SHORE PROTECTION ASSESSMENT

BEACH NOURISHMENT

HOW BEACH NOURISHMENT PROJECTS WORK

Preserving our coastal economy
asbpa
and ecology since 1926

HEALTHY BEACHES ARE VITAL TO OUR WAY OF LIFE

People in the United States highly prize the thousands of miles of sandy beaches along our nation's coasts

Our beaches – a precious national resource – help define the physical, economic, environmental, and social fabric of our nation:

Many of us choose to live near a beach. The population in counties along U.S. coasts more than doubled from 1960 to 2000. By 2006, more than one half of all Americans lived in coastal counties, which make up just 17 percent of land in the 48 contiguous states. People are still moving to the coasts, which see 3,600 new residents daily.[1]

Development continues near our nation's beaches. Over the last three decades, Americans have built 19 million homes in coastal areas, and people are still building – at the rate of 1,500 homes a day.[1,2] New roads, bridges, and sewers are being constructed to support these increasing populations.

Travelers from diverse economic, ethnic, and racial populations choose the beach over any other American tourist attraction.[3] Each year, our coasts are the preferred vacation destination for an estimated 180 million people, who spend billions of dollars and support more than 2 million jobs.[2] As long as our beaches are healthy, they will continue to lure national and international travelers.

Photo courtesy of Scott L. Douglass

Local, regional, and national economies thrive on the prosperity of American beaches. Coastal watersheds generated a remarkable $6 trillion in 2003 – more than half of the nation's economy.[1] The tourism industry is now the nation's largest employer and fastest growing economic sector. Shipping and commercial fishing industries also contribute significantly to coastal regions and the nation.

Clean oceans and wide beaches are crucial elements of our environment. Beaches sustain animals, fish, sea turtles, birds, plants, and other wildlife including many rare, threatened, and endangered species.

Photo courtesy of the City of Jacksonville, Fla.

Florida's 800 miles of sandy beaches, which contribute more than $15 billion annually to the state's economy, are its greatest economic asset.[4]

Healthy beaches not only are important to our quality of life but also protect people and property along the coasts from hurricanes and coastal storms

A beach's **size**, **shape**, and **sand volume** help determine how well the beach can protect a developed area during a storm. All the various elements of a beach, such as bluffs, dunes, berms, and offshore sand bars – even the width and slope of the beach itself – offer a level of **natural protection** against hurricanes and coastal storms by absorbing and dissipating the energy of breaking waves, either seaward or on the beach itself.

Photo courtesy of Scott L. Douglass

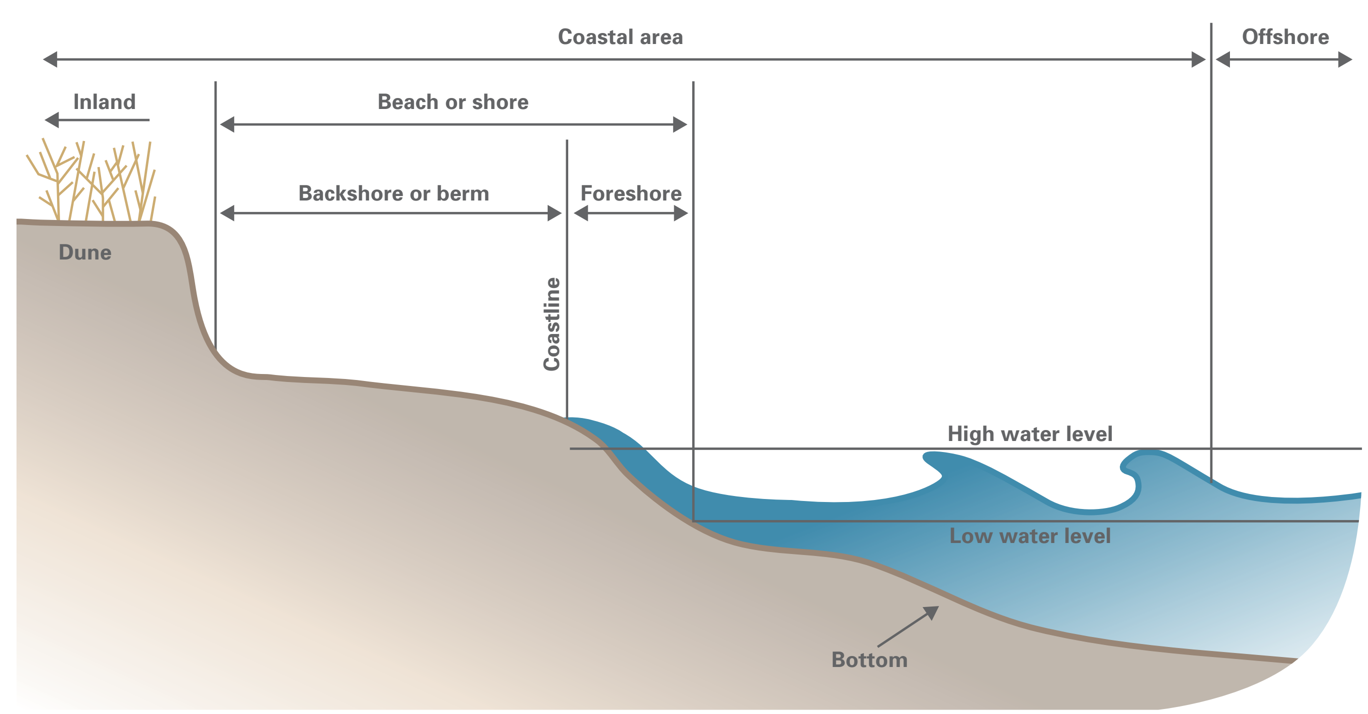
Dunes like this provide protection to people, property, and infrastructure, such as roads, along the coasts.

DYNAMIC AND DIVERSE, COASTAL BEACHES FUNCTION AS A SYSTEM

For thousands of years, the forces of wind, water, storms, sea level changes, and other natural processes have moved the sediments that shape and reshape our coastlines and beaches

These sediments, which range from fine, white sand to coarse gravel and cobblestones, continuously build up, or **accrete**, only to drift away, or **erode**, again and again over time in complex and sometimes unpredictable ways. Wind, tides, currents, and waves constantly keep sediment on the move to build up and wear down natural features such as bluffs, dunes, beaches, sand bars, and inlets. Under normal conditions, wind shapes the dry beach and its dunes while tides, currents, and waves shape the "wet" part of the beach.

Wind, tides, currents, and waves move sediment continuously.



Coastal beaches function as a system. The beach not only includes the dunes and berm, or the dry part of the beach, but also the wet part of the beach that slopes underwater.

It is natural for hurricanes and coastal storms – which move huge volumes of sediment through the system – to erode beaches

Storms erode and transport sediment from the beach into the active zone of storm waves. Once caught in the waves, this sediment is carried along the shore and redeposited farther down the beach, or is carried offshore and stored temporarily in submerged sand bars.

Periodic and unpredictable hurricanes and coastal storms, with their fierce breaking waves and elevated water levels, can change the width and elevation of beaches and accelerate erosion:

- Longer lasting storms, which give the waves more time to attack the beach, cause more erosion and sediment transport than fast-moving storms.
- Very intense storms create higher winds and larger waves, inducing more erosion than less intense storms.

After storms pass, gentle waves usually return sediment from the sand bars to the beach, which is restored gradually to its natural shape. Sometimes, however, sediment moving along the shore leaves the beach system entirely, swept into inlets or taken far offshore into deep water where waves cannot return it to the beach. This causes the shoreline to **recede**, or move farther landward.

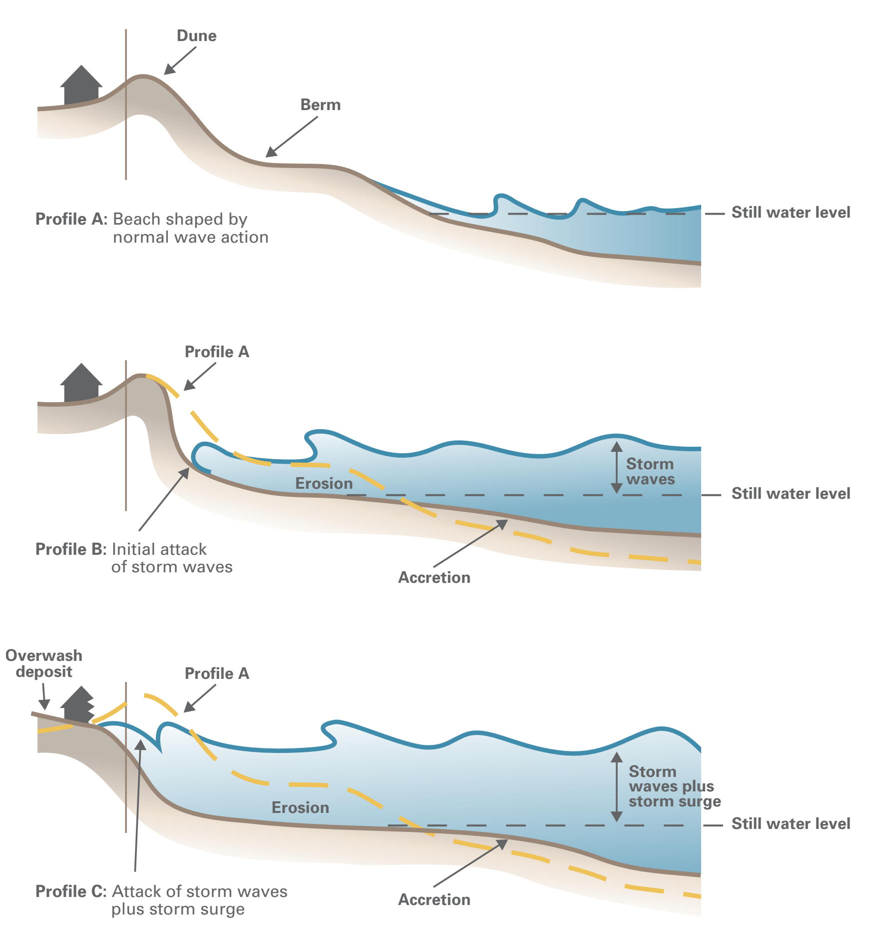
Over time, these processes – combined with sea level rise – produce larger waves that break farther landward. In flat coastal areas, beach erosion and shoreline recession can have dramatic consequences to people and property.

A storm with modest waves affecting the coast for several days – shown here in Scituate, Mass., during the Blizzard of 1978 – can cause more damage to structures and infrastructure than a much larger storm moving quickly over the coast.

Photo courtesy of the City of Virginia Beach

Storm waves break farther up on an eroding beach in 1991 at Sandbridge, Va., threatening people and property.

Complex coastal processes, which vary in intensity and significance, determine how sediment moves



- **Wind** not only produces currents and waves but also picks up and moves sediment on the beach and dunes.
- **Tides** – whose rise and fall depend on local physical conditions and the gravitational effects of the sun, moon, and earth – generate currents.
- **Currents** near the beach are formed through a combination of wind, tides, waves, and the shape of adjacent sand bars. Currents can move large volumes of sediment along the beach or to deep water offshore.
- **Waves** that break during calm weather cause turbulence, which stirs up sediment from the shore bottom. This sediment can be deposited onshore and offshore, parallel or perpendicular to the beach.
- **Accretion** and **erosion** refer to changes in sediment volume in a coastal area. **Shoreline recession** and **shoreline advance** refer to a change in position of the shoreline, farther landward and farther seaward, respectively.
- **Sea level rise** exposes areas farther inland to the coastal processes that move sediment.

Human activities have increased the rate and severity of beach erosion

Decades of beachfront **development** have interrupted the natural and necessary movement of sediment and interfered with coastal processes at our nation's beaches. Beginning in the early 1900s, construction along the shoreline began to forever alter the natural setting and topography to make way for resorts, hotels, boardwalks, roads, houses, marinas, and other recreational amenities. This development, which increased after World War II, frequently eliminated protective sand dunes, weakened bluffs and banks, and reduced beach widths, making coastal communities more vulnerable to winds and high waves. Development today continues to affect accretion and erosion processes upstream and downstream.

The **dredging** of inlets and harbors, which removes sediment to improve navigation, has changed sediment processes in coastal waters. The construction of dams and stormwater retention ponds for inland flood control has blocked new sediment from entering the coastal system.

The addition of **hard structures**, such as groins for coastal stabilization, sometimes has made erosion worse. Structures like these have been designed to retain sediment moving along the shore and help maintain wide beaches by minimizing or slowing down local erosion. In the past, however, if these structures were not designed properly, they sometimes transferred erosion problems farther down the beach.

Because of natural processes – coupled with the effects of development and other human interventions – sediment in certain areas is being lost to the coastal system

In some regions, wide beaches are narrowing, or **retreating**.[2] When accretion and erosion are not in balance, there are consequences to beaches, coastal habitats, people, recreation, and the economy. For example, too little sediment in some areas can make valuable real estate, coastal wetlands, or recreational amenities more vulnerable to damage; too much sediment in commercial shipping channels can restrict the passage of ships delivering goods to our ports.

Photo courtesy of Marlowe & Company

Coastal development – driven by economics and aesthetics and regulated at the local level – has been occurring for decades. Even though government at all levels has created programs and restrictions to discourage further growth in vulnerable areas, coastal development continues.

Photo courtesy of Marlowe & Company

If nature cannot take its course with natural renourishment, coasts can erode.

Photo courtesy of NOAA Coastal Services Center

Beginning in the 1930s, communities attempted to control erosion by installing structures such as groins.

NARROW, ERODING BEACHES HAVE INSUFFICIENT SAND VOLUME TO PROTECT DEVELOPED COASTAL AREAS FROM THE EFFECTS OF HURRICANES AND STORMS

Significant destruction from flooding, wave attack, and storm surge is more likely as an eroding beach assumes a steeply sloping profile and the coastline moves inland, ever closer to people and property along the shore

The physical characteristics of the coastline, tides, and other factors can affect what happens when a storm makes landfall on an eroding beach. While the width of the beach affects wave attack, the elevation of the beach affects **storm surge**, a higher than normal rise in sea level caused by high winds and topped by waves. Storm surge can inundate and destroy coastal areas. The higher the storm surge, the closer the water and waves are to more people and property. On an eroding beach at a low elevation, even a modest storm surge can cause significant damage.

Photo courtesy of Scott L. Douglass

Rising water can inundate low **barrier islands**, cut a new **inlet**, and wash sediment **inland**. Waves can attack the base of a dune or create **vertical cuts** that erode the dune completely, exposing people and property to potential damage. Waves can **scour** sediment from around structures and pilings and strip bricks off of homes. Erosion can undermine **slabs**, which can fail and then damage homes. Even **property farther inland** is at risk as shorelines continue to recede and dunes collapse, since the storm surge's fast-moving water can rapidly inundate and destroy structures behind the beach.

Hurricane Ivan in 2004 caused the shoreline to recede 40 feet on the Alabama and Florida panhandle coasts and produced up to 165 feet of erosion in certain areas. Some dunes that were 30-feet high were eroded to just 2 feet. Ivan's storm surge washed over the low-lying barrier islands near Gulf Shores, Ala., transporting sediment and cutting a new inlet. Several miles east, where barrier islands rose higher, dunes eroded, undercutting and toppling five-story condominium buildings.[5]

Heavily populated areas with significant coastal development – but without sufficient sand volume, a wide beach, and protective dunes – risk great damage from hurricanes and coastal storms.

Eroding beaches threaten the environment, recreation

If a beach cannot provide a protective buffer, **coastal wetlands** are at risk: In fact, sediment overwash, salt water inundation, and erosion may cause essential wetlands to disappear.

Beach erosion may harm ecosystems by changing **habitat conditions** for wildlife. In some cases, habitat for sea turtles, birds, fish, plants, and other organisms may be lost. Sufficient sand with the right characteristics and in the proper locations is crucial for sea turtles to nest, and for birds to nest and feed.

A receding shoreline also can jeopardize a coastal area's capacity for **recreation.** If beaches become narrow or unstable, travel and tourism along the coasts will suffer.

SOCIETY RESPONDS

Because people highly value the economic, recreational, and environmental resources on the coasts, there is public interest in protecting our nation's beaches

People are driven by a strong desire to protect life and property. Trillions of dollars in property, structures, and infrastructure overlook our nation's shorelines. Eroding beaches, left alone, will continue to put people, as well as our cultural, historic, economic, and environmental resources, at risk for damages from hurricanes and coastal storms.

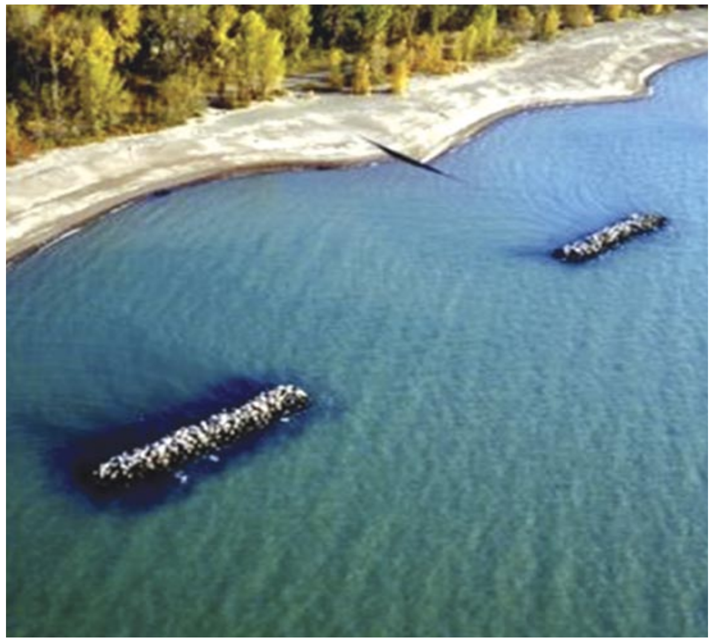
Measures designed to protect our nation's coasts and prevent or reduce damages ultimately cost less than federal disaster assistance and insurance payouts if overwhelming economic losses occur after a natural catastrophe.[6] If significant damages can be prevented, emergency equipment can get into a coastal region faster, evacuated residents can return home sooner, and the high costs of cleanup and rebuilding structures and infrastructure can be avoided.

Shore protection can help safeguard the public's investment in our nation's coasts

Shore protection projects are designed to retain and rebuild natural systems such as bluffs, dunes, wetlands, and beaches and to protect structures and infrastructure landward of the shoreline. Shore protection not only can reduce a storm's potential physical and economic damages from waves, storm surge, and the resulting coastal flooding but also can mitigate coastal erosion and even help restore valuable ecosystems that may have been lost such as beaches, wetlands, reefs, and nesting areas.

There are several ways to protect the shore:

- **Hard coastal structures**;
- **Non-structural solutions** such as **relocation** or **retreat** (controls that restrict building and coastal development); and
- **Soft measures** such as **beach nourishment**.



Breakwaters, constructed offshore but parallel to the shore, break waves before they reach the shore. Breakwaters help retain sand and reduce local erosion.

Photos courtesy of USGS

Storm surge can inundate structures on an eroding beach and cause them to collapse. Hurricane Ivan in 2004 destroyed these structures at Orange Beach, Ala.

Hard structures parallel to the shore, such as breakwaters or seawalls, help stop waves from affecting the shore or beachfront dwellings; structures perpendicular to the shore, such as groins, influence the movement of sediment along the shore by waves and currents.

In the past, hard structures were used exclusively for shore protection, but sometimes they changed the shape and nature of beaches and even blocked sediment transport. Today hard structures are still used when appropriate, either alone or in combination with beach nourishment.

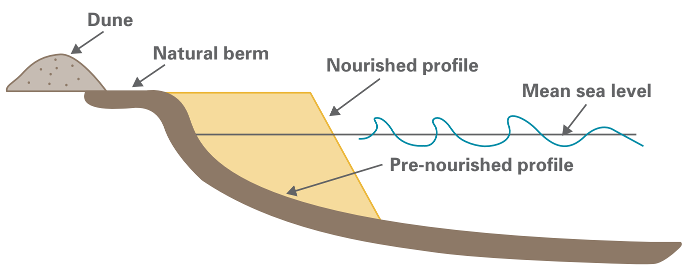
Non-structural solutions such as increasing building setbacks, elevating structures, and implementing zoning restrictions may lessen the consequences of erosion, but they won't slow it down. And retreating from the shore, leaving property, structures, and infrastructure behind – some $3 trillion along the East Coast alone – is rarely practical or politically feasible.[7,8] It is difficult to reverse some 300 years of development.

Beach nourishment, the only shore protection method that adds sand to the coastal system, is the preferred method for shore protection today

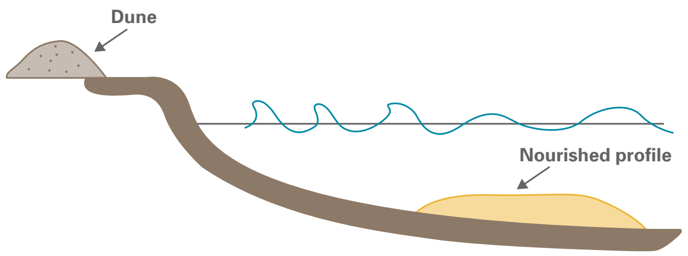
During a **beach nourishment** project, large volumes of beach-quality sand, called beach fill, are added from outside sources to restore an eroding beach. Or, a beach is constructed where only a small beach, or no beach, existed.[8] Ultimately, beach nourishment widens a beach and advances the shoreline seaward.

This beach nourishment project is under construction at Virginia Beach, Va.

Photo courtesy of the City of Virginia Beach



Coastal engineers often place beach fill directly on the beach to extend the natural berm seaward.



In some cases, beach fill is placed as underwater mounds.

Beach nourishment projects are designed and engineered to work like natural beaches, allowing sand to shift continuously in response to changing waves and water levels. Coastal engineers may decide to place beach fill as underwater mounds, directly on the beach, as dunes – or all three. This sand, once placed, is redistributed gradually by natural processes affecting the beach system. Ultimately, the wider, nourished beach, which slopes gently downward below the water, and the taller sand dunes protect the shore by acting as naturally protective buffers.

- The gradual slope of the nourished beach causes waves to break in shallow water as they begin to feel bottom. As water rushes up the beach, wave energy dissipates.
- Water running back down the beach redistributes sediment, which is deposited in deeper water or moved along the shore.
- These sediments often create an offshore bar that causes waves to break farther offshore, again dissipating wave energy, and thus protecting people and property behind the beach.

To ensure that a nourished beach continues to provide protection and mitigate the effects of hurricanes and coastal storms, the project must be supplemented with additional quantities of sand, called **periodic renourishment**, as needed.

The federal government helps communities protect certain beaches by providing shore protection with beach nourishment

Coastal development began in the early 1900s. In those days, individual property owners attempted to build their own structures to control erosion after hurricanes and coastal storms – but with unacceptable results. These structures not only were ineffective and unattractive but also harmful to the environment.[9]

In 1930, Congress authorized the U.S. Army Corps of Engineers to play a role in shore protection. During the 1950s, construction began on the first 18 federal shore protection projects, most of them involving beach nourishment. Through 2006, the Corps has constructed 87 major shore protection projects, most on the Atlantic coast. Today the Corps continues to provide shore protection, including beach nourishment, under the Flood and Coastal Storm Damage Reduction Program as part of its civil works mission. Other Corps water resource activities include navigation, recreation, ecosystem restoration, and emergency response.

Beach nourishment, which adds sand to the coastal system, protects people and property from the effects of hurricanes and coastal storms by widening a beach and advancing the shoreline seaward. This project was constructed at Panama City Beach, Fla.

Photos courtesy of Tom Campbell

The Corps of Engineers manages the federal shore protection program.

Photo courtesy of the City of Virginia Beach

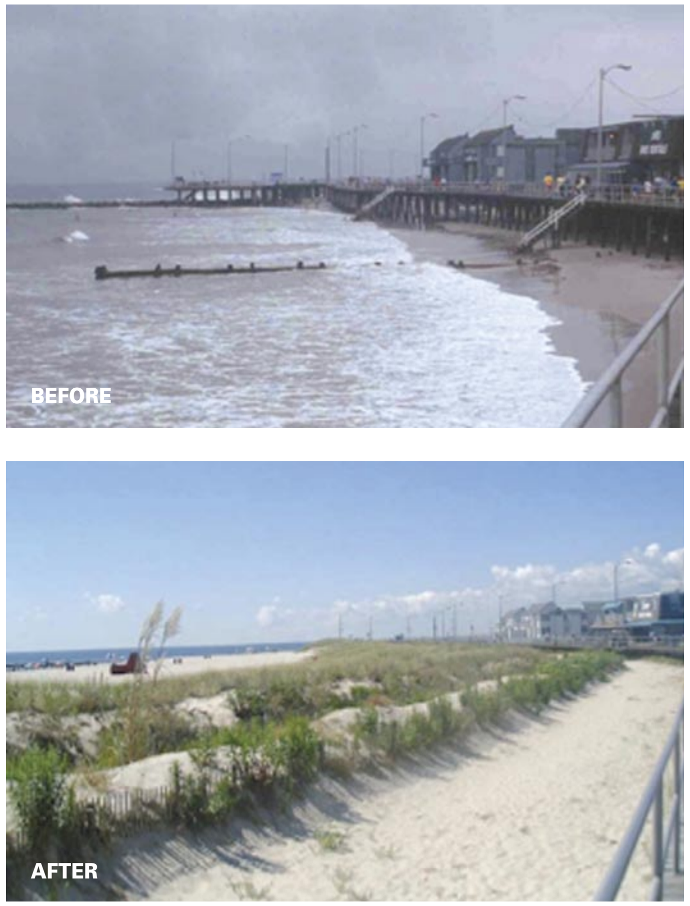
Local governments often initiate beach nourishment projects

Beach nourishment projects often begin after a local government decides that it has valuable resources – dense development and other economic and environmental resources behind a beach – needing protection from hurricanes and coastal storms. The community already may have endured flooding and property damage from recent storms, or its narrowing beach may be affecting recreational capacities and threatening the local economy.

The local government approaches the federal government with a request for assistance; the federal government must determine that there is a federal interest in protecting these areas to prevent damages. For projects with federal involvement, the beach receiving protection must be accessible to the public; for example, there must be adequate parking or access to public transportation. Additionally, the community requesting the project must be willing to help pay for it, since Congress requires that costs for beach nourishment and periodic renourishment be shared by the federal government and the local sponsor, which operates the project over time.

Not all proposed projects will get built. Projects must go through a rigorous evaluation process, including an environmental analysis, reviews by state and federal agencies, public hearings, and the Corps' internal review process.

From 1950 through 2006, the Corps has helped construct beach nourishment projects on approximately 350 miles of U.S. shoreline, with most projects on the Atlantic and Gulf coasts. Beach nourishment projects constructed by the Corps have reduced damages to coastal development caused by erosion, hurricanes, and flooding; protected and renewed the natural habitat; and provided recreation and economic benefits.



Dunes included in a beach nourishment project act as a protective barrier, preventing flooding and storm damage caused by storm surge, wave runup, and overtopping. This project was constructed at Ocean City, N.J.

Photo courtesy of Scott L. Douglass

Photo courtesy of J. Richard Weggel

Photo courtesy of Marlowe & Company

BEACH NOURISHMENT PROJECTS ARE ENGINEERED

Coastal engineers use their knowledge of complex coastal processes and decades of experience in beach nourishment to plan and design projects

Every beach nourishment design is unique, since different beaches in different areas have different physical, geologic, environmental, and economic characteristics and different levels of protection justified. Because it's impossible to predict with certainty what wave or storm conditions will be in a given year, coastal engineers use **computer models** to help design beach nourishment projects based on a range of **expected beach behavior** and **certain types of storms**.

During the planning process, the study team must evaluate complex environmental issues; find ways to maximize benefits and minimize construction costs; and ensure that the project complies with federal, state, and local laws and regulations. Some key questions are:

What are the site boundaries and design considerations?

Will beach nourishment take place on a long, straight beach – the typical location – within a "pocket beach," or next to an inlet? The design must consider climatology, the shape of the beach, type of native sand, volume and rates of sediment transport, erosion patterns and causes, waves and water levels, historical data and previous storms, probability of certain beach behaviors at the site, existing structures and infrastructure, and past engineering activities in the area.

By understanding beach topography above and below the water, coastal engineers can identify coastal processes at the site, calculate the volume of beach fill needed, and determine how long the project will last before renourishment is required. Periodic renourishment intervals – which vary based on the initial design, wave climate, sand used, types of storms, and project age – range on average from two to 10 years.[8]

Photo courtesy of the City of Virginia Beach

This beach nourishment project is under construction at Sandbridge Beach in Virginia.

Beach nourishment is not an exact science; variables and uncertainties exist. Actual periodic renourishment intervals may differ from planned intervals based on conditions at the nourished beach and the frequency and intensity of storms from year to year.

What features should be designed and constructed?

Monitoring of past beach nourishment projects – and better scientific information on how these projects interact with sediment transport and other coastal processes – have improved beach nourishment designs, which can include beach berms, sand dunes, feeder beaches, underwater berms, and some types of hard structures.

A higher and wider **beach berm** is designed to reduce wave energy. New **sand dunes** may need to be constructed or existing dunes improved to reduce damage from inundation. By acting as a protective barrier, dunes help prevent flooding and storm damage caused by storm surge, wave runup, and overtopping. **Berm height** and **width**, **dune height**, and **offshore slope** are critical elements of a beach nourishment design.

Sometimes a **feeder beach**, which stockpiles beach fill for distribution naturally to other parts of the project area, may be required. In some cases, sand is placed in shallow water so waves can move it gradually toward the beach; in other cases, sand may be placed offshore in an **underwater berm**. **Hard structures** such as groins may be included to reduce the forces that cause rapid sediment losses and extend the time between renourishment events.

Beach nourishment projects are designed to optimize storm damage reduction benefits relative to costs. Designing a project to protect against any and all storms is not economically feasible. Extreme conditions and severe storms could exceed the capacity of a beach nourishment project to protect people and property.

Photos courtesy of the City of Jacksonville, Fla.

During project design, coastal engineers often include features that improve habitat and encourage turtles and shorebirds to nest and dwell on the nourished beach.

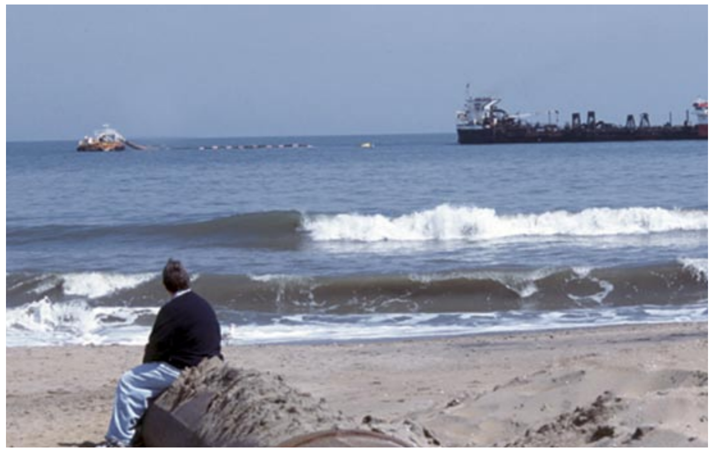


Photo courtesy of Scott L. Douglass

Photo courtesy of Scott L. Douglass

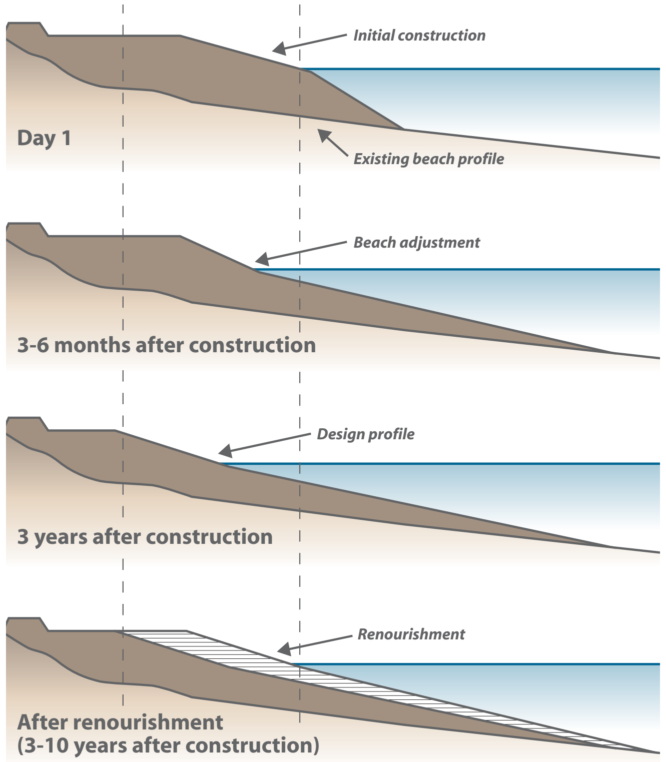
What 'borrow source' for beach fill should be used?

The sand to nourish a beach comes from a borrow source, chosen based on compatibility of sand, cost, removal and transportation, and environmental factors. Beach fill can be dredged from **underwater** sources of sediment such as harbors, navigation channels, or waterways, or from other large, offshore deposits, which is now common. Dredged material can be pumped through pipelines directly onto the beach or transported to the shore via specially designed barges before being pumped onto the beach. Or, sand for beach fill can be taken from **dry land** sources and transported by trucks.

Finding an affordable borrow source with sufficient quantities of high-quality beach fill is challenging. Grain size, color, composition, and texture of the material should match the native sand as closely as practical to ensure proper project performance. If one borrow source is depleted over time, coastal engineers find another affordable borrow source.

During construction of a beach nourishment project, sand is placed so that natural coastal processes can reshape the nourished beach into the desired configuration as intended by coastal engineers

The dry beach may seem "**overbuilt**" during construction, since sand is often placed on the shore at fairly steep slopes. After construction, it is normal for the newly nourished beach to **readjust** and change substantially within the first few months. Engineers expect modest waves to move and spread the sediment so that the nourished beach can begin assuming a more natural form. This sediment will continue to move offshore, so that larger waves are prevented from reaching the shore, and along the shore. This movement of sediment, while decreasing the width of the nourished beach somewhat, is not erosion; rather, it indicates that the project is performing as designed.



After a beach nourishment project is constructed, coastal engineers expect the beach to change gradually over time and assume a more natural form.

Beach nourishment projects can have multiple benefits

Besides mitigating coastal erosion and protecting life and property through hurricane and storm damage reduction, beach nourishment projects can provide **environmental**, **recreational**, and **aesthetic** benefits. For example, nourishing and widening an eroding beach can:

- Protect threatened or endangered plants in the dune area;
- Protect habitat behind dunes or next to beaches;
- Create or restore habitat, lost through erosion, for sea turtles, shorebirds, and other beach organisms; and
- Create new nesting areas for endangered sea turtles and spawning grounds for other species.

Beach nourishment projects also can create and sustain wider beaches for recreational activities such as fishing and boating and protect infrastructure enjoyed by tourists. Healthy beaches not only are crucial to the nation's travel and tourism industry but also can help revitalize local economies by increasing property values, condominium rentals, retail sales, and demand for services.

Photo courtesy of the City of Virginia Beach

ENVIRONMENTAL CONSIDERATIONS ARE INTEGRAL TO BEACH NOURISHMENT PROJECTS

Since sediment is constantly being redistributed – and coastlines and beaches are always on the move – plants, fish species, and other marine life are well adapted to the natural processes of accretion and erosion. Nevertheless, the type, timing, extent, and duration of these changes can affect our ecological resources. Studies are still being conducted to determine how these species become accustomed to the physical changes that occur when a beach nourishment project is constructed and periodic renourishment occurs.

Because beach nourishment projects can affect environmental resources at the borrow source and placement site, **responsible planning and design** are needed to prevent or reduce adverse effects to the environment and wildlife before, during, and after construction:

- Beach fill can be dredged from borrow sources in ways to minimize turbidity and in thin layers to protect organisms and habitat.
- Sensitive areas such as reefs and hard bottom areas can be avoided or protected from damage during dredging.
- Beach fill can be selected to match the native sand size and composition as closely as possible; closely matched beach fill helps accommodate species' needs for sea turtle nesting, egg incubation, and hatching success.
- Construction can be scheduled during specific months to avoid disrupting nesting, spawning, or other behaviors and associated habitat.
- Care can be taken to avoid creating steep berms or scarps, which can force female sea turtles and beach nesting birds to lay their eggs too close to the water, where they could be washed away by tides.

Photo courtesy of S. Brooke

- Coastal engineers can build environmental amenities into a project based on needs at the site. In an eroding area, the project can be designed to produce an artificial "overwash fan," which spreads sand landward of the dune line into waters behind a barrier island, for example. In an area with a sensitive-species habitat, however, the project can be designed to prevent a natural overwash fan, since additional sand could harm such habitats.

HOW BEACH NOURISHMENT WORKS WHEN A STORM COMES ASHORE

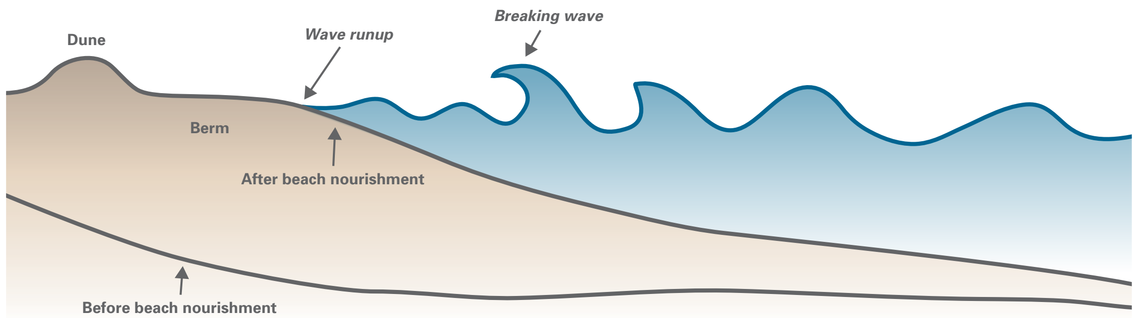
It is natural for nourished beaches and dunes to erode and change as they dissipate and absorb wave energy during a storm

Coastal engineers expect that large storms will induce **sediment transport** from the nourished beach and move sand offshore. When this happens, waves begin to break farther from the shoreline, thus weakening their force before they reach the shoreline itself. In this way, beach nourishment projects help protect dunes and property from further erosion, decrease flooding, and limit how far ashore storm surge will go.

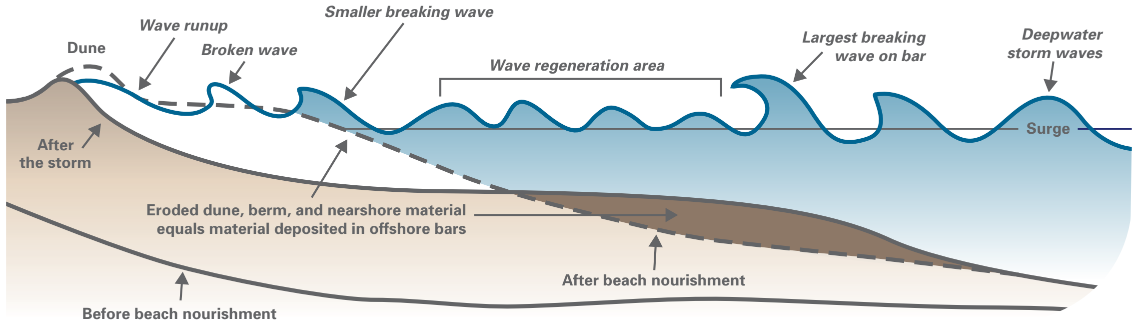
A **wide, flat beach berm** with a sufficient volume of sand keeps the erosive power of the waves from reaching and destroying the dunes and structures and can reduce damages significantly from waves, inundation, and erosion. Without beach nourishment, the starting point for damage would be farther onshore; a nourished beach, with sufficient sand volume and healthy dunes, absorbs the storm's energy, even during slow-moving storms, and helps prevent damages to structures and infrastructure.

Photo courtesy of the City of Virginia Beach

An estimated $105 million in damage was prevented after Hurricane Isabel struck a nourished beach with a seawall at Virginia Beach in fall 2003.[7] The project was designed to stop a 9-foot storm surge – and it did. The nourished beach minimized wave attack and overtopping of the seawall, the community's last line of defense.



A nourished beach (pre-storm)



A nourished beach (post-storm)

Photo courtesy of the City of Jacksonville, Fla.

Beach nourishment projects work by allowing the destructive forces of waves to strike the beach instead of the structures and infrastructure behind the beach.

The height and sand volume of a dune, stabilized by vegetation, also play an important role in reducing damages. During large storms, the dune on a nourished beach is usually the last line of defense that can absorb wave energy, protect against storm surges, and minimize or prevent flood damages.

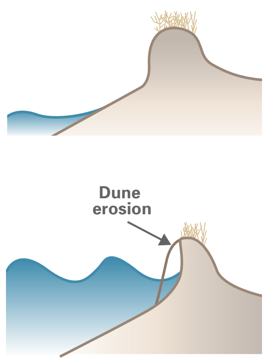


Illustration courtesy of USGS

When a storm strikes a nourished beach, sediment is redistributed in two ways: in the **longshore** direction, to adjacent beaches, and in the **cross-shore** direction, either toward the sea or toward land. At first, shoreline recession produced by the cross-shore transport of sediment may seem significant. But it is not unusual for nourished beaches to change dramatically in response to storms. Storm-generated currents and waves will redistribute great quantities of sediment, changing the profile of the nourished beach.

Nourished beaches begin to 'heal' after a storm

Within hours or days – with milder weather and time – sediment that has moved offshore or alongshore during a storm begins to move back onshore, since much of it remains in the system. After a few months, dunes begin to recover with wind-blown sand. The sediment returns gradually, carried by smaller waves, to restore the beach and prepare it to protect the shore during future storms. Sand that moves to other areas offshore or alongshore can nourish adjacent beaches and also have a positive effect by dissipating wave energy in other locations.

However, a beach nourishment project can last only so long before natural processes and storms will have transported too much sediment outside the project area. If the volume of sand on the dry beach cannot provide adequate shore protection, **renourishment** may be required to rebuild and restore the berm before erosive processes affect dunes, development, and valuable ecosystems behind the beach.

Beach nourishment projects can be considered successful – even when a beach changes dramatically after a storm

The goal of beach nourishment is not to maintain a wide, dry, exposed beach. In fact, after a storm, a nourished beach may be narrow, the shoreline may have moved landward, waves may have eroded or even overtopped the dunes, great quantities of sand may have moved offshore or alongshore, and the beach may need renourishment. But that doesn't mean the project was a failure. **A beach nourishment project is considered successful if damages from waves, inundation, and erosion have been prevented or reduced significantly, and development and ecosystems behind the dunes are still intact.**

Photo courtesy of USGS

During Hurricane Fran in 1996, no structures were destroyed and no oceanfront development endured significant damage at Wrightsville Beach, N.C., the site of a Corps beach nourishment project. However, as shown here on Topsail Island, an unprotected area, the shoreline eroded, and the dunes and hundreds of structures were destroyed.[6]

Photo courtesy of Scott L. Douglass

A beach nourishment project at Ocean City, Md., constructed in 1990 and 1991 at an initial cost of $37.5 million, immediately prevented an estimated $93 million in damage to structures and infrastructure after severe storms struck the area the following two winters.

THE FUTURE OF OUR COASTS: WHAT'S IN STORE

Continued population migration and development along the coasts, impacts from global climate changes, relative sea level rise, and more frequent and intense storms will continue to affect our coastlines

From 1985 to 1994, when sea surface temperatures were lower in the tropics, there were only half as many hurricanes as there have been since 1995, when sea surface temperatures and wind conditions in the Atlantic shifted. Now that the United States is in the midst of a new, long-term weather cycle, scientists predict that frequent, clustered hurricanes will become more common, with more major hurricanes making landfall over the next 10 to 30 years. As waters remain warm, they're likely to spawn more intense hurricanes.

Societal changes, however, pose the greatest threat

The more people and property along the coasts, the more vulnerable we are, and the larger the potential losses – including loss of life – from the effects of hurricanes and coastal storms on eroded beaches.

Nourishing an eroded beach in a highly developed area allows nature to take its protective course. However, if we don't take care of our nation's beaches, they will lose their naturally protective function, putting people, property, and the environment at great risk.

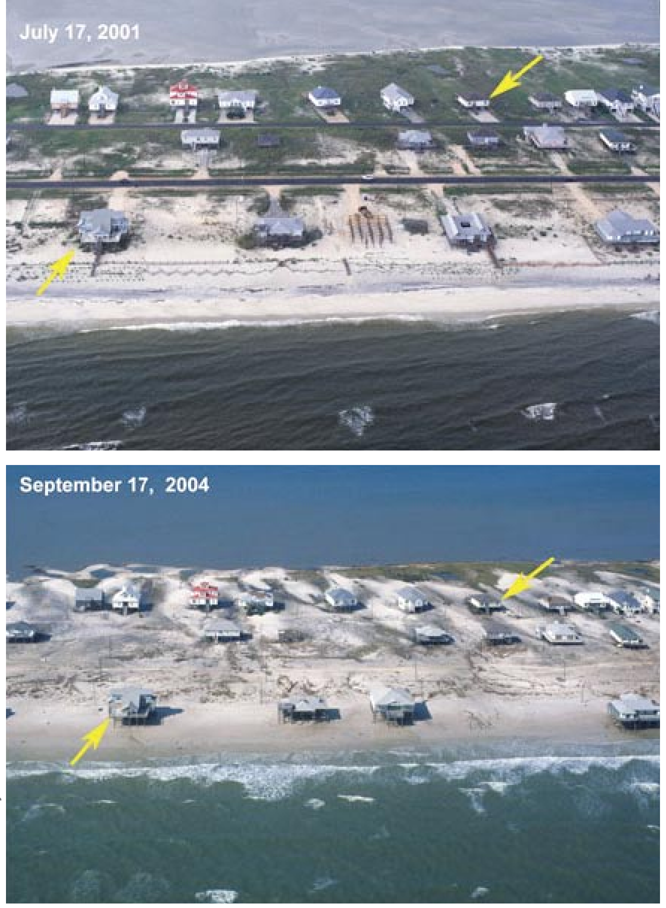
These are considerable challenges for the 21st century.

As long as beach nourishment projects are planned, engineered, and constructed properly – and periodically renourished – beach nourishment is a sound and cost-effective shore protection method.

In the future, it is likely that more communities may turn to beach nourishment as the preferred method of shore protection to reduce storm damages and help protect life and property, mitigate coastal erosion, and restore the ecosystem.

Photo courtesy of Marlowe & Company

Beaches will continue to retreat if sediment in certain areas is lost to the coastal system.

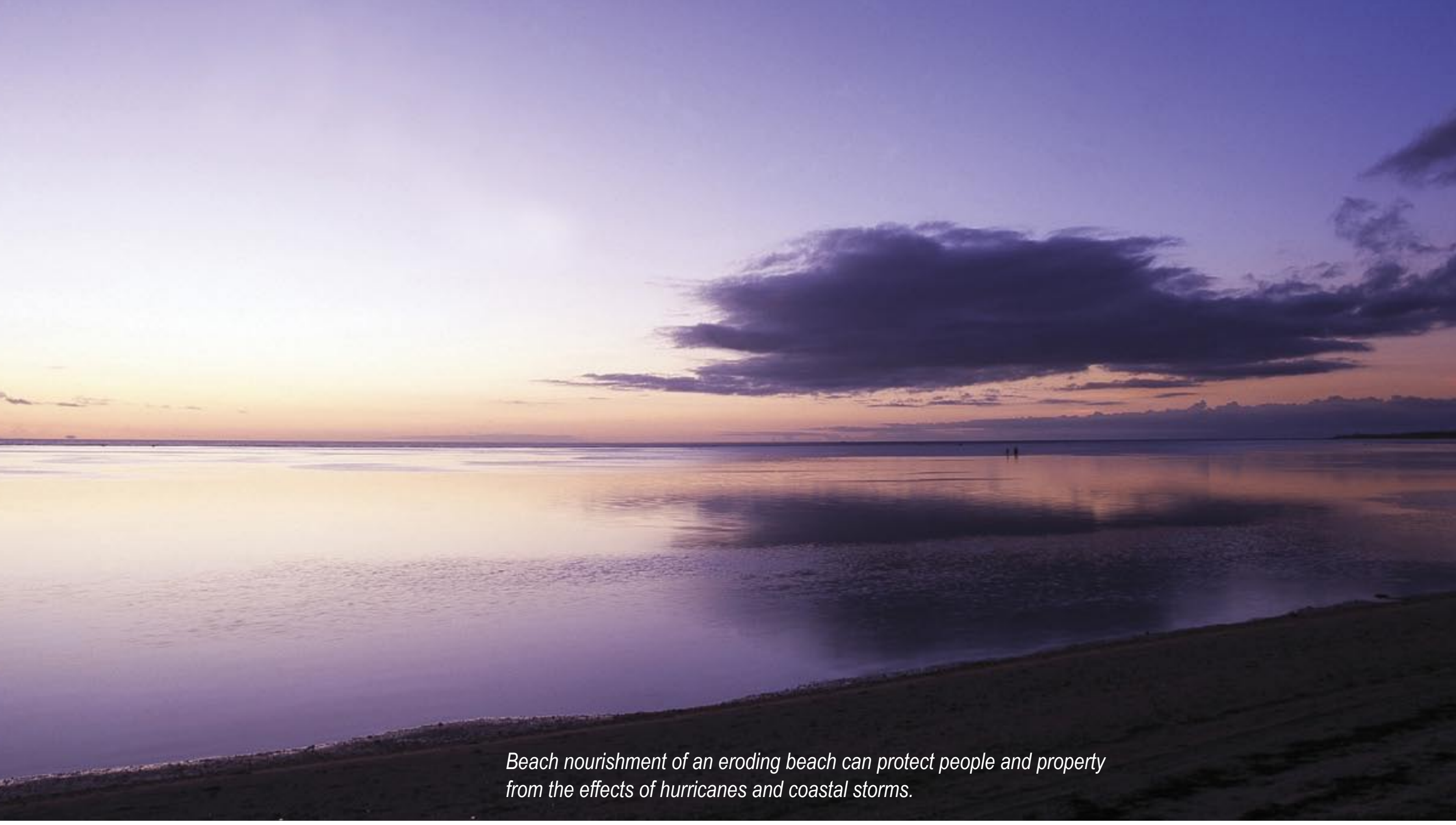


Photos courtesy of USGS

Eroding beaches – if left alone – will continue to lose their naturally protective function.

Photo courtesy of Scott L. Douglass

Our highly developed coastlines will continue to be vulnerable to the effects of hurricanes and coastal storms.



Beach nourishment of an eroding beach can protect people and property from the effects of hurricanes and coastal storms.

FOR MORE INFORMATION ABOUT BEACH NOURISHMENT

Please contact the Coastal and Hydraulics Laboratory, Engineer Research and Development Center (ERDC), at CHL-Info@erdc.usace.army.mil.

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SHORE PROTECTION ASSESSMENT

US Army Corps of Engineers®

Shore Protection Assessment is an initiative to evaluate how federal shore protection projects performed in the wake of hurricanes Charley, Frances, Ivan, and Jeanne in 2004. Shore Protection Assessment is a unique opportunity for a comprehensive and coordinated technical evaluation. The U.S. Army Corps of Engineers and others will use these findings to improve future projects by better predicting how storms move sediment, change shores, and cause damage.

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