

Coastal Bluffs Provide More Sand To California Beaches Than Previously Believed

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Coastal geologists have assumed for years that sediment-laden rivers that enter the Pacific Ocean along the Central and Southern California coast supply up to 90 percent of the sand on the region's beaches. However, new research by two independent groups of UCSD scientists indicates that what had been thought to be a minor source of sand - erosion from coastal bluffs and cliffs - could account for about half of the region's beach sand.

Various types of concrete surfacing and reinforcement of bluffs as well as layering large boulders as rip-rap along the base of bluffs tend to "armor" them, slowing or preventing such erosion. Determining the source of sand, according to the researchers, is the logical first step in any effort to preserve Southern Californian beaches.

In a paper to be presented October 12 during the annual meeting of the American Shore and Beach Preservation Association in San Francisco, Adam Young, a Ph.D. candidate in UCSD's Jacobs School of Engineering, will report the unexpectedly high contribution of coastal bluffs and cliffs to the supply of beach sand. Young, who has also submitted his results to the *Journal of Coastal Research*, used laserscanning technology to generate a series of 3-D topographical maps that quantified coastal bluff erosion with a high degree of accuracy during the past six years.

Based on the volume of material that has fallen from the bluffs during the study period, Young concluded that half of the beach sand in the Oceanside Littoral Cell, a 50-mile stretch of California coast from La Jolla north to Dana Point, was likely derived from the bluffs.

In recognition of his research, which was funded by California Sea Grant, the University of California's Coastal Environmental Quality Initiative, and UCSD's Center for Earth Observations and Applications, the American Shore and Beach Preservation Association on Oct. 11 will present its 2005 Education Award to Young. In addition, the California chapter of the association will present its 2005 Robert L. Wiegell Coastal Studies Scholarship to Young, also in recognition of his bluff erosion research.

"While keeping in mind that six years is only a brief snapshot in the life of the Southern California coastline, our results call into question the conventional wisdom that coastal bluffs don't contribute much to the beaches," said Scott Ashford, a professor of structural engineering at UCSD and Young's faculty advisor. "Adam's results should alert all groups interested in the preservation and development of Southern California's beaches that the assumptions they have been using to identify the supply of beach sand should now be re-examined."

Ashford said decades-old photographs of the Southern California coast taken from the ground and the air also have documented the steady pace of erosion. However, he said the photographs lack the precision and accuracy of the laser scanning technique called LIDAR, an acronym for light detection and ranging. Ashford said the 3-D maps generated by LIDAR permitted Young to calculate the unexpectedly high volume of bluff material that has fallen onto beaches during the study period.

"A new question we're interested in now is 'What if we stopped armoring the bluffs and cliffs and allow them to erode naturally?' " Ashford said. "Would such a moratorium be enough to replenish the beaches? We need to do more work to address a range of questions like that."

At the wave washed western edge of the campus, Neal Driscoll, a geology professor at UCSD's Scripps Institution of Oceanography, and graduate student Jennifer Haas have studied the same 50-mile stretch of beach north, but with a completely different technique. The Scripps team used a mineralogical fingerprinting technique. They compared sand grains collected from beaches in the study area to grains taken from coastal bluffs, rivers, and from dredged material that the San Diego Regional Beach Sand Project used to replenish the region's disappearing beaches.

After examining the population of sand grains on beaches in the La Jolla area, the Scripps team determined that sea cliffs must be an important source of sand to those beaches. Based on their observations, Haas and Driscoll concluded that 50 percent of the sand came from erosion of the bluffs and cliffs. Haas successfully defended her master's thesis in spring 2005.

"What is exciting to me is that both our engineering group at the Jacobs School and the geology group at Scripps took completely different approaches, but arrived at the same conclusion, which is that bluffs and cliffs appear to be a much more important source of sand in the Oceanside Littoral Cell than had been previously believed," Ashford said.

The Scripps team found a type of clear-quartz grains in the coastal cliffs, but collected predominantly frosted quartz sand grains in the rivers and offshore borrow sites from which sand has been dredged for placement on erosion-prone beaches. "In La Jolla, the beaches have a large proportion of clear quartz, which indicates that the cliffs are a significant source of beach sand," Driscoll said. "There's just no other way around it."

Driscoll and Ashford agree that Central and Southern California rivers carry a huge amount of sandy sediment to the Pacific Ocean during seasonal downpours. "When the rains come, the majority of the sediment discharge occurs during an extremely small percent of the time," Driscoll said. "Often, the sediment-laden river water is denser than seawater, so when this slurry reaches the coast, it sinks and follows the bottom, escaping the shallow water region near the shore where it could replenish sand to the beaches."

In dry years there is very little sediment in Southern California rivers flowing into the Pacific. "In wet years," Driscoll said, "the rivers flow like fire hoses, with most of the sediment ending up offshore in deeper water."

California Sea Grant, the largest of the 30 Sea Grant programs nationwide and administered by the University of California, recently awarded \$200,000 to Ashford and Driscoll to collaborate and expand their investigation of the relationship between bluff erosion and beach sand supply in the Oceanside Littoral Cell.

The Center for Earth Observations and Applications at UCSD, which partially funded Young's bluff-scanning project, was formed in 2005 with a grant from UCSD Chancellor Marye Anne Fox. John Orcutt, deputy director of scientific affairs at Scripps Institution of Oceanography, directs the center.

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