Grade 6 Activity

Science skills

- Hypothesizing
- Experimenting
- Observing
- Deducting

Concepts

- Currents, waves, and wind move sand along the coast of California.
- Human-built structures alter the natural movement of sand along beaches.

California Science Content Standards

2. Topography is reshaped by weathering of rock and soil and by the transportation and deposition of sediment. As the basis for understanding this concept:
2.a. Students know water running downhill is the dominant process in shaping the landscape, including California's landscape.
2.c. Students know beaches are dynamic systems in which the sand is supplied by rivers and moved along the coast by the action of waves.

Objectives

Students will:
1. Describe the forces that naturally shape California's beaches.
2. List the benefits and risks of human-made structures that alter coastal bluffs and beaches.

Time to complete

One hour 15 minutes

Activity 6.2
Shifting Sands

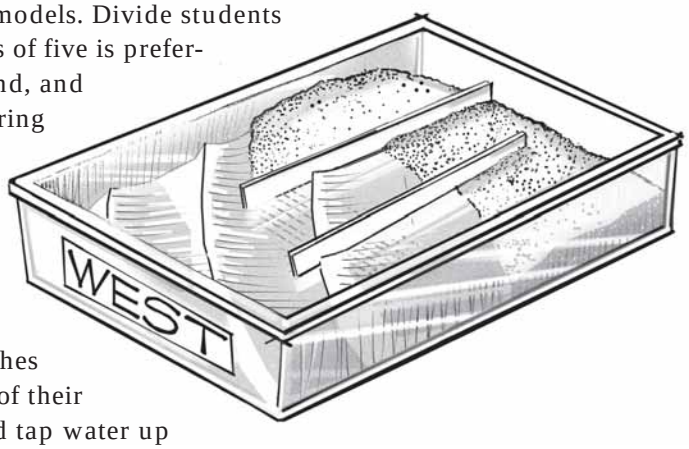
The ocean is constantly in motion, and nearshore currents carry sand and sediment along with them. Structures we build to protect the coast from erosion can change the shapes of beaches, for better or for worse!

Activity

1. Have students read background material from "Background and Model Instructions" worksheet (allow 10 minutes or so).

2. Lead whole class discussion on beach erosion, cliff erosion, and the protection of beachfront property. Describe the processes that create beaches. (*Wind, waves, currents bring sand to beaches; currents and waves move sand along the coast*). What types of structures do people build to protect their coastal property? (*Groins, rip-rap, seawalls.*) What happens when you disrupt the natural flow of sand along our coast? (*Some beaches are built up, while others get smaller. Smaller beaches increase the risk of erosion of coastal cliffs and bluffs.*)

3. Following instructions on worksheet, guide students in building the models. Divide students into small groups (groups of five is preferable). Distribute pans, sand, and rulers. Students should bring a pencil and unlined paper to their group. Students use tape to label the shorter sides of the pan "East" and "West." Students pour up to 4 inches of sand into the east end of their pans, and then gently add tap water up to 2 inches deep on the west end of the pan.



4. Students fold their paper into fourths. Using one section labeled *Diagram #1*, students draw their experimental models.

5. Student #1 uses a ruler to create a gentle wave action in the pan, in a general west-to-east movement.

6. Each student draws how the model appears after wave action (label it *Diagram #2*). What are the effects of erosion? How has the coastline changed as a result of the wave action?

7. Student #2 positions the sand in its original model configuration. Student #3 sets two to three rulers on-edge into the sand lengthwise about 4 inches apart, representing groins. Student #4 uses a ruler to create the same gentle west-to-east wave movement. What happens in between the groins? What happens to the shoreline? Students draw *Diagram #3*. Now, Student #5 makes waves coming from the northwest.

Mode of instruction

Whole class discussion followed by small group hands-on activity.

Materials

1. 12-inch rulers (4 for each group)
2. Rectangular pans or plastic bins (9" or 12" deep, more than 12" long, one for each group)
3. All-purpose sand (79 lb. Bag)
4. Tap water
5. Overhead projector
6. Photocopies of "Shifting Sands Background and Model Instructions" worksheet, one per student
7. Overhead transparency, "Groins and Jetties"

Preparation

Collect materials for beach models. Photocopy overhead transparency "Groins and Jetties," and "Shifting Sands Background and Model Instructions" worksheet.

Outline

Before class

1. Gather materials for the number of groups (five students per group).
2. Photocopy onto overhead transparency "Groins and Jetties." Photocopy "Shifting Sands Background and Model Instructions," one for each student (two pages).
3. Prepare a beach model on your own to determine how much sand needs to go into the pans you have, and experiment with making waves. Prepackage the appropriate amount of sand into sealable plastic bags—about two cups, depending on size of pan.

During class

1. Lead whole class discussion on beach erosion and the effects of groins, jetties, and cliff protection structures.
2. Divide class into small groups (five students per group).
3. Distribute materials to each group. Describe how to label the model and how to create waves.
4. Have students illustrate their results.
5. Display and discuss overhead transparency.

Do beaches in between the groins change? Students draw *Diagram #4* to indicate how the beaches look after completing this wave action.

Results and reflection

1. Display the overhead transparency of the beach images with groins and jetties. Ask students what they think are the forces at work here. (*Currents, waves, actions of waves hitting a vertical surface, water carrying sand in suspension*).

2. Compare and contrast jetties with groins. *(Groins protect beaches from getting washed away by waves and currents. Jetties help to protect inlets and harbors from filling up with sand moving along shore. Both jetties and groins can be constructed of rock. Both affect beaches to either side.)*

3. Discuss social and political aspects of building beach protective structures on public and private land. What happens if a beachfront homeowner wants her or his beach to be larger, because she or he is concerned the home is threatened by waves, and builds a groin to nourish the beach? The homeowner's property is located north of a public beach, and the longshore current goes north to south. What will happen to the homeowner's beach? What will happen to the public beach? Should he or she be allowed to build the groin? Who will be responsible for the loss of the multi-million dollar home if the groin is not built and the waves destroy the home and property? How could this situation have been prevented? *Note: in most cases, a California homeowner would not be permitted to construct such a groin.*

Conclusions

Currents, waves, and wind determine movement of sand along our coast. Structures we make to protect beaches may have unintended effects. Living on the coast requires cooperation and compromise.

Extensions and applications

Hold a classroom discussion or have students write research papers on the following topics.

- What are the effects on the coast due to the armoring of coastal cliffs that normally would be eroding?
- Rules, regulations, and laws govern the construction of groins, jetties, and concrete cliff barriers. How can we balance public safety and recreation needs with needs of private property owners?
- What are the benefits and risks of building on coastal cliffs and bluffs or beaches? How can we allow the natural forces of accretion and erosion to occur with minimum disturbance to human-made structures?

Adapted from

Erosion Creates a Change in the Landscape, from Consortium for Oceanographic Activities for Students and Teachers (COAST). Walker, Sharon H. and Kimberly Damon-Randall (Senior Editors) and Howard D. Walters (Associate Editor). 1998. Oceanography and Coastal Processes Resource Guide. Institute of Marine Sciences, J.L. Scott Marine Education Center and Aquarium, administered by The University of Southern Mississippi, Biloxi, Mississippi.

Additional resources
www.wsspc.org/tsunami/CA/CA_survive.html
www.epa.gov/owow/estuaries/coastlines/dec99/lossmaui.html

Shifting Sands: Groins and Jetties

Jetties are built to protect the entrance channel to a harbor so boats can enter and leave safely, as well as to stabilize the entrance. In California, beaches upcoast of jetties are usually larger than beaches downcoast of them. Why?

Most piers are built on pilings, large poles sunk into sediment or rock underwater. Most piers allow sand to flow underneath them; the pier in the middle of this photograph does not affect the flow of sand. However, the solid groin at the end of the sandy beach does.

The scalloped shape of the beaches shown in this image from southern California reflects the result of many groins built to protect sandy beaches.

What happens to sea cliffs when protective sand beaches aren't present?

Shifting Sands
Background and Model Instructions

Glossary

Seawall: a structure built on a beach, often made of concrete, parallel to shoreline, designed to protect buildings from the action of waves.
Revetment or rip-rap: A structure consisting of large rocks or other materials stacked in front of an eroding cliff, dunes, or structures to protect from wave attack.
Groin: A structure built perpendicular to the shoreline designed to trap sand moving along the shore due to the longshore current. A groin or group of groins usually extend to the end of the surf zone and are used primarily to replenish or stabilize beaches.
Jetty: Structures built in pairs that extend further into the ocean than a groin, to stabilize a navigation channel and keep the water calm for harbor entrances. The construction of both groins and jetties severely affects the flow of sand moved by the longshore current, depriving downstream beaches of sand.
Beach nourishment (replenishment): the process of moving sand from the offshore continental shelf or inland areas and depositing it onto the beach. Sand is dredged from the offshore shelf, often a mile or so from shore, and is loaded onto a barge which carries it close to the shore. The sand is sprayed onto a beach with the intent of widening the beach and increasing its height. The process of beach nourishment can be expensive, and it works best when the sand will stay in place for a long time. In some areas, winter storms have removed the sand added by the nourishment process within a single year.

Background

The ocean is in constant motion, fueled by currents, winds, tides, and waves. Every time you visit California's coast, you witness the effects of the powerful forces of ocean waves and currents (whether or not you can see them at the time). Currents usually can't be seen from the surface, but you can see waves as they break on the beaches, cliffs, or just offshore over submerged reefs. The word "wave" is used to describe an actual swell of water, as well as energy that moves through water.

Tsunamis. Waves can be caused by wind, undersea volcanic eruptions, or earthquakes, though most waves are caused by wind. Those caused by volcanic activity or earthquakes are called "tsunamis." A tsunami is a series of sea waves most commonly caused by an earthquake beneath the sea floor. In the open ocean, tsunami waves travel at speeds of up to 600 miles per hour. As the waves enter shallow water, they increase in height. The waves can kill and injure people and cause great property damage where they come ashore. The first wave is often not the largest; successive waves may be spaced many minutes apart and continue arriving for a number of hours.
Since 1812, the California coast has had 14 tsunamis with wave heights higher than three feet; six of these were destructive. The worst tsunami resulted from the 1964 Alaskan earthquake—it caused twelve deaths and at least $17 million in damages in northern California. Evidence suggests that large earthquakes capable of producing large tsunamis recur every two or three hundred years (California OES Earthquake Program, Earthquake Education Center, Humboldt State University). For information on what to do in case of tsunami, check this web site: *www.wsspc.org/tsunami/CA/CA_survive.html*

Surface Waves and Currents. Though both are powered by wind, waves and currents are different from each other. Waves transfer energy across the ocean surface from one part of the ocean to another. Surface currents are powered by the frictional drag of the wind on the ocean's surface, can be swift, sustained, and river-like, and are responsible for mixing water and transporting sediments and nutrients long distances. Surface currents are quite regular, and are

formed in conjunction with major global wind patterns, whereas surface wave direction and velocity are affected by changing winds during storms and vary widely. As waves transfer the energy to the sea surface, the ocean water moves up and down, like a float bobbing on the water. The stronger and longer the duration of the wind, and the greater the distance over which it blows, the larger the waves. When a wave enters shallow water, it starts to feel the ocean floor and the lower part of the wave slows down while the upper part continues until it topples over. This is when it "breaks" on the beach. Breaking waves (or "breakers") also stir up sand and move it onto the beach.

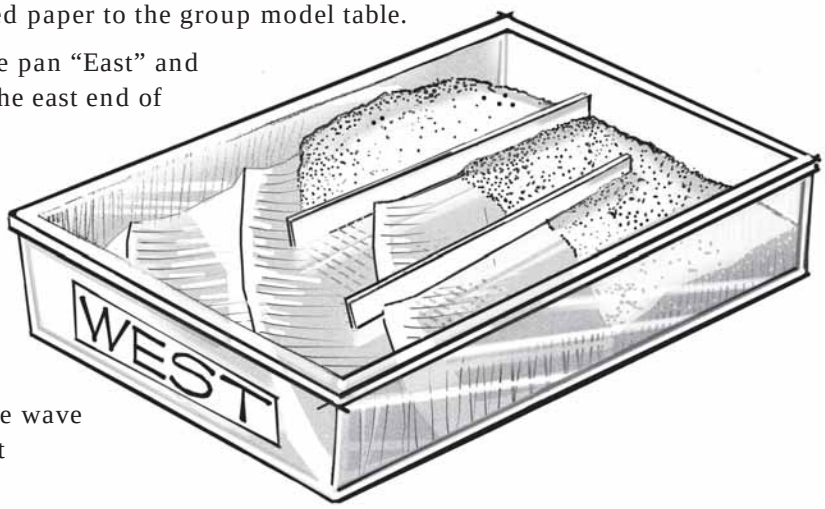
Erosion, Transport, and Deposition. Currents and waves also move sediments along the shoreline. Removal of the sediments is called *erosion*. Movement of the sediment is called *transport*. When the sediments settle out on a beach, it is called *deposition*. During storms, waves and currents have more energy and more sand is removed. *Coastal erosion* is a natural process that occurs as cliff, bluff, or beach erosion. Coastal erosion is a fact of living on the coast, though many people (usually home and business owners who have valuable ocean front property) see it as a problem that must be contended with. Deposition causes some harbors to be filled with sand, and they then must be dredged regularly.

Building Beaches. Coastal engineers can "build" the size of their beach by constructing groins. An unfortunate side effect of jetties and groins happens on the beaches downcurrent of the structures. As the water moves with the longshore current, it carries sand with it. The water and sand hit the side of the groin, and the sand builds up on the beach that is upcoast of the jetty or groin. But, this means that the beach on the other side of the jetty or groin gets less sand, as the sand is stopped by the groin. What property owners do on their property can affect beachside property nearby and even public beaches.

Building a Beach Model

1. Each student brings a pencil and unlined paper to the group model table.

2. Using tape, label the shorter sides of the pan "East" and "West." Pour up to 4 inches of sand into the east end of the pans.



3. Gently add tap water up to 2 inches deep on the west end of the pan.

4. Fold your paper into fourths. Draw experimental model on one section and label it *Diagram #1* (use one-fourth of the paper).

5. Student #1 uses a ruler to create a gentle wave action in the pan, in a general west-to-east movement.

6. All students draw how the model appears after wave action (*Diagram #2*). What are the effects of erosion? How has the coastline changed?

7. Student #2 positions the sand to its original model configuration. Student #3 sets two to three rulers on-edge into the sand lengthwise about 4 inches apart, representing groins. Student #4 uses a ruler to create the same gentle west-to-east wave movement. What happens in between the groins? What happens to the shoreline? Draw *Diagram #3.* Now, Student #5 makes waves coming from the northwest. Do the beaches in between the groins change? All students draw *Diagram #4* to indicate how the beaches look after completing this wave action.