To better protect US coasts, research suggests mixing engineering and ecology

August 30 2013

As the peak of hurricane season menaces the Northern Hemisphere, a researcher at the University of Kansas is promoting fresh approaches to safeguarding American coastlines from storm surges, tsunamis and mounting sea-levels.

So-Min Cheong, associate professor of geography and a lead author with the Intergovernmental Panel on Climate Change, said combining traditional engineering, like sea walls and beach nourishment, with ecological barriers is a better strategy for defending costal environments and populations.

"There's high uncertainty and a dynamic coastal environment, with possible increases in intensity and frequency of storms," Cheong said. "Storm surges also are more likely combined with the rising sea. This requires a combination of strategies that are long-term and adaptable to a changing climate."

In a paper published in the September issue of *Nature Climate Change*, Cheong suggests use of so-called "no-regret" and "low-regret" options that protect coastlines and communities from natural disaster while also offering other paybacks, even if disaster never strikes.

"These are options with the least regret that generate net benefit after accounting for costs," she said. "For example, conserving and restoring nature, plus protecting people and property."

Cheong said that recent estimates suggest that costal protection from climate change will cost the U.S. more than $1 trillion by the year 2050.

She points to the benefits of cultivating natural ecosystems to protect at-risk coastal areas. Among the most advantageous of these are marine and terrestrial grasses, trees and oyster reefs—natural structures that oftentimes are destroyed by manmade engineering solutions.

Oyster reefs, for example, protect shorelines by cutting incoming wave energy and marsh erosion, said the KU researcher.

"Oyster reefs play a significant role in controlling turbidity, water quality and primary production by removing algae, bacteria and suspended organic matter," said Cheong. "Oysters help to retain nutrients in estuarine ecosystems and provide food sources for other species, leading to the maintenance of a diverse and stable food web. In addition, oyster reefs are ecologically valuable as an essential fish habitat by providing nursery and refuge ground for many recreationally and commercially valuable organisms, and supporting production of economically important species, such as blue crabs, red drum, spotted sea trout and flounder in the Northern Gulf of Mexico."

Mangroves—clusters of trees that thrive in swampy shoreline areas, especially in tropical zones—are another ecological solution gaining acceptance as a coastal defense.

"Mangroves alleviate the impact of moderate tsunami waves," said Cheong. "In addition, the roots of mangroves trap sediments, add to the surface elevation and provide protection against sea-level rise. The co-benefits of mangrove restoration range from the provision of local employment and fish breeding grounds to reforestation after extensive deforestation, carbon sequestration and the regulation of rainfall patterns."

Likewise, maintenance and restoration of marshes can be vital to promote adaptation to a changing environment, according to Cheong.

Co-author Brian Silliman of Duke University said building with nature instead of against it is the key. "For example, marsh and mangrove ecosystems can enhance local fisheries while simultaneously increasing protection against threatening storm surges," he said. "Although coastal plant ecosystems such as marshes can help shorelines keep pace with sea level rise by trapping sediments, they often have a much greater effect on dampening the size and reach of storm surge, which is expected to be one of the largest threats to coastal communities over the next 50 years."

Ultimately, Cheong said that local factors must determine the best mix of coastal defenses for any area.

"Ecological engineering offers an option to co-exist with traditional engineering by maintaining levees with a thick grass cover and wetlands seaward of the levees to reduce exposure to waves," says Cheong. "But in some places, they may not be able to co-exist. If there's no space for marshes or mangroves, then traditional engineering such as levees, beach nourishment or land-use change and relocation could be the only solutions to protect against inundation. Local biophysical and social conditions are important in providing appropriate coastal adaptation strategies."

The authors said that decisions about defending U.S. shores from natural disasters traditionally have been made by politicians and engineers. However, they suggested that an interdisciplinary team including ecologists and social scientists should participate to take full advantage of the benefits that nature provides when combined with engineering.

Provided by University of Kansas