BARRIER ISLAND STUDY REVEALS SURPRISING RESPONSES TO RISING SEAS

The coastline of Cape Hatteras, on the Outer Banks barrier islands, changed drastically due to Hurricane Isabel in 2003. A comparison between a 1999 (above) and a 2003 (below) photograph illustrates the fragility and dynamic nature of barrier islands.

A new model that tracks the evolution of barrier islands along the coast reveals why some of these islands are more vulnerable to sea-level rise — and the results are a bit surprising and potentially controversial, researchers say.

Barrier islands, low-lying strips of sand that run parallel to the mainland, are constantly in motion as they adjust to changing sea levels and supplies of sediment. Over long periods of time as sea levels rise or the sediment supply decreases, barrier islands tend to migrate toward the mainland, picking up extra sediment by eroding the seafloor as they move. That sediment replenishes the islands, keeping their "heads above the water." They can also acquire sediment through alongshore sediment transport, called longshore drift, or storms can erode sediment from the ocean-side of islands and overwash the islands, depositing that sediment on the land-side of the islands. A problem arises when seas rise faster than an island can move, causing the barrier island to either disintegrate or "drown," becoming submerged. The question is: What causes some islands to drown and others to collect more sand and stay above the water surface?

Predicting the future of barrier islands in response to rising seas is important because these islands protect coastal wetlands, and their disappearance could severely disrupt coastal development, says Jeff Williams, a geologist at the U.S. Geological Survey in Woods Hole, Mass., and co-author of the study published in the Journal of Geophysical Research. "Our goal," Williams says, "was to use a behavior model based on our understanding of barrier [island] geology and geometry, and to then plug in different variables to better understand barrier islands in general and to predict what will happen in the future."

This study used data from North Carolina's Outer Banks chain of barrier islands to rank the importance of different variables — such as sediment supply and the rate of sea-level rise — in determining how barrier islands respond to sea-level rise. The team found four major variables that determine a barrier island's response to sea-level rise. But the single most important factor was the degree to which the seafloor beneath a barrier island, called the substrate, is composed of sand versus mud.

The model experiments demonstrate that the composition of a barrier island and the land on which it moves are vital in determining the island's likelihood of survival, says Laura Moore, a

DID YOU KNOW?

The human sperm gene is 600 million years old. Researchers from the Northwestern University Feinberg School of Medicine in Chicago, Ill., discovered that a gene called BOULE, which is involved in sperm production, is present in almost all animals, from insects to mammals. The findings, reported in PLoS Genetics, suggest that modern sperm production arose from a common ancestor.

geologist at the University of North Carolina in Chapel Hill (previously at the University of Virginia in Charlottesville) and the study's lead author. Islands with sandier substrates are better poised to withstand sea-level rise than islands with muddier substrates, because the former can acquire sand more easily to replenish themselves.

Thus their research seems to show that no matter what the island's size, muddier barrier islands, such as Louisiana's Chandeleur Islands in the Gulf of Mexico, are disappearing, primarily because they have to move farther than their sandier counterparts in order to acquire enough sand, notes Brad Murray, a geologist at Duke University in Durham, N.C., who was not involved in the study. Meanwhile, islands that have a rich supply of sand, such as the Outer Banks, are safe from rising sea levels for the time being. "We've found that if you don't armor the Outer Banks, these barrier [islands] are likely to survive in the near term," Moore says. Armoring the islands might include building breakwaters or seawalls, which would disrupt the natural system of sand migration and prevent the barrier islands from migrating landward.

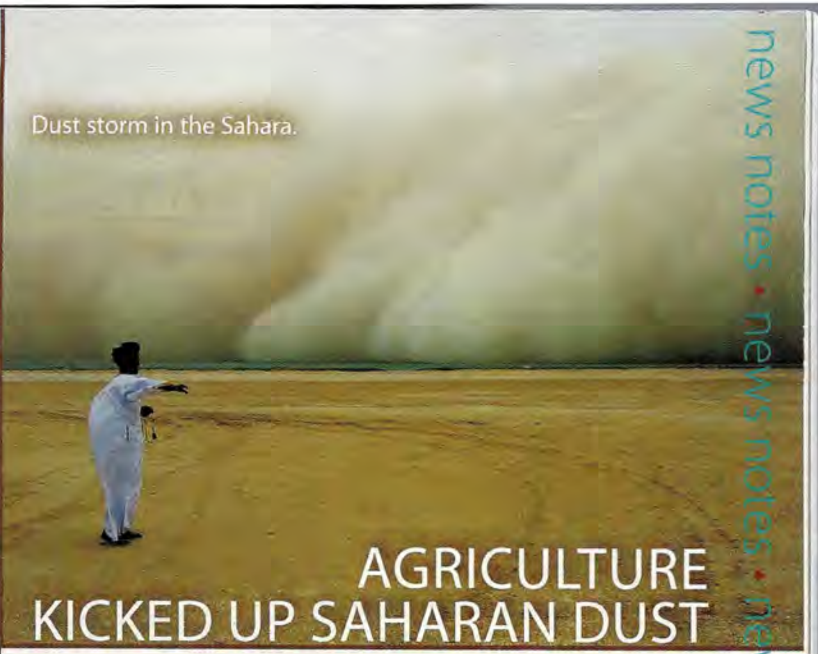
The part of this that is counterintuitive, Moore says, is that size doesn't seem to matter. "I expect this study to spark a little controversy," Moore says. The researchers were surprised to find that smaller barrier islands might outlast larger ones, if they have the right substrate. Besides the composition of the substrate, other important factors include the slope of the substrate, the rate of sea-level rise and the rate of sediment supply. But "this is the first effort to quantify the effects of multiple changing parameters on barrier islands' response to sea-level rise, and it is the best evaluation yet of the factors that make a barrier [island] more or less likely to survive," she says.

This is a nice study because it takes into account more variables than previous studies of barrier island response to sea-level rise, which used simplified assumptions, Murray says. This research is also significant because it emphasizes the importance of a barrier island's past, which tends to be overlooked, says Andrew Ashton, a researcher at the Woods Hole Oceanographic Institution in Massachusetts, who was not involved in the study. For example, Murray adds, having a history of losing sediment puts an island in a better position to withstand the rising water, because a history of losing sand forces a barrier island to dig more deeply into the substrate, so it can grab more sediment from the substrate as it moves landward.

The next step is to carry out more specific modeling projects of barrier islands in other regions, such as along the eastern shore of Virginia and the Gulf Coast, Moore says. "This is a somewhat new and evolving approach," she adds. "Each barrier island has its own history, and so each island also has different inputs."

Patrick Morgan

Dust storm in the Sahara.



AGRICULTURE KICKED UP SAHARAN DUST

Each year, billions of tons of dust are carried by trade winds from the western coast of Africa across the Atlantic Ocean. Now, a 3,200-year-long record of dust deposited along the northwest coast of Africa shows two distinct trends in the amount of dust picked up by these winds over that time: Until about 200 years ago, dust deposition correlated to changes in precipitation in tropical West Africa. But in the 19th century, dust deposition sharply increased, as commercial agriculture began to develop in the Sahel, the fertile regions bordering the vast desert to the north and south.

The Sahara Desert is the largest source of mineral dust anywhere in the world. Measurements of airborne dust collected beginning in the mid-1960s, as well as satellite data in the late 1970s, have shown an uptick in dust deposition in the early 1970s, thought to be due to drought in that region. But how precipitation related to dust deposition in earlier centuries was less clear.

Scientists led by marine geologist Stefan Mulitza of the University of Bremen in Germany used the chemistry and grain-size distribution of sediments collected from a core off the coast of Africa to go much deeper in time, studying changes in deposition through the centuries. They distinguished dust particles from riverine particles in the core based on several factors, such as mineral content and sediment size: Dust particles, for example, are relatively rich in silicon and tend to be coarser than the finer particles suspended in river waters.

River particles dominated the sediments from about 1200 B.C. until about A.D. 200, the team wrote in Nature. For the next 700 years, the sediments show a gradual change in the relative abundances of river and dust deposition, as the dust fraction slowly increased, correlating to drying conditions known to have occurred on land at that time. Over the next few hundred years, fluctuations in precipitation correlate with increased or decreased dust fractions in the offshore sediments. Then, in the early 19th century, the sediments show a sudden, sharp increase in the percentage of dust that is not related to changes in precipitation on land. This, the authors noted, coincides instead with a marked change in agriculture in the Sahel, as farmers began to grow commercial crops and encroach on previously forested areas, exposing additional soil to erosion.

Carolyn Gramling

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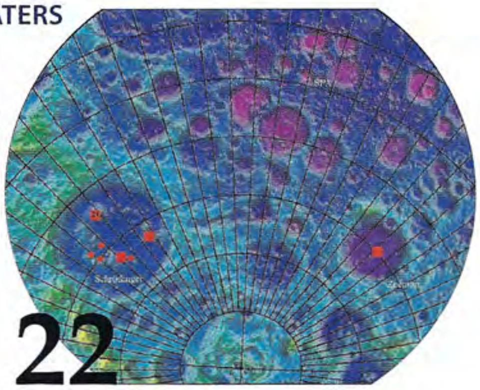

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