Researchers map historic sea-level change on the New Jersey coastline

May 23 2013

Horton (far right) and colleagues used fossilized marsh vegetation to reconstruct historic sea levels.

(Phys.org) —Hurricane Sandy caught the public and policymakers off guard when it hit the United States' Atlantic Coast last fall. Because much of the storm's devastation was wrought by flooding in the aftermath, researchers have been paying attention to how climate change

and sea-level rise may have played a role in the disaster and how those factors may impact the shoreline in the future.

A new study led by the University of Pennsylvania's Benjamin P. Horton, an associate professor in the Department of Earth and Environmental Science, relied upon fossil records of marshland to reconstruct the changes in sea level along the New Jersey coast going back 10,000 years.

The team's findings confirm that the state's sea level has risen continuously during that period. In addition, their analysis reveals that there have been times of very high rates of sea-level rise that coincided with periods of glacial melting, a particularly relevant finding to conditions today as a warming climate has caused the large ice sheets of Antarctica and Greenland to melt into the sea.

Even leaving climate change out of the equation, the investigation indicates that sea levels will continue to rise over time, increasing the chances of disruptive flooding as was seen following Sandy.

"We're trying to better understand past sea-level changes because they are key to putting the future in context," Horton said.

The study was published in the *Journal of Quaternary Science*. Horton's co-authors were Simon E. Engelhart, who earned his doctorate at Penn and is now at the University of Rhode Island; David F. Hill of Oregon State University; Andrew C. Kemp, who earned his doctorate and completed a postdoctoral fellowship at Penn and is now at Yale University; Daria Nikitina of West Chester University; Kenneth G. Miller of Rutgers University; and W. Richard Peltier of the University of Toronto.

To gain insight into the variations in New Jersey's past sea levels, the

team compiled and standardized data from multiple studies conducted during the last few decades. All the studies used fossil evidence of marsh vegetation to estimate sea level at various times during the Holocene, with data points from 10,000 years ago through the year 1900.

"We knew that the sea level across the whole of the U.S. Atlantic Coast, including New Jersey, has been rising for the last 10,000 years," Horton said. "But it's been rising at different rates. We wanted to find out the reasons for the different rates of rise and the processes that control them."

An analysis of the data revealed three distinct time periods in which the rate of sea-level rise varied. From 10,000 to 6,000 years ago the sea level rose an average of 4 millimeters per year: from 6,000 to 2,000 years ago 2 mm per year; from 2,000 years ago until 1900,1.3 mm per year.

This last figure, a sea-level rise of 1.3 mm per year, is due to the fact that the land along the coast is naturally subsiding, or sinking over time. This rate may serve as a baseline to incorporate into future flood-risk planning, Horton noted. And the 4 mm rate of rise last seen thousands of years ago may also be relevant to the New Jersey shore's near future.

"If you look at what was happening 6 to 10,000 years ago, the ice sheets were melting on Earth, both from northwest Europe and North America, contributing to those high rates of rise," Horton said. "Now what's happening? Greenland and Antarctica are melting and could trigger similar rates of sea-level rise."

But 4 mm may not be the ceiling for rates of rise. Sea-level rise was higher than that even earlier than 10,000 years ago and could reach those rates again if climate change triggers catastrophic melting of ice sheets.

"Ice sheets don't respond linearly to temperature rise; they go through

thresholds," Horton said. "That could lead to far higher rates of sea-level rise if they reach one of these tipping points."

Local factors could also drive the rate of rise much higher than 4 mm per year. While the scientists' analysis did not suggest that tidal ranges have changed significantly in the time range they studied, anthropogenic factors, such as dredging in the Delaware Bay or groundwater extraction in the Atlantic City region, could serve to increase tides or sediment compaction, thus effectively driving sea level higher in those areas.

"To model what the ocean is doing, you have to incorporate what the land is doing, too," Horton said. "This is the way we're starting to go from global to regional projections of sea level."

More information: onlinelibrary.wiley.com/doi/10 … 02/jqs.2634/abstract

Provided by University of Pennsylvania