

Summary

Coastal erosion threatens to damage nearly 87,000 homes along the shoreline of the United States in the next 60 years, according to a report released in 2000 by the Federal Emergency Management Agency. Population growth, rising sea levels, hurricanes, dams (which block the resupply of sand to beaches) and severe storm events associated with El Niño events are escalating concerns that damage from shoreline erosion could cost hundreds of millions in coming decades. In California, these concerns are intensified by demographics and geography: about 80 percent of the state's 34 million residents live within 50 kilometers of the ocean and about 86 percent of the state's shoreline is classified as actively eroding.

Coastal bluff erosion is of particular concern in counties such as San Diego and Santa Cruz, where homes have been built on top of landslide-prone bluffs and where heavy surf scours the shore.

The Project

In this project, earth sciences professor Dr. Gary Griggs of the University of California at Santa Cruz was funded to investigate the influence of waves, groundwater and bluff composition on erosion rates in San Diego County. His work suggests that erosion estimates have overemphasized the role of wave action on bluff stability while underestimating the importance of bluff composition.

For the study, he and his colleagues analyzed historical aerial photos of the San Diego shoreline at eight representative sites, each nearly half a mile in length. The



Homes built on actively eroding bluffs in San Diego County are no longer fully supported from beneath, making them vulnerable to earthquakes and landslides. Photo: California Sea Grant archives.

photos spanned a 40- to 60-year period, long enough to document changes in the position of the shoreline—the basis for calculating erosion rates.

They then examined the statistical relationships between erosion rates and those processes that cause seacliff failure. They looked, for example, at variations in wave energy along the coast, levels of groundwater seepage and at structural features of the sea cliffs, things such as joints and fractures.

Based on their analyses, the best predictor of bluff stability is bluff composition, particularly rock strength. Variations in rock material along the shore were associated with average rates of erosion that ranged from 3 centimeters a year in La Jolla to 43 centimeters a year in Carlsbad. Consistent with other studies, Dr. Griggs found that

groundwater also plays an important role in weakening bluff materials.

Impacts

The technical underpinning of this study was the ability to use a process known as soft-copy photogrammetry to digitize aerial photos of the coast without significant distortion and at high resolution. Without these high-resolution digital images, it would have been impossible to compute erosion rates. Dr. Scott Ashford of University of California, San Diego has been funded by California Sea Grant to use photogrammetry to evaluate the effectiveness of bluff-stabilization methods in San Diego County.

The 2000 FEMA report on coastal erosion included Griggs' analyses for San Diego and Santa Cruz counties.

Cooperating Organizations

United States Geological Survey
Western Coastal and Marine
Geology Team

Publications

Benumof, B.T., C.D. Storlazzi, R.J. Seymour, and G.B. Griggs. 2000. The relationship between incident wave energy and seacliff erosion rates: San Diego County, California. *J. Coastal Res.* 16(4): 1162–1178.

Benumof, B.T. 1999. The dynamics, kinematics, and geomorphic evolution of the San Diego, California coastline. Ph.D. dissertation abstract, University of California, Santa Cruz.

Benumof, B.T., and G.B. Griggs. 1999. The dependence of seacliff erosion rates on cliff material properties and physical processes: San Diego County, California. *Shore & Beach* 67(4): 29–41.

Trainee and Thesis

Benumof, Benjamin T., Ph.D., University of California, Santa Cruz, 1999, "The Dynamics, Kinematics and Geomorphic Evolution of the San Diego Coastline."

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