CHAPTER 12

Managing Sediment and Shorelines

The natural flow of sediment over land and through waterways is important for sustaining coastal habitats and maintaining attractive beaches. However, excess or contaminated sediment can destroy habitats, poison the food chain, and endanger lives. Too little sediment can also alter habitats and allow beaches to wash away. Because navigational dredging, infrastructure projects, farming, urban development, and many other necessary and beneficial human activities can interfere with natural sediment processes, their impacts should be understood and managed. A national strategy for managing sediment is needed to reduce harm to natural resources, address ecological and economic needs, and achieve goals such as greater beneficial uses of sediment from navigational dredging. Such a strategy should manage sediments on a multi-project, regional basis, and involve all relevant parties. The strategy should also foster improved methodologies for evaluating beneficial uses of dredged material, along with additional research, monitoring, assessment, and technology development to improve sediment management.

Understanding the Dual Nature of Sediment

Sediment in ocean, coastal, and Great Lakes waters is composed of inorganic and organic particles created through erosion, decomposition of plants and animals, and human activities. Sediment may be carried by wind or water from upland areas down to coastal areas, or may originate in the marine environment. Sediments along coastlines are transported by wind, waves, and currents in dynamic processes that constantly build up and wear away cliffs, beaches, sandbars, inlets, and other natural features.

From a human perspective, sediment has a dual nature—desirable in some locations and unwanted in others (Box 12.1). Sediment can be used to create or restore beaches and to renew wetlands and other coastal habitats. Such activities are referred to as beneficial uses. Undesirable sediment can cloud water and degrade wildlife habitat, form barriers to navigation, and contaminate the food chain for marine plants, animals, and humans.

Whether sediment is desirable or not, its location and movement can have large economic and ecological consequences. For example, excess sediment in shipping channels may cost ports millions of dollars in delayed or limited ship access, while in other locations insufficient sediment deposits could result in the loss of valuable coastal wetlands.

Box 12.1 Sediment: Friend or Foe?

Sediment levels that are too high or too low can be detrimental to both natural environments and man-made structures, including extreme cases where structures are lost due to beach and cliff erosion. But sediment such as sand and gravel can also be viewed as a valuable resource.

Too much sediment can lead to…

- obstructed channels
- overflowing rivers
- smothered reefs
- high turbidity that blocks sunlight

...while too little sediment can lead to...

- disappearing beaches
- eroded riverbanks
- wetlands losses
- altered river profiles

Sediment can also be used for…

- construction material
- beach nourishment
- wetland restoration
- replacement of agricultural soil

The dual nature of sediment as both a threat and a resource to humans and the environment makes its management particularly challenging. To complicate matters further, the natural processes that create, move, and deposit sediment operate on regional scales, while management tends to focus on discrete locations—a single beach, wetland, or port. In addition, the policies that affect sediment location, transport, and quality fall under the jurisdiction of diverse programs within multiple agencies at all levels of government. This complex governance approach makes it difficult to manage sediment at the appropriate scale and in consonance, rather than in conflict, with natural processes. The prospect of global climate changes further complicates matters. For example, predictions of increased storm activity and changes in runoff patterns may adversely affect sediment delivery from upland areas, accelerate shoreline erosion, and result in increased runoff of contaminated sediments to coastal waters.

Reviewing Federal Roles in Sediment Management

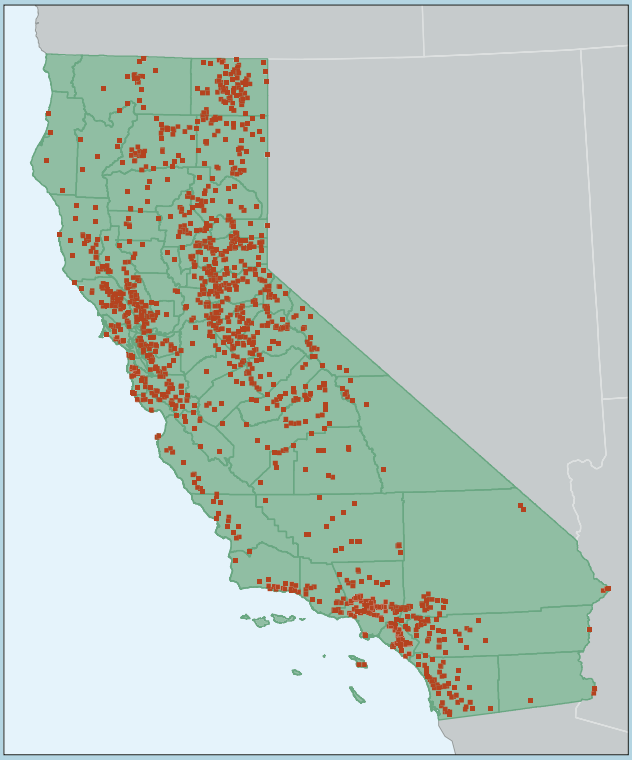
The federal government's role in managing sediment in the marine environment covers five areas: navigation-related dredging; beneficial use of sediment; construction of infrastructure to reduce flooding and erosion hazards; management of contaminated sediment; and basic and applied research into sediment processes. As with many ocean and coastal issues, numerous federal agencies are involved.

The U.S. Army Corps of Engineers (USACE) plays a large part in nearly all of these areas and is the lead agency for all but contaminated sediment. The U.S. Environmental Protection Agency (EPA) has oversight of ocean disposal of dredged material, and the cleanup and disposal of contaminated sediment. The National Oceanic and Atmospheric Administration (NOAA) administers the Coastal Zone Management Program, which requires participating coastal states to have enforceable policies to protect ocean and coastal resources, including policies that affect sediment management. NOAA's National Marine Fisheries Service and the U.S. Department of the Interior's (DOI's) U.S. Fish and Wildlife Service have responsibilities for living marine resources and habitat that also give them a role in evaluating the impacts of proposed sediment projects undertaken or permitted by federal agencies. DOI's Minerals Management Service identifies and authorizes access to sand deposits in federal waters suitable for beach nourishment and wetlands protection projects. The U.S. Geological Survey advances research on the sources, transport, impacts, disposal, beneficial use, and other aspects of sediment. USACE, NOAA, and EPA also conduct related research efforts, and the National Science Foundation and Office of Naval Research fund many relevant studies.

Other federal programs have less direct, but no less important impacts on sediment. The U.S. Department of Agriculture's Natural Resources Conservation Service plays a central role in efforts to reduce agricultural soil erosion, much of which finds its way to estuaries and the ocean. USACE and DOI's Bureau of Reclamation operate flood control, water storage, and hydroelectric projects which retain, and occasionally release, large amounts of sediment. Sediment also is addressed extensively through the nation's regulation of point and nonpoint sources of pollution, with EPA and NOAA as the principal federal agencies involved.

Some activities that affect sediment, such as dredging and shoreline erosion control projects, fall under specific laws, often implemented in isolation from each other. Other activities are addressed under broader, less specific authorities. Even seemingly well designed projects can sometimes create more problems than they solve, or encounter frustrating delays, because of poor communication among stakeholders, and confusion about the many programs that remove, relocate, prevent, or accelerate the transport of sediment. At this time, there is no consistent mechanism to ensure that each individual sediment-related project is considered in a larger ecosystem-based context.

Figure 12.1 Dams Impede Sediment Destined for the Coast



■ Dam Location

To support California's exponential population growth, over 1,400 dams have been constructed across the state for a number of purposes, including water storage, irrigation, flood control, recreation, and hydroelectric power. However, dams constructed in coastal watersheds block the flow of sediments needed for natural beach replenishment.

Source: California Department of Boating and Waterways. "California Beach Restoration Study." <www.dbw.ca.gov/beachreport.htm> (Accessed May 2004).

Altering Sediments through Human Intervention

Changing Sediment Quantities

Many human interventions in sediment processes are unintentional, occurring as a by-product of routine economic activities that overload or deprive natural systems of sediment. Activities such as forestry, agriculture, and urban development yield great benefits to the nation, but also accelerate natural erosion. Excess sediment suspended in the water column or accumulated at the bottom of water bodies can create problems for other industries, such as shipping, fishing, and tourism, and can harm aquatic life.

Conversely, flood control, water supply, and hydroelectric projects prevent the natural movement of sediment, contributing to downstream erosion and subsidence problems (Figure 12.1). As older components of this infrastructure become too costly to maintain, or are rendered obsolete for structural or economic reasons, disposing of the enormous quantities of trapped sediment will pose a new set of problems. Development in coastal communities can also disrupt natural sediment movement, causing erosion in some places and accretion in others. Such projects may have unintended effects on neighboring jurisdictions, both upstream and downstream, that had no role in the planning process.

Changing Sediment Quality

Over the last fifty years, lakes, rivers, and harbors have accumulated bottom sediment contaminated with heavy metals (such as lead, copper, and arsenic) from mining and industrial activities, as well as long-lived toxic chemicals (such as DDT, MTBE, PCBs, and dioxin)(Box 12.2). Continued discharges from municipal waste and industrial plants, and polluted runoff from agricultural and urban sources, perpetuate the problem, while newly identified contaminants such as flame retardants are now being detected in ocean and coastal sediments. Toxic chemicals from sediment can accumulate in marine plants and animals, causing reproductive failure, impaired growth, disease, and death. They may also pose health risks to humans who consume or come in contact with tainted marine products.

Of the 12 billion cubic yards of sediment that comprise the top 2 inches underlying U.S. waters, an estimated 10 percent is thought to be contaminated at levels that pose possible risks to marine life, wildlife, and humans.[1] Of the 300 million cubic yards of sediment the USACE dredges annually to facilitate navigation, an estimated 5 to 10 percent is contaminated.[2] Once a portion of sediment becomes contaminated, it becomes a source of further contamination downstream.

Currently, six laws and seven federal agencies are involved in the dredging or remediation of contaminated sediment, depending on whether the material is to be removed, deposited, or treated. Different sets of laws apply when navigational dredging or environmental cleanup is the primary focus of activity. A 1997 National Research Council report concluded that this patchwork of laws generally fails to manage contaminated sediment according to the risk it poses to the environment, does not adequately weigh the costs and benefits of different solutions, and imposes lengthy and unnecessary delays in addressing problems.[3]

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) established the federal Superfund program to clean up the nation's uncontrolled or abandoned hazardous waste sites. At over one hundred locations, bottom sediments in rivers and harbors are so contaminated they are designated as Superfund sites. The EPA estimates that cleanup of the thirty most highly contaminated sites in rivers, lakes, and coastal areas may cost hundreds of millions of dollars.[4]

The presence of contaminated sediment greatly complicates the management of dredged material. For example, such sediment would be inappropriate for use in wetland restoration or erosion control projects. Costs are also much higher for the safe and secure disposal of these materials. The very process of dredging contaminated sediment increases ecological and human health risks because some of the sediment inevitably becomes resuspended and carried to new locations during removal.

Box 12.2 The Legacy of Sediment Contamination

Long-term remedial response action is required at areas on EPA's Superfund list, one of which is Fox River and Green Bay, Wisconsin. From 1954 to 1971, PCBs were released during the manufacture of carbonless copy paper by seven companies along the banks of the river. The chemical releases left 11 million cubic yards of contaminated sediment in Fox River and Green Bay. The EPA estimates that up to 70 percent of the PCBs entering Lake Michigan via its tributaries come from the Fox River. This contamination has affected water quality, recreation, and the health of people, fish, and birds. Elevated PCB concentrations in some Lake Michigan fish have prompted health advisories. Native Americans in the area have been particularly affected because of the importance of subsistence fishing to their community.[i,ii]

[i] Balas, M. "Fox River Cleanup Is Talk of the Town, But What About Restoration." *The Green Bay News-Chronicle.* October 22, 2003.

[ii] Wisconsin Department of Natural Resources and U.S. Environmental Protection Agency. *Superfund Record of Decision for Operable Units 3, 4, and 5.* Madison, WI, and Washington, DC, June 2003.

Developing Regional Strategies for Sediment Management

Sediments flow continuously downstream to the coast, on and offshore, and back and forth along the coast. A project-by-project approach to sediment management can result in expensive actions that may undermine the interests of other stakeholders. For example, flood and erosion control structures, while temporarily protecting targeted locations, interrupt the natural transport of sediment along the coast, preventing the accumulations that create beaches and maintain wetlands, exacerbating coastal erosion, and potentially threatening life, property, and coastal economies in other locations. Similarly, upstream sediment diversions or contamination can have major impacts in estuaries and other coastal areas.

Coastal stakeholders have increasingly recognized the need to develop more proactive and preventive strategies. However, their absence from broad watershed planning efforts—where decisions about land use and water management could reduce excess and contaminated sediments at their source—makes such change difficult to realize. (A more detailed discussion of watershed planning efforts appears in Chapter 9.) The nation needs both a better understanding of the interactions between human activities and sediment flows, and a better mechanism for involving all potentially affected parties.

Moving toward an ecosystem-based management approach is a critical step. The new National Ocean Policy Framework outlined in Part II creates a structure for regional coordination and cooperation among the many parties affected by sediment. Participation by federal, state, and local entities in watershed management efforts, along with key stakeholders such as coastal planners and port managers, is one way to diminish upland sources of excess and contaminated sediment that harm the marine environment.

Recommendation 12–1

The National Ocean Council should develop a national strategy for managing sediment on a regional basis. The strategy should incorporate ecosystem-based principles, balancing ecological and economic considerations.

In addition, the strategy should:

- acknowledge adverse impacts on marine environments due to urban development, agriculture, dams, dredging, pollutant discharges, and other activities that affect sediment flows or quality.
- ensure involvement of port managers, coastal planners, land use planners, and other stakeholders in watershed planning.
- emphasize watershed management as a tool to address upstream land uses that affect sediment input to rivers and coastal waters.

Regional sediment management will require coordination among diverse interests, political jurisdictions, and levels of government to achieve environmental, social, and economic goals. For example, construction and restoration projects in coastal areas often face long permitting and planning delays, which can substantially add to project costs and be ecologically detrimental. A regional sediment planning process that identifies pre-approved beneficial use sites through a collaborative stakeholder process could help expedite projects, resulting in quicker realization of economic benefits to the region.

A regional approach could also help prioritize projects. In considering beach nourishment proposals for two nearby sites, priority might be given to one of the sites if natural sediment transport processes would result in secondary nourishment of the down-coast site, doubling the impact of the investment. Regional sediment management could also inform coastal land use planning and permitting decisions, moving new development or post-disaster rebuilding away from erosion hot spots, as discussed in Chapter 10.

One of the difficulties in undertaking a regional approach to managing sediment is that the definition of a region may differ substantially among parties engaged in land use planning, port management, coastal development, wetlands protection, or fishery management. To understand the sources and transport of sediment, a region might extend tens to hundreds of miles up and down rivers and the coastline. Alternately, for management of dredged material at a port, the region might be linked to the size of that port. Coastal erosion and living marine resources may define other scales. These definitions should be reconciled to achieve effective sediment management in an appropriate regional context.

Moving Toward Regional Sediment Management at USACE

USACE's traditional protocols for dredging and other sediment management projects consider the impacts of those projects individually and on short-term and local scales—typically from one to thirty years, across areas of less than ten miles—despite widespread recognition that coastal processes operate at regional scales with time frames of up to 250 years and geographic extents of dozens of miles from a project's location.[5] In many cases, this disregard for the scale over which natural processes operate has resulted in projects having unintended adverse impacts on nearby coastal resources, placing too much sediment in the wrong place or too little where it is needed.

More recently, USACE, with support from Congress, has begun pursuing alternatives to its project-by-project approach. For example, USACE created the Regional Sediment Management Program based on general direction from Congress to develop long-term strategies for disposing of dredged materials and to cooperate with states to develop comprehensive plans for coastal resource conservation. Under this program, USACE collaborates with states, communities, and other diverse stakeholders to develop plans to manage sediment across a region that encompasses multiple USACE dredging projects.

To date, the Regional Sediment Management Program has undertaken six demonstration projects around the country. Early results have yielded technology improvements, information sharing, and the building of a base of experience in more comprehensive management of construction activities affecting sediment. Nevertheless, scientific, technological, and institutional hurdles remain to implementing truly regional sediment management.[6]

[Dredging related] navigation and environmental challenges must be addressed within the context of rapidly increasing population growth in the coastal zone and the resulting tensions between residential, recreational, and economic uses and the need to preserve, protect and restore critically important ecological resources.

—Major General Robert Griffin, *Director of Civil Works, U.S. Army Corps of Engineers, testimony to the Commission, October 2002*

Recommendation 12–2

Congress should direct the U.S. Army Corps of Engineers (USACE) to adopt regional and ecosystem-based management approaches in carrying out all of its sediment-related civil works missions and should modify USACE authorities and processes as necessary to achieve this goal.

Weighing the Costs and Benefits of Dredging

Navigational Dredging

Widespread adoption of regional sediment management practices will help address many problems. However, until such practices are common—and even once such frameworks are in place—certain sediment activities merit special attention. Dredging for navigational purposes is perhaps the most direct and prominent way humans affect sediments in marine waters, and the federal government is in charge of dredging activities for this purpose.

Navigational dredging in ports and waterways seeks to remove accumulated sediment that blocks or endangers vessels and prevents access by ships that continue to increase in size and draft, requiring wider and deeper channels. An estimated 400 million cubic yards

of sediment (300 by USACE and another 100 by private permittees) are dredged annually to maintain and improve navigation.[7] As the volume and value of goods transported by water continues to grow, the importance of maintaining efficient, modern ports increases. (Chapter 13 includes a broader discussion of port planning in the context of maritime commerce and transportation.) All dredging, whether related to navigation or not, can have negative impacts. These impacts may include habitat disturbance and the dispersion of sediment—frequently contaminated—to new locations, with unintended impacts on the ecosystem.

One frequent complaint associated with dredging projects is the time involved from conception to completion. Currently, the process of planning, permitting, and completing a navigation channel improvement project (widening or deepening) can take more than twenty years. Reasons for delay include inconsistent funding allocations and congressional approvals, the complexity of the project review process, and scientific uncertainties. Such lengthy time frames can be ecologically and economically detrimental to a region. Delayed access to a port may reduce ship traffic and trade, and environmental impact statements may become outdated. At the same time, certain projects may be legitimately questioned by those who believe there are less costly or environmentally damaging alternatives.

EPA and USACE are currently investigating mechanisms for improving the efficiency of the planning and permitting process for management of dredged material. These efforts should be encouraged. A streamlined process could help evaluate the necessity of a proposed dredging project, look for opportunities to improve sediment management, and set priorities among projects.

Box 12.3 Beach Nourishment: One Use for Dredged Sediment

Dredging of sediment does take place outside the navigation context, most notably for use in beach nourishment to protect recreation, tourism, and beachfront property. Such projects have been a source of great contention. Proponents champion beach nourishment as essential to protecting life, property, and beach-dependent economies. Opponents decry it as a costly taxpayer-subsidized activity that threatens coral reef and other ecosystems and creates incentives for inappropriate development in coastal areas subject to storm, flooding, and erosion hazards. Political representatives are often pressured to support beach nourishment projects where eroding shorelines threaten the economic health and safety of a coastal community.

However, as the National Research Council noted in a 1997 report, the process for determining when, where, and how to use dredged sediment for beach nourishment suffers from a number of deficiencies, including a lack of performance criteria, inadequate technical and economic methodologies, outdated design standards, insufficient stakeholder involvement, an inadequate understanding of the physical and biological mechanisms of beach and littoral systems, and a failure to plan for the long term or in a regional context.[i] Because the high costs of undertaking and maintaining these projects are borne in large measure by the public, investments should target projects that will render the greatest benefit and where other alternatives, such as moving development away from eroding areas, are not possible. Achieving this goal will require a better understanding of sediment processes and a method for considering beach nourishment proposals in a regional context.

[i] National Research Council. *Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies.* Washington, DC: National Academy Press, 1997.

Beneficial Uses of Dredged Material

Dredged material has long been used to create new land for commercial, residential, and infrastructure developments, as well as to bolster beaches and barrier islands to protect against storm and erosion hazards and enhance tourism and recreation (Box 12.3). Since the 1970s, these beneficial uses of dredged material have also included environmental enhancement, such as restoration of wetlands, creation of wildlife habitat, and improvement of fish habitat. Surprisingly, navigation-related dredged material does not find its way into beneficial use projects as often as perhaps it should. This is due in part to sediment contamination, but also to USACE policies that favor disposal in open waters or in upland dump sites. These policies may be unnecessarily foregoing opportunities to support economic growth or environmental protection and may have serious unintentional consequences for aquatic ecosystems.

Techniques of Cost-Benefit Analysis

Under current USACE policies, navigation-related dredged material is primarily viewed as a waste stream and diversion for beneficial use is considered extraneous to the navigation mission. For the federal government to cover the costs of a navigational dredging project, USACE regulations require that the dredged material be disposed of in the "least costly, environmentally acceptable manner consistent with engineering requirements established for the project." During its project evaluation process, USACE determines the least-costly disposal method, designated as the Federal Standard, and decides on the appropriate cost-sharing structure with nonfederal partners. If the Federal Standard option is not used, the nonfederal partners must assume a larger portion, sometimes over 50 percent, of the project costs.

Because USACE cost-benefit methodologies tend to undervalue the benefits of projects that use dredged material, while failing to account for the full costs, including environmental and other nonmarket costs, of traditional disposal methods, the least-cost option generally favors open-water disposal of dredged material. A more accurate system for selecting and ranking projects would be based on a comparative net economic and environmental return for the United States rather than a narrow cost-benefit analysis for a specific project. Recognizing the advantages of beneficial-use projects may also justify spreading the costs among a wider array of stakeholders. To check the USACE's assumptions and methodologies, the analyses should be peer-reviewed, as called for in a recent National Research Council report.[8]

Recommendation 12–3

The U.S. Army Corps of Engineers should ensure that its selection of the least-cost disposal option for dredging projects reflects a more accurate accounting of the full range of economic, environmental, and other relevant costs and benefits for options that reuse dredged material, as well as for other disposal methods.

National and Regional Dredging Teams

Recognizing the benefits of improved sediment management, a number of ports have developed long-term plans for managing dredged material, including the ports of Boston, New York and New Jersey, Houston, Long Beach, Los Angeles, Oakland, Seattle, and others. These long-term plans were intended to avoid delays caused by new environmental testing procedures, the determination that some dredged material was not suitable for ocean disposal, and the lack of disposal alternatives, all of which had added years to the expected completion of some port expansion and navigational dredging projects.

Long-term planning efforts for managing dredged material can bring together federal agencies, port authorities, state and local governments, natural resource agencies, public interest groups, the maritime industry, and private citizens to forge agreements that, among other factors, increase the likelihood of beneficial uses of dredged material. These types of initiatives were encouraged by a 1994 Interagency Working Group report to the Secretary of Transportation, *The Dredging Process in the United States: An Action Plan for Improvement*. Three years after the Action Plan's publication, a 1997 National Research Council report echoed its findings and recommendations.[9]

The Action Plan concluded that early acknowledgment of environmental concerns and effective public outreach could substantially reduce potential conflicts and delays. Specific recommendations included: creation of a timely, efficient, and predictable regulatory process; support for port or regional scale planning by partnerships that involve the federal government, port authorities, state and local governments, natural resource agencies, public interest groups, the maritime industry, and private citizens prior to seeking project approval; involvement of dredged material managers in watershed planning to emphasize the importance of reducing sediment loadings and contamination at their source; and encouragement for the environmentally sound, beneficial use of dredged materials, such as wetlands creation and beach nourishment. The Action Plan also emphasized the need to continually integrate the best available science.

In subsequent years, progress was made on some elements of the Action Plan, most importantly the 1995 establishment of the National Dredging Team co-chaired by EPA and USACE, but other elements lagged. In 2003, the National Dredging Team issued *Dredged Material Management: Action Agenda for the Next Decade*[10] as a successor to the 1994 Action Plan. The Action Agenda's twenty-two recommendations focus on increasing beneficial use of dredged material, using effective watershed planning to improve sediment management, strengthening and expanding the number of regional dredging teams, and improving integration with water quality, coastal management, and fisheries management programs.

Recommendation 12–4

The National Dredging Team should ensure vigorous and sustained implementation of the recommendations contained in its *Dredged Material Management: Action Agenda for the Next Decade,* moving toward more ecosystem-based approaches. Regional dredging teams, working with regional ocean councils, should establish sediment management programs that expand beyond single watersheds to larger regional ecosystems.

Improving Understanding, Assessment, and Treatment

An enormous constraint to improved sediment management is a poor understanding of sediment processes in the marine environment and a paucity of effective management techniques. This is particularly true for contaminated sediment.

Coordinated Strategy Needed

Numerous ongoing research programs exist to improve the nation's understanding of sediments and sediment management techniques, but they are often fragmented, uncoordinated, and inadequately funded. Despite some scientific advances, these programs have not produced the needed engineering models, innovative management techniques and technologies, or comprehensive information about the source, movement, location, volume, quality, and appropriate use or disposal of sediment on a regional and national basis.

The National Shoreline Management Study, a USACE initiative launched in 2002, holds promise for yielding information to better coordinate and synthesize federal sediment activities. The study is examining why, where, and to what extent U.S. shorelines erode or accrete and will investigate other aspects of sediment management, such as economic and environmental issues and the roles of stakeholders in shoreline management. The results could help establish national priorities for shoreline management, but only if there is a mechanism for translating those results into action. In addition to maintaining the National Shoreline Management Study, which looks primarily at physical shoreline processes, USACE should significantly expand support for research and monitoring of ecological and biological functions and processes.

The U.S. Geological Survey (USGS) plays an important role by collecting, analyzing, interpreting, and disseminating data on sediment flows and chemistry independent of any regulatory or operational concerns. Thus, USGS can be instrumental in providing a reliable scientific foundation for a new approach to managing sediments.

Recommendation 12–5

The U.S. Army Corps of Engineers, working with U.S. Department of the Interior agencies, the National Oceanic and Atmospheric Administration, and the U.S. Environmental Protection Agency, in consultation with state and local governments, should develop and implement a strategy for improved assessments, monitoring, research, and technology development to enhance sediment management.

The enhanced sediment monitoring called for in Recommendation 12–5 is an integral part of the national monitoring network described in Chapter 15.

USACE's role in major construction projects that significantly alter watersheds brings with it an obligation to understand the potential impacts of these activities prior to their implementation. Current project-by-project planning and funding, along with severely limited discretionary funds for broader ecosystem research, have made this extremely difficult. Existing funding formulas also severely limit post-project monitoring, precluding long-term analyses of project outcomes and adoption of adaptive management.

Recommendation 12–6

Congress should modify its current authorization and funding processes to require the U.S. Army Corps of Engineers (USACE), or an appropriate third party, to monitor outcomes from past USACE projects and assess the cumulative, regional impacts of USACE activities within coastal watersheds and ecosystems. Such assessments should be peer-reviewed consistent with recommendations from the National Research Council.

Contaminated Sediment

The characterization, containment, and treatment of contaminated sediment in marine environments, whether through removal or treatment in place, continue to be technically difficult and prohibitively expensive. Thus, the best defense against damage from contaminated sediment is to prevent its creation or escape. Unfortunately, because reductions from upland point and nonpoint sources remain a major challenge, additional marine sites will most likely continue to be affected.

Recent EPA and National Research Council reports recognize the difficult ecological and economic problems associated with contaminated sediment management and stress the importance of adopting an adaptive management approach to deal with such problems.[11,12] Scientifically sound methods for identifying contaminated sediment and developing innovative technologies for source reduction, as well as improved dredging and treatment of this material, are critical steps toward improving the economic and ecological

health of coastal areas. To be successful, these efforts will require new resources and effective regional planning. The contaminated sediment science plan, issued by EPA in draft form in 2002 but never finalized, appears to provide a sound framework for identifying and ranking the science and approaches needed for improved management of contaminated sediment, and for promoting improved coordination within EPA and among the many other federal entities with contaminated sediment responsibilities.

Recommendation 12–7

The U.S. Environmental Protection Agency, working with other appropriate entities, including state and local governments, should build upon EPA's 2002 draft contaminated sediments science plan to develop and conduct coordinated strategies for assessment, monitoring, and research to better understand how contaminated sediment is created and transported. The strategies should also develop technologies for better prevention, safer dredging or onsite treatment, and more effective post-recovery treatment of contaminated dredged material.

References

1 U.S. Environmental Protection Agency. *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States.* EPA–823–F–98–001. Washington, DC, 1998.

2 National Research Council. *Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies.* Washington, DC: National Academy Press, 1997.

3 Ibid.

4 Evison, L. "Contaminated Sediment at Superfund Sites: What We Know So Far." Presented at U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Workshop on Environmental Stability of Chemicals in Sediment. San Diego, CA, April 2003.

5 Lawson, M., J. Rosati, and N.C. Kraus. *Overview of Regional Coastal Sediment Processes and Controls. Coastal and Hydraulics Engineering Technical Note* CHETN–XIV–4. Vicksburg, MS: U.S. Army Corps of Engineers Research and Development Center, 2002.

6 Martin, L.R. *Regional Sediment Management: Background and Overview of Initial Implementation.* Institute for Water Resources Policy Studies Program. IWR Report 02–PS–2. Vicksburg, MS: U.S. Army Corps of Engineers, July 2002.

7 Interagency Working Group on the Dredging Process. *The Dredging Process in the United States: An Action Plan for Improvement. A Report to the Secretary of Transportation.* Washington, DC: U.S. Environmental Protection Agency, 1994.

8 National Research Council. *Adaptive Management for Water Resources Project Planning*. Washington, DC: National Academy Press, 2004.

9 National Research Council. *Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies*. Washington, DC: National Academy Press, 1997.

10 U.S. Environmental Protection Agency. *Dredged Material Management: Action Agenda for the Next Decade*. EPA 842–B–04–002. Washington, D.C., 2003.

11 U.S. Environmental Protection Agency. "Draft Contaminated Sediment Remediation Guidance for Hazardous Waste Sites." *Federal Register* 67 (December 3, 2002): 71964.

12 National Research Council. *Bioavailability of Contaminants in Soils and Sediments: Process, Tools and Applications*. Washington, DC: National Academy Press, 2003.