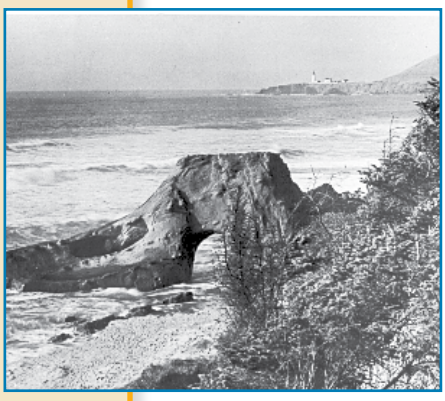
Case Study 1: Ocean Rock and Roll

A Case of Gradual Coastal Erosion at Work

By observing the photographs on this page, you will see one hundred years of erosion at work. In 1890, a large rock called Jump-Off Joe stood off the coast of Oregon. Look at the photographs and see how over time water wore away the land that made up Jump-Off Joe. Jump-Off Joe was made of sandstone, a very soft type of rock. The land in the background, on which the lighthouse sits, is made of basalt. Basalt is a much harder rock than sandstone.

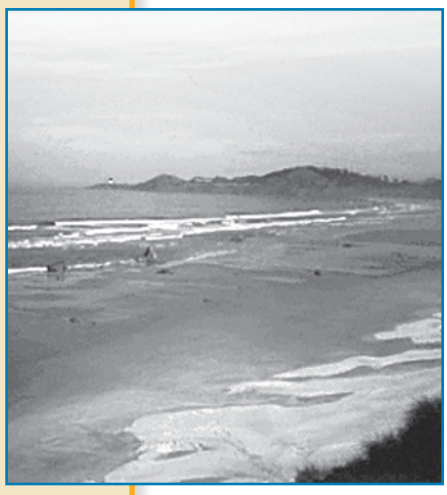
1890



1910

1920

1970



1990

Over a very long time, wave action destroyed Jump-Off Joe. You may not think about water as being powerful. However, if you have ever been caught in a flood, tried to swim in a swift river, or been knocked down by a wave, you know how strong water can be.

Waves striking a shore carry sand particles and are very powerful. The combination of water and sand particles wears down rock faster than water alone.

Jump-Off Joe was a very large rock in 1890. Most likely, it was once even bigger. By observing the series of pictures taken over the course of 100 years, you can see that the rock has been weathered, or worn away. Erosion carries the weathered particles away and deposits them in another location.

The Cape Hatteras Lighthouse, 1985. The ocean shoreline is just 46 m (150 ft) from the lighthouse.

The Cape Hatteras Lighthouse, 2000. The lighthouse was moved back from the ocean 884 m (2900 ft) in a massive engineering project.

Case Study 2: Where's the Beach?

Moving the Cape Hatteras Lighthouse

The Cape Hatteras Lighthouse was built in 1870. At that time, people did not fully understand the forces of erosion. So building the lighthouse 457 m (1500 ft) from the water seemed reasonable. For over a hundred years, the lighthouse warned ships away from dangerous waters in a part of the ocean called the "Graveyard of the Atlantic." However, after 129 years, the lighthouse itself was in danger. Coastal erosion had worn away about 396 m (1300 ft) of beach. The lighthouse now sat within 46 m (150 ft) of the very waters it had warned so many sailors to stay away from. In 1999, the lighthouse was moved 884 m (2900 ft) back to save it from falling into the ocean.

The Cape Hatteras Lighthouse is located on the Outer Banks of North Carolina's barrier islands. Barrier islands are found all along the eastern coast of the United States, parallel to the mainland's shoreline, and along many other shorelines around the world.

Seen from above, a view of the barrier islands off the Outer Banks of North Carolina.

These long, sandy islands protect the mainland from the winds and pounding waves of the sea. But the islands are constantly changing, eroding in one place and building up in another. This is the result of waves, currents, winds, storms, and a rising sea level.

Barrier islands are often in need of protection from the forces of erosion. After all, if they were to disappear, mainland shorelines would be defenseless against the seas. Their best defense is the dunes.

Dunes are anchored in place by the deep roots of dune plants. Most beach communities work hard to protect their dunes, asking people to stay off the dunes and not pick the dune plants. Still, barrier islands are eroding at incredible rates. Because of their beauty and recreational value, barrier islands are popular places to build homes and visit. Often, people build along these beaches without considering erosion.

Beach erosion has many causes:

- building houses and hotels near the ocean;
- a rapid rise in average ocean levels;
- the gradual sinking of coastal land;
- efforts to reduce erosion that have not worked and instead have increased erosion; and
- global warming, which will speed up the rise in sea level.

But erosion is not all bad. Without erosion, there would be no beaches, dunes, barrier islands, or bays. Bays are bodies of water found between barrier islands and the mainland. They are productive nurseries for many marine organisms.

No Perfect Solutions to Erosion Problems

Places with buildings on the edges of cliffs above beaches often have serious problems with erosion. As cliffs began to erode, as they did in the city of Miami Beach, Florida, the ocean was getting closer to the buildings. People were afraid that the buildings, including many homes, would be destroyed if the cliffs collapsed.

Many cities faced with these problems try and stop the erosion of cliffs in different ways. Several of these ways have been tried in Miami Beach, and all along the Atlantic coastline. To slow down erosion, city engineers often build barriers along beaches or into the water. Structures built include seawalls—made of concrete, steel, or wire cages filled with pebbles, or groins and jetties—different types of barriers made of rocks. They are designed to keep ocean currents from carrying away sediment and sand. Often these structures shift the movement of **sediment** or sand to other parts of the beach, causing more damage in another area.

Breakwaters, long heaps of rocks dumped parallel to the shore, reduce the strength of waves before they reach the beaches. Some people object to breakwaters because they can spoil ocean views.

sediment: solid fragments of inorganic or organic materials that come from rock and are carried and deposited by wind, water, or ice.

Jetties (left) are similar to groins, but are used to keep sand away from shipping channels. This erosion-control method helps one area of the beach but hurts another area.

Breakwaters (left), are promising solutions to the problem of beach erosion. Some people object to the way breakwaters block views of the ocean.

Another way to restore beaches is to pump lots of sand onto them through a process called "beach nourishment." Just as food nourishes bodies, the sand, taken from deep in the ocean or construction projects, helps to build up the beaches. This process is expensive and, because erosion continues to remove the sand, beach nourishment must often be repeated after several years.

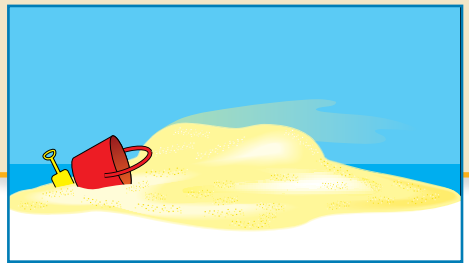
Seawalls (left), made of concrete, rock, steel, or wire cages filled with pebbles, are built in many places to slow down the effects of erosion.

Case Study 3: Landslides

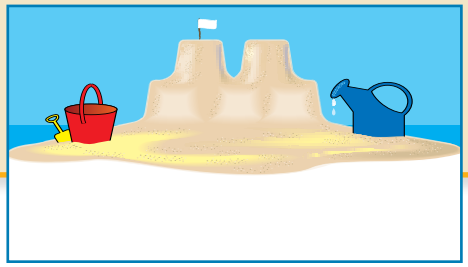
A Case of Gravity and Water

A landslide is the sliding downhill of loose rocks and soil. Landslides occur when gravity pulls on rocks and soil. You can see from the picture how a landslide has left a huge scar that will quickly lead to further erosion. Landslides happen when the forces holding soil or rock together are smaller than the force of gravity pulling them down. For example, fires sometimes burn the trees and brush on steep mountains. The roots of the trees and brush help hold the soil in place. Once they are gone, the soil and rocks slide down the slope.

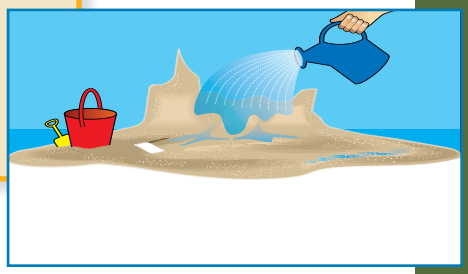
Once a landslide has occurred, the rate of erosion by water, gravity, and wind speeds up. Erosion leads to more erosion. Rain can get into rocks and cause them to become unstable. When unstable rock and soil get wet, they get heavier. The force of gravity pulls them more strongly. Land often moves more after a soaking rain.



As a child, you may have experienced the effects of a landslide yourself. If you try to build a sand castle with very dry sand, the sand tumbles downhill as it is pulled by gravity.



When you use moist sand, the sand particles stick together and the sand castle remains sturdy.



If too much water is added to the sand, the sand will become fluid-like, and it will flow downhill. The extra water strains the forces holding the sand together, and then gravity pulls the sand downward.

friction: a force that resists motion.

Laguna Beach Landslide

In 2005, the Laguna Beach landslide in California destroyed at least 11 homes. Many people were evacuated. However, this landslide could have been predicted, according to many people..

The landslide occurred because heavy rain from months earlier accumulated in the ground. This wetness reduced **friction** between the rocks the homes were built on and the underlying ground. Water accumulated in layers deep beneath the surface. If the water content of soil becomes high enough, the soil will flow like a fluid. At the Laguna Beach location, the soil deep beneath the surface became fluid-like and began to flow downhill. Drier soil and rocks from upper layers and the surface were carried along on top of the flow. This caused the landslide to push and batter homes in its path, instead of flowing around them.

Landslides happen on steep slopes. Builders in Laguna Beach should have studied the conditions before building homes in the area. But, many of the houses in this area were built before current building laws were in place. There are a lot of areas in Southern California that have conditions similar to those in Laguna Beach.

The steep slopes and rainstorms in the coastal town of Laguna Beach, California, have resulted in serious landslides, as many people anticipated. After the landslide of 2005, over a thousand people were evacuated from 500 homes and much property was destroyed or severely damaged.

Case Study 4: The Dust Bowl

Erosion Caused by Wind

The Dust Bowl occurred in the middle region of the United States, including areas of Kansas, Texas, and Oklahoma. The Dust Bowl was the name given to a 10-year period of drought that occurred in the 1930s. During this time, many people suffered great hardships, and many died.

The Dust Bowl happened because people came to the area known as the Great Plains and started plowing and farming the land. This land was not ideal for farming, but the settlers did not understand this. They did not know how to farm the plains and did not understand the effects farming could have on the land.

Before the Civil War, when settlers first passed through the Great Plains, the area between the Mississippi River and the Rocky Mountains was dry. It did not seem worth staying there, as there was no gold to be found, and the land could not be farmed. These early settlers continued on to the west coast. On old maps, they called this area "The Great American Desert."

Settlers began arriving again in the 1880s, after a period of exceptionally heavy rains. The plains were bursting with tall grass and appeared to be ideal for farming. Few people remembered how dry the plains had been just 20 years before.

People mistakenly believed that farming itself would cause more rain to fall. They also thought that building railroads and bringing in electric wires would cause more rain to fall by changing the natural electric cycles of the air. In the 1890s, there was a short drought, but soon the rains came again. It seemed like rain was normal and droughts were unusual.

In the 1930s, the drought returned, and it stayed for 10 years. The farmers had broken up the prairie soil and plowed under the native grasses. They then planted wheat. But the wheat could not survive in a drought like the grasses could. When the wheat died, its roots no longer held the soil in place. Farms turned into deserts covered with blowing sand. Huge dust storms whipped millions of tons of soil into the air. Dust storms blew soil from Kansas all the way to New York City.

Cattle were found dead in the fields with two inches of dust coating the insides of their stomachs. People coughed up clumps of dirt from the dust they had been breathing. Many of the people left the area looking for a better life somewhere else. They became known as "Okies" since many of them came from Oklahoma. A reporter, writing about one of the

drought: a long period of dry weather with very little or no rain.

largest dust storms, called the area the "Dust Bowl," and the name stuck. The wind blew fertile topsoil away. Even today, this area has not completely recovered. Unfortunately, the Dust Bowl could have been avoided if the settlers had recalled the dry history of the area, had used different farming methods, and had not overplowed and overgrazed the land.

The Dust Bowl is the name given to the area of huge dust storms caused by many years of drought in the 1930s. The lack of rain, along with the plowing under of the prairie soil in the Great Plains, including Kansas, Oklahoma, and Texas, caused millions of tons of soil to blow into the air. Thousands of farms were abandoned, and many people lost their homes and suffered many illnesses from all the dust and dirt in the air. The effects of the Dust Bowl are still felt today in the Great Plains, where erosion caused by the dry winds blew away much of the fertile topsoil.