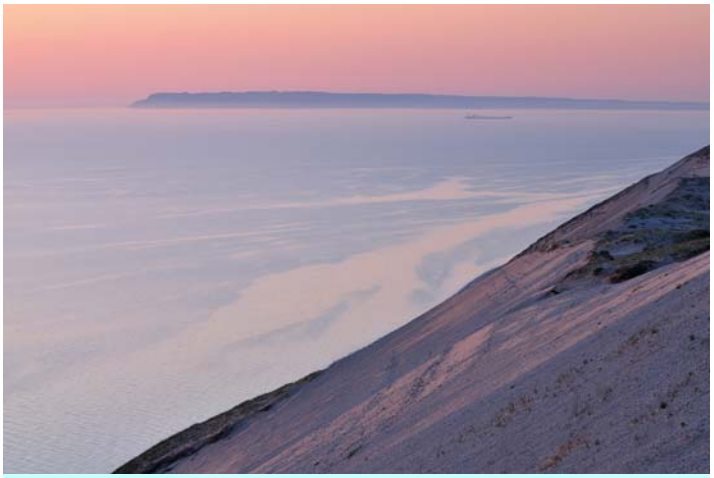
Landslide!

Sleeping Bear Dunes National Lakeshore has been voted one of the most beautiful sites in the United States. However, this national landmark can also be among the most volatile. Located in the northwestern "mitten" of lower Michigan, the land descends hundreds of meters to the shores of Lake Michigan. Sometimes, that descent turns into a landslide. For example, in February of 1995, a stretch of beach nearly 600 m wide slid into Lake Michigan. What causes these landslides? Why do they happen in some places more than others?



The dunes at Sleeping Bear Dunes National Lakeshore in northwestern Michigan descend to Lake Michigan.

Factors that Affect Slope Stability

Four key factors affect the stability of slopes: gravity, water, composition, and triggering events such as volcanoes or earthquakes. When slopes become unstable, landslides, mudslides, or rockslides may occur. Of course, gravity is the ultimate force that causes any landslide, but what other factors are involved? In the case of the slide at Sleeping Bear Dunes, scientists needed to quickly figure out what caused the disappearing beach to ensure the safety of visitors to the lakeshore. The scientists knew that no unusual seismic activity had occurred. Therefore, they could rule out volcanoes or earthquakes as the triggering event.

Snow covering the dunes along Lake Michigan creates flowing "sculptures."

Water would seem to be the obvious cause. After all, the dunes are located along the shore of Lake Michigan. Could coastal erosion be a result of water currents undercutting the offshore slope? Scientists were able to rule out coastal erosion caused by lake water because the prevaling currents in the area actually deposit sand along the coast. (In fact, scientists discovered that the currents were filling an underwater hole, caused by a 1971 landslide, at the rate of more than 0.5 million cubic meters per year.)

Could the slide have been caused by melting snow or some other source of water accumulation? Such an event would have increased the saturation levels of the dunes. The scientists pursued this possibility. The 1995 slide occurred during a period of

unseasonably warm weather in February. Scientists hypothesized that water from melting snow increased pore pressure on the dunes. (Pore pressure is the fluid pressure between the grains of sand in a dune.) Increased pore pressure results in less friction and cohesion between the grains of sand. This likely caused the dunes to become volatile, or unstable.

The "ghost forest" on this dune by Lake Michigan shows the effects of shifting sand.

To guard against future volatility, researchers from the United States Geological Survey (USGS) have installed monitoring devices at Sleeping Bear Dunes to measure pore pressure. They also use Global Positioning System (GPS) data from satellites to track any shifting of the dunes. They can then restrict access to the dunes as necessary to protect visitors.

Stabilizing the Slopes

At Sleeping Bear Dunes National Lakeshore, stabilizing efforts remain more of a monitoring function than a preventive measure. The slopes there aren't threatened by human activities such as the construction of buildings and roads. In areas where landslides occur because of human intervention, solutions as simple as covering slopes with chicken wire or cement help to prevent slides.

Even in the absence of humans, however, the local winds of northwestern Michigan cause the dunes at Sleeping Bear Dunes to migrate over time. As the dunes move, sand buries trees and other vegetation. The winds also expose "ghost trees" buried decades ago. Sometimes, these shifting dunes threaten to cover the few buildings left in the park. In fact, in the 1930s, the USGS buildings had to be moved to prevent them from being engulfed by the dunes.