

Mitigating Shore Erosion on Sheltered Coasts

Much like ocean beaches, sheltered coastal areas experience land loss from erosion and sea level rise. The many bulkheads and other structures built to protect coastal properties in those areas cause changes to the coastal environment that threaten landscapes, public access, recreational opportunities, natural habitats, and fish populations. A new management approach is needed that takes into account all available erosion prevention alternatives and their attendant costs, benefits, and impacts. The regulatory preference for permitting bulkheads and similar structures should be changed to favor more ecologically beneficial solutions.

Erosion is a natural phenomenon that threatens properties built on coastal shores. Although open coasts have been the focus of most studies on erosion and technologies for stabilizing the shoreline, sheltered coastal areas, such as those found in bays and estuaries, also suffer land loss from erosion and high waters. For example, the Maryland Geological Survey estimated that Maryland lost as much as 20 acres of land on the western shore of Chesapeake Bay in the wake of Tropical Storm Isabel, causing \$84,000,000 in damages to shoreline structures.

Landowners frequently respond to the threat of erosion by armoring the shoreline with bulkheads and other structures. Although the armoring of a few properties has little impact, the proliferation of structures along a shoreline can inadvertently change coastal environments and ecosystems. Managers and decision makers have been challenged to balance the trade-offs between protection of property and potential loss of landscapes, public access, recreational opportunities, natural habitats, and reduced populations of fish and other marine species that depend on these habitats.

At the request of the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (USACE), and the Cooperative Institute for Coastal and Estuarine Environmental Technology, this report examines the impacts of shoreline management on sheltered coastal environments and strategies to minimize potential negative impacts to adjacent or nearby coastal resources. Overcoming the obstacles associated with the existing management framework will require a number of societal and institutional changes. The report recommends development of a new shoreline management framework to help decision makers evaluate the spectrum of available approaches to shoreline erosion problems in the context of the environmental setting. The new framework would include assessment of the physical and ecological properties of the shoreline and the potential cumulative impacts.



Photo courtesy VIMS photo archive

SHELTERED COASTS AND EROSION

Sheltered coasts are shorelines that face smaller bodies of water in contrast to open ocean beaches. These smaller water bodies are typically calmer with less wave energy. Lower energy conditions foster habitats and ecological communities, such as marshes and mud flats, typically not found on open coasts. The unique characteristics of sheltered coasts affect the potential technological approaches and the consequences of actions taken to stem erosion and land loss from sea level rise.

Erosion is caused by (1) winds; (2) waves, currents, and tides that transport shoreline sediments; and (3) weathering processes that destabilize landforms such as bluffs and cliffs. Although natural processes contribute to erosion, the rate may be accelerated by human activities such as construction of dams upstream of estuaries or installation of groins and seawalls that alter the magnitude and direction of sediment transport. Inundation can also increase because the ground sinks when sediments settle and compact or subsurface resources, such as groundwater and petroleum, are withdrawn. Other human activities that increase erosion include dredge and fill operations, wetland drainage, boat traffic, and channel dredging.

Sea level rise will exacerbate the loss of waterfront property and increase vulnerability to inundation hazards. It changes the location of the coast line, moving it landward and exposing new areas and landforms to erosion. Additionally, sea level rise is chronic and progressive, requiring a response that is correspondingly progressive.

CURRENT APPROACHES TO PROTECTING AGAINST EROSION

The pressure to develop and stabilize shorelines in sheltered coastal areas is increasing because coastal populations are growing. More people desire waterfront homes and coastal property values have risen. There are several types of mitigation measures to stabilize shorelines. The most common response is “hold the line” strategies that harden the shoreline with structures such as bulkheads and revetments. There are alternatives, such as constructed marsh fringes, that are designed to preserve more natural shorelines. The selection of the type of response to prevent or offset land loss depends on understanding local causes of erosion or inundation.

A shift away from the hold the line approach has been slow, in part because there is a greater familiarity with these methods than with alternative approaches such as constructing a marsh fringe or using vegetation to stabilize a bluff. Contractors are more likely to recommend structures such as bulkheads because they have experience with the technology and know the design specifications and expected performance. Landowners often assume that a hard, barrier-type structure will be required to prevent loss of property and protect buildings. In many regions, government regulations may unintentionally encourage shoreline armoring because it is simpler and faster to obtain the required permit(s).

However, there are indirect costs associated with mitigation options that armor the shoreline. Many of these costs are borne by the public rather than the



The photos show different methods of shoreline hardening along the coast of Long Island, Long Island Sound. Wood bulkhead (upper left); concrete seawall (upper right); stone revetment (lower left) and gabion seawall (lower right). Problems that can arise with these methods include loss of sand that nourishes downdrift beaches, over-steepened shorefaces, and loss of habitat and recreational access. Source: Tanski (2005).

landowner. For example, installation of a groin to trap sand can affect neighboring beaches and bulkheads may lead to loss of fronting beaches along with attendant public access and scenic amenities. When marshes are affected, highly diverse and productive plant and animal communities may be lost along with the vital ecosystem services they provide—nursery, areas for important fish stocks, removal of excess nutrients from land runoff, feeding areas for migratory birds, and sediment stabilization.

A NEW SHORELINE MANAGEMENT FRAMEWORK

Changing the current practice of armoring sheltered coasts will require a change in the shoreline management framework. Decision makers should appreciate the costs and benefits of the spectrum of potential solutions to shoreline erosion problems, including potential cumulative impacts on shoreline features, habitats, and other amenities. The management framework should encourage approaches that minimize habitat loss and enhance natural habitats in environments where such methods offer effective stabilization. Overcoming the obstacles associated with the current regulatory environment will require a number of societal and institutional changes in the following areas:

Improving Knowledge of Sheltered Shoreline Processes and Ecological Services

Overall, less is known about physical process of sheltered coastal systems than of open coasts. In most areas, the scope and accessibility of information regarding the causes of erosion at specific sites and the overall patterns of erosion, accretion, and inundation in the broader region (estuary, lagoon, littoral cell) is insufficient to support the development of an integrated plan for managing shore erosion. The report recommends that federal agencies (e.g., USACE, EPA, USGS, and NOAA), state agencies, and coastal counties and communities support targeted studies of sheltered coast dynamics to provide an informed basis for selecting erosion mitigation options that consider the characteristics of the broader coastal system rather than simply addressing immediate problems at individual sites.

Improving Awareness of the Choices Available for Erosion Mitigation

Many decision-makers, particularly homeowners but also some state and federal regulators, are not sufficiently informed about the mitigation options available to them or the short and long term impacts of their choices. Decision makers need assessments of new techniques and materials designed to mitigate

shore erosion. The report recommends that major federal agencies involved in permitting activities (EPA, USACE, and NOAA) initiate a national policy dialogue that can be used to develop guidelines for mitigating erosion on sheltered coasts. As part of this dialogue, the agencies should develop publications that contain objective information about erosion mitigation techniques, including descriptions of the conditions under which each option would be effective.

Considering Cumulative Consequences of Erosion Mitigation Approaches

Cumulative impacts refer to the combined effects on legal, social, ecological, and physical systems. From a legal or regulatory standpoint, issuing permits may set a precedent, potentially facilitating the approval process for future requests for similarly situated structures. From an ecological standpoint, the cumulative impact of the loss of many small parcels will at some point alter the properties, composition,



Planting vegetation offers an alternative for reducing erosion at some sites. Top photo shows a pre-project shoreline on Wye Island in Queen Anne's County, Maryland. Marsh grass was planted on sand fill and short, stone groins were placed. Middle photo is three months after installation. Bottom photo is six years after installation. Source: Hardaway and Byrne (1999).

and values of the ecosystem. In addition, the economic, recreational, and esthetic properties of the shoreline will be altered, with potential loss of public use, access and scenic values. These cumulative effects are rarely assessed and hence are generally unknown, but an understanding of them is necessary to prevent an underestimation of the impacts of individual projects. The report recommends that cumulative effects be assessed in shoreline management plans, and that a precautionary approach be taken if there is insufficient information to determine cumulative effects.

Altering the Permitting System

The current permitting system fosters a reactive response to the problem of erosion on sheltered coasts. Decision-making is usually parcel-by-parcel and based on relatively little environmental information. The path of least resistance drives choices through a rigid decision-making process, with inadequate attention to the cumulative effects of individual decisions. The state and federal agencies (EPA, USACE, and NOAA) need to convene a working group to evaluate the decision-making process used for issuing permits for erosion mitigation structures to revise the criteria for sheltered coasts, including consideration of potential cumulative impacts. In many jurisdictions, obtaining a permit for bulkheads and similar structures is simple and fast relative to alternative measures. The report recommends changing the regulatory system to make it easier to get a permit to install shore stabilization alternatives that maintain natural shoreline features.

Improving Shoreline Management Planning

Creating a more proactive “regional approach” to shoreline management could address

some of the unintended consequences of reactive permit decisions. The term “regional” is used in this report to reflect an area of shoreline that is defined by functional physical or ecological parameters such as littoral cells, or the scale of processes that affect sediment transport. Several examples of regional planning already exist for shorelines: the USACE Regional Sediment Management (RSM) program, EPA’s National Estuary Program, and some special area management plans approved by state coastal management programs. This report provides a list of findings and recommendations about the strengths and weaknesses of these programs and how they could be used to address erosion mitigation on sheltered coasts.

CONCLUSION

Until the government regulatory framework addresses the regional scale of the processes controlling sediment transport, stabilization of individual sites will often include structures that damage adjacent areas and create a domino effect of coastal armoring. The dimensions of the regulatory framework should match the scale of the processes that contribute to shore erosion.

Currently there is no national mandate to document erosion processes on sheltered coasts or develop regional scale plans. No federal agency has been assigned to provide that scale of planning, although some states have become more proactive in shoreline management. Hence, implementation of a regional plan will require a new commitment for coordination among local, state, and federal programs, including a regional general permit.

Committee on Mitigating Shore Erosion Along Sheltered Coasts: *Jeff Benoit (Chair)*, SRA International, Arlington, Virginia; **C. Scott Hardaway, Jr.**, College of William and Mary, Virginia Institute of Marine Science, Gloucester Point; **Debra Hernandez**, Hernandez and Company, Isle of Palms, South Carolina; **Robert Holman**, Oregon State University, College of Oceanic Atmospheric Sciences, Corvallis; **Evamaria Koch**, University of Maryland, Center for Environmental Science, Horn Point Laboratory, Cambridge; **Neil McLellan**, Shiner Moseley and Associates, Houston, Texas; **Susan Peterson**, Teal Partners, Rochester, Massachusetts; **Denise Reed**, University of New Orleans, Department of Geology and Geophysics, New Orleans, Louisiana; **Daniel Suman**, University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, Florida; **Susan Roberts**, (*Study Director*), National Research Council.

This report brief was prepared by the National Research Council based on the committee’s report. For more information, contact the Ocean Studies Board at (202) 334-2714 or visit <http://dels.nas.edu/osb>. Copies of *Mitigating Shore Erosion on Sheltered Coasts* are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.

