

WHAT'S GOING ON WITH OUR BEACHES?

COASTAL EROSION

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WHERE DOES ALL THE SAND GO ?

Sunshine State Standards: SC.D.1.4.1, SC.D.2.4.1
SC.H.1.4.1, SC.H.2.4.1
SC.H.2.4.2

Objectives

Students will gain a basic understanding of beach erosion and its causes.

Materials

Stream table, wooden block, sand, ruler, watch with second hand (for investigation)

Procedure

Lecture on beach erosion will provide background information that students need to conduct investigation.

Activity

- Part A: Students will take notes on first half of beach erosion lecture. Followed by discussion and oral quiz.
- Part B: Students will write a paragraph on what they learned from lecture.
- Part C: Continue lecture until complete. Students then list at least five causes of beach erosion and explain how each factor contributes to that erosion. Discuss solutions to prevent or curb beach erosion.
- Part D. Students conduct Beach Erosion Investigation using sheet attached. Work in pairs and write lab report of finding.

Assessment

Grade paragraphs and lab reports.

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SESSION 1

OBJECTIVES/GOAL: To give students a basic understanding of the concept and process of beach erosion.
To discuss some of the causes of beach erosion.

TEACHER ACTIVITY	STUDENT ACTIVITY	GOAL	EVALUATION	TOOLS
Discuss concept and process of beach erosion	Write a paragraph on what students learned from the discussion	To learn how beaches erode	Turn the paragraph in for extra credit	
Discuss the causes of beach erosion		To learn some of the causes of beach erosion		

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SESSION 2

OBJECTIVES/GOAL: To discuss some of the causes and effects of beach erosion.
To explore some solutions to beach erosion.

TEACHER ACTIVITY	STUDENT ACTIVITY	GOAL	EVALUATION	TOOLS
Review Session 1 by asking students questions	Ask questions about Session 1	To reinforce the importance of knowing about beach erosion	List five or more major causes of beach erosion	
Discuss causes and effects of beach erosion	Write a paragraph on what they learned from the discussion.	To learn about the causes and effects of beach erosion	Ask students to explain how these causes contribute to beach erosion	Complete "Beach Erosion Investigation" project
Discuss solutions and things students can personally do to help overcome beach erosion	Come up with additional solutions to help stop beach erosion	To gain knowledge and think creatively about possible solutions		

BEACH EROSION INVESTIGATION

This activity is taken from Earth Science Source Book Phase II: A Guide to Earth Science Activities and Resources (Columbia: Center for Science Education, University of South Carolina).

Purpose

The purpose of this investigation is to determine the effects of gentle and strong waves on beach erosion.

Materials

Stream table or other large rectangular container
Wooden block (example: 4" piece of 2x4)
Sand
Ruler
Watch or clock with second hand

Procedure

1. Tape or plug the drain of the stream table.
2. Pour approximately 2.5 cm of water into the container.
3. Add clean sand to one end to stimulate a beach
4. Sketch Beach Profile 1.
5. Place block in end of stream table opposite the beach.
6. Move block very slowly to create small waves for 3 minutes. The waves should be just large enough to move the sand a little bit.
7. Observe the sketch Beach Profile 2.
8. Leave new beach in place.
9. Move block more rapidly to create large waves for 3 minutes.
10. Observe and sketch Beach Profile 3.

Observations

Beach Profile 1 Beach Profile 2 Beach Profile 3

1. What differences are there between how a small and large wave erode a beach?
2. What differences would you expect in the profile of a beach in summer and winter?
3. What other factors might effect beach erosion?

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SESSION 1

OBJECTIVE/GOAL: To give students a basic understanding of the concept and process of beach erosion.
To discuss some of the causes of beach erosion.

Key Concepts:

- Beaches are the most common shore forms in the United States. Beaches are gentle slopes covered with loose sediment. The sediment particles, ranging from fine silt to coarse gravel or cobbles in size, are moved by wind and water to form the typical beach.
- Erosion is the wearing away, or corrosion, by which material is taken away from the earth's surface. Most erosion results from the combined activity of several factors: heat, gases, water, wind gravity and plant life.
- It is a fact that beaches erode. This is considered a problem in many coastal communities. However, the process of erosion is what created beaches in the first place. When oceans first covered the surface of the earth millions of years ago, there were no beaches. There were only rocky shores. Over the course of millions of years, these solid stones were broken down into rocks, which in turn were broken down into pebbles and then into gravel and then into sand. Rivers also carried down silt and sand from the mountains and deposited these into the oceans and seas of the world.
- The ability of water to move material depends on its speed. Large waves or fast-moving currents can carry larger quantities and heavier littoral drift. Material picked up from inland heights, from river beds and banks, and from shoreline areas is deposited wherever the water is slowed down, and it may be picked up again when the velocity of the water increases. Growing shores are fed or "nourished," by material that has eroded from somewhere else. Often, attempts to reduce erosion and build up one area will result in reduced deposition elsewhere, "staving" another shoreline. Erosion and accretion are two faces of the same process, which may either occur at extremely slow rates or make dramatic changes in the shoreline within a human lifetime.
- Currents can make and break the shore, depending on the circumstances. There are two main types of currents that shape the beaches: longshore and nearshore currents (also called rip tides). Longshore currents develop when waves hit the beach at non-90-degree angles. The current moves in the direction in which the waves crash parallel to the shore. Longshore currents develop on long and straight beaches. These currents carry loose sand grains down the shore to deposit them in

slow moving areas. These currents can sometimes wash away great quantities of sand when the conditions are right. Nearshore currents are created when waves hit the beach at 90-degree angles. These currents flow perpendicular to the beach in the seaward direction. They are very strong and narrow. These can also carry away large quantities of sand.

- Under normal conditions, the sand level on any beach rises and falls throughout the year. During the wet, rainy season, waves pull sand offshore onto sandbars and other offshore locations. The beach is then slowly replenished to its proper level during the dry season, when sand is pushed back onshore by steady wave action. On a normal healthy beach, waves are capable of moving up to one million cubic yards of sand per year.
- Changes in high and low water levels due to seasons, tides, storms, droughts or floods can expose new surfaces to erosion. Seasons and storms, which affect the movement and level of water and the strength and direction of wind, alter patterns of erosion and deposition. Storms whip the water into waves higher than normal, resulting in rapid erosion of vulnerable areas and propelling stones or other debris onto shore with unusual force. As seasons turn, wind strength and direction also change, altering the path of waves and currents and resulting in new areas of erosion or accretion. Where ice forms, it reduces wave actions, which may slow erosion and at the same time it exerts tremendous horizontal and vertical forces that may weaken structures on the shore. Winter freezes and spring thaws affect rivers, streams and lakes, changing their water levels and the speed of currents.
- During a storm, a beach yields to the water sand it has been storing in the dunes. The waves carry the sand to the sea and deposit it on the ocean floor. During calm periods, erosion reverses. The sand is moved slowly landward by the orbital motion of gently waves. The ocean currents and waves keep the beach in perpetual motion.
- Most of the sand movement about a beach occurs in and just beyond the surf zone: waves and currents hold particles of earth in suspension until the weight of the particles causes them to sink. As every wave breaks on the beach, a thin layer of sand is carried along. When the wave retreats, the sand is taken back to the surf zone. After a storm, a vertical cut in the high point of the beach (the berm) and a steeper, sloping beach face show that large waves have claimed a great deal of the shore. The energy and steepness of a large wave has more power to hold more sand particles in suspension and take sand off the beach than smaller waves. Calm seas, although they have a certain energy level, tend to leave more sand on the berm than they carry away to sea.

- The shape of the shoreline is a factor in the erosion process. The parts of the shore that extend into the water are more vigorously attacked than the shoreline of inlets or bays. Incoming waves tend to bend around these peninsulas, headlands, extended beaches or seawalls and concentrate their energy on the front and sides of the area. Extra protection or reinforcement is often needed on these exposed parts of the coast.
- Sea levels determine where the waves will break. But, to a great degree, the sun determines how they break, because it is the sun that warms the air to generate the winds that power them. Breaking waves transfer solar energy to the coastline. The size of the waves depends on how fast, how long and over what distance or fetch, the wind has blown. The harder, longer and farther the wind blows, the bigger the waves.
- The closer they are to the wind that made them, the choppiest the waves are. As they spread out and calm down, they become more regular and are known as swells. When waves move into shallow water, water at the surface moves faster than water caught up in the friction of the bottom. The waves steepen and become unstable. When the water is only a little deeper than the height of the wave, the waves break, releasing much of its energy to reshape the beach.
- The backshore is bordered on the inland side by dunes that are formed by the wind blowing sand along the beach until it meets an obstruction. The carrying power of wind is much less than that of water and even a small obstruction can result in a significant deposition.
- The existence of cliffs on a coast indicates that erosion is taking its toll on the beach. Waves hurl themselves at the cracks in the cliff wall. The pressure of the water and the compressed air creates a wider crack, causing the earth to break off into pieces. More waves grind the pieces of earth together to make sand. The chemical reaction of salt water and oxygen breaks down rocks, which come into contact with seawater.
- Earthquakes and other geological disasters can dramatically change beaches over a course of hours, or even minutes. If an earthquake occurs somewhere in the ocean, a huge wave ("Tsunami") as high as 30 feet can result. One such wave can wash away great amounts of sand and damage entire towns and coastal communities.

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SESSION 2

OBJECTIVE/GOAL: To discuss some causes and effects of beach erosion.
To explore some solutions to beach erosion.

Key Concepts:

- What is a Beach and what does it do? The U.S. Environmental Protection Agency (EPA) defines a beach as “the area of unconsolidated material, such as sand, pebbles or rocks that extends landward from the low water line to the place where there is marked change in material or physiographic form, or to the line of permanent vegetation (usually the effective limit of storm waves).” In other words, a beach is the sandy, pebbly or rocky shore of a body of water.
- The beach is the boundary between the water and the land; it is an area for human settlement and agriculture. Our beaches form the shapes of bays and harbors and provide fresh water for coastal towns. The beaches of the US and the rest of the world are teeming with economic and ecological growth. The United States has 19,000 miles of beaches, 500 miles of which have been set aside in ten National Seashores. Each National Seashore is protected by its own legislation and managed by the National Park Service.
- The beach provides a unique habitat for a variety of plants and animals. For example, 75 percent of migratory waterfowl live in or depend on coastal beaches during their life span. Dune vegetation provides nesting areas for several kinds of birds and animals. The types of species found on a beach are determined by the type of beach. In the hot, wet climate of the tropics, mangrove trees dominate estuarine or lagoonal beaches. In the harsher climate of New England, beaches are dominated by a few species of hardy grasses and bushes that can withstand strong winds, cold winters and intense summer sun.
- The beaches of the world are the continents' defense against the rising sea. The coasts can absorb the storms by changing their shapes and then rebuilding themselves during periods of gentle waves. Human activity, however, interferes with the natural cycles of the ocean. When ground water is over pumped and sedimentation interferes with ground water and rivers, subsidence occurs and the land begins to sink. The more populous a region becomes, the more likely subsidence will occur. America's population is growing by about 2.6 million people every year. Where humans interfere with river systems, sediment shoots past lowlands and is taken out to sea or blocked upriver, creating more severe shoreline

erosion and a relative increase in sea level. The heavy development of beach resorts and other coastal areas means that few wetlands have the means and time to slowly reestablish themselves upland.

- When communities are first built, there may appear to be few problems. The beach tends to shield people and houses from the raging waters during storms and hurricanes. After a time, however, the beach can wear out. Beaches became narrower and water can wash away whole houses. No one is sure why beaches erode only at certain times. Pessimists say that the world's beaches are disappearing. Optimists say that beaches are actually becoming wider in the process. The fact is that both are correct. When beaches erode in one place, they grow in another. It is part of a natural cycle. Everything grows, falls apart and then grows again. Same is true with beaches. No one knows for sure what determines the cycle, but it does happen. When some areas were first settled, the beaches were extremely wide, making them attractive locations for living, swimming, fishing, surfing or any number of activities. Over 75% of the US population lives within 100 miles of a beach.

- Beaches are an important part of the complex and dynamic coastal watershed. Lake, river and ocean beaches are America's top vacation choices. We take almost two billion trips to the beach each year and spend billions of dollars in beach communities. Although inadequate protection or overuse of beaches can lead to their alteration or destruction, some simple actions can be taken to protect these valuable systems.

- Coastal erosion is caused by something or someone influencing natural sand flow. Mining of beaches and the construction of man-made structures create an enormous impact on coastal erosion by preventing natural sand flow and the replenishment of beaches. Man-made structures have an adverse affect on the coastline. Building a dam or any man-made structure can prevent sand flow to a beach.

- One of the leading causes of beach erosion has been greenhouse warming. Greenhouse gases such as carbon dioxide, nitrous oxide, methane and chlorofluorocarbons are generated by human activity, like the combustion of wood and fossil fuels. These gases are accumulating in the atmosphere and trapping the sun's radiation heat. Trees around the world are also being cut down in massive quantities, leaving fewer forests to recapture the chief greenhouse gas, carbon dioxide. Global warming occurs as a result of carbon dioxide being released into the environment and the temperature within the earth's atmosphere slowly increasing, thereby causing glaciers to melt and the sea level to rise. As the water level rises around the world, new land is exposed to wave action and erosion. The increasing concentrations of greenhouse gases in the atmosphere are likely to raise the average temperature of the earth by 2.5 to 5.5 degrees Celsius over the next century.

- After the last ice age, the rapid melting of glaciers rapidly raised sea level. That melting tapered off about 6,000 years ago and sea level – compared to land – became fairly stable. However, over the past century, sea level over much of the United States has risen by 25 to 30 centimeters relative to land, according to Jim Titus, the EPA's project manager for sea level rise.
- The level of the sea is also expected to rise with warming seas and the melting of polar ice caps. The EPA estimates that seas could rise anywhere from half a meter to two meters by the year 2100. Such a rise in sea level would result in widespread economic, environmental and social disruption.
- Coastal erosion is a serious national problem with long-term economic and social consequences. All 30 states bordering an ocean or Great Lake have erosion problems and 26 are presently experiencing net loss of their shores.
- As seas continue to rise, the risk of flooding has increased, as storm surges become more severe. Beach erosion, another implication of sea level rise, will accelerate because rising sea levels cause the offshore bottom to rise, which prevents sand from returning to the dry part of the beach when it is eroded during a storm. James Titus estimates that a 20-foot rise in sea level will erode beaches by 100 to 200 feet unless efforts to nourish the beaches are expanded.
- Beach erosion is a global problem that depends and fluctuates depending on the local conditions and morphologic process in a particular area. As humans have built permanent structures on coastlines, coastal protection has become necessary to protect building and industry, while preserving features such as beaches and inlets.
- Coastal protection projects help stabilize a coastline. Having a knowledgeable professional can help to ensure successful protection against erosion. Badly designed or improperly installed devices to help stop the erosion maybe worse than nothing at all. They may actually accelerate erosion. Changing the ways in which the shoreline can be used may actually create an eyesore. One option to help stop erosion is to build structures such as jetties and groins perpendicular to the shoreline to trap in the sand.

Solutions To Beach Erosion:

Why Restore Eroded Beaches? Beach erosion threatens the very resource that residents and visitors enjoy. Fifty percent of Florida's beaches are experiencing erosion. At present, about 299 of the state's 825 miles of sandy beaches are experiencing "critical erosion," a level of erosion which threatens substantial development, recreational, cultural or environmental interests. While some of this erosion is due to natural forces and imprudent coastal development, a significant amount of coastal erosion in Florida is directly attributable to the construction and maintenance of navigation inlets. Florida has over 60 inlets around the state, many have been artificially deepened to accommodate commercial and recreational vessels and employ jetties to prevent sand from filling in the channels. A by-product of this practice is that the jetties and the inlet channels have interrupted the natural flow of sand along the beach causing an accumulation of sand in the inlet channel and at the jetty on one side of the inlet and a loss of sand on the beaches on the other side of the inlet.

One way to restore eroded beaches is through beach nourishment. In a typical beach nourishment project, sand is collected from an offshore location by a dredge and is piped onto the beach. A slurry of sand and water exits the pipe on the beach and once the water drains away, only sand is left behind. Bulldozers move this new sand on the beach until the beach matches the design profile. Beach nourishment is a preferred way to add sand to a system which has been starved by the altered inlets because it provides a significant level of storm protection benefits for upland properties and is the least impactful to the coastal system. An additional benefit of beach restoration projects is that they quickly restore shorebird and marine turtle habitats.

□ Possible Action Steps:

1. Reduce the amount of carbon dioxide released into the atmosphere.
2. Dredging – taking sand from off-shore locations (beach nourishment).
3. Build Groins – structures that lay perpendicular to the shoreline and slow the transport of sand along the shoreline.
4. Breakwaters – reduce the wave action in harbors.
5. Sand dunes – store sand and reduce the energy of storms.

□ What You Can Do:

1. Make yourself aware of the problem. Most people do not realize that there is a problem.
2. Try to reduce the amount of carbon dioxide and other harmful gases released into the atmosphere.
3. Write to Congress, asking that your representatives study the problems seriously and enact appropriate legislation.

SOURCES USED

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NOTE: See Diagram of US Coastlines and Florida Coastline, indicating erosion zones.

Gather photographs of a Normal Beach and an Eroded Beach