Beach Erosion

Name:
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http://whyfiles.org/091beach/index.html

1. Why did the Cape Hatteras lighthouse have to be moved?
2. List 3 effects of coastal erosion that are threatening coastal residents.
3. What factors cause beaches to move?
4. What is a barrier beach?
5. What is beneficial about glacial landform erosion?
6. List four things cause beach-erosion at the coast?
7. What does global warming have to do with coastal erosion?
8. What are some of the drawbacks of localized solutions to beach erosion?
9. What are four examples of places with extensive coastal erosion problems?
10. Why do some beaches in Southern California now have bare rock?
11. How does the speed of geologic change caused by beach erosion compare with the speed of geologic change caused by continental drift?
12. When are beaches susceptible to the most beach erosion?
13. What are three sources of sand for beaches?
14. How does a beach protect the coast?
15. What is the drawback of seawalls?
16. Why does sand accumulate on the updrift side of a groin?
17. What is the major drawback of groins?
18. What are two cons to using "beach nourishment"?
19. How do breakwaters work to prevent beach erosion?
20. A submerged breakwater acts similarly to what natural feature?

Beach Erosion

Invited to the house-warming?
If you need some second-hand boxes, the Cape Hatteras Lighthouse is the place to look. After all, the 208-foot tall landmark was just hauled more than a quarter-mile back from its former perch, where it was threatened by the encroaching sea. And the end of every big move, we know, is signaled by a curbside littered with cardboard.

The lighthouse went a'truckin' after coastal erosion chewed away about 1,300 feet of beach, bringing the waves to within 150 feet of the 4,800-ton sentinel. When the light was erected in 1870, it stood about 1,500 feet back from the waves.

The lighthouse, on the Outer Banks, North Carolina's long barrier beach, was built to warn ships from waters called "the graveyard of the Atlantic." Ironically, the move should serve as a warning about the growing problem of coastal erosion.

Erosion is not just plaguing the Outer Banks. Coastal residents up and down the United States are worrying about undermined cliffs, disappearing beaches, and the occasional dwelling diving into the briny.

Beaches are constantly moving, building up here and eroding there, in response to waves, winds, storms and relative sea level rise. Yet when commoners like you and me, and celebs like Steven Spielberg, build along the beach in places like Southampton, N. Y., we don't always consider erosion. After all, real-estate transactions are seldom closed during hurricanes or northeasters, which cause the most dramatic damage to beaches.

Yet Southampton, like all the barrier beaches that protect land from the sea, is vulnerable to obliteration by the very factor that makes it so glamorous: the sea. And the problem is increasing because the sea is rising after centuries of relatively slow rise, and scientists anticipate that the rate of rise will continue to increase in the next century. Land, in many places, is also slowly sinking. The result is a loss of sand that places the occasional beachside home inconveniently near -- or in -- the water.

Still, erosion cuts in two directions, says Jim O'Connell, a coastal processes specialist with the Sea Grant program at Woods Hole Oceanographic Institution. "Without the process of erosion, we would not have the beaches, dunes, barrier beaches, and the highly productive bays and estuaries that owe their very existence to the presence of barrier beaches." Erosion of glacial landforms provides most of the beach sand in Massachusetts, he points out.

A popular destination
The beach-erosion problem has many causes. Among them are:

- The desire to live near the sea.
- A historically rapid rise in average ocean levels, now estimated to be rising at about 25 to 30 centimeters per century in much of the United States.
- The gradual sinking of coastal land (since the height of the land and the sea are both changing, we use "relative sea level rise" to describe the rise of the ocean compared to the height of land in a particular location).
- Efforts to reduce erosion that have backfired and instead increased it.
- Global warming, which is expected to accelerate the rise in sea level.

The result is a threat to beaches and coastal communities around the world.
At stake is far more than a movie mogul's mansion. New Orleans, now several feet below sea level, would face a greater threat of annihilation. Island nations across the Pacific Ocean could disappear beneath the waves.

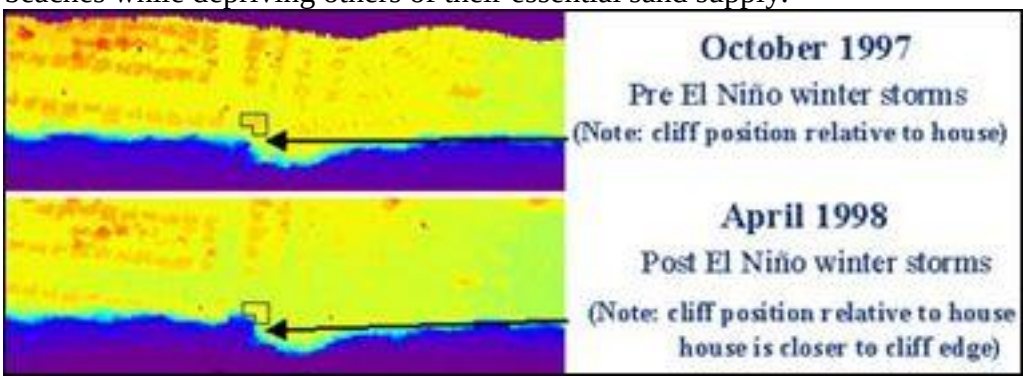
Millions of Bangladeshis, already exposed to typhoons that drown hundreds of thousands at a time, would have to find new homes in one of the Earth's most crowded nations.

The predictions growing out of global warming studies are unsettling. Much of Long Island's extensive barrier beach, including not just the homes of the rich and famous in the Hamptons, but also public treasures like the vastly popular park at Jones Beach, would be submerged if sea levels rise by three feet, according to a projection by the National Environmental Trust, a Washington, DC, advocacy group. (As we'll see later, a three-foot rise over the next 50 to 100 years is possible, but extremely unlikely, according to current predictions.) Coastal erosion is a knotty issue. Slowing global warming -- the ultimate cause for heightened concern about the future -- is proving problematic, to put it charitably. And many localized cures for erosion are worse than the disease. Some are "beggar-thy-neighbor" solutions that steal sand from one location to save another. Others are expensive Band Aids that pump sand from deep waters to the beach, where it immediately begins washing away.

A widespread problem

How extensive is the coastal erosion problem? Consider:

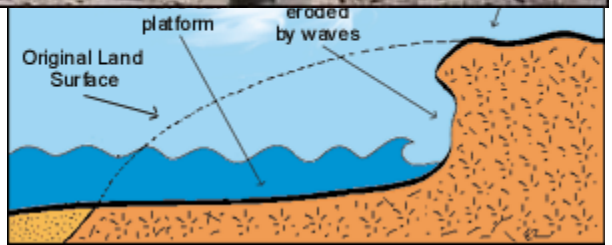
- During a 1992 storm, the Atlantic Ocean broke through a barrier island near Westhampton, N.Y., destroying about 190 of the 246 homes on the island. The breakthrough was blamed on structures designed to build up beaches that blocked the flow of sand along the shore. These so-called groins build up some beaches while depriving others of their essential sand supply.



- Seventy-two percent of coastal towns in Massachusetts are "exhibiting a long-term erosive trend," says O'Connell.
- Beaches in Southern California are losing vast amounts of sand, and some are down to bare rock. The beach sand came from river sediment, but damming and water removals have impeded that supply. One drastic solution, the removal of Matilija dam on the Ventura River, is under consideration, with twin goals of restoring trout to the ocean, and sand to the beaches around Santa Barbara.
- In Britain, the Observer magazine described, under the headline "Incredible Shrinking Britain," cliffside houses tumbling into the English Channel.
- In Galveston, Texas, more than 140 property owners entered legal limbo when beach erosion moved the public beach (defined as bare sand without vegetation) to their property.

A thin line of protection

All geology is about change. Continents, as we know, drift gradually around the globe. The ocean floor is being created



at the mid-ocean ridges and recycled beneath the crust at the margins. Mountains rise up and gradually erode back.

These changes are slow, inexorable, and usually gradual. The changes on a beach, in contrast, can happen literally overnight, at least during a storm. Even without storms, sand may be lost to longshore drift (the currents that parallel coastlines). Or sand may be pulled to deeper water, essentially lost to the coastal system. On the positive side, sand arrives from eroding uplands, river sediment, and longshore drift.
How's the beach this year? That depends on recent storms. To paraphrase Heraclitus, the ancient philosopher, "You can never step on the same beach twice."

Change -- with a purpose
All this change, however, is useful to those who live sheltered by the beach. Aside from providing recreation and wildlife habitat, beaches are protection for whatever lies behind. Like those foam-packed highway barriers that give way on impact, beaches absorb energy from the sea. "Beaches are a very significant dissipater of wave energy," says O'Connell. "The wider, more gently sloping and permeable they are, the more energy will dissipate before it reaches landward development or natural resources."

Simple solutions boomerang
Cities like Miami Beach that built right up to the bluffs above the beach soon noticed that the bluffs were eroding, bringing the ocean a bit too close for comfort. The city responded by reinforcing the bluffs with **sea walls**. But the walls reflected wave energy back to the sea, accelerating erosion, and depriving the beaches of sand that normally erodes from bluffs. For both reasons, sea walls have fallen from favor.

Having said this, we must point out that sea walls are contentious. Some experts, like Spencer Rogers of the North Carolina Sea Grant program, say they don't accelerate erosion, but rather prevent the landward migration of the beach. Nevertheless, he says, since the ocean side of the beach keeps moving, "What beach you do have will disappear" even if a sea wall is built along an eroding shore.

Landowners plagued by disappearing beaches quickly realized that building a rock wall perpendicular to the beach -- a **groin** -- would gather sand on the updrift side of the wall. The physics is simple: The structure slows the longshore currents that carry sand, and slow-moving water can carry less suspended sediment -- sand. The result is that sand is deposited on the updrift side, depriving the downdrift side of sand.

Groins were heavily built along the New Jersey coast, but they've also fallen into disfavor. "They work for the updrift property owner, but it's obvious that they remove sand from the longshore system," says Jim O'Connell, a coastal processes specialist at Woods Hole Oceanographic Institution, "resulting in less sand for the downdrift property."

Call it robbing Peter to pay Paul. Call it beggaring thy neighbor. Call it any cliché you like -- building groins is highly discouraged in many places. As O'Connell points out, the coastline is "all one linked system. If you alter one area, you will be causing an alteration in another."

Faced with a kick to the groin, if we may phrase it thusly, beach restorers have resorted to pumping sand onto beaches, taking the sand from deep waters or dredging projects. This expensive solution seems to work -- for a while -- and it's the "method of choice these days," as Robert Dalrymple, a civil engineer at the University of Delaware Sea Grant program, puts it. So-called "**beach nourishment**" helped restore Miami Beach, to name one of many eroded beaches.

Eventually, however, the same forces that denuded the beach in the first place will remove sand, causing the problem to return. On the Middle Atlantic coast, you can figure to pump sand onto a beach about every five years, Dalrymple says.

Fine tuning

If you're getting the picture that preventing beach erosion is either feckless or counterproductive, there is a bright side. Although coastal engineering devices are not perfect, "most of the solutions you've heard about will work in the appropriate places," Dalrymple says. Take sea walls, regarded just short of strychnine by many coastal experts. "You hear lots of bad things about sea walls on the open coast," he says, yet they may work "if you have lots of sand moving past."

Dalrymple says even groins may have a place: "Robbing of sand will not happen when you fill the groin fields with sand before you use them. You don't make sand with these devices," he observes, but they can protect sand pumped in from elsewhere.

(Groins, incidentally, helped cause the Hatteras Lighthouse erosion, Rogers says. In the 1970s, the Navy built two groins just north of the lighthouse, to protect a building. Predictably, the groins caused erosion on the downdrift side, and, according to Rogers, "you'd have to say" it was a classic case of a groin field robbing sand from the downdrift side.)

Take a break, water!

Another possible solution is building offshore **breakwaters** to reduce wave energy before it reaches the beach. Breakwaters are long heaps of rocks dumped parallel to the shore to intercept waves, and 6,000 have been built in Japan. "Depending on how they are used, they will do fine," Dalrymple says, although he grants visible breakwaters can be "eyesores."

More intriguing, he says, is a **submerged breakwater**, which offer many of the same benefits, without besmirching the horizon with rock piles. In essence, a submerged breakwater acts as a coral reef, causing the waves to break before reaching shore. However, Dalrymple says the details of how and where to build them have yet to be worked out, (and we imagine surfers would despise them).

Finally, Dalrymple points to the sand schlepping system shown in the photo here. The beach erosion at the top was caused by jetties built about 30 years ago to protect a channel used by pleasure boaters. The jetties interrupted the longshore drift, allowing the outgoing tidal current from the inlet to funnel sand to deep waters, where it becomes less useful than a bikini to a Victorian matron -- it will never be formed into a sand castle.

As the inlet project demonstrates, the young discipline of shoreline engineering is an area requiring lots of ingenuity and fine tuning, Dalrymple says. And it's just as well -- the beach is the destination of choice for millions of Americans each summer, and is worth $800-million per year in tiny Delaware alone.