Why you want oysters and a salt marsh between you and a hurricane

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More coastal towns are building “living shorelines” for storm and flood protection.

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The living shoreline of cordgrass and oyster reef was built by NOAA to protect Pivers Island in Beaumont, North Carolina.
NOAA Fisheries

In September 2018, Hurricane Florence slammed into Beaufort, North Carolina, a town on the state’s inner banks that sits just 10 feet above sea level. The hurricane brought a 2.5-foot storm surge and sustained winds of 75 miles an hour that lasted some three days.

Florence was a big test for two different strategies for protecting the coast. While the areas with “hard” solutions — seawalls — sustained damage and significant erosion, a section of coastline with a “soft” solution, called a “living shoreline,” fared much better. According to the National Oceanic and Atmospheric Administration, the Beaufort Living Shoreline oyster reef and marsh was “intact after the storm, with minimal erosion.”

As the Gulf coast and Eastern seaboard ready for the 2019 Atlantic hurricane season, which began officially on June 1, more communities are trying to stabilize and fortify their coastlines against future storms, flooding, and sea level rise. The more than 120 living shorelines around the country are showing that a combination of oyster reefs, oyster shells, rocks, marsh plants, and other natural materials can be an effective alternative to seawalls. They’re also far less expensive.

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While environmental groups like the Nature Conservancy have promoted these soft solutions for years, a new federal law is also propelling living shorelines into the mainstream.

The law, America’s Water Infrastructure Act of 2018, signed by President Trump in late October, requires the United States Army Corps of Engineers (USACE) to consider soft

solutions such as living shorelines when planning to protect the coast against flooding. The Act is also aimed at improving water quality; marshes are known for their ability to filter and clean polluted water, including herbicides, pesticides, and heavy metals.

The Army Corps budget for 2019 includes $1.491 billion for its flood risk management program, to "reduce the risk of loss of life and property damage from [river] and coastal flooding … through structural and non-structural measures." Bureaucracy is slow to embrace change, however, and a number of USACE seawall projects are pressing forward, despite controversy and high costs.

Seawalls protect seaside homes along Faria Beach north of Ventura in Ventura County. Ventura County is home to the state's most armored coast, with 65 percent of its shore reinforced.
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The shortcomings of seawalls, explained

Seawalls are hard structures that block waves approaching the shore. This solution dates back to the Roman Empire, before modern development had wiped out most coastal wetlands, and before current sea level rise.

Some are located in the water. Some, such as vertical bulkheads (stone, concrete, or vinyl), are set against the shore like a retaining wall.

Seawalls are expensive to build and maintain, and do not stand up well to severe storms. When waves break on seawalls, they "scour" the bottom — their turbulence digs away at the sand at the base of the seawall.

Eventually, as a hollow grows under the wall, it cracks and tips over, making seawalls more vulnerable to erosion than natural defenses. The city of Marco Island, Florida, is just one community dealing with scouring damage. San Francisco voters recently approved a $425 million bond to repair the Embarcadero seawall, which is expected to be impacted by sea level rise.

Vertical seawalls deflect waves, magnifying rather than dampening them. If you were to hold up a salad plate and direct your kitchen nozzle at it, water would splatter back at you, because the dish is rigid. Properties adjacent to bulkheads experience stronger wave impacts, like an innocent bystander being hit by a ricocheting bullet. The minute your neighbor installs a bulkhead, your waterfront erodes faster.

The same physics work at a larger scale. Both vertical and sloped seawalls are prone to violent overrunning by waves during storms.

One new type of seawall, shaped like a breaking wave, is better at sending wave energy back out to sea. These "recurved" walls reflect waves without being as tall as vertical seawalls. If you tried your kitchen sink experiment with a shallow soup bowl, you'd find it extremely effective in directing the water straight back at you!

Recurved walls, however, are more expensive than bulkheads due to their complex engineering, and require more frequent repairs. Recurved seawalls are already popular in Europe, and some US municipalities, such as Weymouth, Massachusetts, are using them.

Coastal communities are increasingly pushing back against seawalls

Many flood-prone cities, desperate for a solution, are spending massive amounts of money building seawalls, often under USACE guidance. For instance, USACE is planning an unpopular $20 billion system of seawalls and levees in the Houston-Galveston area of Texas.

Outspoken Galveston residents have good reason to be skeptical of USACE-designed levees, as a $14 billion levee system recently completed in New Orleans is already sinking and is expected to be ineffective by 2023. USACE acknowledged that it had not fully taken into account sea level rise when designing the New Orleans project.

Meanwhile, on the east coast of Staten Island, residents are questioning the wisdom of a $615 million USACE project that includes a 4.3-mile seawall. The seawall is designed to anticipate a sea level rise of about a foot over the next 50 years, considerably less than the levels projected by the New York Department of Environmental Conservation, NOAA, or a report released last summer by a group of federal agencies. The Staten Island project is part of a $110 billion project to protect New York and New Jersey, although the Sierra Club recently issued a statement claiming that the proposed shore-hardening would ultimately increase flooding and beach erosion.

Salt marshes act as giant sponges

Coastal habitats such as salt marshes, on the other hand, reduce the number of human lives and properties at risk from storm surge and sea level rise by half, according to a study in *Nature*. In early fall, at the height of hurricane season, marsh grass reduces wave energy twice as much as in early summer due to its growth phase. A salt marsh projecting just 15 feet from the shore can absorb 50 percent of incoming wave energy.

"Wetlands … absorb floodwaters by acting as a natural sponge," explains Kate Brogan of NOAA's Fisheries Department.

Salt marshes prevented more than $625 million in direct flood damages during Superstorm Sandy in 2012, according to a 2017 study in *Nature*.

Wetlands endure storms better than hardened shores; in one North Carolina study, 76 percent of bulkheads in the central Outer Banks were damaged during Hurricane Irene, compared with *none* of the coastal habitats studied.

Yet rather than protecting these natural sponges, we're destroying them. The US loses 80,000 acres of coastal wetlands each year, largely to development, drainage, erosion, and pollution. "That's approximately seven football fields every hour," according to NOAA's Office of Habitat Conservation.

Oyster shells, which are used in many living shorelines, sit near the water's edge in Fulton, Texas.
Matthew Busch for the Washington Post via Getty Images

Living shorelines are an affordable solution that can be scaled

Living shorelines are easy to install, compared with seawalls, and cost far less; the average expense is $361 per linear foot, about a third the price of a concrete bulkhead. In some communities, volunteers install them at only the cost of the materials. Living shorelines also last indefinitely.

In contrast, a vinyl bulkhead averages about $686 per linear foot, a wooden bulkhead $652 per linear foot, and a concrete bulkhead $1,022 per linear foot. Most of these structures last 20 or 30 years (50 for vinyl), with a projected replacement cost of 120 percent of the original expense.

The sills of living shorelines — often made of crushed rock or bags of oyster shells, placed about 15 feet offshore — are positioned in front of wetlands. If existing marsh is sparse, plants may be supplemented by planting plugs of grass during the installation process. The marsh plants in living shorelines do the real work; sills just provide temporary tranquility in which they may take root.

Once marsh grass is established, it spreads into deeper water, capturing silt as it goes. The captured silt mixes with organic matter to become soil, and gradually extends the shore further into the sea. Living shorelines have been successfully deployed in Norfolk, Virginia, for example, as well as in the hurricane-vulnerable Outer Banks of North Carolina.

Often, marine life takes hold as well, and the sills turn into living reefs, teeming with fish, crabs, and other shellfish. A healthy salt marsh is marked by a profusion of salt-resistant plants, such as the cord grass Spartina alterniflora, succulent pickleweed, and bulrushes. The marsh attracts dragonflies; fly-catchers like the red-winged blackbird with its distinctive trill; and leggy wading birds, intent on the crabs and mummichogs below. Salt marshes are often punctuated by little channels, peaceful places to explore by canoe.

A large-scale variant of the living shoreline is the “living levee.” This approach is being pioneered in the San Francisco Bay Area. The Bay Area is home to the South Bay Salt Pond Restoration Project, which will restore over 15,000 acres of industrial salt ponds to wetlands, combating coastal flooding.

Living levees are extremely wide, with a slope so gradual they’re nearly horizontal. The slope leaves room for wetlands to form and to retreat uphill as the sea level rises. The Oro Loma living levee, just south of Oakland, was completed in 2017 and incorporates about 70,000 marsh plants. It protects the community of San Lorenzo, which lies only 36 feet above sea level. While sea level is expected to increase gradually in the Bay Area over the next few decades, storms can exacerbate the situation right now. In January 2019, for example, tidal waters washed over the San Francisco’s Embarcadero one rainy day.

Living shorelines are not appropriate for every location; container ships can’t dock in a salt marsh, so shore hardening is necessary in major ports. Nor would they be appropriate at public swimming beaches, where people seek sand rather than silt. But for many towns, or for coastal homeowners, living shorelines could be an excellent alternative.

Innovative projects combine hard and soft solutions

For already-hardened shorelines like New York City, there is a movement toward hybrid projects combining hard and soft solutions. The largest US project currently being planned is New York’s billion-dollar wall-and-park storm protection system. Known as the “BIG U,” it will wrap around the southern tip of Manhattan. The design combines a large curved seawall with parks filled with salt-resistant plants. On the East Side, floodable green space 11 blocks deep will be added adjacent to the water as a buffer zone.

As for USACE, bureaucratic inertia won’t last forever. The Army Corps is already beginning to plan hybrid solutions; the Galveston project mentioned above includes “the restoration of dunes and marshes,” in addition to the controversial levees and seawalls.

The Water Infrastructure Act of 2018 comes at a good time; over the past decade, coastal municipalities have gradually incorporated living shorelines into their standard permitting processes, reducing red tape. If USACE models living shorelines as a durable, low-cost solution, it could encourage homeowners and municipalities to take the plunge themselves.

The more living shorelines that are built, and the more existing marshes that are preserved, the greater the protective factor, but the degree to which coastal habitats protect the shoreline depends in great part upon acreage. A patch of salt marsh here and there won’t have nearly as much effect as a long, uninterrupted stretch.

Although coastal habitats can be remarkably protective against flooding and storm surge, they don’t work well “unless significant intact coastal habitat is conserved,” according to

NOAA. If we helped nature help us by expanding the extent of coastal habitats, such solutions could be a source of hope to those who live and work along US coasts.

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