BIRDS'-EYE "MOVIE" MIGHT HELP SAVE VENICE MARSHLAND

The city of Venice sits atop small islands in a marshy lagoon along the Adriatic Sea in northeastern Italy.

Courtesy of NASA/GSFC/MITI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team

Researchers are taking the long view, combined with a birds'-eye view, of Venice's marshes to try to preserve them from rising seawater. They are relying on aerial photographs that reveal the wetlands' changing shape.

The flow of water and sediment around Venice, Italy, has been artificial for centuries. Since the fall of the Roman Empire, residents have diverted the rivers that feed the Venice lagoon to provide a defensive buffer. The diverted rivers prevented sediments from the Po River Basin from settling throughout the delta where they would normally replenish the delta's salt marshes and might have eventually formed a land bridge. Instead, canals carry sediments straight to the Adriatic Sea, leaving the delta around the lagoon to settle and sink, just like other canalized deltas such as the Mississippi River Delta. Other factors, such as rising sea levels and increasing flood frequency, have also played a part in shaping the salt marshes in the Venice lagoon.

Understanding the net effects of river diversions, however, is difficult: Flooding can bring more sediment with it, but it also carves new channels and erodes the sides of marshes. A new analysis of more than six decades' worth of aerial photographs shows that one small part of the Venice lagoon may be adapting to changing sea levels and flooding, offering a natural laboratory for understanding how best to sustain vital marshes.

To track how Venice's marshes are responding to changing water flows, geologists Federica Rizzetto and Luigi Tosi, both at the Institute of Marine Sciences in Venice, examined aerial photos and sea-level records dating from 1938 to 2006. The researchers then measured shifts in the margins of the salt marshes, the sinuosity of channels through the marshes, and the width of the channels. Then they plotted those changes in time alongside changes in sea level and the region's short-term flooding history.

"Evidence from our analysis will provide important information for the validation of mathematical models" of the lagoon, Rizzetto says. Earlier studies of the Venice lagoon only measured sediment accretion at sampling points, but the aerial photos provide a more detailed "four-dimensional movie" of the marsh's responses to water levels, she says.

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The team found that the margins of the salt marshes eroded in bursts of a few years when sea levels rose from 1950 to 1970 and again in the 1990s, and changed less during periods when sea levels stabilized, they reported in Geology. When sea levels were higher, new creeks and channels formed in the marshes, along with some new ponds. The shapes of the creeks changed too, growing straighter and wider, which the authors correlate with the increasing frequency of flood surges as sea levels rose. The changes are most pronounced at the western end of the salt marsh, where high waters from the Lido inlet make a stronger impact than elsewhere.

Location and vegetation seem to be important. Other studies that directly measured sedimentary accretion in river deltas have shown that existing vegetation can help marshes trap sediments and other organic particles, says John Day, an ecologist at Louisiana State University who was not involved in the new study. This study "gives much more legitimacy" to previous studies elsewhere, he says, because the new study relies on an independent method of measuring wetlands morphology: photographic evidence.

The data are helpful "because we can extrapolate and provide a wide picture" in many other places with similar water flow, says Giovanni Cecconi, chief engineer of the Consorzio Venezia Nuova, a consortium of Venetian construction firms formed to study and protect the city. "It's a bottom-up pattern that can give you the big picture," he says. "It's important to learn by … measuring and monitoring what happens," instead of trying to build predictive models of the lagoon based only on theories.

If earth scientists can create models that explain how marshes interact with water levels over such a long time period, they may be able to help plan future interventions in Venice's salt marshes to prevent sediment loss, Rizzetto says. But because researchers expect sea levels to rise faster in the future, the authors suggest that the sediment-trapping capacity of the Venetian salt marsh may not always be able to keep up.

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