

Studies challenge established views on sand migration along San Diego County coast

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A renowned oceanographer who has studied the California coast for decades says new research challenges a well-established notion about how sand flows within the surf and long-shore currents that constantly

shape the state's beaches.

Studies show sand doesn't always flow south and in some cases is carried north between the coastal communities, said Reinhard Flick, a member of the Scripps Institution of Oceanography's Coastal Processes Group.

"That's a new finding, and it's important," Flick said. "This strongly suggests that little, if any, sand flows south from Oceanside to Carlsbad."

Carlsbad and Oceanside, like many coastal cities, are losing sand at alarming rates.

The accumulating data could change how local officials approach efforts to preserve their eroding coastlines, particularly sand replenishment projects that cost tens of millions of dollars and can be wiped out by the storms of a single El Niño winter.

Past studies by researchers at the University of California, the California Coastal Commission and the U.S. Geological Survey have shown that the dominant ocean currents carry sand from north to south within what's known as the Oceanside littoral cell, a 50-mile length of coast stretching from the Dana Point Harbor to La Jolla. Most replenishment project are designed with that idea in mind.

"The major agent of sediment transport along the coast is longshore drift, which moves the sand southward," states a recent USGS summary of coastal changes. Southern California beaches are relatively steep, which concentrates sediments in a narrow zone that can vary according to the seasons.

Carlsbad and other San Diego County coastal cities passed resolutions last year opposing an Oceanside proposal to build retention devices, such as rock groins, on the grounds that the structures would stop the flow of

sand south to their beaches.

Since then, Oceanside has continued to work on sand replenishment and retention plans, while downplaying the possibility of groins. Three consulting teams are competing to win a design contract for the project, called Re:Beach.

Wave-driven sand transport is complex and detailed, Flick said. Shoreline studies have grown more accurate with the development of improved technology such as Lidar, which stands for Light Detection and Ranging, a system that uses laser pulses to measure the movement of [beach](#) materials.

An accumulation of recent Lidar data shows a wide variety of movement within the Oceanside littoral cell that includes the coast of most of San Diego and Orange counties, he said. The cell is actually "a series of sub-cells" with lagoons, rivers and jetties as boundaries, though still with some interaction.

"Oceanside is not completely isolated from Carlsbad," he said. "There is a constant local exchange to maintain a continuous small ribbon of beach. However, large southward sand movement is episodic, and the two cities' littoral systems are much more isolated than the old 'one littoral cell from Dana Point to La Jolla' concept implied."

Oceanside's harbor jetty has blocked the flow of sand since the federal government built the Camp Pendleton boat basin in the early 1940s. Another jetty at the San Luis Rey River also helps to hold sand on the beach near the harbor.

Sediment is pumped from the harbor mouth every spring and helps to maintain a wide beach as far as the city pier. But after a few blocks south of the pier the beaches are barren for about two miles, down to the

city's border with Carlsbad at the mouth of Buena Vista Creek.

"The general southward transport of sand on our coast, especially during large wave events (such as storms), remains intact," Flick said.

"However, under normal conditions, the transport at the lagoon and river mouths is almost always reversed and flows back north."

These reversals are not caused by any coastal structures or by the river mouths, but by the related offshore topography that bends the wave directions to make this happen, he said. Local wave conditions are shaped by many factors such as lagoons, rivers, creeks, offshore reefs and even the distant Catalina Islands.

Sea-level rise is another factor in the movement of coastal sediments.

"We have to start honestly considering the trade-off decisions between nature and coastal intervention that will be forced upon us in California and every other urbanized coast in the world by accelerating [sea-level rise](#) starting about mid-century, just 27 years off," Flick said.

"These current debates over sand retention in Oceanside may soon appear trivial depending on the trajectory of sea level after about 2050," he said. "There is no question that sea level is and will continue to rise, perhaps for centuries."

Jayne Timberlake, Oceanside's coastal zone administrator, said the accumulating research data on coastal erosion is good for her city's beach replenishment efforts. "This is a major change in how we think about the littoral system, but it is not new," she said.

The change comes from an accumulation of data that helps validate long-held opinions about how erosion varies from place to place, season to season and year to year.

"It really means that jurisdiction by jurisdiction we can deal with our own sub-cell and not expect major implications for other subcells," Timberlake said.

The annual dredging of the Oceanside harbor provides clear evidence that the predominant southern currents don't carry sand very far, she said. "Every year we place tons of sand (dredged from the harbor) on the beach down to the pier," she said. "And every year it doesn't get to South Oceanside. So how is there a river of sand going south?"

The sand disappears from Oceanside's shores, but it's still unclear where it goes. Some flows to offshore deposits just past the surf zone, which can be mined for replenishment projects. But farther out there are deep canyons that could hold unreachable sediments.

Design teams competing for Oceanside's next sand project have been asked to account for some of these unknown factors, Timberlake said.

The teams have been asked to clearly depict how their designs can be adaptable to different circumstances such as sea-level rise, the direction of sand movement, and proposed management plans, she said.

Carlsbad remains wary of any project that could interfere with the natural flow of sand in its direction, despite the new information.

"Whatever design the city of Oceanside ultimately chooses for its sand nourishment and retention pilot project will need to undergo studies and analysis, including identifying any potential impacts to other coastal cities in the region," said Carlsbad Parks and Recreation Director Kyle Lancaster. "For now, we are continuing to monitor the project and staying in contact with the project staff in Oceanside."

Recent work by William O'Reilly, also a Scripps oceanographer,

supports the idea that littoral cells are complicated regions with sand following numerous pathways.

Another factor is the periodic appearance of El Niño conditions, which occur every two to seven years, he said. The El Niño brings warmer ocean temperatures and an increased chance of strong winter storms with big waves that can quickly sweep huge volumes of sand off the beaches.

"The beach gets quite narrow, and it takes multiple years to come back," O'Reilly said in a video presentation.

"The good news is that all of the state beaches south of the San Elijo Lagoon ... show positive trends in recovery since (the last significant El Niño in) 2016," he said. "That bad news is that north of the San Elijo inlet, (at places such as Moonlight Beach in Encinitas and South Carlsbad State Beach in Carlsbad) they have been doing the opposite since 2016."

The reasons are unknown, he said, but one possibility is that there is simply less sand along the North County coast.

Mitch Silverstein, countywide policy director for the Surfrider Foundation, brought up the possibility that nothing flows south from Oceanside because Oceanside has so little sand. Flick agreed.

"If there is no sand, there is no sand to transport ... no matter what the waves are doing," said Flick, who has studied oceanography since 1969.

Most of the sand movement occurs in the surf zone, he said, and little is known about how the material moves in water deeper than 13 feet.

In 1993, Flick wrote a paper called "The Myth and Reality of Southern California Beaches," which explained that the region's beaches are

naturally small and the largest ones are created by human development and projects such as dredging. That remains true today, he said.

"It is an eroding coast, it has been for 20,000 years," Flick said. Beaches near the county's lagoons and harbors are wider because they get sand when those areas are dredged. For example, the beach at Coronado is wide because it gets sand from the San Diego harbor.

"We have to remember we are in an urban area," he said, and the coastline along most of Southern California is no longer natural.

Keeping the coastline livable will require a balance of choices, especially as sea-level rise accelerates, he said. All [coastal cities](#) are looking for ways to slow erosion and protect their beaches.

"This is why the (California) Coastal Commission is so important," Flick said. Voters established the state agency in 1972 to monitor development and maintain public access to coastal resources.

"It helps us keep this balance," he said. "It's critical ... as going forward we are going to have to make choices."

He's not an advocate for sand retention devices such as groins, he said. But he supports solutions such as the "living shoreline project" at Cardiff State Beach in Encinitas.

The living shoreline project was completed in 2019 as part of the restoration of the San Elijo Lagoon. Contractors built a rock revetment along the edge of the beach and covered it with sand and native plants to make it look like a natural dune.

In a big storm the sand and plants may wash away, but the rocks will remain to protect the beach and the highway behind it. The sand and

plants can be replaced.

Lidar data shows that, contrary to most of the San Diego County shoreline, Cardiff State Beach has widened by 25 meters since 2002 and 15 meters since 2007, according to O'Reilly's work.

Multiple factors in addition to the shoreline project have contributed to the widening, including two regional sand replenishment projects, the annual placement of sand from the mouth of San Elijo Creek onto the beach, and the location of natural reefs near the north and south boundaries that help hold [sand](#) on the beach.

Similar living shoreline projects are proposed for Dockweiler State Beach and Manhattan Beach in Los Angeles County, and others elsewhere in the state.

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