Regional Sediment Management

Corps Environmental Operating Principles and RSM

Galveston District shares RSM approach

Corps RSM authorities and policies

RSM field site evaluation for geomorphic response

Coastal mapping: From SHOALS to CHARTS

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Regional Sediment Management

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Painting of a fantasy sediment region by Thomas Vaughan, VIS, ITL, USACE ERDC, Hanover, NH

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Regional Sediment Management approach complements Corps' Environmental Operating Principles

When the National Environmental Policy Act was passed in 1969 and signed into law on January 1, 1970, the United States established a national policy to encourage productive and enjoyable harmony between man and his environment; promote efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; and enrich the understanding of ecological systems and natural resources important to the Nation. During the ensuing 30 years, many agencies and organizations across all levels of government have worked to achieve the intent of the Act. The Corps has steadily moved toward a stronger role in environmental stewardship to carry out its missions more effectively.

In March 2002, the Commander and Chief of Engineers, Lt. Gen. Robert B. Flowers, issued a set of Environmental Operating Principles (EOPs) identifying ways for the Corps to integrate its activities with natural resource statutes, values, and sound environmental practices. These EOPs give corporate coherence to the Corps' work and recognize the Corps' responsibility for sustainable use, stewardship, and restoration of our Nation's natural resources.

The Corps' increasing activity in regional sediment management directly supports these EOPs. The EOPs emphasize sustainable systems through improved business practices. Regional sediment management contributes to sustainability through improved project operation and increasing project and program integration. The table that follows matches the EOPs with regional sediment management objectives and initiatives.

Environmental Operating Principles
Regional Sediment Management

US Army Corps of Engineers®

Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.

Sediment has to be managed regionally to achieve environmental sustainability. A premise of regional sediment management is to base decisions on desirable objectives for the region and on an understanding of the sediment processes and transport pathways within that region. Knowledge of the relationship between sediment and ecosystem will contribute to a healthy and robust environment.

Continued on next page...

Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.

Regional sediment management looks at the "big picture" and identifies interdependencies. Environmental impacts can be mitigated through sediment management activities within a region. Decisions based on engineering, science, and stakeholder consensus about best environmental practices will result in the proper balance between the physical and the biological elements.

Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.

A cornerstone activity in regional sediment management is the formation and active participation of stakeholder groups. Stakeholders bring economic and environmental interests to the table. Balanced objectives for the region are based on consensus.

Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.

Applying regional sediment management principles and developing capabilities made the Corps a responsible steward of the environment for its projects. In the eyes of our partners and regional stakeholders, the Corps accepts responsibility and accountability for its actions, and at all times acts within the confines of the law.

Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.

Through regional sediment management, the Corps reduced cost of sediment management projects while increasing benefits. Additional benefits will be realized from current actions over time, and lifecycle planning is an important aspect of regional sediment management research and demonstration projects.

Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.

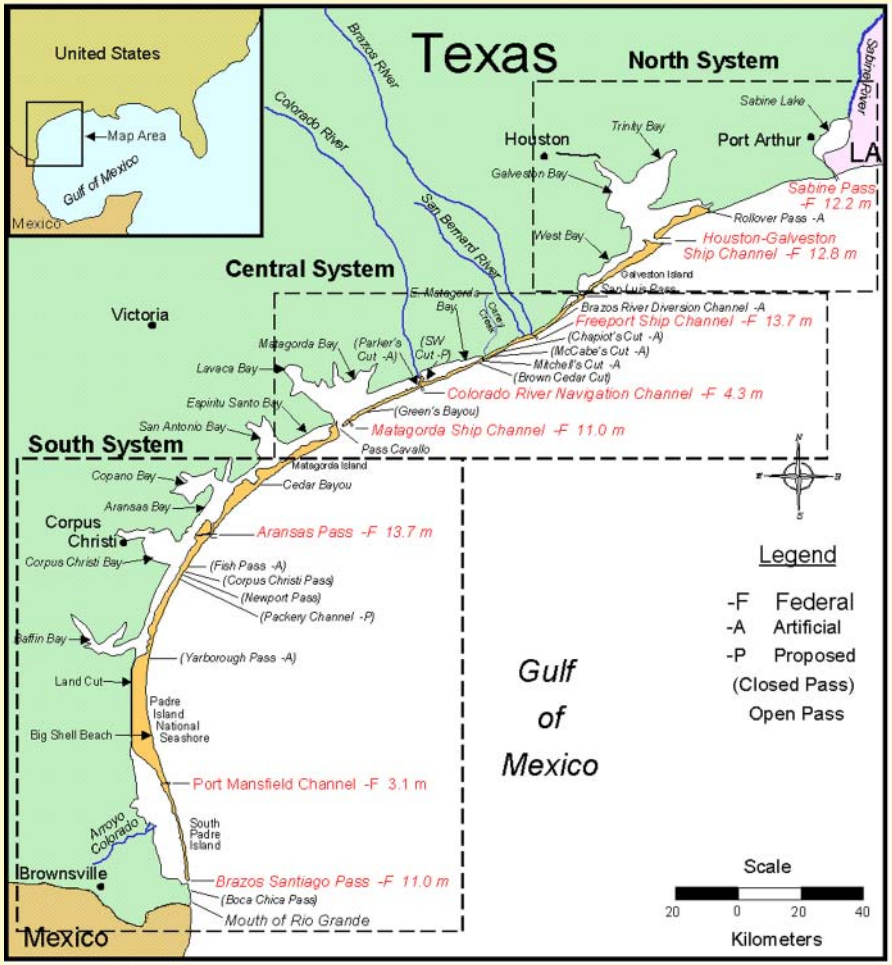
A regional sediment management objective is to produce an information and knowledge environment, complete with data, software tools, and procedures that facilitate effective decision-making for the Corps and all regional stakeholders. Both Corps-funded research and field demonstrations for regional sediment management show what can be done effectively and efficiently today. Through a technology and partnership interface, capabilities continue to improve.

Respect the views of individuals and groups interested in Corps activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

The Corps' mission to manage sediment in the watershed is limited and shared with other Federal and local stakeholders. As it is recognized that sediment management throughout a region can have significant impacts elsewhere in the region, the Corps must be an active stakeholder and partner in any ongoing activities in regions where its mission responsibilities exist. Corps RSM research and demonstration project team members are taking an active role in the interest of the Corps' mission requirements.

Galveston District launches O&M-based regional sediment management initiative

The Corps' regional sediment management strategic approach is finding resonance among engineers, scientists, planners, and managers at the Corps Districts and Divisions. The RSM Information Exchange Bulletin, serving as a forum for RSM ideas, is seeking information from all sources for publication. The following reprint of a "White Paper" from the Galveston District is hailed by Galveston personnel as an excellent guide to that District's approach to regional sediment management. The document, dated 25 March 2003, is a cooperative effort of Galveston District and ERDC personnel. For additional information about the paper, contact Ronnie G. Barcak and Jeffrey P. Waters from the Galveston District or Dr. Nicholas Kraus, at ERDC CHL, Vicksburg. Minor updates were added on 26 August 2003 in preparation of publishing, reflecting progress in the development of products.



U.S. Army Corps of Engineers, Galveston District
Regional Sediment Management Initiative White Paper

Background

The Gulf of Mexico coast of Texas is 350 miles long, of which almost 300 miles consist of sand barrier islands backed by pristine estuaries, bays, and lagoons. The total shoreline extent of its inland coastal water bodies exceeds 1,000 miles. Thirteen permanent or semi-permanent inlet and river mouths connect to the Gulf, and numerous ephemeral inlets exist along the coast. Tropical storms and hurricanes extensively modify the coast, to which the Galveston seawall attests. The Gulf shoreline of Texas is largely undeveloped, with the exceptions of Galveston Island and South Padre Island. The population of Texas is growing at one of the fastest rates in the United States, and development along the coast is increasing, bringing construction along the Gulf and bay shorelines, deepening of inlet navigation channels, and proposed opening of several new inlets. At the same time, the Gulf coast of Texas and certain bay shores are experiencing erosion, and environmental preservation is a priority.

In this complex coastal environment, the Galveston District routinely conducts activities and associated studies that can alter the hydrodynamics, sediment pathways, and sediment distribution in one of the largest dredging programs in the Corps of Engineers. The District maintains eight Federal navigation channels connecting to the Gulf of Mexico, the Texas portion of the Gulf Intracoastal Waterway, and numerous Federally authorized coastal inland and river navigation channels. The District also conducts shore-protection and environmental preservation studies, and in general serves as an active Federal steward of the coast.

Although the Galveston District has been a leader in beneficial uses of dredged material, much greater efficiencies and reduced dredging costs are expected through a hydrodynamic and sediment-handling system approach to its dredging operation and maintenance (O&M) activities. Such a system approach recognizes the processes acting at large time and space scales within which, for example, navigation channel maintenance and jetties interrupt sediment transport and water movement, to which the coast and bays respond. Therefore, the Galveston District has initiated a regional sediment management (RSM) plan to coordinate its O&M functions and other coastal activities and as a means of providing state agencies and private industry with partnership opportunities that extend throughout the coast.

The Galveston District RSM plan will develop and apply predictive technology for quantifying the hydrodynamic and sediment-sharing coastal systems of Texas and for evaluating the system-wide consequences of proposed engineering actions and modifications of existing projects. RSM will allow the Galveston District to optimize O&M and beneficial uses requirements while reducing overall costs and environmental impacts. The plan will also provide information and tools for the District to conduct its full range of engineering and environmental actions along the coast.

The systems approach of RSM brings many benefits. Project impacts are evaluated beyond their local boundaries to determine possible unintended consequences, which often appear after several years and can be extremely costly. At the same time, looking beyond project boundaries also brings new and better solutions, together with cost savings and an improved environment. The monetary and environmental costs of repeated short-term fixes are avoided. RSM promotes innovation and flexibility in developing ways for projects to share study results, manage sediment to mimic nature, and sustain the environment. The availability of RSM tools will also allow rapid-response studies, decisions, and executions in unanticipated situations before costly emergency conditions are reached.

In summary, RSM promotes:

- Conservation and sound management of sediments in bays, estuaries, and the littoral zone, treating sediments as a resource.
- Designing in a way that works with nature and regional sediment movement, automatically introducing a long-term perspective and increased project longevity.
- Conceptual and programmatic linkages among District projects, studies, and activities involving sediment in a region covering navigation channel maintenance, flood and storm damage reduction, ecosystem restoration and protection, and beneficial use of dredged material.
- Linkages among operations and new projects to achieve greater efficiency, typically through cost savings and increased speed of study, design, and execution.
- Partnerships with state and local agencies and with private industry for managing the coast in a sound and cost-effective manner in a balance of interests and resources of all stakeholders.

Products

RSM is a new way of managing the coast, from the rivers and watersheds, through the bays, lagoons, and estuaries, and ultimately to the coast. Significant cost reductions, longevity of projects, and improved environmental conditions are expected benefits. Entirely new predictive technologies are being developed in the Corps' R&D community to support RSM. The new RSM products and tools will be implemented in the Galveston District and available to its partners for joint management of the coast. Example products are:

- A regional geographic information system (GIS) and associated databases to allow rapid and accurate analysis of project conditions and to support predictive technology. The regional GIS will cover navigation channels, placement areas, and the coast.
- A regional circulation model that connects the coast, inlets, waterways, inland coastal waters, and rivers. The ADCIRC circulation model contains nested wave models at inlets and other project areas along the coast.
- Regional sediment budgets for managing sediment in a balanced manner.
- Sediment transport models and shoreline-response models for evaluating navigation channel performance, sand bypassing at inlets, and shoreline change, including the RSM program's new CASCADE model.

RSM, as a strategic approach, supported by several Corps authorities and policies

By Lynn. R. Martin, Institute for Water Resources, U.S. Army Corps of Engineers

The idea of a system approach to the management of sediment is so reasonable that many engineers, scientists, managers, and other stakeholders have embraced the regional sediment management concept. Supporters recognize that RSM makes sense, leads to better decisions, and saves money. It also can foster valuable partnerships and other benefits in the near and/or long term. As Corps offices pursue application of the RSM approach, the questions arise: "What authority governs RSM applications?" and "Where can I find Corps policy on RSM?"

Editor's Note: The article appearing here addresses regional sediment management from an internal U.S. Army Corps of Engineers policy viewpoint, addressing implementation of the RSM concept as a synergistic way to carry out projects and programs in Corps Districts and Divisions. The article notes that RSM is a new way of managing projects within the Corps, and that it is not a "funded program." The information does not refer to the Corps' RSM Research and Demonstration Programs, where experimental and applied research is performed.

Authorities and policies that support RSM are implicit rather than explicit. RSM is a concept, or approach, to carrying out projects and programs rather than a specific "program" (see Editor's Note). RSM, as an integrative watershed or system approach, is consistent with and supported by Corps authorities and policies:

- A number of authorities support implementing RSM by enabling and encouraging regional or comprehensive studies, approaches, and perspectives in water resource problem solving, and some are specific to sediment and sand management, storm damage reduction, shoreline erosion protection, and management of dredged material.
- The Civil Works Strategic Plan identifies RSM as an example of the type of watershed or systems approach that present Corps leaders are advocating for the future.
- U.S. Army Corps of Engineers Policy Guidance Letter 61, Application of Watershed Perspective to Corps of Engineers Civil Works Programs and Activities, emphasizes and encourages application of a watershed and system perspective within and across Civil Works programs. (Available at: *http://www.usace.army.mil/inet/functions/cw/cecwp/branches/guidance_dev/pgls/pdf/pgl61.pdf*.)

- Corps planning guidance emphasizes a watershed perspective, consideration of landscape implications of navigation improvements, systems analysis in shoreline studies, and the development of dredged material management plans (DMMPs) (ER 1105-2-100).
- Policy and guidance on DMMPs encourage their development, not only for all projects, but also for groups of projects, where it makes sense to plan for capacity, material use, and disposal via a coordinated approach.

The Corps' authorities, policies, and programs that support RSM are presented in the report "Regional Sediment Management: Background and Initial Implementation," IWR Report 02-PS-2, available at: *http://www.iwr.usace.army.mil/iwr/pdf/02ps2sed_man.pdf*. This material is also summarized in Technical Note ERDC/RSM-TN-8, available at: *http://www.wes.army.mil/rsm/pubs/technote.html*. The authorities that support regional approaches, authorize Corps studies or work in coastal areas, or are otherwise relevant to RSM are presented in the table below.

Civil Works Authorities that Support Regional Sediment Management

1. Sec. 202 of WRDA 2000, Watershed and River Basin Assessments. Amends sec. 729 of WRDA 1986, providing authority to assess the water resource needs of river basins and watersheds including ecosystem protection and restoration, flood damage reduction, navigation and ports, watershed protection, water suppy, and drought preparedness.

2. Basin and Specific Study Authorities. A number of specific study resolutions and authorities allow, if not emphasize, comprehensive examinations of water resources needs and opportunities.

3. Planning Assistance to States (sec. 22). Sec. 22, WRDA 1974, as amended, authorizes the cooperation wth states and Indian tribes in preparing plans for the development, utilization, and conservation of water and related land resources of drainage basins, ecosystems, and watersheds.

4. Sec. 227(d) of WRDA 1996, State and Regional Plans. Amends the 1946 Shore Protection Act, by adding sec. 4, "State and Regional Plans" authorizing the Secretary to cooperate wth states in preparation of comprehensive state or regional plans for the conservation of coastal resources.

5. Sec. 516 of WRDA 96, Sediment Management. Authorizes the Secretary to enter into cooperative agreements wth non-Federal interests wth respect to navigation projects, or other appropriate non-Federal entities, for the development of long-term management strategies for controlling sediments at such projects.

6. Sec. 5 of the River and Harbor Act of 1935. Requires consideration of the broader landscape in navigation improvements studies. Improvements potentially affecting adjacent shoreline will include analysis of the probable effects on shoreline configurations (not less than 10 miles on either side of the improvement).

Continued...

Civil Works Authorities that Support Regional Sediment Management (Concluded)

7. Changes to Completed Projects to Improve the Environment or Examine Changed Economic Conditions (sec. 216, River and Harbor and Flood Control Act of 1970). Authorizes investigations for modification of completed projects or their operation due to significantly changed physical or economic conditions and for improvng the quality of the environment in the overall public interest.

8. Mitigation of Shore Damage Due to Federal Navigation Projects (sec. 111, River and Harbor and Flood Control Act of 1968, as amended by sec. 940 of WRDA 1986). Authorizes the investigation and recommendation of structural and nonstructural measures to prevent or mitigate erosion or shoaling damages attributable to Federal navigation works; implementation is also authorized if the Federal share of the first cost of construction is $5,000,000 or less.

9. Storm Damage Reduction, Sec. 103, River and Harbor Act of 1962 (PL 87-874). As amended, authorizes a program for Federal participation in the cost of protecting the shores of publicly owned property and private property where public benefits result.

10. Emergency Streambank and Shoreline Erosion Protection for Public Facilities and Services (sec. 14, Flood Control Act of 1946 (PL 79-526). As amended, authorizes projects to protect public or nonprofit public facilities or services threatened by natural processes on steambanks and shorelines.

11. Placement of Dredged Materials on Beaches. Sec. 145, WRDA 1976 (PL 94-587). As amended by **sec. 933** of WRDA 99, placement of beach quality sand from new construction or O&M dredging on beaches at state request.

12. Beneficial Uses of Dredged Material, Sec. 204 of the WRDA of 1992. As amended, authorizes the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection wth dredging for new project construction or maintenance.

13. Aquatic Ecosystem Restoration, Sec. 206, WRDA 1996. Authorizes the restoration and protection of aquatic ecosystem structure and function. No linkage to an existing Corps project is required. Cap of $5,000,000 in Federal funds per project.

14. Project Modifications for Improvement of Environment, Sec. 1135, WRDA 1986. As amended, authorizes review of completed water resources projects to determine the need for modifying the structures or operations to improve the quality of the environment. Review to determine if the operation of projects has contributed to the degradation of the quality of the environment is also authorized. Recommended structural and operational changes must be consistent wth the authorized project purposes. Cap of $5,000,000 in Federal funds per project.

15. Selection of Dredged Material Disposal Methods, Sec. 207, WRDA 1996. A disposal method that is not the least-cost option may be selected if the incremental costs are reasonable in relation to the environmental benefits, including the benefits to the aquatic environment from creation of wetlands and control of shoreline erosion.

RSM approach: Evaluating field sites for suitable geomorphic response

By Maureen K. Corcoran, USACE ERDC Geotechnical and Structures Laboratory, Vicksburg, MS

Fluvial systems adjust to changes from natural events and human intervention with a sedimentological response. Environmental ecosystems exist or perish in balance with fluvial processes and sediment transport. Human populations have historically established themselves in close proximity to rivers and streams and have also become an integral part of the balance. Efforts to protect and preserve human interests by managing the natural river system are vital to human survival. Strategies have been implemented to provide flood management and erosion control and to maintain waterways for irrigation and transportation (Figure 1). Changes made to a fluvial system can have profound implications when a sedimentological response to an adjustment or alteration of a river system produces undesirable results. Optimal management of fluvial systems requires a clear understanding of the geomorphic processes and associated sediment systems. Proven methods and procedures are needed for predicting and evaluating the response and recovery of fluvial systems to natural and anthropogenic stimuli and to ensure the success of future human intervention.

Figure 1. Allendale Dam on the Woonasquatucket River, Providence, RI. An example of a structure for flood management

A watershed approach to sediment management ties sedimentological and hydrological aspects together, demanding new and innovative research designs. The RSM program at USACE ERDC is in its second year, with engineers and scientists laying the foundation for various research objectives of the program (*Research briefs*). One important

aspect is a clear understanding of the diverse parts of the ecosystem under consideration. It is, therefore, easy to understand that a basic component of an RSM approach is knowledge about the behavior and interface of water and sediment on the ecosystem. Thus, an assessment that provides details of field sites that are relevant to studying geomorphic response in regional systems through geomorphic investigations and evaluations of selected sites will add to understanding this response in fluvial systems.

For this purpose, field sites were selected to assess the underlying causes and mechanics of the reaction, response, and recovery of regional sediment systems to natural stimuli, management practices, and engineering actions, and to provide methods and procedures for predicting and evaluating fluvial sediment systems. Fluvial systems selected for this investigation were the Lower Mississippi River, Amite River, Abiaca Creek, Pascagoula River, Woonasquatucket River, and Willamette River.

Figure 2. Six field sites located within the geologic provinces: (1) Lower Mississippi River, (2) Amite River, (3) Abiaca Creek, (4) Pascagoula River, (5) Woonasquatucket River, (6) Willamette River, (7) site to be selected from the L.A. District

Field Site Selection

The six selected field sites represent varied environments, geologic province, and river type (Figure 2). Geologic provinces are separated by distinctive landscape defined by textural variations and surface patterns.

The Lower Mississippi River, Amite River, Abiaca Creek, and Pascagoula Rivers, located in the southcentral United States, represent the Atlantic Province Plain. The Woonasquatucket River in Rhode Island and the Willamette River in Oregon are situated in the Appalachian Highlands and the Pacific Mountain System, respectively.

Each river is important for navigation, wildlife habitat, and/or irrigation.

Human activities on or near the rivers have led to flooding, erosion, pollution, and loss of navigational routes, agricultural land, and wildlife habitat. Site characterizations have been initiated at each site and provide good historical data. A geomorphic assessment of each field site will provide updated information about geomorphic processes, both positive and negative, that produce a reaction, response, and recovery in each of the selected fluvial systems. Research addresses alteration of sedimentological features and the impact on river morphology and the entire watershed.

Lower Mississippi River

The Lower Mississippi River, extending south from Cairo, IL, to the Gulf of Mexico, has been investigated extensively in the past, but these studies have not included changes in sedimentological features. Proposed research there includes, from north to south, the St. Francis-L'Anguille Basin, the Yazoo Basin, the Boeuf-Tensas Basin, and the Atchafalaya Basin. Extreme natural events such as the New Madrid earthquakes of 1811-1812 and the flood of 1927 have affected the river.

There is a long history of management and engineering of the Lower Mississippi for navigation, flood control, and channel stabilization. Work performed includes channel realignments and diversions, levee construction, dredging, the building of revetments and dikes, and natural and artificial meander bend cutoffs. Extensive records exist on significant events and work performed on the river. Morphological change records include hydrographic surveys dating from 1880 forward, river engineering data, historic planform maps, and aerial photography, but interpretation of these changes is usually not addressed. Sediment transport records and stage discharge records are also available, adding to an extensive database. Availability of these data provides an excellent research opportunity for study of this large river and will contribute valuable insight towards the coastal restoration plan, *Coast 2050: Toward a sustainable coastal Louisiana*. The plan focuses on strategies jointly developed by Federal, state, and local interests to address Louisiana's massive coastal land loss problem. A geomorphic assessment of the Lower Mississippi River will aid in defining specific ecosystems and processes that substantially alter the landscape, negatively impacting the coastal economy.

Amite River

The Amite River and its tributaries lie within the Lake Pontchartrain Basin and flow south from the Mississippi - Louisiana state line toward Baton Rouge, LA. South of Baton Rouge, the river flows southeast to end in Lake Maurepas and, finally, into Lake Pontchartrain. The Amite River is mainly a meandering, coastal plain stream. Pleistocene and Holocene sediments fill the drainage basin. The basin area is approximately 2,000 square miles.

This important river system is one of Louisiana's designated "Natural and Scenic River Systems" and provides a habitat for the threatened mussel, *Potamilus inflatus* (inflated heelsplitter). Certain reaches of the river have undergone extensive point bar and in-channel sand and gravel

mining since the 1970s (Figure 3). These mining operations have contributed to the loss of riparian habitat.

The river system has responded to anthropogenic activities with observable changes in geomorphology. Comparison of historical aerial imagery and topographic maps reveals significant changes in the meander configuration of the river. After gravel mining, decreased sinuosity is apparent along with channel instability and headcutting that proceeds upstream into the Mississippi River tributaries. Localized and temporarily increased channel gradients developed along the mined reaches, and erosion increased in these areas.

A geomorphic investigation of the Amite River will allow documentation of the morphological changes induced by gravel mining. The information will contribute to understanding the response of sensitive ecosystems to geomorphic reactions.

Figure 3. Gravel mining along a reach of the Amite River in Louisiana (photo provided by Dr. David Patrick, University of Southern Mississippi)

Abiaca Creek

Abiaca Creek Watershed lies within the Yazoo Basin in central Mississippi. Abiaca Creek flows through varied topography and soils, beginning in the loess hills and flowing westward to the Matthews Brake National Wildlife Refuge (NWR), finally entering the Yazoo River.

Agricultural development since the 1830s led to soil erosion that permanently altered the topography in the area. Severe flooding and sediment accumulation in the downstream reach of the creek caused bank erosion, gully erosion, and overland flow erosion. These events led to the loss of agricultural land, transportation routes, and cultural features, as well as excessive sediment deposits in Matthews Brake NWR. Sand and gravel mining and base level lowering of the Yazoo River have also

contributed to erosion problems.

Abiaca Creek Watershed is an excellent study site for the RSM. The spatial extent of the watershed is well defined and offers a chance to study a fluvial system with varied topography and soils. The headwaters flow through loess hills to a flat, sandy floodplain. Problems of erosion, starting in the early- to mid-1800s, led to flooding and channel filling by sediment. Matthews Brake NWR has also been placed at risk by continued erosion in the watershed. Sand and gravel mining continue along the bank of the creek and contribute to the soil erosion. The loss of agricultural land, transportation routes, and cultural features has prompted corrective measures.

A variety of corrective measures have been completed in this small area and include channelization, grade control measures, flood control measures, and a levee (Figure 4). A current assessment of the geomorphic response to these most recent improvements is needed.

Figure 4. The Corps constructs a levee along Abiaca Creek for flood control

Pascagoula River

The Pascagoula River system in southern Mississippi lies upon unlithified Coastal Plain sediments and has been described as one of the least regulated river systems in North America (Dynesius and Nilsson 1994). Being unregulated, the erosional processes in this basin would occur slowly over long periods of time and consist of the downstream migration of meanders and cutting off of meander bends.

An existing topographic map and SPOT image of the mid-part of the basin reveal the confluence of the Leaf River (west) and Chickasawhay River (east). This confluence is the beginning of the named Pascagoula River, and it is located approximately 40 miles southeast of Hattiesburg, MS, and approximately 45 miles due north of the Gulf of Mexico.

The Pascagoula River system provides an opportunity to study fluvial processes in an environment relatively free of human activity. The upstream reaches are the breeding grounds of the Gulf sturgeon, and the downstream reaches include coastal wetlands. This important river basin contains numerous recreational and sporting areas and includes wildlife management and U.S. National Forest areas. System stability is evident in Figure 5, which illustrates the meander configurations for a 15-mile reach south of the confluence for 1920, 1942, and 1982. The illustration shows that the river has changed very little during the recent past.

Woonasquatucket River

The Woonasquatucket River, located in northcentral Rhode Island, flows 18.5 miles from the town of North

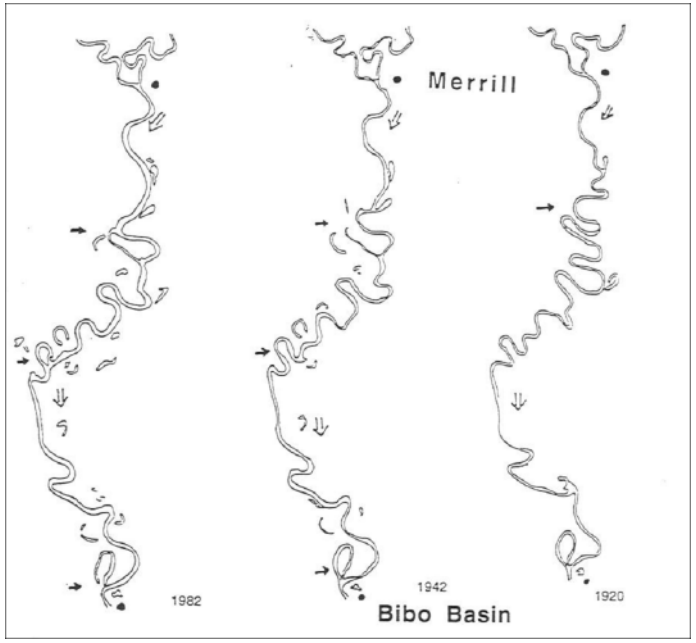


Figure 5. Planform of the Pascagoula River for a 15-mile reach between the town of Merrill and Bibo Basin showing meander configurations in 1920 (right), 1942 (center), and 1982 (left). These data were taken from topographic maps

Smithfield, through Providence, to Upper Narragansett Bay and has a watershed area of 32.4 acres. The river, designated as one of 14 American Heritage Rivers, played a key role in early industrial development. During the early- to mid-1800s, the river was straightened and routed through several textile mills to provide energy for their operation. Unfortunately, the American Industrial Revolution and subsequent factories constructed along the river polluted the river with sewage and industrial waste, including dioxin, polychlorinated biphenyls, and volatile organic compounds. In spite of the contamination, the area remains a major flyway for migratory birds and waterfowl and is home for 60 threatened and endangered wildlife species. Narragansett Bay is also a large and important saltwater estuary.

The Centerdale Manor Restoration Project Superfund site is located in North Providence along the river where cleanup efforts are currently under way. Extensive work in this area to determine the extent of contamination includes groundwater and soil sampling, clearing, soil capping, and construction of monitoring wells. Geophysical data and aerial photography are also available. A geomorphic study of the river is currently under way to target areas that are susceptible to contamination and will include sediment core sampling as well as geochemical analyses. Contaminants are usually found in fine-grained sediments and organics.

The Woonasquatucket River Greenway Project is in place with plans to restore more than 5 miles of the river in the city of Providence. The project will create a linear park with a bike/pedestrian path connecting recreation areas for the public.

A large amount of data includes historic maps and aerial photography that are available for study and comparison with current river conditions. A geomorphic analysis will be completed. The data will provide opportunities to observe the response of the Woonasquatucket River to human activity over an extended period of time (see back cover photo).

Willamette River

The Willamette River, also an American Heritage River, is located in northwestern Oregon and is bordered to the east by the volcanic rocks of the Cascade Mountains and to the west by uplifted marine rocks of the Pacific Coast Range. The river flows north to the city of Portland and into the Columbia River.

Basin fill sediments, reaching thickness of up to 1,300 ft, include fine-grained clay, silt, and sand as well as coarse-grained gravels from alluvial fans near the major drainages. Several layers of Pleistocene Lake Missoula flood deposits also fill the Willamette River Basin. The floods generated a lake in the area that was up to 400 ft deep and resulted in sediment deposits ranging from silt to large gravel units .

The Willamette Basin is 180 miles long and 80 miles wide, contains productive agricultural and forest land, and supports important fishery resources. Population increase and changes in land use along the river have resulted in pollution from sewage, industrial waste, and agricultural chemicals. Soil erosion, elevated concentrations of nutrients, and synthetic compounds such as pesticides from agriculture and landscaping have resulted in declining populations of fish and a degradation of the aquatic ecosystem.

The river currently has 14 improvement structures in place for flood control and management of erosion. Location sites have been identified for a total of 54 structures. Flood control of the river is adequate and the floodway has remained relatively unchanged in most places for 100 years. The Willamette River is currently a "sediment starved" river and gravel moves only during floods (Figure 7).

Figure 7. View across the Willamette River toward the Pacific Coast Range

Available information concerning changing river conditions over time includes gauge records dating back 60 years, historical cross-sections and maps dating back to the late 1800s, and aerial photography. Data on six large floods occurring during this century show that, for unknown reasons, flood size has decreased over time. Investigation of the river's response to impacts from changing weather patterns, logging, forest fires, and human activity is possible based on the availability of this extensive data.

Selection Criteria

The six field sites currently selected for study as part of the RSM program were chosen to represent a range in geological settings and environments within the continental United States. Many of the rivers have been altered to control flooding and erosion or to preserve navigation routes while others have had little human intervention. Site characterization is complete for all of the rivers but did not include a geomorphic evaluation. Historic data are available for all of the rivers.

A geomorphic assessment of each field site will provide vital information on how the geomorphic processes have altered sediment features. This understanding will enhance efforts to predict and evaluate riverine sediment systems in the future. The information will lead to sound management practices of some of our most important natural resources.

Contact Information:

More information is available from Maureen K. Corcoran, Geotechnical and Structures Laboratory, *Maureen.K. Corcoran@erdc.usace.army.mil*, Dr. David S. Biedenharn, Coastal and Hydraulics Laboratory, *David.S. Biedenharn@erdc.usace.army.mil*, or Julie R. Kelley, Geotechnical and Structures Laboratory, *Julie.R.Kelley@erdc.usace.army.mil*. In addition, an ERDC RSM Technical Note, *Field Site Selection for Evaluation of Geomorphic Response in Regional Sediment Systems* (in preparation), will be published soon. It contains additional information and an extensive reference list of publications on the subjects addressed in this article. In order to be notified when the technical note is published online, a list server registration is available at: *http://www.wes.army.mil/rsm/pubs/listserver.html*.

Regional coastal mapping and charting gets boost with upgrade in multinational project

By James B. Heslin, USACE ERDC, Coastal and Hydraulics Laboratory, Vicksburg, MS

Information is also based on Francis, LaRocque, Gee, and Paton: *Hydrographic Lidar Processing Moves into the Next Dimension*, published by the Hydrographic Society of America.

Lidar hydrography has been in use worldwide since the mid-1980s, and the current systems have shown to have unique capabilities, particularly in shallow, hazardous, and remote areas. The systems have also demonstrated their flexibility and mobility to respond rapidly to evolving requirements in both the coastal management and defense scenarios. As the technology has evolved, the data rates have increased and algorithms are being developed to extract more information from the data. To complement the higher volumes and variety of data there has been a parallel evolution of the approaches to processing, driven particularly by the massive amounts of data from shallow water multibeam systems. An effective area-based approach needs to satisfy three important elements: a data structure designed for area processing, rigorous automated filtering techniques, and the integration of these capabilities within an intuitive and efficient three-dimensional (3D) area-based view of the data that allows rapid and accurate analysis as well as validation of the automated processing.

The Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), a partnership between the U.S. Army Corps of Engineers, the Naval Meteorology and Oceanography Command, and the National Ocean Service, is developing a new generation coastal mapping and charting capability. Named CHARTS (Compact Hydrographic Airborne Rapid Total Survey) (Figure 1), this new airborne laser system is under development by Optech Inc., Toronto, Canada, with support from Technology Partnerships Canada and the U.S. Navy. CHARTS' field test will take place in South Florida beginning July 28, 2003, and lasting approximately 5 weeks. CHARTS is a multisensor system consisting of three sensor components, a 1000-Hz hydrographic sensor, 10,000-Hz topographic sensor, and a geo-referenced photogrammetric camera that operates from a wide

Figure 1. CHARTS is one-fourth the size of SHOALS

variety of commercially available photogrammetric aircraft. The fusion of the three sensors is based on years of experience gained by JALBTCX through prior versions of SHOALS' operations.

System description

The CHARTS system has a modular ground control system (GCS) in three parts and an air-borne component (ABC). The ABC includes hydrographic and topographic lasers, a digital camera, the Applanix inertial reference unit (POS/AV), a laser chiller, removable hard drives (data recording media), and a NavCom global positioning system (GIS).

The GCS's three modules are: Management and Planning Software—MAPS; Downloading, Auto processing, Visualization Software—DAViS, including an integrated Fledermaus editing application (Figure 2); and Statistics Reporting Software—StaRS. These modules enable the survey team to manage, plan, collect, process, and 3D visualize and edit an entire CHARTS survey project.

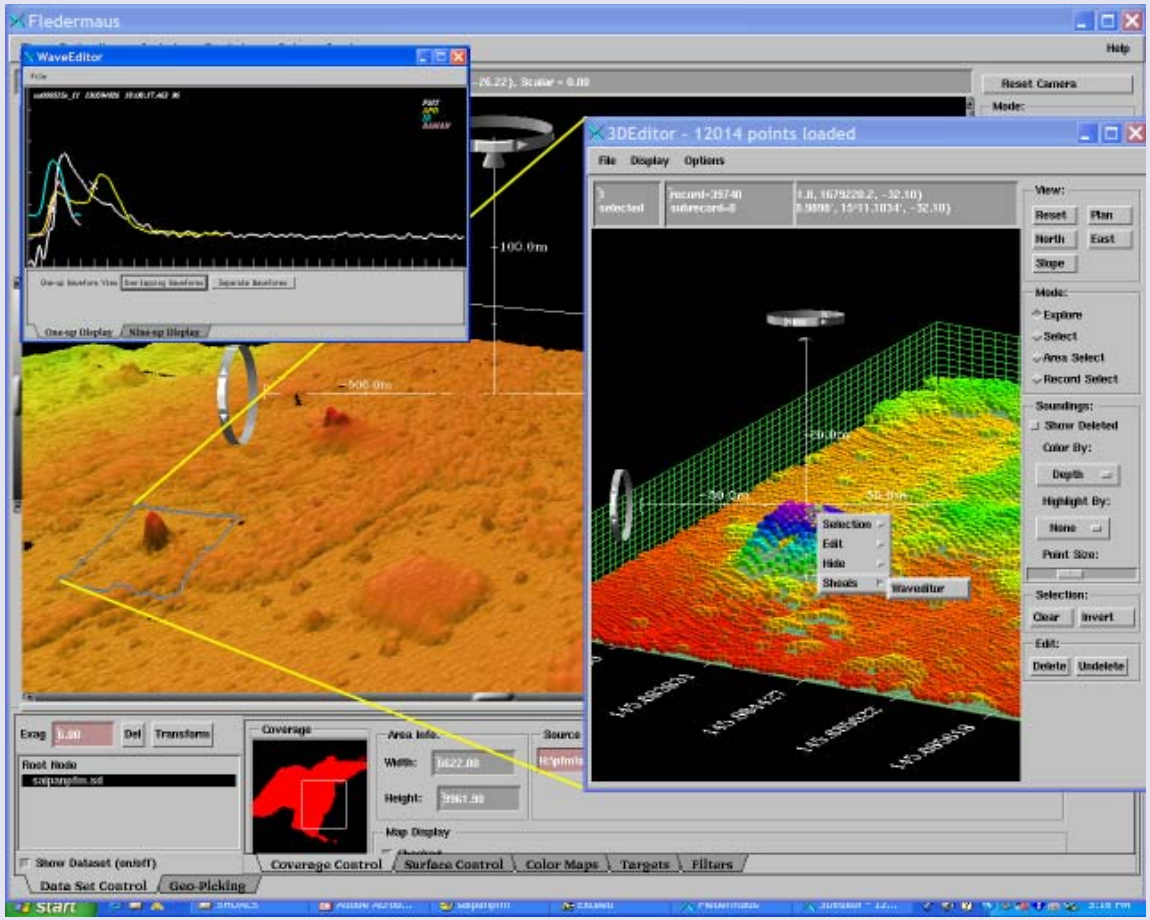


Figure 2. U.S. Naval Oceanographic Office survey data, Saipan

Coupled with Fledermaus, a commercial survey editing tool, and CHARTS 3D editor, complete and seamless control of the data is available to the field surveyor as well as the office user. In this new system, processing software fusion is an invaluable improvement since it eliminates the transfer of files, lessening the chance of introducing errors into the survey

while collecting nearly 5.5 GB per hour of raw data.

CHARTS is a state-of-the-art survey tool for comprehensive coastal mapping and charting of the physical conditions as well as the environment. Similar to SHOALS, but with the additions of a topographic laser and geo-referenced digital camera, CHARTS will be used by the Corps of Engineers to measure and monitor our Nation's coast in support of regional sediment management. Figure 3 represents an example of data fusion with a geo-referenced digital image overlaid with hydrographic and topographic contours. The Naval Oceanographic Office, owner of CHARTS, will use it to conduct surveys in support of its worldwide nautical charting mission.

The hydrographic sensor provides longitude (x), latitude (y), and depth (z) and waveforms. The topographic sensor provides x1, y1, z1, i1 and x2, y2, z2, i2 where i represents the intensity of the return signal. The digital camera system provides a geo-referenced down look image that will aide the user while editing CHARTS data and easily mosaic into a GIS. This most basic information (x, y, z) from the hydrographic and topographic lasers enables Corps engineers and scientists to measure and quantify the physical conditions along our coasts to support regional management decisions and to develop a regional sediment budget. Other information and products consist of nautical charts; beach, jetty, and pier cross-sections and profiles; delineation of roads; bare-earth digital elevation models; and

Figure 3. Data Fusion - Hydro + Topo + Imagery

identification of vegetated areas. CHARTS' digital camera provides a geo-referenced image. From this image, a mosaic can be built that provides a digital image of the coastline. These products broaden the knowledge base about coastal environments.

Research and development efforts are currently under way by the Navy to further enhance CHARTS' capabilities. These include bottom typing derived from the CHARTS laser return signal or waveform and the ability to determine bottom type such as sand, silt, or vegetation, adding data for many potential uses. More sensor fusion is under way with research and development application for coupling a hyperspectral scanner with the CHARTS system. Such research combines these two remote sensing systems, allowing depth calibration from the hyperspectral scanner and improving the bottom typing ability of CHARTS.

Current developments in hydrographic lidar and the evolution of SHOALS to CHARTS have been made possible by the efforts of the JALBTCX and Optech. JALBTCX and Optech are looking forward to the CHARTS field tests and a successful operational life that will support the Corps mission beginning in FY04. For more information see *http://shoals.sam.usace.army.mil/pages/Generation.htm* or contact *James.B.Heflin@erdc.usace.army.mil*.

Some information regarding terms:

CHARTS is the label the U.S. Naval Oceanographic Office (NAVO) has given to the SHOALS-1000T (T because of topographic LASER option being coupled with the hydro LASER). SHOALS-1000, SHOALS-1000T, SHOALS-1000TH are the names of Optech's commercial product line. So CHARTS is a SHOALS-1000T, but NAVO decided to rename it CHARTS. The TH system is the hydro/topographic option coupled with a hyper spectral sensor.

Mark your Calendar

1-4 Oct - INTERCOH - 2003. 7th International Conference on Nearshore and Estuarine Cohesive Sediment Transport Processes. The conference will be held at the Virginia Institute of Marine Science, School of Marine Science, College of William & Mary, Gloucester Point, VA, USA. POC: Jerome P.-Y. Maa, Prof. of Marine Science, Virginia Institute of Marine Science, Gloucester Point, VA 23062, Tel: (804) 684-7270, fax: (804) 684-7250. Details of the conference program, hotel accommodation, local transportation, and air transportation will be available through the site: *http://www.vims.edu/intercoh/*.

20-23 Oct - The 19th Annual International Conference on Soils, Sediments, and Water, University of Massachusetts, Amherst, MA, Registration fees: $495.00. Visit *www.UmassSoils.com* or email Denise Leonard at *dleonard@schoolph.umass.edu* for more information.

22-24 Oct - Interregional Conference on Integrated Watershed Management: Water Resources for the Future, Porto Cervo, Sassari, Sardinia, Italy. POC *Moujahed Achouri*.

28-30 Oct - U.S. Section PIANC Annual Meeting, Roundtable on Protecting America's Ports from Natural and Man-Made Disasters. Portland, OR, Downtown Marriott. More information at *http://navigation.usace.army.mil/octprogram2.pdf*.

17-19 Nov - Conference on Soil Erosion under Climate Change: Rates, Implications and Feedbacks, Tucson, AZ, USA. Contact: *Mark Nearing*.

2004

11-15 Jan - 83rd TRB Annual Meeting. Washington, DC, USA.

21 Jan - Controlling the Loss of Soil to Water, one-day conference, Burlington House, Piccadilly, London W1J OBG, UK. Sponsored by the Geological Society. More details can be obtained from Dr Michelle Clarke, NSRI, Cranfield University, Silsoe, Bedfordshire MK45 4DT, UK. Tel: + 44 (0) 1525 863120, fax: +44 (0) 1525 863253, email: *michelle.clarke@cranfield.ac.uk*; Dr. Marianne McHugh, NSRI, Cranfield University, North Wyke, Okehampton, Devon EX20 2SB, UK, Tel: +44 (0) 1837 883547, fax: +44 (0) 1837 82139, email: *marianne.mchugh@bbsrc.ac.uk*. See call for papers in News Briefs Section, *www.wes.army.mil/rsm/news/*.

27 Sep - 1 Oct - WODCON XVII, *Dredging in a Sensitive Environment*, World Dredging Congress XVII at CCH - Congresss Centrum Hamburg, Germany. In conjunction with SMM 2004, the Shipbuilding, Machinery and Marine Technology International trade fair. Contact the Central Dredging Association, PO Box 488, 2600 AL Delft, The Netherlands. Tel: +31 15 278 3145, fax: +31 15 278 7104; email: *ceda@dredging.org* and Westin Oaks. More information can be found at *http://www.woda.org/WODCONXVII/index.html*.

28 Apr-1 May 2004 - 3d International Symposium on Gully Erosion, Oxford, MS, USA. Information can be found at *http://gullyconference2004.olemiss.edu/*.

Summer 2004 - Symposium on Erosion, Lima, Peru. Point of contact is Professor Suarez Diaz, email *erosion@epm.net.co*.

4-9 Jul 2004 - 13th International Soil Conservation Organization (ISCO) Conference in the theme: Conserving Oil and Water for Society: Sharing Solutions, Brisbane, Australia. More information is available from Mike Grundy, Tel: +61-7-38969395, fax: +61-7-38969898, *grundym@nrm.qld.gov.au* or *mik_beth@bigpond.net.au*. Brochure at *http://www.isco2004.org/*.

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