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US Army Corps of Engineers heads natural solutions for coastal flooding in New York and New Jersey

Team visiting the successful Elders West marsh island restoration project in Jamaica Bay, New York. Credit: USACE.

Sand being pumped through pipelines onto Gilgo Beach, one of several beaches receiving sand replenishment with the Fire Island Inlet to Montauk Point, New York, Coastal Storm Risk Management Project. Credit: James D'Ambrosio, Public Affairs.

Holding the line

US Army Corps of Engineers heads natural solutions for coastal flooding in New York and New Jersey

By JoAnne Castagna

Last spring, Dr. Todd Bridges and his colleagues were visiting a part of the San Luis National Wildlife Refuge in California, a remote region that encompasses 45,000 acres of rivers, woodlands, wetlands and grasslands.

Over the years, the refuge has experienced flooding many times. Bridges, National Lead for the US Army Corps of Engineer's Engineering nature initiative, was there to see how the refuge and associated restoration was working as a nature-based solution for flood risk reduction.

He was pleased with the results that included the restoration of 7,000 acres of floodplain habitat through a combination of conventional, natural, and nature-based engineering features. Conventional features including levees and pump stations and natural features including the planting of 600,000 native trees.

While touring the project, Bridges came across a group of men who traveled several hours to visit the refuge for the first time. He asked them what they thought, and one man said, "It looks prehistoric and heavenly. We're visiting what we're losing; it's painful too."

Bridges has spent much of his career researching how conventional and nature-based engineering features can be used together in projects to provide storm risk reduction, maintain wildlife habitats, provide recreational space, and most importantly to maintain the natural resources cherished by so many. "People need nature. Concrete can't satisfy all of the needs people have. Projects that include natural engineering features also provide social benefits."

Bridge's research is helping to make the Army Corps an international leader in the use of natural and nature-based engineering features. Many are benefitting, including the Army Corps' New York District, which has experienced extensive coastal flooding and is increasing the use of these features in its projects.

Natural and nature-based engineering features are landscape features used in combination with conventional engineering features. Natural features occur naturally in the landscape and nature-based features are engineered, constructed or restored to mimic natural conditions.

Examples of these features include beaches and dunes; vegetated environments, such as maritime forests, salt marshes, freshwater wetlands, fluvial flood

plains, and seagrass beds; coral and oyster reefs; and barrier islands. "By combining something natural and nature-based with something conventional, we make the system better overall," Bridges says. "This is nature supporting engineering and engineering supporting nature."

For example, he says when a concrete flood wall is designed to include an expansive reef and marsh in front of it, the wall provides flood protection benefits during storms while the reef and marsh system reduce the power of waves, can grow with sea level rise, captures carbon, improves water quality, and provides recreational opportunity. The combination is better than either of them.

The Army Corps has been working with natural and nature-based features for years, but recently there's increased interest due to climate change.

On Earth Day in April 2022, President Joe Biden issued Executive Order 14072: Strengthening the Nation's Forests, Communities, and Local Economies, which directs to take multiple actions designed to tackle the climate crisis, make our nation more resilient to extreme weather, and strengthen local economies, including focusing considerable attention and federal effort on nature-based solutions.

As a result, Bridges and other Army Corps staff worked with the White House to develop a report on how the federal government can accelerate the use of nature-based solutions. In addition, the Army Corps with collaborators recently released a set of guidelines for how to use natural and nature-based features.

The award-winning guide—the "International Guidelines on Natural and Nature-Based Features for Flood Risk Management"—involved five years of collaboration with scientists and engineers from around the world and is one of the first guidelines of its kind.

These guidelines are now being used by engineers inside and outside the Army Corps including those with the Army Corp's New York District. Following are two of its projects that include natural and nature-based engineering features—The Fire Island Inlet to Montauk Point, New York, Coastal Storm Risk Management Project and the Hudson Raritan Estuary New York and New Jersey Ecosystem Restoration Project.

A flock of Cormorants, a type of bird, in Jamaica Bay. Credit: Don Riepe

Fire Island Inlet to Montauk Point, New York, Coastal Storm Risk Management Project

This project is taking place along the south shore of Long Island, New York. Long Island extends out east into the Atlantic Ocean from New York City. Along the south shore of the island there are barrier island chains from Coney Island to Shinnecock Inlet. A barrier island is a long narrow island that lies parallel and close to the mainland, protecting the mainland from erosion and storms.

The project encompasses an 83- mile subset of the barrier islands of the south shore of Long Island—from Fire Island Inlet to Montauk Point and extends inland two miles. In between Long Island's mainland and these barrier islands are the Great South Bay, Moriches Bay and Shinnecock Bay.

Over the years, the south shore of Long Island has become very populated. Today, there are approximately 150,000 residents within the project area. The region also receives a large influx of seasonal beachgoers and visitors annually.

The south shore is also very developed. Within the project area, there are 46,000 buildings that include 42,600 homes and 3,000 businesses, and critical infrastructures including 60 schools, two hospitals, and 21 firehouses and police stations.

In the past century, especially in the last 20 years, Long Island's developed coast has experienced storm damages. Elevated tides and waves from these storms caused extensive flooding and sand erosion, leaving communities and shore life vulnerable.

In 1992, a Nor'easter breached a barrier island in several locations. Water from the ocean side of the island washed over and into the bay side, splitting the island, creating a breach or gap. The breach quickly turned into a full-blown major inlet that swallowed up 160 homes.

Most recently was Hurricane Sandy in 2012. Storm surge from Sandy eroded forty

percent of the beach sediment from some areas and created three breaches in the barrier islands, leaving the area vulnerable to significant damages.

This project is a collaboration between numerous agencies and communities that will manage the risks and attendant loss of life from tidal flooding, waves and erosion, in part by restoring the natural coastal processes while minimizing environmental impacts for the barrier islands and back bay communities on Long Island's south shore. The project utilizes conventional, natural, and nature-based features that include the restoration of barrier islands, beaches and dunes.

Restoration of Barrier Islands

According to the International Guidelines, barrier islands are a critical element in the multiple lines of defense when it comes to coastal flooding. They provide multiple benefits including reducing coastal erosion and flooding from wind-driven waves and extreme water levels, on the nearby habitats and shorelines. In addition, they provide critical habitat for threatened and endangered species and migratory birds, as well as provide access to recreational opportunities and navigation.

As part of this project, the eroded barrier island chains from Fire Island Inlet to Shinnecock Inlet and the shorefront area east of Shinnecock Bay to Montauk Point will be built back up using dredged sand.

Peter Weppler, Chief, Environmental Analysis Branch, New York District, US Army Corps of Engineers, says building these barrier islands up will also help to restore the natural cross barrier island transport of sand. "This sand will naturally flow to areas where it's needed, augmenting the resiliency, and enhancing the overall barrier island's natural system coastal processes."

Maintaining barrier islands is so critical that the Army Corps established a range of breach response plans that will close barrier island breaches immediately after storms for the next 30 years.

Project Area Map of the Fire Island Inlet to Montauk Point, New York, Coastal Storm Risk Management Project. Credit: USACE

"People need nature. Concrete can't satisfy all of the needs people have. Projects that include natural engineering features also provide social benefits."

— Dr. Todd Bridges, National Lead, US Army Corps of Engineer's Engineering

Restoration of Beaches & Dunes

According to the International Guidelines, beaches and dunes are valuable to flood risk reduction because they dissipate wave energy, can trap sediments, and have the potential to grow with rising sea levels. In addition, they provide habitat for diverse species.

Dunes are areas of the beach where sand is elevated several feet to act as a buffer between the waves, wind, storm water levels and the structures landward on the beach. Over the years, much of Long Island's south shore has eroded, removing the natural beachfront and dunes that provide coastal protection to the communities from storm surge.

The beaches and dunes will be restored with sand dredged from several federal channels including Fire Island Inlet and shoals and Moriches and Shinnecock Inlets and shoals and from offshore sand borrow areas. The sand will be placed in a way to mimic natural features and native vegetation will be planted to create nesting and foraging habits for endangered wildlife, including the piping plover, least tern, black skimmers, yellow oystercatchers and seabeach amaranth.

A sand-replenished beach with dunes can prevent elevated ocean waters, caused by storms, from inundating coastal communities. Anthony Ciorra, Project Manager, New York District, US Army Corps of Engineers, says, "Post-Hurricane Sandy analysis showed that beaches that had previously received sand placement and dune construction sustained less damages and saved an estimated $1.3 billion in avoided damages on New York and New Jersey shorelines."

Aram Terchunian, Coastal Geologist and President of First Coastal Consulting Corporation, saw this first-hand on the south shore of Long Island. "Superstorm Sandy is the event that really proved the importance of beaches and dunes as effective natural features. Sandy was a violent storm that broke three inlets through Long Island's barrier beach system. At West Hampton Dunes, it was a nonevent. The beaches and dunes withstood the storm fury with only a small incursion over the dune near a vehicle overpass, which was rectified within hours. The Village of West Hampton Dunes was up and running within 24 hours of Sandy's visit."

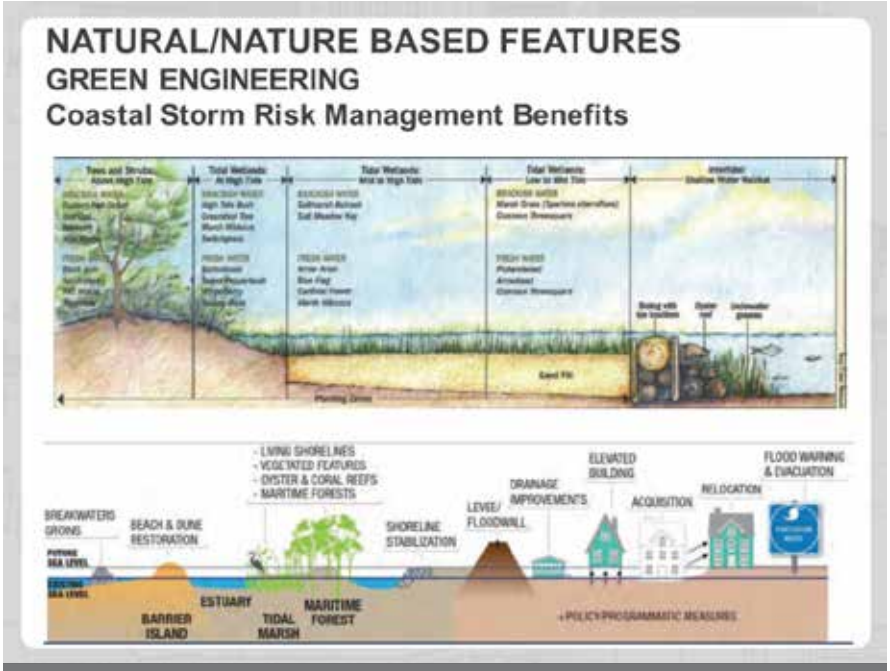
Terchunian has worked with the Army Corps for decades as a representative of several south shore villages and towns on the east end of Long Island.

Storms, like Sandy, may occur more frequently in the future due to relative sea level change. The project is monitoring relative sea level change and adjusting the project when necessary, so that it will continue to perform as planned. This may mean over time increasing the volume of sand that is placed on beaches and increasing the height of dunes to account for observed increases in relative sea level change.

Joseph Vietri, Director of Coastal Storm Risk Management National Center of Expertise, North Atlantic Division, US Army Corps of Engineers, happens to live on one of the barrier islands. He predicts that future low, intermediate and high rates of Army Corps relative sea level change projections could increase anywhere between approximately 1 to 6 feet over the next 100 years, resulting in more frequent and severe storm damages.

Bridges says the natural and nature-based features may actually be more capable of adapting to changing environmental conditions than conventional features. "For example, if you have a levee and marsh as part of a project. The hard levee will not move in response to sea level rise, but the marsh can migrate on its own if we haven't put something in its way."

According to the International Guidelines, coral and shellfish reefs can act as the first line of defense against flooding, storm damage and erosion in coastal areas.



Types of natural and nature-based features used in Coastal risk management projects. Credit: USACE.

Hudson Raritan Estuary New York and New Jersey Ecosystem Restoration Project

The Hudson Raritan Estuary is located within the boundaries of the Port District of New York and New Jersey and is situated within a 25-mile radius of the Statue of Liberty National Monument.

An estuary is a partially enclosed, coastal water body where freshwater from rivers and streams mixes with salt water from the ocean. Estuaries can include a variety of habitats including salt marshes, mangrove or maritime forests, mud flats, tidal streams, rocky intertidal shores, reefs and barrier beaches.

The Hudson Raritan Estuary is a complex ecological system located within a highly urbanized region of 20 million people that includes the New York Harbor, rivers, wetlands, coastlines and open waters. Over the years, industrialization has degraded the estuary and hardened the coastlines resulting in the tremendous loss of habitat. The estuary has lost more than 85% of its tidal wetlands, 99% of its freshwater wetlands, and 100% of its oyster reefs.

Restoring the estuary is important because the ecosystem provides habitat for birds, fish, shellfish, and other wildlife, maintains water quality by filtering out contaminated sediments, provides recreational opportunities, boosts the region's economy, and acts as a buffer from flooding for

coastal communities during destructive and powerful storms.

One study done by Lloyd's of London showed marshes play a critical role in reducing damage to infrastructure from coastal storms. The study showed that during Hurricane Sandy marshes prevented $625 million in direct flood damages across twelve states. In New Jersey, coastal marshes reduced property damages by more than 20%.

Lisa Baron, Project Manager, New York District, US Army Corps of Engineers, says the plan for the Hudson Estuary Program is to restore a mosaic of 621 acres of habitat at 20 individual project sites. "These projects will restore estuarine and freshwater wetlands, shorelines, fish passage, oyster reefs, shallow water habitat, coastal forests and marsh islands while providing maximum ecological and societal benefits to the region."

Work is starting up on several of these restoration sites. Natural and nature-based features being used include salt marshes and oyster reefs.

Restoration site locations for the Hudson Raritan Estuary New York and New Jersey Ecosystem Restoration Project. Credit: USACE.

Restoration of Salt Marshes

According to the International Guidelines, coastal wetlands and intertidal areas can reduce flood and erosion risks in coastal environments because they can dampen wave, surge, and current energy, trap sediments, and, in the correct settings, be self-sustaining under rising sea levels and other pressures. They provide additional benefits including fish production, filtration of pollutants from upland runoff, water quality mediation, recreation and carbon sequestration.

Within the Hudson Raritan Estuary is Jamaica Bay. The bay is located in portions of the Boroughs of Brooklyn and Queens in New York City and is part of the Jamaica Bay Park and Wildlife Refuge, the country's first national urban park and one of the Gateway National Recreation Areas that is visited by millions of people each year. The bay covers 26 square miles and opens to the Atlantic Ocean. The land surrounding the bay is heavily developed and includes John F. Kennedy International Airport, the Belt Parkway and several landfills.

Inside the bay there is a marsh island complex. In the last century, these once-vibrant islands have been rapidly disappearing resulting in extensive habitat loss. Eight-five percent of the wetlands have been lost in the region. This loss is primarily due to human development that's included the filling in of marshes and open water areas, hardening of shorelines, sewer overflows, and landfill leachate or water containing contaminants seeping from landfills.

The disappearing marshes pose a threat to wildlife and coastal communities. It's been estimated that the marsh islands if left alone would vanish completely by 2025. Fortunately, due to work the Army Corps has performed over the years, this

Aerial photo of the Yellow Bar marsh island restoration project in Jamaica Bay, New York. Credit: USACE.

will not happen. The Army Corps, along with partnering agencies, has restored approximately 160-acres of marsh islands in Jamaica Bay through a number of successful restoration projects.

Baron says restoring these marsh islands provides significant benefits to the region. "The restored marsh islands keep the sediment within the Jamaica Bay system; wetland vegetation stabilizes the island; the islands reduce waves and erosion of surrounding shorelines and adjacent islands; the wetlands improve water quality within the bay; and the marsh islands that we construct will continue to build the ecological resilience of the bay to respond to increasing sea level rise."

In fact, according to a report released by the US Army Engineer Research and Development Center, the Army Corps restoration of a Jamaica Bay marsh island in 2011 likely mitigated storm surge during Hurricane Sandy the following year and helped to protect the community. The Cross Bay Bridge—which is near this island—was not damaged due to Sandy and was only temporarily closed.

In contrast, bridges east of this structure suffered substantial damage and were closed until the following year. Stakeholders attribute the bridge's survival to the nearby restored marsh island.

The Army Corps in collaboration with the New York City Department of Environmental Protection plans to restore five additional marsh islands as part of the Hudson Raritan Estuary Restoration Program and is currently advancing one of these marsh islands that sits in the heart of the bay—Stony Creek Marsh Island.

Sixty-two acres of the island will be restored. To perform this work, approximately 150,000 cubic yards of sand will be beneficially used from the dredging of the Jamaica Bay Federal Navigation Channel or nearby Ambrose Channel and placed on the island. The material will be graded and contoured to appropriate elevations suitable for a marsh and then planted with native vegetation.

When completed, the island will have 26 acres of low marsh, 22.5 acres of high marsh, 3.5 acres of scrub-shrub wetland, 8.7 acres of shallow marine habitat, and 1.4 acres of tidal channels or narrow inlets.

This will create a healthy marsh island within one of the most biodiverse regions in

the Northeastern United States. Jamaica Bay provides critical spawning and nursery habitat for more than 80 migratory and estuarine fish species, as well as terrapins and four species of endangered or threatened turtles.

In addition, 300 bird species—or 20% of the Nation's birds—call the bay their home and visit it every year as a stopover point along the Atlantic Flyway migration route to their breeding grounds. They include many species of sparrows, warblers, thrashers, crows, herons and urban birds. Many of the species are listed as threatened and endangered by the US Fish and Wildlife Service, including the threatened piping plover and red knot.

Dr. Todd Bridges (Left) and his colleagues visiting the San Luis National Wildlife Refuge in California, a remote region that encompasses 45,000 acres of rivers, woodlands, wetlands, and grasslands. Credit: Dr. Todd Bridges.

Restoration of Oyster Reefs

According to the International Guidelines, coral and shellfish reefs can act as the first line of defense against flooding, storm damage and erosion in coastal areas. Reefs do this by buffering wave energy. Reefs also provide additional benefits, including fisheries production, habitat and biodiversity, recreation, and tourism and revenue.

Unfortunately, in the Hudson Raritan Estuary, oyster populations are practically extinct. Up until the late 1800s, the bottom of the estuary was blanketed with oysters. The eastern oyster populated 200,000 acres of the estuary; today it's considered ecologically extinct, primarily caused by water pollution, dredging, poor land management and overharvesting.

The Army Corps in collaboration with the New Jersey Department of Environmental Protection and the NY/NJ Baykeeper is aiming to bring the oyster back with the Oyster Restoration at Naval Weapons Station Earle Project in New Jersey.

The Naval Weapons Station Earle is a secluded Naval location on the coast of New Jersey, on the Raritan Bay. The plan is to expand a .25-acre oyster reef constructed by the NY/NJ Baykeeper to create a 10-acre oyster reef habitat under the station's 2.9-mile pier that is close to the land and away from naval ship activity.

Stacey MacEwan, project manager, New Jersey Department of Environmental Protection, Office of Natural Resource Restoration says that oysters bring a range of benefits to the estuary. "[They] improve water quality through filtration processes, but the reef itself provides a vertical structure that supports a diverse community of fish and invertebrate species, and the reef structure can also help to protect the shoreline from erosion. This type of project can provide large-scale benefits in a relatively small footprint."

Meredith Comi, Coastal Restoration Program Director with the NY/NJ Baykeeper, says that knowing that protecting our shorelines is leading to an increase in species diversity is very cool and is even more of a reason to use natural and nature-based features in resilience projects.

Bridges may have felt a pang of sadness when the tourist he encountered in the San Luis National Wildlife Refuge expressed that the survival of our natural resources is fleeting. But there is also hope that many of these natural resources will continue to thrive for future generations, especially with the increased use of natural and nature-based engineering features.

Terchunian is optimistic that the natural features provide multiple benefits, including flood and erosion protection, habitat creation, open space, and recreation. These benefits accrue to multiple segments of society from naturalists to property owners and the average citizen. Building natural beaches and dunes will ensure that there is room on the beach for everyone." ■

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