CHAPTER 5. MITIGATION

Mitigation eliminates or reduces the damage that can be done to existing or proposed development or to the coastal environment when natural hazards impact a property or when humans take action in response to that event. According to a Multi-Hazard Mitigation Council report a dollar spent on mitigation saves society four dollars.

Mitigation measures can be either non-structural measures or structural measures. Non-structural measures include changes a community or person can undertake to make property less susceptible to flooding, erosion, or other hazards, such as elevating buildings, using buffers and vegetation, and avoiding development of hazardous areas. Structural measures include levees, floodwalls, seawalls, rip-rap, diversions, groins, jetties, and beach nourishment.

BASIC: COMMON PRACTICES

Structural projects attempt to keep floodwaters away from area inhabited by people or to protect property from coastal erosion. Dams, levees, seawalls, groins and other structural measures often cause the following adverse impacts:

- Disturb the land and disrupt natural water flows, often destroying habitats (for example, levees can isolate wetlands, which are then drained for development);
- Are built to a certain flood protection level that can be exceeded by a larger flood or by overtopping or failure of the structure, causing even more damage than might have occurred without the structure;
- Can create a false sense of security when people protected by a structure believe that no flood could ever reach them so they do not take personal mitigation measures (shown by the levees in New Orleans and along the Sacramento River, and by the March 14, 2006 dam failure on the island of Kauai, Hawaii);
- Require regular maintenance to ensure that they continue to provide protection, something that is often neglected over the years. On structural projects, operation and maintenance are usually the responsibility of local government. (Some levees in southeast Louisiana had subsided and not been raised before Hurricane Katrina overtopped them);
- Are expensive, sometimes requiring capital bond issues and/or cost sharing with local, regional, or State agencies;
- Can divert flood flow onto other properties and reduce the floodplain's storage capacity increasing downstream flood peaks;
- Can alter the timing of flood peaks, causing increased flooding on other properties; and
- Can adversely affect adjacent, unprotected properties by interrupting littoral drift and starving adjacent beaches of needed sediment.
- Loss of life and property, reduced recreational opportunities, degradation of environmental quality, and alteration of traditional coastal uses are some of the detrimental impacts of shoreline erosion and subsequent coastal flooding.

Where coastal or shore protection structures already exist, communities must ensure that either they are properly operated and maintained or removed if they can no longer be maintained.

Breakwater

Jetties

Rip rap

Seawall

Beach Nourishment

Groins

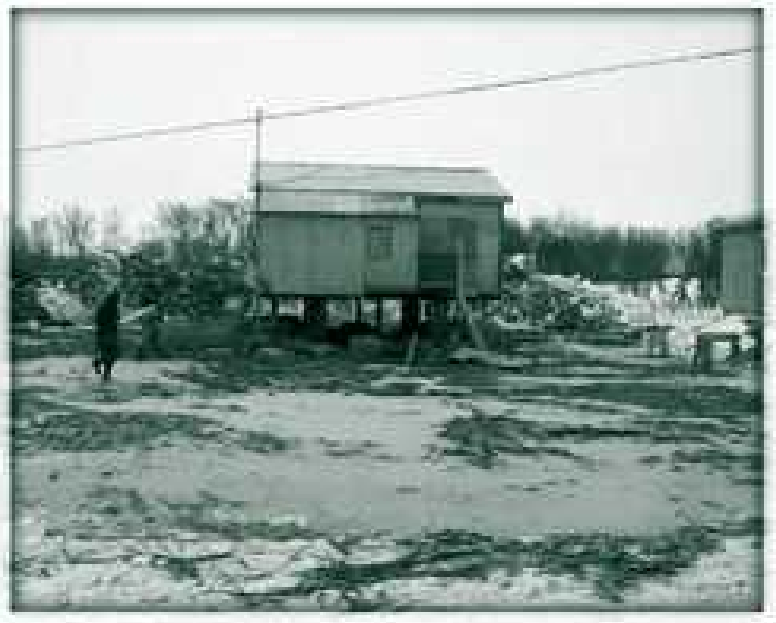
BETTER: HUMAN ADJUSTMENT TO FLOODING

Because of the expense and adverse impacts from flood protection structures, many communities have turned to nonstructural approaches to reduce flood losses. Instead of trying to control water, these techniques focus on altering development practices and how people respond to floods.

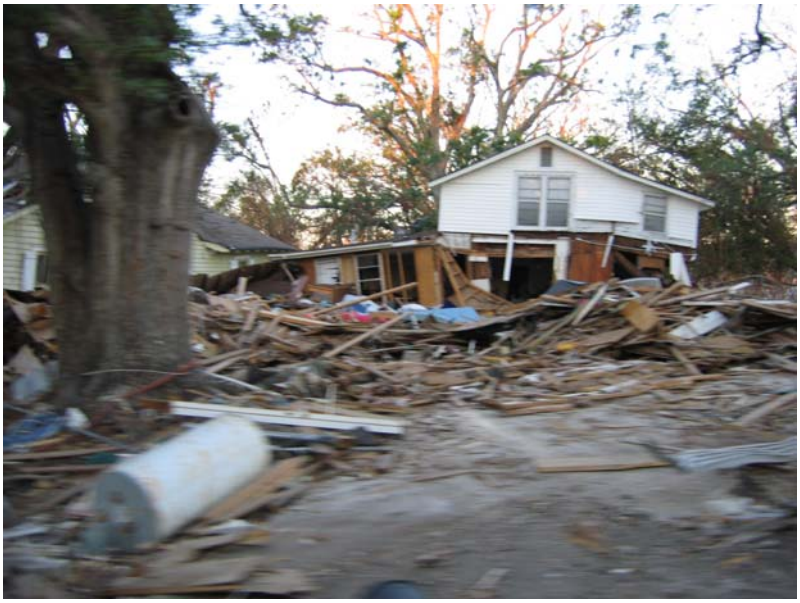
The first step in altering development practices can be the development of a comprehensive flood hazard plan to address your community's hazards and risks (See Appendix C for a description of coastal hazards). The plan should provide recommendations to minimize exposure, such as modification to existing zoning maps, building standards and regulations. A major tool for altering development practices is enforcement of the community rules, regulations, and procedures. The lack of enforcement has the domino effect of increasing flood damage. When one property owner is allowed to violate community standards, others follow. This makes it difficult for courts to order compliance because all violations are not treated equally. Cumulative violations increase damage and disaster costs because buildings constructed illegally are more susceptible to flooding and other coastal hazards. Immediate enforcement action, with significant fines, prevents other violations. When the staffs of regulatory programs find illegal revetments, seawalls, groins, or other shore protection structures, the property owner should be required to apply for an after-the-fact permit. Structures that do not meet permit requirements should be removed. Enforcement can also include payments into wetland mitigation banks, fines for illegal activity, and restoration of coastal resources.

Relocation

Relocating a structure inland from the shoreline on higher ground is generally considered the surest and safest way to protect it from coastal flooding. Relocation can also reduce the risk to a community's infrastructure and the risk to first responders. Communities should favor this action to reduce their liability and costs for providing services and infrastructure. Several federal programs are available to help offset the cost of pursuing this option.



Relocating a house (Alaska)

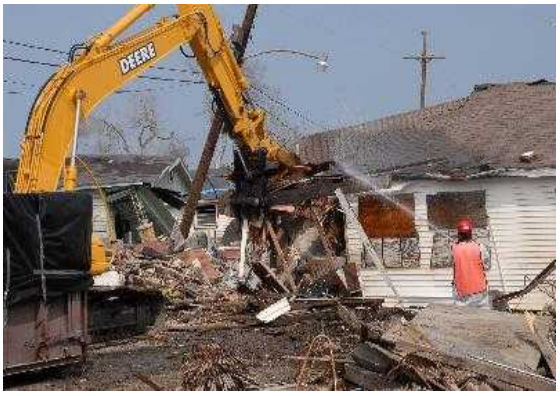


Damaged house, Biloxi

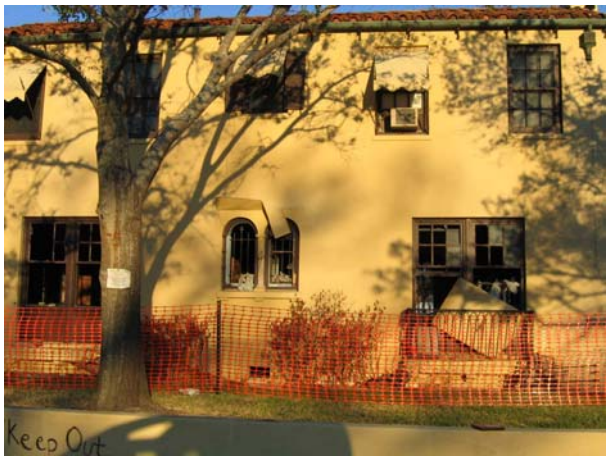
Specialized house-moving companies have the ability to move a structure, even an unwieldy and historic one, as demonstrated by the relocation of the Cape Hatteras lighthouse. The lighthouse, built on a barrier island off the North Carolina coast, was threatened by a gradually encroaching shoreline as the barrier island migrated. The structure was successfully relocated in 1999 to a site about 2,900 feet inland.

Acquisition

However, higher ground and/or moving inland are no guarantee of protection, as victims on the Gulf Coast learned in 2005. The storm surge from Hurricane Katrina exceeded levels thought to represent the ultimate in storm surge by as much as 11 feet and destroyed structures more than a mile from the beach. Acquisition ensures that structures will no longer be potential damage statistics. They also will not become debris that can impact other property nor add to the community disaster recovery costs. The purchased land is usually converted to public open space, such as a park. Acquiring and clearing buildings is also a way to convert a problem area into a community asset, obtain environmental benefits (e.g. wetlands protections) and reduce impacts on others. Coastal areas subject to storm surge, steep slopes, or coastal erosion and for buildings on larger slabs, constructed out of brick or masonry, or too dilapidated to move may be good candidates for acquisition.



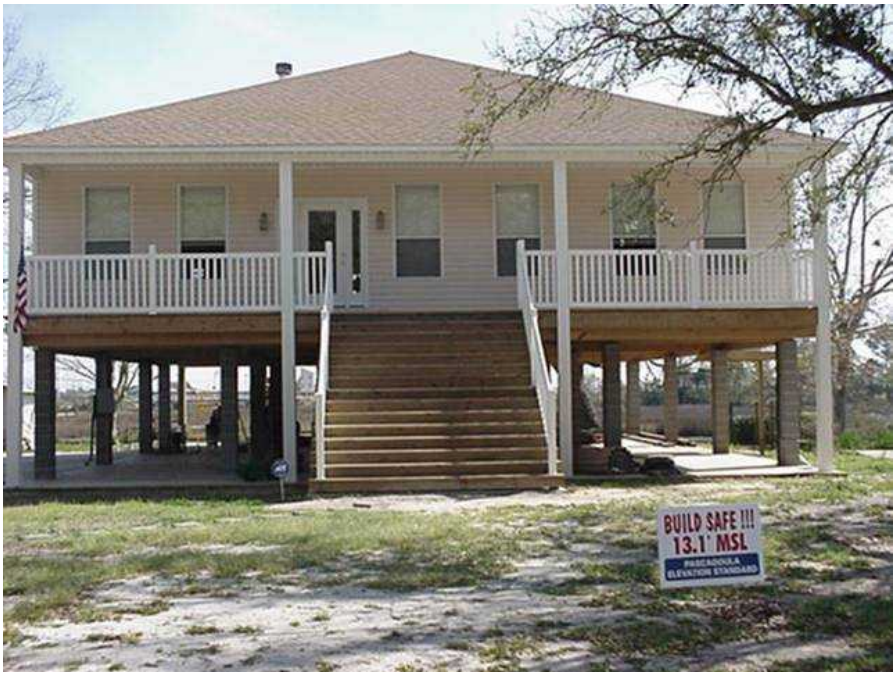
Demolishing a house



Damaged structure too large to relocate

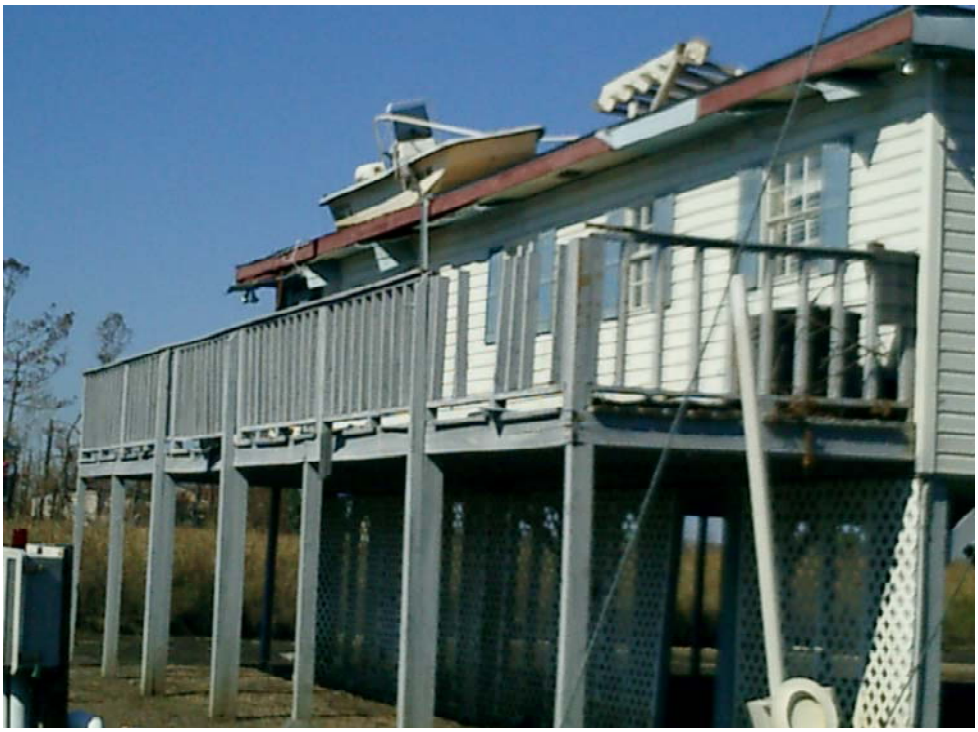
Elevation

Elevating an existing building to comply with the local zoning ordinance or to raise it above the most recent storm surge level is often a good on-site protection method. When the first floor of living space is elevated above the base flood, floodwaters don't reach the most damage-intense part of the building. FEMA has developed guidance on elevating buildings on the coast (FEMA, 2005c) and how to ensure the foundations of elevated structures are adequate (FEMA, 2006c). All coastal-area property owners should purchase flood insurance on the structures and their contents. Flood insurance not only reimburses for flood damage, but the standard policy has provisions (called Increased Cost of Compliance coverage or ICC) to cover costs associated with bringing a substantially damaged structure into compliance with current standards. For example, if a NFIP insured structure is below the base flood elevation and is substantially damaged by a flood, this additional funding is available to help pay for elevating the structure.



Pre-Katrina elevation helped to save this house

New Orleans homes with basements



This structure not elevated enough to avoid having a boat being left on its roof by Katrina

Geodesic dome style to resist wind forces

Navigation Channels, Waterways, and Harbors

Flooding from storm surge or tsunami can be amplified when the flood flow is funneled landward from the sea. This can be minimized by increasing the dissipation area available to the flood waters. Communities should prevent in-filling of adjacent wetlands and other low land or even create additional wetlands or lowlands near susceptible land.

Non-structural Shore Protection

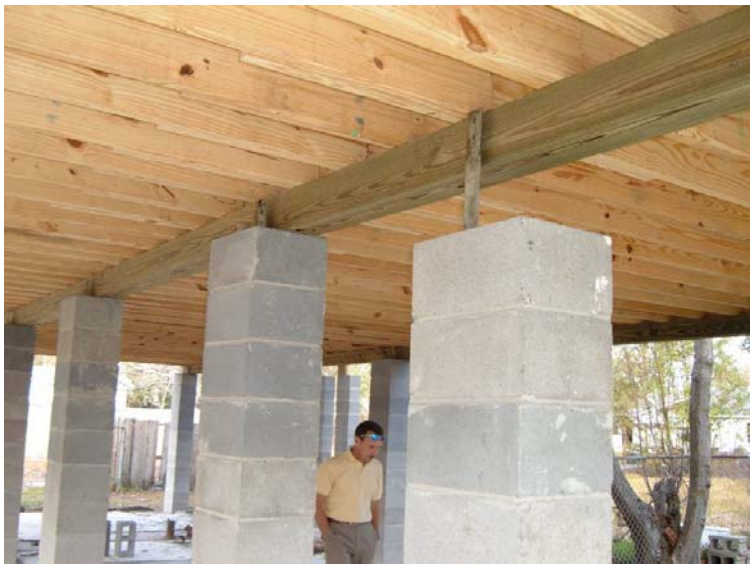
Shore protection structures are increasingly being considered a “last resort” for mitigation of erosion (Pope, 1997; USACE, 2002). Non-structural options to be considered before resorting to structures include

- Adaptation to natural coastal processes (by using large setback distances, relocating or acquiring and demolishing threatened buildings, etc.);
- Restoration of natural shorelines (by retaining and nourishing beaches, re-vegetating the shore, conserving or constructing dunes and beach ridges, creating or restoring wetlands, removing failed and failing structures, modifying the ends of structures that must stay to minimize the end effects on other properties and natural resources, etc.); and
- Moderation of erosion (stabilizing coastal slopes, slowing wind erosion, improving existing protective structures, tripping waves, etc.).

If the planning process involves the property owners that need protection, they may well become more supportive of nonstructural measures. Projects that are well planned and involve the public with information have a higher participation rate.

Other Mitigation Measures

Communities can also develop other mitigation measures for coastal property owners, starting with a structural assessment of building vulnerability. Mitigation measures can include anchoring structures to resist flotation, using hurricane clips and similar wall and roof bracings, installing protective shutters on windows and glass doors (FEMA, 1997, pp. 23-25), maintaining and enhancing vegetative cover in riparian corridors, stabilizing dunes with fences and vegetation to reduce erosion and attenuate flood flows, avoiding impervious coverage on the property, avoiding hardening of the shoreline (e.g. the use of retaining walls), and minimizing impacts of any on-site development such as detention ponds. FEMA's Mitigation Best Practices is a web site with a collection of illustrated stories about mitigation projects and activities at http://www.fema.gov/plan/prevent/bestpractices/index.shtm .



Hurricane bracing, MS

For additional information on mitigation success stories, see ASFPM (1999, 2002), Department of Crime Control and Public Safety (1999), FEMA (1997) and FEMA's Mitigation Best Practices

NAI LEVEL: MITIGATING ADVERSE IMPACTS

The No Adverse Impact (NAI) approach advances alternatives for mitigating the negative impacts of coastal development through actions that will probably cost less than would disaster recovery. At the same time, communities should select mitigation measures that contribute to the sustainability of the community and the values and functions of the floodplain, wetlands, and other coastal environments. Some appropriate NAI mitigation measures are:

- Improved management of surface water and groundwater to improve the stability of coastal slopes;
- Slowing shoreline erosion with "hybrid" stabilization techniques, such as a combination of vegetation and geotextile netting. This hybrid technique is more resistant to erosion than vegetation alone in moderate energy environments, and still provides diverse habitat, which rip-rap alone cannot do;

- Slowing wind erosion with vegetation, including trees and shrubs that absorb wind energy;
- Augmenting (or mimicking) natural shoreline defenses, such as near shore shoals and bars;
- Avoiding new development on coastal properties where facilities are likely to be damaged or destroyed or where debris and objects carried from the properties during a storm or flood pose a threat to other persons, services, and structures; and
- Regulating fill on lowlands in proximity to the sea, streams, bays, wetlands, and estuaries.

Non-structural measures can have impacts on other people, their property and natural floodplain functions. Following are some adverse impacts of mitigation efforts identified as BETTER that should be taken into account and mitigated:

- Acquisition and relocation is often done piecemeal, leaving what is called a checkerboard pattern of vacant lots and buildings that either did not qualify for the program or whose owners did not want to move.
- Elevation and floodproofing still leave buildings surrounded by floodwaters during a flood. Occupants often try to ride out the flood or try to get to and from their property during high water, requiring costly police and fire protection.
- If allowed, owner-designed measures, especially dry floodproofing (construction measures incorporated into the design of a building to protecting its utilities and prevent floodwaters from entering the building), may not adequately account for all the forces that floodwaters place on a building. This can result in severe structural damage to the building. The streets, utilities, and other infrastructure that serve an elevated or floodproofed building are still exposed to flood damage and public costs for that damage. It is important to remember that existing buildings should not be protected at the expense of other properties (e.g., through redirected floodwaters or increased flows). Corrective actions must not be allowed to create new flood problems. Dry floodproofing is no guarantee. Storm surge may exceed the design of a structure that was dry floodproofed.

A restaurant in Mandeville, Louisiana, located on the shoreline of Lake Pontchartrain, was dry floodproofed to protect the building from inundation likely to result from heavy rain accompanied by strong southerly wind on the lake. Water from the lake would “push” into the rivers and bayous and prevent the rainwater from draining away, resulting in ponding on the floodplain. The restaurant (estimated value of $700,000) received 6 to 12 inches of floodwater on numerous occasions, resulting in 11 flood claims totaling $94,055. The building was floodproofed with a waterproof membrane covered by bricks for a total project cost of $200,000 (FEMA, 2002c). However, Hurricane Katrina had a storm surge of 6–8 feet across the Mandeville shoreline, far exceeding the protection level of the dry floodproofing in place. The restaurant sustained substantial damage as a result of the Hurricane Katrina storm surge.

Natural Shorelines

Communities can decide to cause no additional adverse impact to the shorelines that are a natural, protective buffer between the storms and tsunamis of the sea and human investments near the shore. Beaches can be maintained and nourished; beach ridges and dunes can be protected, reconstructed, and re-vegetated. Communities can plant vegetation on eroding coastal slopes; restore or create wetlands; remove failed or failing shore protection structures; and restore other natural shoreline features as needed.

Climate Change

The NAI principle can be implemented in a way that builds in some resiliency and adaptability to account for the consequences of potential climate change. Such change seems likely to alter river and coastal processes in a way that will threaten both natural habitat and coastal development. Some anticipated alterations in climate patterns include changes in the frequency and severity of floods, hurricanes, and other coastal storms; more frequent freeze-thaw cycles and less shore ice on northern, temperate shores; and sea level change. At a minimum, communities at the NAI level would incorporate anticipated relative sea level rise within in the next 100 years (the life span of structures built) into the BFEs established for their community. They should plan for the possibility of rapid (or abrupt) climate changes over the span of a decade, as well as more gradual climate changes over several decades to a century.

Water Quality

Communities can construct projects within coastal watersheds that not only reduce flooding but also have water quality benefits as well. Similarly, the agricultural and forestry activities should implement best management practices (BMPs) to minimize runoff in coastal watersheds. State park, recreation, and fish and wildlife agencies should incorporate stormwater detention projects, buffer strips, porous pavement, and vegetative plantings to reduce erosion in and runoff from refuges and management areas, parks, or recreation facilities in coastal watersheds.

State water resource agencies can use Environmental Protection Agency funds (Section 319, Clean Water Act, 33 *USC* 1251) to support demonstration projects and programs addressing nonpoint sources of pollution. The Natural Resources Conservation Service has programs to address nonpoint source pollution and protecting wetlands and riparian habitat through its P.L.-566 Small Watershed Projects (*Catalog of Federal Domestic Assistance* #10.904), the Environmental Quality Incentives Program (*Catalog of Federal Domestic Assistance* #10.912), and the Wildlife Habitat Incentives Program (*Catalog of Federal Domestic Assistance* #10.914). For additional federal programs, see www.cfda.gov and search by agency and sub agency. Conservation and rehabilitation of wetlands and riparian habitat and erosion prevention reduce runoff and contribute to lower flood stages in coastal watersheds.

Monitoring

Monitoring is a vital part of managing the risks of adverse impacts both on neighbors' and one's own property. Monitoring is particularly crucial in this time of changing climate as disagreeable surprises appear one-by-one: unexpected drought, record floods, severe storms, and extreme rainfall events. In order to implement corrective actions, many communities must undertake a monitoring program to justify the expense and effort of corrective actions.

Documenting shoreline position on neighboring properties when shore protection structures are constructed and checking it annually can help ensure the structure is not having adverse impacts on adjacent properties. Video taping development along the coast and in floodplains can help identify development and shoreline modifications that have been constructed without proper permits.

Shore Protection Structures

To avoid adverse impacts, communities should require shore protection structures be: 1) designed and built according to coastal engineering standards and consider potential adverse impacts including minimization of impacts to adjacent properties, 2) monitored for performance and condition, 3) maintained in an as-built condition and 4) modified as needed to minimize adverse impacts.

Groins should be no higher than the beach they are intended to build so that when filled they will pass sand to the down drift coastline. The States of New York and Massachusetts require that groin fields be filled with sand at the time of construction: since the groin is already filled, the natural sand supply can continue to move normally and nourish down drift areas, instead of being captured by the groin. Revetments and seawalls should be located as far as feasible from the normal range of water's edge to protect the land only from the most severe storms and to minimize interactions between these structures and waves during more frequent storms and tidal ranges.

Communities can ban new structures and modify existing structures that are likely to cause storm surges and tsunami waves to be amplified and cause adverse impacts. Although bulkheads and other vertical walls may be needed to some extent in harbors and other waterways, they should be minimized as much as possible, because wave reflection can cause adverse impacts on other properties and on waterway activities. Some measure of wave absorption should be required on new bulkheads if wave reflection would create a problem for others. An absence of grout between rocks or blocks in seawalls, revetments, and groins better dissipates wave energy and allows vegetation to grow. Projects that deflect wave energy can also provide habitat for marine life if nooks and crannies are designed into the structure.