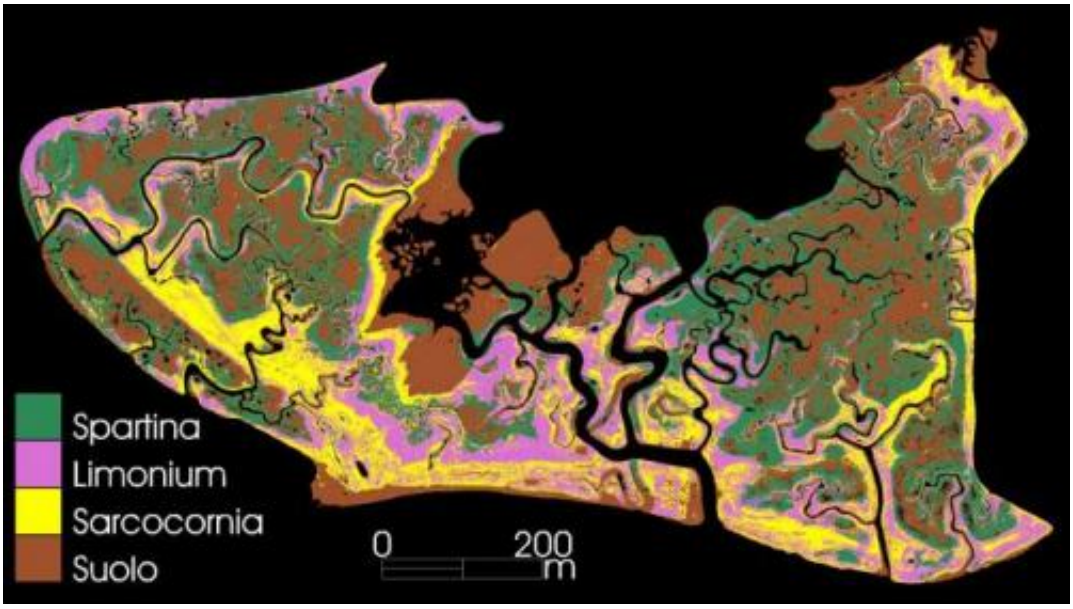
Marsh plants actively engineer their landscape

February 13 2013



A digital map of one portion of the Venetian marsh shows the distribution of several species of marsh plants. Credit: Courtesy of Marco Marani, Duke University

Marsh plants, far from being passive wallflowers, are "secret gardeners" that actively engineer their landscape to increase their species' odds of survival, says a team of scientists from Duke University and the University of Padova in Italy.

Scientists have long believed that the distribution of plants within a marsh is a passive adaption in which species grow at different elevations

because that's where conditions like soil aeration and salinity best meet their needs.

But this team found intertidal marsh plants in Italy's famed Venetian lagoon were able to subtly tune, or adjust, their elevations by producing different amounts of organic soil, and trapping and accumulating different amounts of inorganic sediments as part of a complex interplay with the environment.

"Our study identifies the visible signature of a two-way feedback occurring between the vegetation and the landscape," said Marco Marani, professor of ecohydrology at Duke's Nicholas School of the Environment and Pratt School of Engineering. "Each species builds up the elevation of its substrate to within a favorable range for its survival, much the way corals in the animal kingdom do."

The finding may help scientists better predict marsh ecosystems' resilience to climatic changes such as sea level rise.

"Obviously, this is not a conscious choice on the part of the plants," Marani said. "It's a natural mechanism—how marshes work. We just didn't understand it in such detail until now."

The study appears this week in the early online edition of the Proceedings of the National Academy of Sciences.

The team used numerical modeling to visualize the dynamic interactions of marsh ecosystems over time, and tested the models against detailed topographical surveys of elevations and distributions of plant species in the Venetian lagoon.

"We've been studying this same marsh for 15 years and, as in similar studies around the world, we were using GPS technology with an

accuracy of plus or minus one centimeter in elevation," Marani explained. For the new study, they used a more precise surveying instrument, an electronic theodolite, which measure elevations accurately to within less than one millimeter. "It allowed us to observe differences so subtle that they went unnoticed before," he said.

The differences in substrate-building capabilities between species are often minute, but they allow each species to stabilize the soil within different stable states, or layers, in the marsh. Some species prefer elevations at or below mean sea level; others prefer higher elevations that are less often inundated.

"Interestingly, our models and surveys show that plants make trade-offs when colonizing within their preferential ranges," Marani said. "Entire sections of a species' vegetation patch often are located above the elevation needed for its maximum biomass productivity." This gives it a bit of margin to compensate for external fluctuations, such as the rates of relative sea level rise or sediment availability.

"Essentially," he said, "the species hedges its bet by trading maximum productivity for greater long-term stability."

Scientists have long known that biodiversity plays an important role in a marsh ecosystem's long-term health and survival, "but this paper provides a clear causal link suggesting how and why," he said. "The take-home message is that the more species you have colonizing different levels within a marsh, the more resilient to abrupt change the marsh as a whole will be."

He said that marshes in which an invasive species, such as cordgrass, has pushed out other species will be less resilient to climatic changes.

More information: *Proceedings of the National Academy of Sciences.*

DOI 10.1073/pnas.1218327110