown 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 *tierra templada*, or cool country. Next comes *tierra fría*, or cold country. The highest zone is known as *tierra helada*, or frost country.

The link between climate and elevation is based on two factors. The first is **solar energy**, or heat and light given off by the sun. This energy warms Earth's surface. Some solar energy is also reflected by Earth back into the air. The air closest to the surface absorbs most of this reflected heat.

The second factor is gravity. Gravity pulls air in the **atmosphere** down toward Earth. This makes the air denser at lower elevations. The denser the air, the more heat it can absorb. As you move higher, the air thins 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, the cooler it gets. This is true even 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. Quito's average temperature is much cooler, just 55°F. The reason for the difference is elevation. Guayaquil is located at sea level, while Quito sits at an elevation of 9,350 feet. One city lies in *tierra caliente*, the other in *tierra fría*.

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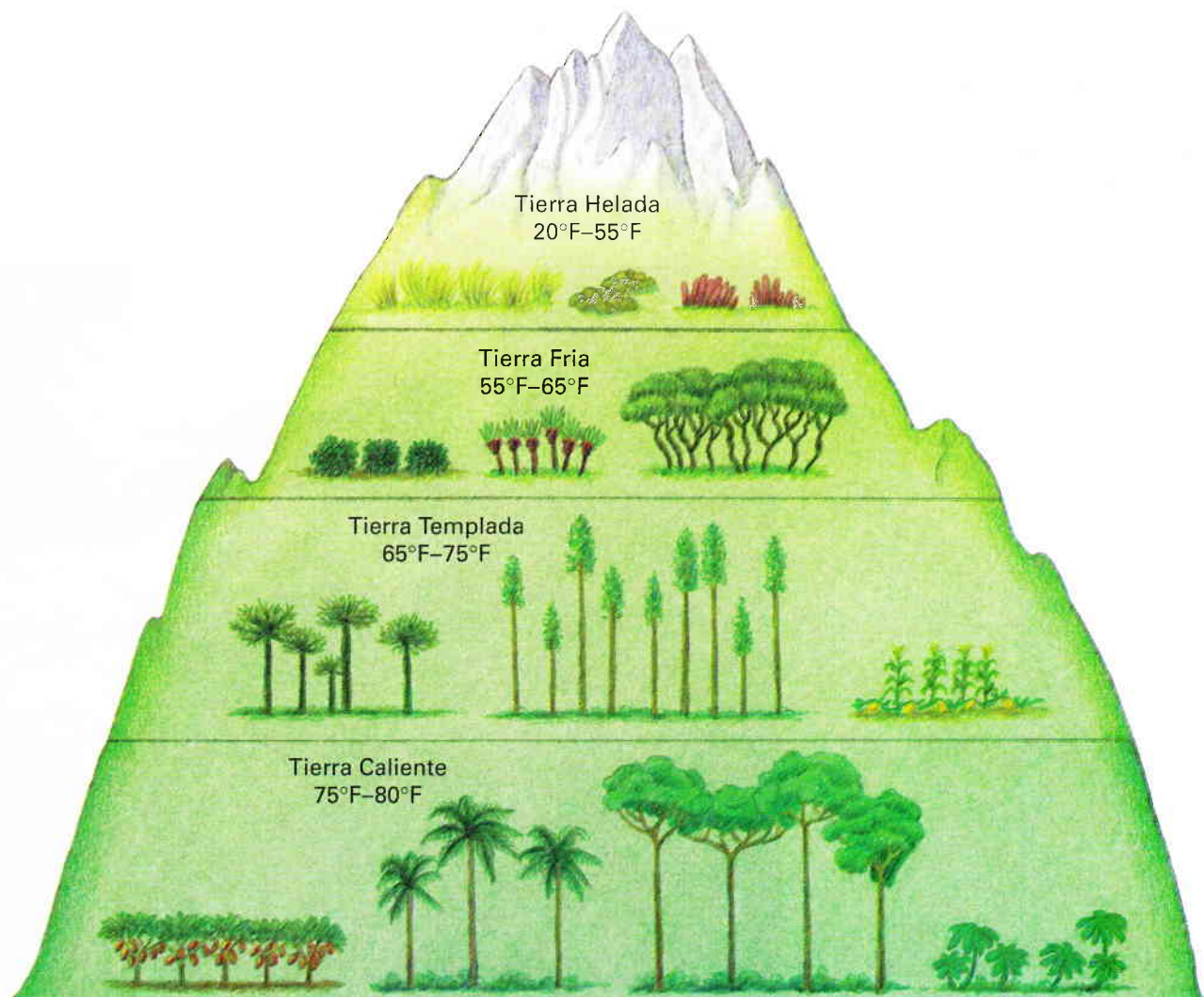
altitudinal zonation the division of land into zones based on elevation, which in turn helps determine climate and vegetation

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

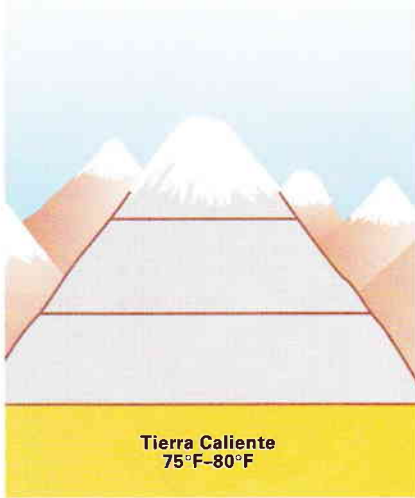
tree line the highest elevation where trees grow on a mountain

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.



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.

13.3 The Tropical Lowlands: Tierra Caliente

A worker is picking bananas on a plantation in Ecuador. It's hot, and he has to stop often to wipe the sweat from his brow. He also has to watch out for spiders. Tarantulas like to hide in the banana stalks. Their bite may not be deadly, but it is painful.

This banana plantation is located in the tierra caliente. Most of this zone is tropical lowlands. It lies at the foot of the Andes on both the eastern and western sides. People here must adapt to a hot year-round climate.

Physical Characteristics The tierra caliente is the lowest of the Andes' four elevation zones. It goes from sea level to approximately 3,000 feet. The climate is generally hot and humid. The average temperature range is 75°F to 80°F.

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

The Pacific coast of Peru is different. It also lies in the tropics, but gets little rainfall. Here the land is desert. Great sand dunes rise up in some places. Other parts are flat and rocky. Where there is water from rivers or streams, however, the vegetation is tropical.

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 a difficult place to live. As a result, it is less populated than cooler, higher zones. Some inhabitants are descended from Africans who were brought by the Spanish to work on large plantations as slaves. **Indigenous peoples** also live in some parts of the tropical rainforest.

People in this zone have adapted to life in the tropics. Farmers plant crops that do well in the heat. Among the most common crops are bananas, rice, and sugarcane. People dress in light clothing. They live in houses that are open to cooling breezes. Their houses are often made of bamboo or wood, with palm-thatch roofs. Some are raised on stilts to protect against flooding.

13.4 The Pleasant Uplands: Tierra Templada

In the rolling hills of Ecuador's tierra templada, gardeners are raising flowers. They tend 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. The mild weather of Ecuador provides the perfect climate for growing flowers.

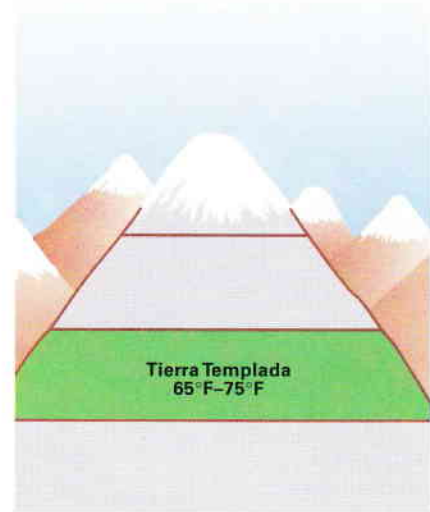
Physical Characteristics The tierra templada is the second elevation zone of the Andes. It lies between approximately 3,000 and 6,000 feet above sea level. At these elevations, the climate is **temperate**. Temperatures range from 65°F to 75°F, and there is rarely any frost. This pleasant weather lasts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

In this zone, the vegetation changes with the elevation. At lower elevations, tropical plants like palms, bamboo, and jungle vines are common. At higher elevations, broadleaf evergreen forest is typical.

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

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. But the main commercial crop of the tierra templada is coffee. 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 this zone 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. Richer residents may live on large estates called *haciendas*. During the heat of the day, people wear light clothing. They switch to warmer clothing for the cool mornings and evenings.



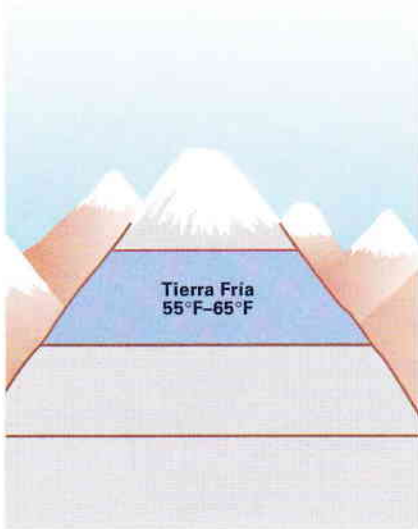
The Tierra Templada

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.



The Tierra Fria

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.



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. She walks down old stone streets built by her ancestors, the Incas. A light frost on the stones makes them slippery, so she steps carefully. She is used to life in the highlands.

Physical Characteristics The tierra fría covers much of the central Andes. This zone lies between 6,000 and 12,000 feet. Average temperatures vary from 55°F to 65°F. But the nights are colder. At high elevations, temperatures often dip below freezing.

Mountains and valleys are the main physical feature in this 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 of over 11,000 feet between Peru and Bolivia. It contains Lake Titicaca, the world's highest **navigable lake**. A navigable lake is one that is large and deep enough for big boats. Lake Titicaca is rumored to hold hidden treasure. Legends say the Incas threw a huge amount of gold into the lake to keep it away from Spanish invaders.

Vegetation in this zone depends partly on rainfall. In some places, enough rain falls to support dense forests. Pines and other **conifers** are found there. In other places the land is so dry that only shrubs and grasses will grow.

Elevation also 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 Around half the population of the central Andes are indigenous peoples. Most live in the tierra fría. The two main indigenous groups are the Quechua and the Aymara. Both 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 them from the cold. They also build thick-walled houses out of stone or **adobe** brick. Even their bodies have adapted. They have developed larger lungs to get 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 include potatoes, wheat, barley, corn, apples, and pears.

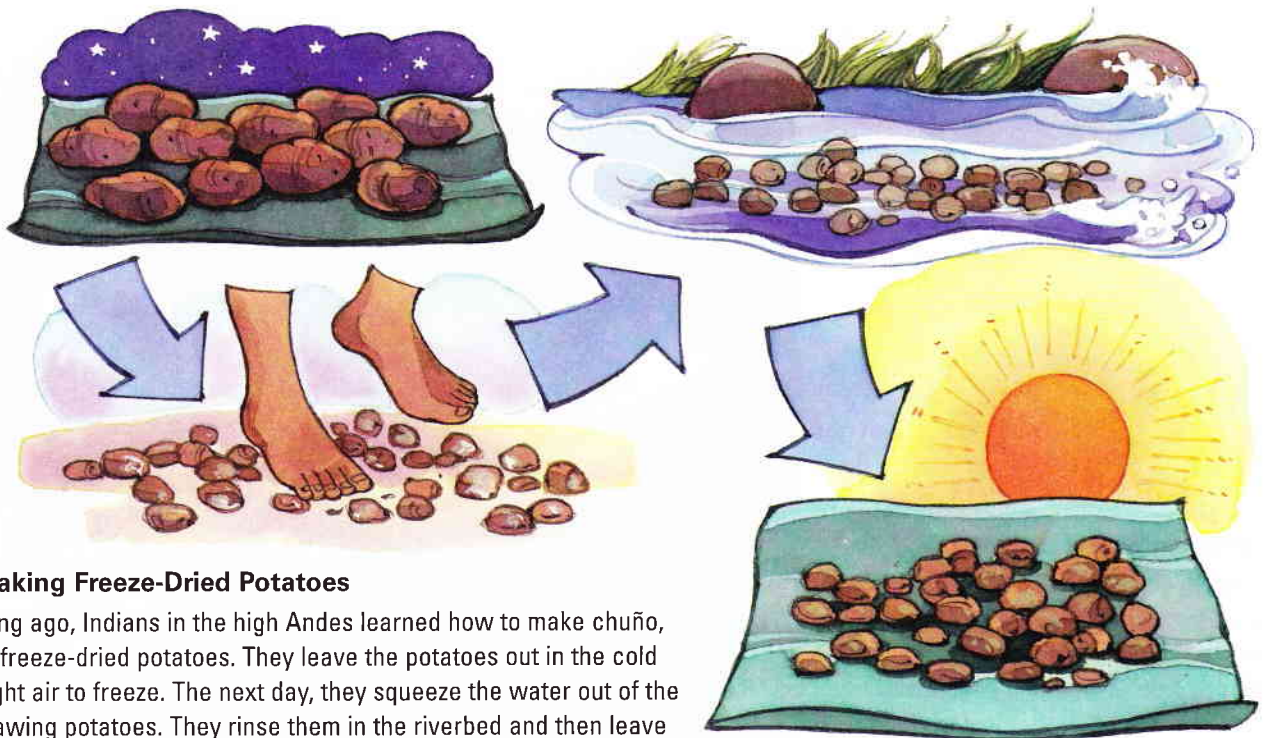
Farmers also use **terracing** to carve fields out of steep hillsides. They build walls on the slopes and fill them in with soil to create flat land for planting. They irrigate the terraces with mountain streams. This method of farming goes back to ancient times. The Incas used terracing to build a great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



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 is **vertical trade**. This is the trade of farm products between higher and lower zones of the Andes. Highland farmers can't grow crops from lower zones, such as bananas, oranges, and tomatoes. So traders bring those products up to highland markets. They also take highland crops, like potatoes and wheat, down to low-land markets. Through vertical trade, people who live in one zone can have access to foods grown in other zones. In this way, they can get 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.



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.

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 go 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 walk slowly. The air is very thin. If people move too fast, they can get 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. Average temperatures vary from 20°F to 55°F. This is an extreme environment. The climate is cold and windy. It often freezes at night, and snow falls at the higher elevations. The **snow line** lies at the upper edge of this zone. The snow line is the elevation where permanent snow and ice begin. Above this level, snow stays on the ground year-round.

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

Human Adaptations The tierra helada is a tough environment for humans. Relatively few people live at these heights. Most are indigenous peoples like the Quechua and the Aymara.

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. These include a native grain called *quinoa*, along with certain types of potatoes. They also raise llamas and alpacas. Both of these animals are related to the camel. They produce thick wool for blankets, bags, and clothing. Llamas also make good pack animals for carrying heavy loads across the mountains.

Some people in this zone work in mines. The high Andes have many mineral deposits, including tin, lead, copper, and silver. Working conditions in the mines are difficult. Many miners get lung disease or are injured on the job. But mining provides 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 peaks. It is cold and rocky here. Snow and ice cover much of the land.

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

Glaciers are very sensitive to changes in climate. They grow or shrink depending on changes in temperature and precipitation over time. If they melt too fast, the result can be disastrous for the people living below. “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 have read about the four elevation zones in the central Andes. Each zone has its own climate and vegetation. You have seen 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. The conditions of life there are just too difficult.

In the future, mountains may become more attractive to people. There are signs that the world’s climate is getting warmer. If this warming trend continues, life will change at high 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.

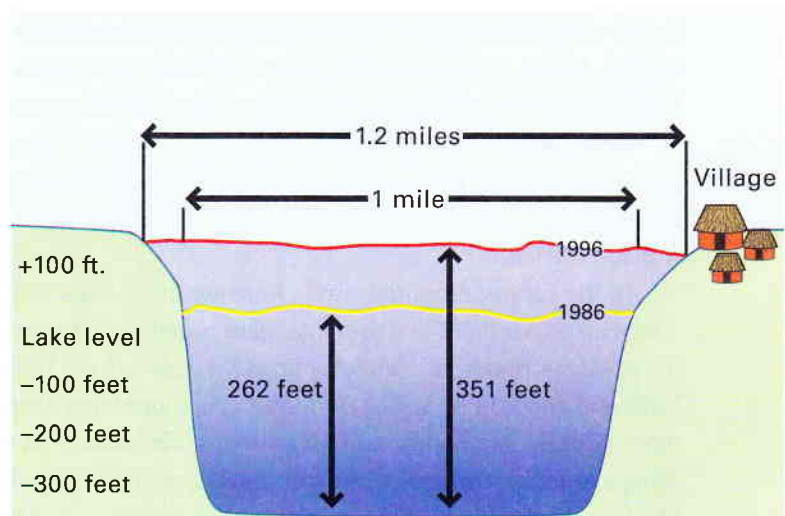
13.8 Global Connections

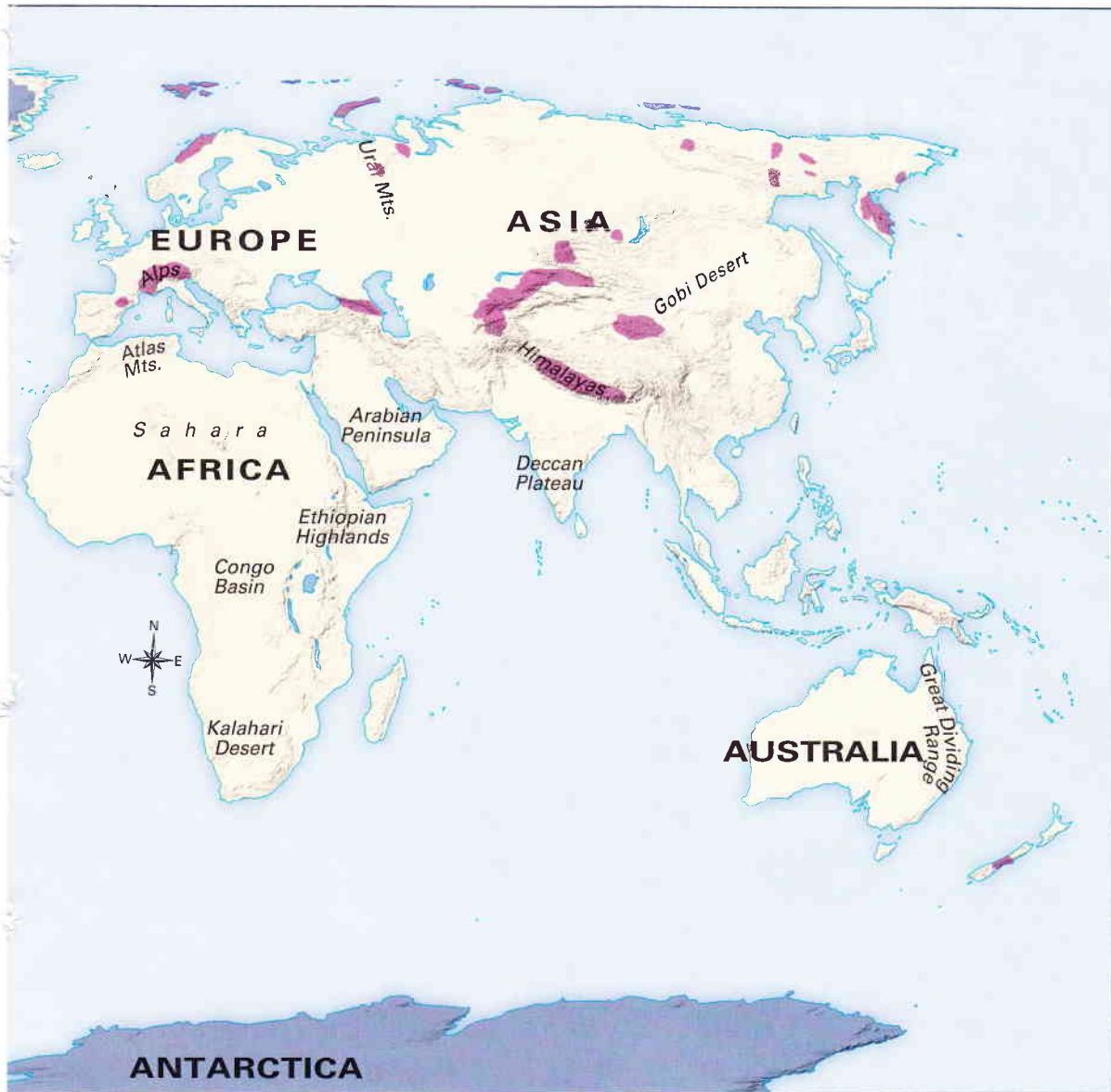
The map on this page shows glaciers around the world. There are about 160,000 glaciers worldwide today. Some are found in lowland cold areas such as Antarctica. Others have formed on high mountain peaks. Can you find examples of both lowland and mountain glaciers on the map?

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

Why are some mountain glaciers retreating? Most scientists blame climate change for shrinking glaciers. They say that Earth's climate is slowly warming. Rising temperatures are causing glaciers to melt more than they used to. As their ice turns to water, the glaciers retreat.

What impact do retreating glaciers have on people living in mountainous regions? Around 75 percent of the world's fresh water is frozen in glaciers. When glaciers melt, they provide water for people to use. For example, glaciers near Quito, Ecuador, supply 80 percent of the 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 Himalayag 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.

