Regional Sediment Management Tools and Technologies

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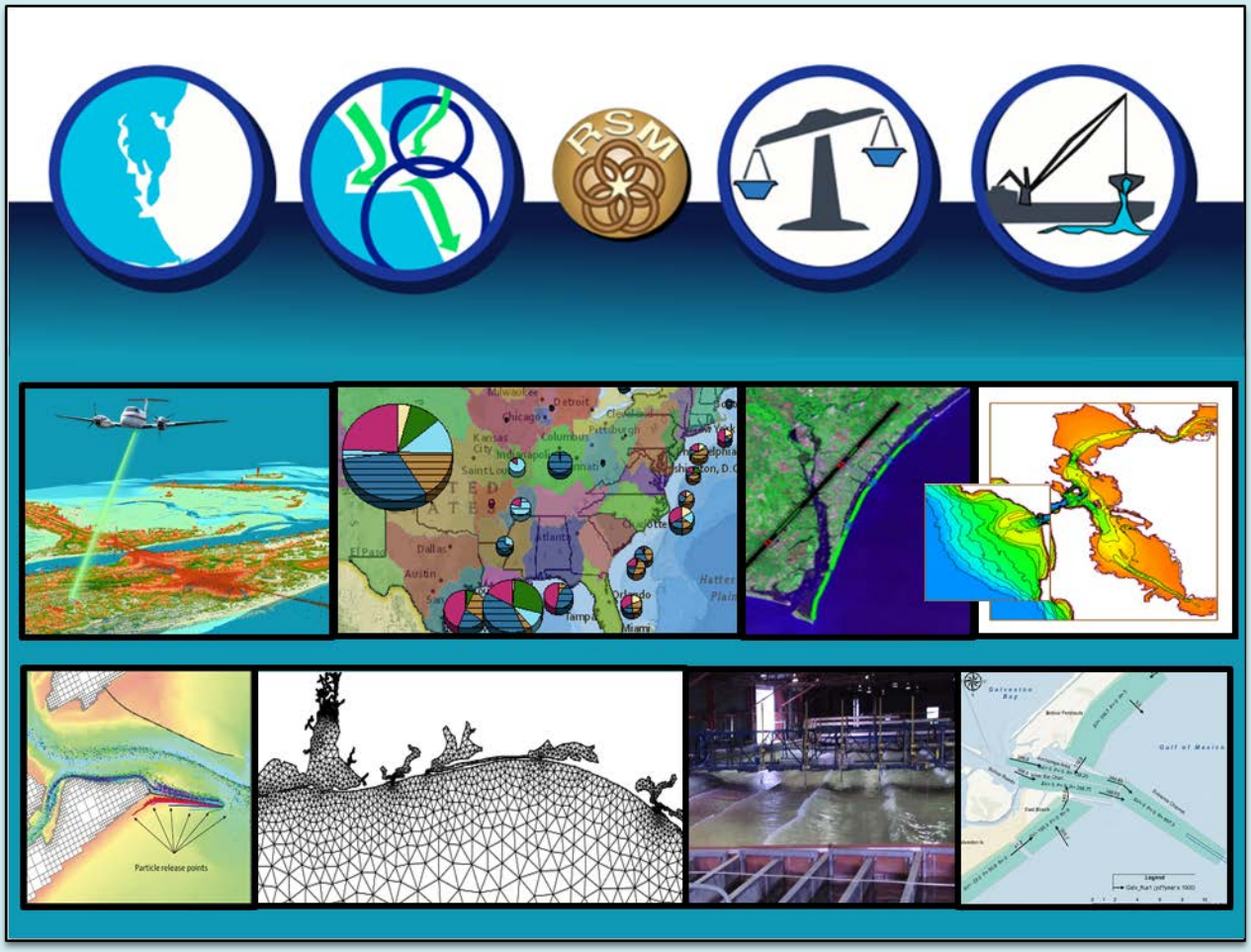

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Regional Sediment Management: Integrated Solutions for Sediment Related Challenges

Points of Contact:

Linda S. Lillycrop
Program Manager, National Regional Sediment Management
Linda.S.Lillycrop@usace.army.mil

Katherine E. Brutsché, PhD
Deputy Program Manager, National Regional Sediment Management
Katherine.E.Brutsche@usace.army.mil

email: rsm@usace.army.mil

http://rsm.usace.army.mil

Regional Sediment Management Tools and Technologies: Volume I, Coastal

1. Introduction

The purpose of this document is to provide a summary of tools and technologies available to facilitate implementation of Regional Sediment Management (RSM) for the Nation's coasts. Riverine and reservoir systems are equally important and benefit from the RSM approach, however, a separate document will be issued reviewing RSM tools and technologies for riverine and reservoir systems. Because there are many strategies and practices, and therefore tools and technologies available to implement RSM, this document is not all encompassing and includes the most commonly used coastal capabilities available. It is noted that the National RSM Program develops, enhances, and applies tools and technologies for regional approaches in collaboration with research programs (U.S. Army Corps of Engineers (USACE), other Federal and non-Federal agencies), USACE Divisions and Districts, academia, stakeholders and partners, and Non-Governmental Organizations (NGOs).

1.1. Regional Sediment Management

The U.S. Army Corps of Engineers (USACE) National RSM Program was initiated in 1999 to take a regional or systems approach to address sediment related issues and support sustainable solutions across multiple projects (primarily navigation, flood risk management, and ecosystem restoration) in coordination with partnering organizations, governments, and stakeholders. RSM Strategies along with the data and knowledge made available through RSM also provide valuable information for emergency management operations. To date, USACE Districts from all Divisions, the Engineer Research and Development Center (ERDC), and the Institute for Water Resources (IWR) have participated in the National RSM Program in collaboration with other Federal and non-Federal stakeholders and partners, Academia, and NGOs. Because sediment related challenges and their solutions vary in different regions of the Nation, regional RSM Teams have been established across the nation to address region specific challenges to managing sediments.

RSM is a philosophy that implements regional and systems approaches to utilize best management practices across multiple projects to improve the management and use of sediments in coastal, estuarine, and inland environments. The overarching goal is to achieve short and long-term sustainable environmental, social, and economic benefits both locally and regionally: increasing benefits while maintaining or reducing costs.

The RSM approach includes multiple components including 1) engagement, communication, and collaboration across entities interested in the management and use of sediments (USACE, Federal and non-Federal agencies, NGOs, States, stakeholders, sponsors, resource agencies, and local communities). This includes participating in or establishing an Interagency Working Group which focuses on sediment management; 2) Integration across multiple projects, communities, programs, authorities, funding and other resources, and USACE Business Lines to allow contributions from all resources in order to achieve success; 3) sound engineering and science in the application of tools and technologies to understand the region, identify and evaluate RSM strategies, overcome challenges, assist in decision making, and adaptive management.

RSM is accomplished by adhering to the following RSM Operating Principles:

1. Recognize sediments as a resource (local and regional) and prioritize use across projects, environments, and/or communities
2. Link and leverage across multiple projects and authorities
3. Improve operational efficiencies and natural exchange of sediments
4. Evaluate and recommend economically viable and environmentally sustainable solutions
5. Consider regional and local implications of project scale actions and benefits
6. Apply/Enhance tools and technologies for regional approaches
7. Share lessons learned, information, data, tools, and technologies
8. Improve Relationships: Communicate and collaborate with Stakeholders, Partners, Resource Agencies, Federal/Non-Federal Agencies, Academia, and Non-Governmental Organizations.

Benefits of applying these principles are improved management and use of sediments, increased benefits, reduced lifecycle costs, improved communication, enhanced partnerships, and more resilient and sustainable projects and systems.

1.2. Communication and Collaboration

The National RSM Program works with USACE Districts, Divisions, and regional RSM teams to integrate the RSM principles into existing and new projects. The Districts and Divisions reach out to their stakeholders, partners, and resource agencies to communicate and collaborate in making decisions and to prioritize and implement RSM actions. With future conditions projected to increase the vulnerability of watersheds, and limited availability of resources, RSM practitioners must leverage partner relationships and existing resources to improve the management and use of sediments across coastal, estuarine, and inland systems to create or maintain efficient sustainable solutions resulting in thriving watershed systems.

1.3. RSM Process

The process to implement RSM is illustrated in Figure 1. It is important to utilize appropriate tools, technologies, and science based information and data throughout the RSM process.

Phase 1: Understand the Region
In order to successfully implement RSM, it is necessary to develop an understanding of the sediment sources and needs, sediment processes, morphologic evolution, ecological conditions, endangered species, pertinent engineering activities, gaps in knowledge, sediment related challenges, and stakeholder and partner goals within a region.

Phase 2: RSM Strategies Project Scale
RSM strategies to improve the management and use of sediments are identified and evaluated at the project scale to understand how projects behave within the existing system and how they would evolve with various RSM strategies under future conditions. Pilot projects are implemented to evaluate new technologies or concepts in order to overcome challenges in improving the use of sediments.

Phase 3: RSM Strategies Regional Scale
Phase 3 is programmatic to integrate the project-level strategies into a regional strategy. Implementation of the strategies are prioritized, regulatory and permitting requirements are identified, and the authorities, policies, projects, and resources through which the strategies will be constructed are identified. Stakeholder and partner participation is integral to decision-making, prioritizing, and overcoming challenges in Phases 2 and 3.

Phase 4: Take Action – Construct and Adaptive Management
Once a project is coordinated and constructed under Phase 4, it is important to monitor the evolution of the project, adaptively manage the project to ensure the project is performing as expected, quantify the value and benefits, share lessons learned, and incorporate the strategy as standard practice.

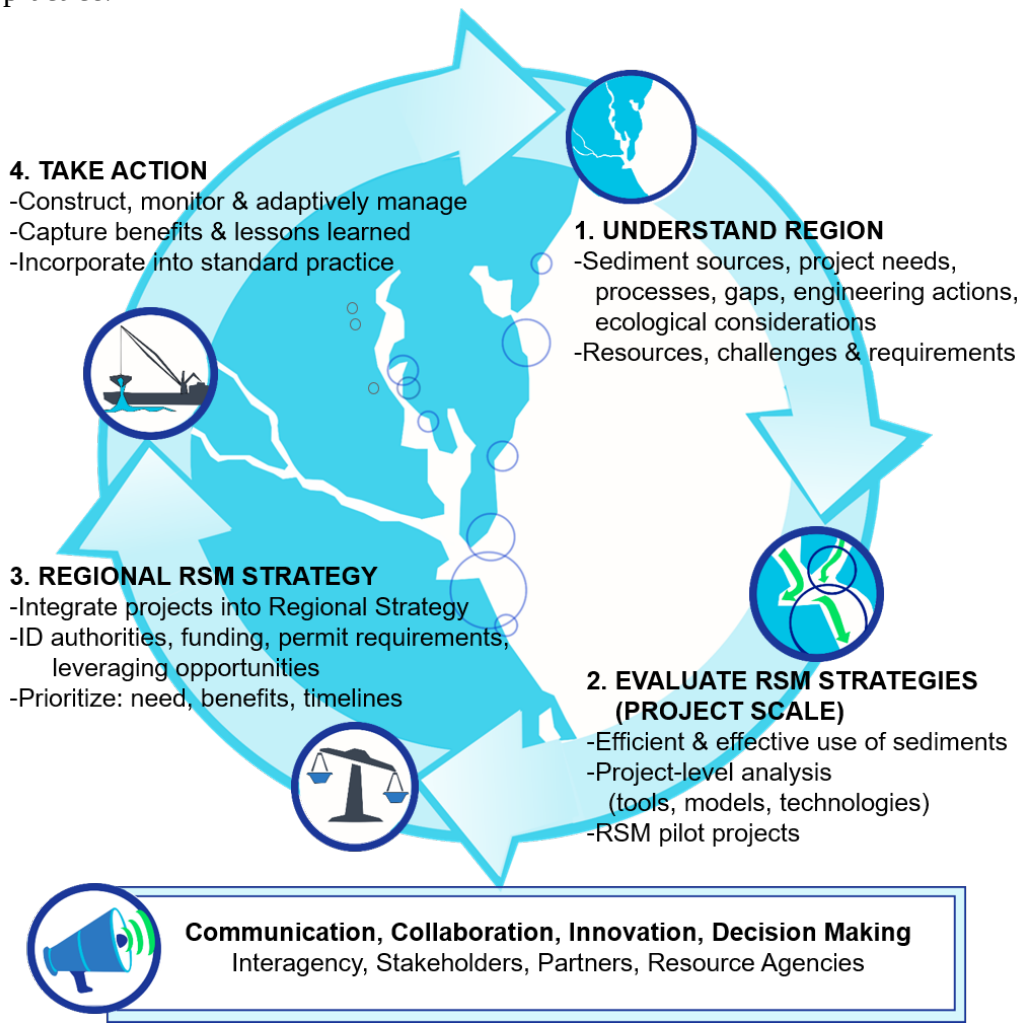

Figure 1. The Regional Sediment Management Process

1.4. Development and Enhancement of Tools and Technologies: Coastal RSM

The National RSM Program collaborates with USACE Research, Development, and Technology (RD&T) programs, USACE Districts and Divisions, stakeholders, partners, and academia, and NGOs to enhance or develop tools and technologies for efficient and effective management of

sediments. This document shares common tools and technologies available to successfully implement RSM approaches for coasts; however, it is not all encompassing due to the broad nature and methods to which the RSM principles can be applied. RSM has amassed a large number of pilot demonstrations of new technologies across the Nation which have been integrated across USACE projects (Operations and Maintenance (O&M) dredging and placement, Shore Protection Projects (SPP), Feasibility Studies, Dredged Material Management Plans (DMMP), Continuing Authorities Program (CAP), etc).

The RSM tools and strategies found within this document are organized to mirror the major phases of the RSM process (Figure 1): 1) Understand the Region; 2) Evaluate RSM Strategies (Project Scale); 3) RSM Strategies (Regional Scale); and 4) Take Action – Construct and Adaptive Management. Through the RD&T programs, a large suite of tools and technologies, ongoing research, and data collection programs are available for application at multiple scales (regional and project scales) and for multiple zones of a watershed, including rivers and reservoirs, wetlands, estuaries, and the coastline (dunes, beaches, and the nearshore). The document focuses on RSM tools for coastal applications.

Figure 2 summarizes the tools appropriate for phases 1-3 of the RSM process across coastal, estuarine, and inland zones. Many of these tools can be applied throughout the RSM process at project and regional scales, as noted throughout the document. Tools that can apply to many portions of the watershed are shown as cross-cutting tools. The tools are listed within the figure according to their acronyms. For more information about the tools listed within this document, refer to the Appendix: Applicable Tools and Point of Contacts, which includes fact sheets describing the tools and a point of contact. Coastal, estuarine, and inland tools are listed, however, for the purposes of this document, only coastal tools will be discussed. For more information on these capabilities and emerging technologies under development, please contact the RSM Program manager, found on the homepage of the RSM website: http://rsm.usace.army.mil.

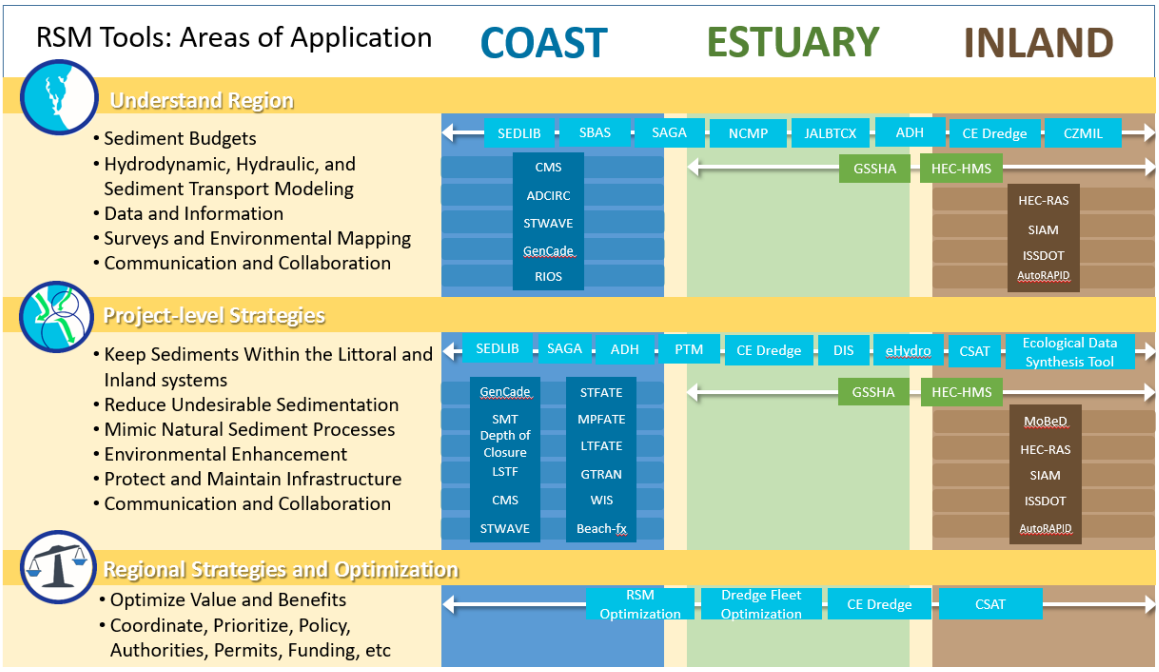

Figure 2. RSM Tools for Coastal, Estuarine, and Inland Systems

2. Understand the Region

The National RSM Program assists in identifying sustainable, cost-effective, environmentally acceptable solutions for managing sediments. The first phase in the RSM process is to develop an understanding of the region: what we know and what we do not know (gaps). This includes understanding the interests and requirements of stakeholders, resource agencies, and partners; existing projects; as well as the sediment sources, needs, transport processes, and characteristics; hydrodynamic and hydrologic processes; morphology; ecological conditions; and engineering activities. A framework is then developed to get the sediment sources to where the sediment is needed, as well as address gaps in knowledge. In this section, regional level concepts, tools, and technologies are discussed.

2.1. Concepts, Tools, and Technologies at the Regional Scale

Key tools and technologies to understand the region include regional sediment budgets as well as application of regional hydrodynamic, hydrologic, sediment transport, and ecological numerical models. Data that may be required to support these tools and technologies include bathymetric and topographic surveys, aerial and hyperspectral imagery, hydrodynamic and hydrologic data, sediment characteristics, ecological data, as well as data about engineering activities such as dredging histories and flood risk management, shore protection, and ecosystem restoration projects. Utilizing Geographic Information System (GIS) capabilities, enterprise databases, and web-based visualization tools greatly enhances the ability to understand and share information on regional scales. The tools, models, and data are available through various programs and databases. These concepts, tools and technologies are divided into several categories.

2.1.1. Regional Sediment Budgets

Regional sediment budgets are an analysis of sediment sources, sinks, and fluxes within a specified region over a given timeframe that provide a conceptual and qualitative understanding of the sediment patterns and pathways over a region. Developing a sediment budget requires an understanding of the sediment sources, sinks, longshore and cross-shore sediment transport rates, areas of erosion and accretion, morphologic changes, and engineering actions over the region. Sediment budgets can be formulated for a range of conditions and at watershed, regional, and project level scales, to provide insights into potential near- and long-term morphologic response to engineering activities and assist with connecting sediment sources to sediment needs.

Applicable Tools (see Appendix for more information): Sediment Budget Analysis System (see SBAS Fact Sheet)

2.1.2. Comprehensive Regional Surveys and Environmental Mapping

Comprehensive, high resolution, regional bathymetric and topographic Light Detection and Ranging (LIDAR) data, aerial imagery, and hyperspectral imagery are available from the National Coastal Mapping Program (*see NCMP Fact Sheet*) implemented by the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX). The LIDAR datasets are used in

developing numerical model grids, shoreline and morphologic (Volume) change calculations, feature mapping, and sediment budgets. The hyperspectral and true-color aerial imagery provide data for habitat and benthic mapping, classifying sediment types and submerged aquatic vegetation, understanding vulnerable areas, and creating landscape metrics. Multibeam surveys, navigation channel transects, and beach profile surveys also provide elevation data for sediment budgets. Other systems like the Radar Inlet Observing System (*see RIOS Fact Sheet*) are used to continuously measure the position of inlet channels and shoaling areas. Ship-mounted units (e.g. Compressed High Intensity Radar Pulse; *see CHIRP Fact Sheet*) provide on sub-bottom profiling data used to determine sediment sources, which are used to inform sediment transport pathways for sediment budgets.

2.1.3. Regional Hydrodynamic and Hydrologic Data

Real-time data for calibration and validation of hydrodynamic and hydrologic models are available through several National programs such as the Coastal Observation Data Systems Program (CODS), Coastal Field Data Collection Program (CFDCP), Coastal Data Information Program (CDIP), National Data Buoy Center (NDBC), and the US Integrated Ocean Observing System (IOOS) Program for coastal projects. Water level and tidal circulation data are available at tidesandcurrents.noaa.gov. Hindcast wave data are also available through the USACE Wave Information Study (*see WIS Fact Sheet*).

2.1.4. Regional Hydrodynamic, Hydrologic, and Sediment Transport Modeling

For coastal systems, it is important to understand the regional hydrodynamic and hydrologic processes that transport sediments. Large-scale numerical models are applied to predict these processes, and the models listed below can be used to develop and refine the sediment budget. The models can be applied at both regional and project level scales.

Applicable Tools (see Appendix for more information): Coastal Modeling System (see CMS Fact Sheet, CMS-Flow Fact Sheet, and CMS-Wave Fact Sheet), Advanced Circulation Model (see ADCIRC Fact Sheet), Steady-State Spectral Wave Model (see STWAVE Fact Sheet), GenCade (see GenCade Fact Sheet), Gridded Subsurface Hydrological Analysis (see GSSHA Fact Sheet), Adaptive Hydraulics Model (see ADH Fact Sheet)

3. Identify and Evaluate RSM Strategies (Project-Scale)

Once the regional system is understood, RSM strategies to improve the use of sediments are identified and evaluated at the project scale. It is important to continue communicating and coordinating with stakeholders and partners to identify potential strategies, define metrics for success, and to make decisions throughout the evaluation process. This section provides an overview of examples of common RSM strategies, and tools that are available to evaluate strategies that address specific needs and challenges. Fact sheets are available in the Appendix to provide further information on the tools discussed in this section.

3.1. Applying RSM Goals to Projects

When considering RSM strategies, the overall goals are to keep sediment in the littoral system, reduce unwanted sedimentation that must be managed later, mimic natural sediment processes when appropriate, enhance the environment, and maintain and protect infrastructure. Because there are numerous types of RSM strategies that can be used, the common strategies are outlined below. Where appropriate, tools that aid in identifying and evaluating the specific RSM strategy are identified.

3.1.1. Keep Sediments within the Littoral System

One of the main goals of coastal RSM is to keep sediments within the littoral system. For navigation projects, dredged sediments from navigation channels are placed beneficially rather than disposing in ocean dredged material disposal sites (ODMDS) or in upland confined disposal facilities (CDF), which permanently removes the sediments from the system and reduces capacity in the ODMDS or CDF. Some examples include beach and nearshore placement, as well as enhancing ecosystems or benthic and aquatic habitat. Erosion control methods can be employed to keep sediments within the system. Sand mining, which removes valuable sediments from the system, should be restricted.

Beach and Nearshore Placement

Inlets and navigation channels are often dredged to maintain navigable depths. As part of RSM, it is important to keep the dredged sediments within the littoral system by identifying potential beneficial uses. It is important to understand the coastal and sediment process for siting placement so the desired outcome is achieved, while minimizing sediment returning to a navigation channel or not transporting downdrift. Beach nourishment and/or dune enhancement are ideal options for beneficial use of dredged sediments, however, direct beach placement is often ruled out due to regulatory restrictions and/or the costs associated with placement. In these cases, nearshore placement is considered the next best option. The goal of nearshore placement is typically to place the sediments in such a manner that sediment will mobilize and transport shoreward. Generally, nearshore placement can either be in the form of discrete mounds, or a bar-like feature referred to as a nearshore berm.

Applicable Tools (see Appendix for more information): Sediment Mobility Tool (see SMT Fact Sheet), Coastal Modeling System (see CMS Fact Sheet, CMS-Flow Fact Sheet, and CMS-Wave Fact Sheet), Steady-State Spectral Wave Model (see STWAVE Fact Sheet), GenCade (see GenCade Fact Sheet), Large-scale Sediment Transport Facility (see LSTF Fact Sheet)

Thin Layer Placement

Thin layer placement is defined as *the purposeful placement of thin layers of sediment (e.g. dredged material) in an environmentally acceptable manner to achieve a target elevation or thickness. Thin layer placement projects may include efforts to support infrastructure and/or create, maintain, enhance, or restore ecological function*. Consideration is given to the thickness of the placed sediment, usually based on environmental controls, and the dispersive or consolidation characteristics of the sediment. TLP projects are not restricted by the depth of placement; therefore TLP techniques are used to create or enhance ecosystem habitat or to place sediments in open water.

Erosion Control Methods

By reducing erosion from the project area, sediments will stay within the littoral system. There are many coastal erosion control methods such a hard structures (i.e. groins and breakwaters) and soft structures (i.e. beach and nearshore placement of sediment). Additional methods include sand fencing to build dunes and reduce the loss of sediment through Aeolian transport, and the use of geotubes and biodegradable containment structures contain sediment for marshes, island creation, etc.

3.1.2. Reduce Sedimentation

Sedimentation in coastal navigation channels, inlets, and harbors hinders marine transportation.

Navigation Channel Sedimentation

The Corps navigation mission is to provide safe, reliable, efficient, and environmentally sustainable waterborne transportation systems (including channels, harbors, and waterways) for movement of commerce, national security needs, and recreation. Sedimentation in navigation channels, inlets, and harbors impedes the ability to provide safe, reliable, and efficient marine transportation, and impacts emergency vessel operations such as U.S. Coast Guard rescue vessels to quickly respond to emergency situations. The beach and nearshore placements described in the previous section are desired because they are generally constructed using sediment dredged from navigation channels in the vicinity of the placement area. Channel bypassing and backpassing can also reduce sedimentation in navigation channels. Awareness of sediment transport processes in the vicinity of the channel provide information necessary to place sediments in manner that it will not transport back into the channel or negatively impact shorelines.

Applicable Tools (see Appendix for more information): Coastal Modeling System (see CMS Fact Sheet, CMS-Flow Fact Sheet, and CMS-Wave Fact Sheet), Steady-State Spectral Wave Model (see STWAVE Fact Sheet), GenCade (see GenCade Fact Sheet), Channel Shoaling Analysis Tool (see CSAT Fact Sheet), Channel Portfolio Tool (see CPT Fact Sheet)

3.1.3. Mimic Natural Sediment Processes

RSM seeks to aid in maintaining natural features and mimicking natural sediment processes by keeping sediments moving through the system. Beaches are created through natural coastal

processes, dunes are naturally created through Aeolian sand transport, and emergent land features and barrier islands are created and maintained through natural sediment transport. Inlets and harbors that are structured (i.e. jetties) as well as dams and reservoirs can cause sediment to accumulate at the structure rather than naturally bypass, which has the potential to impact the sediment supply downdrift. The most common way to alleviate sediment trapping by structures is to mimic the natural sediment transport process through backpassing and bypassing around the structure. A solution to manage the bypassing at inlets is to place dredged channel or updrift sediments downdrift or construct a weir jetty and deposition basin, reducing navigation channel sedimentation and allowing the sediments to be periodically bypassed through dredging or a sand bypassing plant. To simulate the natural building of dunes, common methods are to use sand fencing or recycled Christmas trees to trap wind blown sand. Bypassing sediments along barrier island shorelines and filling breaches caused by storms is another RSM solution.

3.1.4. Environmental Enhancement

RSM alternatives may include some type of environmental enhancement. This includes erosion control, oyster and dredge hole filling, wetland/marsh creation or enhancement, etc., and demonstrations of more environmentally friendly construction methods (i.e. biodegradable containment structures). Habitat creation including sea bird, beach mouse, sea turtle, oyster, and benthic organisms is also a potential RSM strategy.

Applicable Tools (see Appendix for more information): Ecological Data Synthesis Tool (see EDST Fact Sheet)

3.1.5. Protect and Maintain Infrastructure

Finally, RSM can assist with maintaining and protecting infrastructure. Keeping sediments in the system and placing sediments on shorelines helps to maintain healthy beach and dunes systems. Filling scour holes along jetties and training structures assists in stabilizing these structures, and beneficially using sediments rather then disposing in offshore and upland disposal facilities extends capacity of these disposal areas.

3.2. Evaluating Alternatives

Once alternatives are identified, it is important to evaluate each alternative to determine those that maximizes value and benefits, while minimizing potential impacts. There are a wide variety of models, tools, and databases that maybe utilized to evaluate RSM solutions and identify the strategy that is best suited for the project and system. The following are commonly applied tools:

- Hydrodynamic and Sediment Transport Modeling

Applicable Tools (see Appendix for more information): Sediment Mobility Tool (see SMT Fact Sheet), Coastal Modeling System (see CMS Fact Sheet, CMS-Flow Fact Sheet, and CMS-Wave Fact Sheet), Adaptive Hydraulics Model (see ADH Fact Sheet), Particle Tracking Model (see PTM Fact Sheet)

- Analyze Dredging, Placement, and Navigation Channels

Applicable Tools (see Appendix for more information): CE-Dredge (see CE-Dredge Fact Sheet), CE-Dredge Decision Support Tool (See CE-Dredge Decision Support Tool Fact Sheet), USACE

RSM and Beneficial Use: Navigation Sediment Placement (1998 – Present) (see USACE Navigation Sediment Placement Fact Sheet), Multiple Placement FATE (see MPFATE Fact Sheet), General Transport/Long-term FATE (see GTRAN/LTFATE Fact Sheet), Channel Shoaling Analysis Tool (see CSAT Fact Sheet), Automatic Identification System Analysis Package (see AISAP Fact Sheet), Channel Portfolio Tool (see CPT Fact Sheet), eHydro Navigation Channel Condition Reporting (see eHydro Fact Sheet)

- Identifying Sediment Characteristics

Applicable Tools (see Appendix for more information): Sediment Analysis Geo-App (see SAGA Fact Sheet)

- Understanding Depth of Closure

Applicable Tools (see Appendix for more information): Depth of Closure (DOC) database (see Depth of Closure Fact Sheet

4. RSM Strategies (Regional Scale)

Once RSM strategies are evaluated at the project level, the next phase in the RSM process is to develop a regional RSM strategy that integrates the projects across the region and identifies economic value, avenues for construction (authorities, funding, etc.), timelines, necessary coordination, and prioritization.

Tools designed to aid in the decision-making phase of USACE projects integrate information on how the system is behaving and synthesize measurements and metrics into indicators of system operation. Peak system operation is best achieved through optimizing available resources. For USACE projects, these resources often fall into three categories: sediment or natural resources, authorities and financial resources, and equipment. Examples of these optimization tools and resources are included in the following sections.

4.1. RSM Economic Value and Dredge Fleet Scheduling Optimization

The RSM Economic Value and Dredge Fleet Scheduling Optimization Tool documents the economic value through 1) linking projects and regionally managing sediments across navigation and shore protection projects, and 2) optimizing scheduling of the dredge fleet across the region through the Dredge Fleet Scheduling Optimization Tool. The web tool serves as a knowledge management portal regarding potential efficiencies available across navigation and shore protection projects. The tool documents potential value and allows Districts and decision makers to maximize return on investment of appropriated dollars. The RSM Economic Value and Dredge Fleet Scheduling Optimization Tool was developed and applied as a pilot within the USACE South Atlantic Division. For more information on this capability, see the *RSM Economic Value and Dredge Fleet Scheduling Optimization Pilot Fact Sheet*.

4.2. Dredge Fleet Scheduling Optimization

The Dredge Fleet Scheduling component identifies additional efficiencies that can be gained by evaluating the dredge plants assigned to navigation projects and the planned schedule over the course of the dredging season. The optimization model considers localized constraints such as minimum dredging requirements, scheduling due to environmental windows, and suitability of particular dredge plants for specific navigation and/or beach nourishment projects. The result is an optimized dredge utilization schedule synchronized with navigation projects identified for a dredging season. More information on the Dredge Optimization Tool can be located on the *Dredge Optimization Tool Fact Sheet*.

5. Take Action – Construct and Adaptive Management

Once Phases 1, 2, and 3 of the RSM process are completed: 1) the regional sediment system is understood, 2) the RSM strategies are identified and evaluated at the project scale, and 3) a regional strategy has been developed, the next phase in the process is to take action and construct. Once the project is constructed it is important to monitor and adaptively manage to ensure the project is performing as expected, and to improve as needed to achieve expected performance. The value and/or benefits gained through the improved use of sediments are quantified to document and outreach successes. Projects are also monitored to validate tools and technologies that were applied. It is important to document and share lessons learned in order to assist others working to implement similar strategies. Continued collaboration and communication with stakeholders, resource agencies, and partners is necessary to incorporate the RSM strategies into standard practice. The tools, technologies, and programs summarized in previous sections apply to this section.

6. Summary

The purpose of this document is to provide information on the tools, technologies, approaches, and best practices to assist in the implementation of Regional Sediment Management (RSM) in the coastal environment. This document is not all encompassing because there are a wide range of approaches and practices, and therefore tools and technologies available to implement RSM. RSM is a systems approach which uses best management practices for more efficient and effective use of sediments across coastal, estuarine, and inland environments. This document reviews RSM approaches and tools that assist in accomplishing the following RSM Operating Principles:

1. Recognize sediments as a regional resource (local and regional).
2. Link and leverage across multiple projects, business lines, and authorities
3. Improve operational efficiencies and the natural exchange of sediments
4. Evaluate and recommend economically viable and environmentally sustainable solutions
5. Consider regional implications of local sediment actions which benefit the region
6. Enhance technical knowledge and tools for regional approaches
7. Share lessons learned, information, data, tools, and technologies
8. Improve Relationships: Communicate and collaborate with stakeholders, partners, sponsors, federal and non-federal agencies, academia, non-governmental organizations.

Benefits of applying these principles are improved sediment management, increased value and benefits, reduced lifecycle costs, enhanced partnerships, and more resilient and sustainable projects and systems.

7. Acknowledgements

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8. Appendix – Applicable Tools and Points of Contact

- Adaptive Hydrology/Hydraulics Model System (ADH)
- Advanced Circulation Model (ADCIRC)
- Automatic Identification System Analysis Package (AISAP)
- CE-Dredge
- CE-Dredge Decision Support Tool
- Channel Portfolio Tool (CPT)
- Channel Shoaling Analysis Tool (CSAT)
- Coastal Modeling System (CMS)
- CMS-Flow
- CMS-Wave
- Coastal Zone Mapping and Imaging Lidar (CZMIL)
- Depth of Closure Database
- Dredge Fleet Assignment / Scheduling Optimization Model
- Ecological Data Synthesis Tool
- eHydro Navigation Channel Condition Reporting
- GenCade
- Gridded Subsurface Hydrologic Analysis (GSSHA)
- Integrated CHIRP Sub-Bottom Profiler and Dual Frequency Sidescan Sonar
- Large-scale Sediment Transport Facility (LSTF)
- MPFATE, GTRAN, and LTFATE
- National Coastal Mapping Program (NCMP)
- Particle Tracking Model (PTM)
- Radar Inlet Observing System (RIOS)
- RSM Economic Value and Dredge Fleet Scheduling Optimization Pilot
- Sediment Analysis and Geo-App (SAGA)
- Sediment Budget Analysis System (SBAS)
- Sediment Mobility Tool (SMT)
- Steady-State Spectral Wave Model (STWAVE)
- USACE RSM & Beneficial Use: Navigation Sediment Placement (1998 – Present)
- Wave Information Studies (WIS)

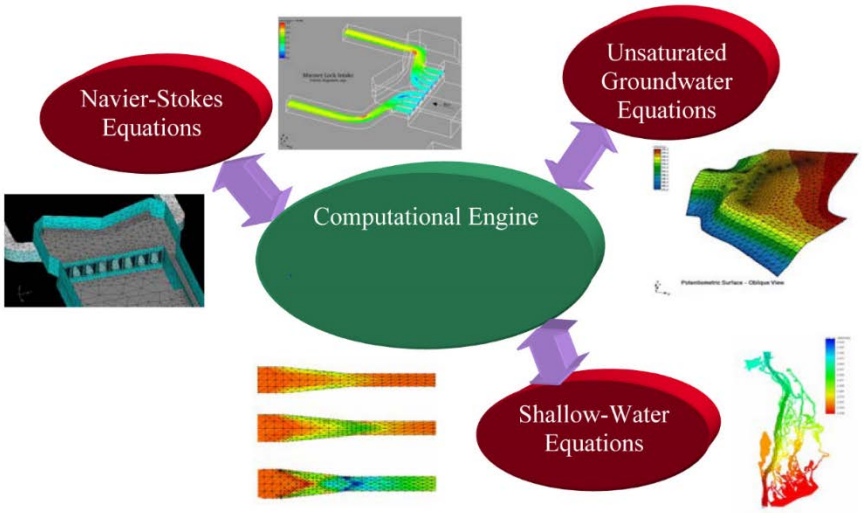
Adaptive Hydrology/Hydraulics Model System (ADH)

Description

Adaptive Hydrology/Hydraulics (ADH) is a modular, parallel, adaptive finite-element model for one-, two- and three-dimensional flow and transport. ADH is a module of the Department of Defense (DoD) Surface-Water Modeling System and Ground-Water Modeling System. ADH simulates groundwater flow, internal flow and open channel flow. The ADH module was developed in the Engineer Research and Development Center's Coastal and Hydraulics Laboratory and is a product of the System-Wide Water Resources Program. The program is available to the Corps of Engineers and other DoD agencies at no charge.

Example Studies

ADH was developed to address the environmental concerns of the DoD in estuaries, coastal regions, river basins, reservoirs and groundwater. It can address a wide range of modeling applications including the design of channel improvements, guardwall porting design, design of fish passage structures, measurements of flood inudation, and the impacts of vessel traffic on hydrodynamics, salinity, and sedimentation.



Products

Overview of features, technical manuals, publications, and software can be found at the following site: https://adh.usace.army.mil/new_webpage/main/main_page.htm

Benefits

The general features in ADH that benefit the user include:

- Adaptation: The user needs only to generate a general mesh to capture the geometry of the problem. ADH will automatically refine it to provide accurate solutions and more stable and less expensive simulations.
- Portability: ADH can run efficiently on a wide variety of platforms ranging from standard PCs to high-end supercomputers.

POC: Jennifer Tate Jennifer.N.Tate@usace.army.mil

Advanced Circulation Model (ADCIRC)

Description

Prediction of potential storm surge water levels is critical in the design of flood and storm damage reduction projects and protection of facilities and infrastructure and beneficial to planning and evacuation of low-lying areas if a storm event occurs. Comprehensive models of hydrodynamic simulations can support operations and maintenance and help minimize dredging, maintain channel reliability, manage inlet and adjacent beach sediment, and predict navigation project performance. To predict storm surge water level and help control the impact of storm damage, experts in hydrodynamic engineering at the ERDC Coastal and Hydraulics Laboratory (CHL) helped to develop the ADvanced CIRCulation Model (ADCIRC).

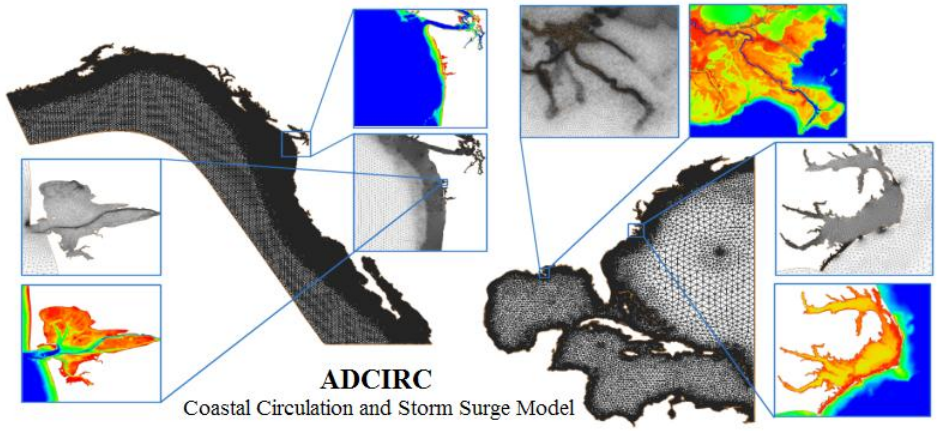
Certified by the Federal Emergency Management Agency (FEMA) for use in performing storm surge analyses, ADCIRC is a hydrodynamic modeling technology that conducts short- and long-term simulations of tide and storm surge elevations and velocities in deep-ocean, continental shelves, coastal seas, and small-scale estuarine systems.

Products

In a single simulation, ADCIRC can provide tide and storm surge elevations and velocities corresponding to each node over a very large domain, encompassing regional domains such as the western North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. As an unstructured coastal ocean circulation model used to compute surface water elevation and currents, ADCIRC runs as a two-dimensional depth integrated (2DDI) model or as a three-dimensional (3D) model to solve time-dependent, free surface circulation and transport problems.

Typical ADCIRC applications include the following:

- Modeling tides and wind driven circulation
- Analysis of hurricane storm surge and flooding
- Dredging feasibility and material disposal studies
- Inlet sediment transport, morphology change, and larval transport studies
- Nearshore marine operations



Benefits

The use of an unstructured grid allows for high localized grid resolution where solution gradients are large and low grid resolution where solution gradients are small, minimizing both local and global error norms for a given computational cost. ADCIRC simulates tidal circulation and storm surge propagation over large computational domains, eliminating the need for imposing approximate open-water boundary conditions that can create inaccuracies in model results, while simultaneously providing high resolution in areas of complex shoreline and bathymetry where it is needed to maximize simulation accuracy.

POC: Chris Massey Chris.Massey@usace.army.mil

Automatic Identification System Analysis Package (AISAP)

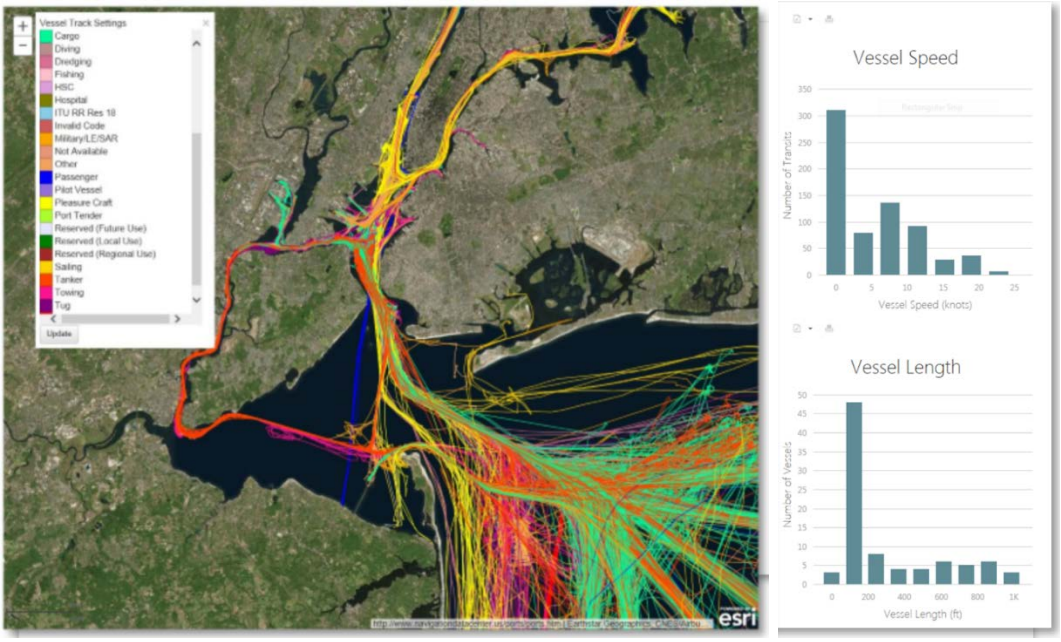
Description

The Automatic Identification System Analysis Package (AISAP) is a web-based tool for acquiring, analyzing, and visualizing real-time and archival data from the U.S. Coastal Guard. Archived AIS data include location, time, speed-over-ground, direction, vessel draft, beam, length, and vessel type information. Through AISAP, USACE personnel can define spatial and temporal filters, visualize traffic density patterns, and analyze vessel utilization patterns. The tool allows for unprecedented access to quantitative and statistically robust measures of navigation project performance through time and the coupling of environmental measurements routinely employed in coastal and navigational engineering studies. AISAP has been applied to a wide variety of USACE District projects including (but not limited to) analyzing incident response, Atlantic sturgeon strikes, Asian carp and barge entrainment, hurricane resilience, and port performance metrics.

Products

The AISAP is available to all USACE personnel, is enabled for user collaboration, and features customizable maps and data outputs including AIS signal heat maps, vessel track lines with customizable filters (e.g. draft, speed, or vessel type), and statistical reporting outputs.

The AISAP web interface is located at: http://ais-portal.usace.army.mil



Benefits

By allowing users to visualize recorded vessel traffic within a larger navigation network, the AISAP supports informed decision making for USACE project managers. In addition, by providing insights into commercial vessel freight movements AISAP can contribute to improved understanding of intermodal freight flows and the subsequent need for maintenance resources. The AISAP can be used to investigate questions of historical travel time, capacity limitations, and the effects of weather or accidents on the flow of freight through waterways.

POC: Kenneth Ned Mitchell Kenneth.N.Mitchell@usace.army.mil

CE Dredge

Description

CE-Dredge is a program to assist with the planning, monitoring, and management of USACE dredging operations. Under the program, custom GIS and database applications support data access for dredging management. The tool provides a standardized, national database for access to dredging information and applications that are intended to improve planning and management, reduce duplication of manual data entry, and improve the analytical capabilities for datasets relevant to dredging operations (including budgets, schedules, and environmental data).

Products

The CE-Dredge platform has several applications for both public and USACE users, available at https://ce-dredge.usace.army.mil

- **CE-Dredge: Decision Support Tool** (USACE ArcGIS Webmap, USACE employees)
  - A web-based viewer that integrates selected Corps enterprise data, knowledge, tool results, and limited external data to allow more efficient and effective planning, communication, and decision-making regarding activities to improve the management and beneficial use of dredge material, optimize placement area usage, improve channel availability, and streamline technical analysis.
- **CE-Tools: Data Viewer** (ArcGIS Desktop Application, Public and USACE)
  - This data access toolbar is for use within the ArcGIS desktop application and allows easy connection to participating District databases. The public can download this toolbar and configure it to link to their local data sources.
- **CE-Tools: Sediment Sampling Tool** (ArcGIS Desktop Application, Public and USACE)
  - The Sediment Sampling Toolbar allows users to organize and access all data related to a core boring or sediment testing activity. This ArcMap toolbar allows users to retrieve detailed sediment sample properties in correlation with any relevant sediment testing results and links related documents such as core boring, gradation curves, or sediment testing reports.
- **Dredging Manager Inspector** (USACE website, USACE employees and contractors)
  - This website allows inspectors, to record inspection results using online forms that facilitate the recording of timesheets for rental contracts, the logging of dredging operations, and the evaluation of disposal area maintenance. Users must register in order to interact with the website.
- **Dredging Manager Viewer (**USACE hosted viewer, USACE employees)
  - With the Dredging Manager Viewer, District project engineers can spatially monitor and manage dredging activities within their project areas: dredging contracts, daily logs of operations, contractor timesheets, consolidated history cards, beneficial usage agreements, disposal area placement and maintenance, and sediment sampling.
- **SEDMAN: Sediment Management Technologies** (MS Silverlight Application, Public & USACE)
  - An interactive decision support tool that helps users select available resources, applications, tools, and other technologies by assisting users with identifying problems based on physical processes, environmental parameters, and other sorting criteria.

Benefits

CE-Dredge provides a centralized agency-wide approach to organizing and approaching dredging related projects.

POC: Mike Mcfarland Michael.E.Mcfarland@usace.army.mil
Rose Dopsovic Rose.Dopsovic@usace.army.mil

CE Dredge: Decision Support Tool

Description

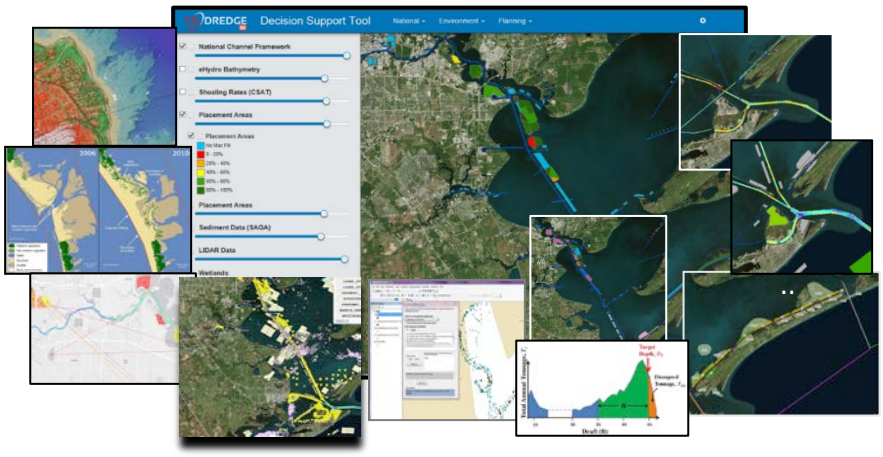
The CE-Dredge Decision Support Tool (DST) is a web-based dashboard providing an integrated, comprehensive approach for strategic dredged material management. The DST integrates selected Corps enterprise data, knowledge, tool results, and limited external data to allow more efficient and effective real time and long-term planning, communication (internal and external), and collaborative decision-making regarding activities to improve the management and beneficial use of dredged material. The goal is to streamline preliminary or DMMP assessments by utilizing the USACE Navigation Data Integration Framework (NDIF) to develop a "living" DMMP capability.

Example Studies

The CE-Dredge DST was developed through collaboration with SWG, SAM, and ERDC for the Gulf Intracoastal Waterway from High Island to Brazos River, Houston Ship Channel, and Galveston Bay. The CE-Dredge Natural Infrastructure Opportunities Tool (NOIT) under development through the Caterpillar Natural Infrastructure Initiative (CAT NII), builds on the NDIF and CE-Dredge DST to incorporate public data to identify and evaluate collaborative opportunities for beneficial use.

Products

Access DST at http://coe samgsp05mob.sam.ds.usace.army.mil/webapplications/A104_DMMPViewer/ and on the Navigation Portal (http://Navigation.usace.army.mil). The DST integrates data from the National Channel Framework, eHydro, Channel Shoaling and Analysis Tool (CSAT), National Coastal Mapping Program (NCMP) elevation, imagery, and landscape metric data, Dredging Manager, National Placement Area Manager, Sediment Analysis and GeoApp (SAGA), Sediment Budget and Analysis System (SBAS), Channel Portfolio Tool (CPT), Ecological Data Synthesis Tool, Beneficial Use of Aquatic Dredged Material Management (BUADMM) Tool, and Dredged Material Management Decisions (D2M2).



Benefits

CE-Dredge DST provides improved data access, visualization, and decision support for Corps dredging operations managers, engineers, planners, HQ, and R&D. The modernization and streamlining of preliminary or DMMP assessments through the USACE NDIF to develop a "living" DMMP capability increases DMMP quality, usability, and adaptability while reducing required steps, costs, and timeframes.

POC: Linda Lillycrop — Linda.S.Lillycrop@usace.army.mil
Safra Altman — Safra.Altman@usace.army.mil
Teresa Parks — Teresa.Parks@usace.army.mil

Channel Portfolio Tool (CPT)

Description

The Channel Portfolio Tool (CPT) is a web-based decision-support package for determining the extent to which Corps-maintained navigation channel depths are utilized by commercial shipping. CPT uses the proprietary, dock-level tonnage database maintained by the Waterborne Commerce Statistics Center (WCSC), part of the Corps' Navigation Data Center (NDC). CPT provides an objective, consistent basis by which channels may be quickly compared to others for prioritization of Operation & Maintenance (O&M) funding, thereby providing improved justification for annual dredging budget items.

CPT provides decision makers with relevant data concerning commercial shipping activity that is directly supported by Corps dredging activities. CPT conducts nearest-neighbor matching of WCSC's Master Docks database with a spatial network representing Corps-maintained channels and waterways. Entries in the tonnage database are routed from origin to destination docks through this network using well-established shortest-path logic. The cumulative statistics for tons, $-value, vessel draft, commodity types and traffic types are then compiled for each channel segment in the network.

Products

- Mitchell, K. N. 2012. "A Review of Coastal Navigation Asset Management Efforts Within the Coastal Inlets Research Program (CIRP): Part 2: The Channel Portfolio Tool." ERDC/CHL CHETN-IV-29. Vicksburg, MS: U.S. Army Engineer Research and Development Center. http://chl.erdc.usace.army.mil/chetn
- Mitchell, K. N. 2009. "Depth-Utilization Analysis for Estimating Economic Activity Supported by Dredging." Terra et Aqua. International Association of Dredging Companies. Number 116.
- Mitchell, K. N., Wang, B., Khodakarami, A. 2013. "Selection of Dredging Projects for Maximizing Waterway System Performance" Transportation Research Record: Journal of the Transportation Research Board, No. 2330, Transportation Research Board of the National Academies, Washington, D.C., pp. 39–46. DOI: 10.3141/2330-06
- Dunkin, L., Mitchell, K. 2015. "Quantitative Approach to Navigation Channels Asset Management." Proceedings of Western Dredging Association and Texas A&M University Center for Dredging Studies' Dredging Summit and Expo 2015. June.

Benefits

CPT data can be easily accessed, queried, and visualized. By allowing users to consider channels as part of a larger navigation network, and navigation as part of a global freight network, the Channel Portfolio Tool supports informed decision making and optimized prioritization of freight system maintenance resources.

POC: Kenneth Ned Mitchell Kenneth.N.Mitchell@usace.army.mil
Marin Kress Marin.M.Kress@usace.army.mil

Channel Shoaling Analysis Tool (CSAT)

Description

The Channel Shoaling Analysis Tool (CSAT) calculates channel-shoaling volumes using historical channel surveys and uses the shoaling rates to predict future dredging volumes. The CSAT leverages ongoing efforts by the USACE to standardize the manner in which hydrographic surveys are uploaded and processed through its eHydro program. The CSAT estimates future localized shoaling rates through a hindcasting algorithm and is designed to incorporate new hydrographic surveys.

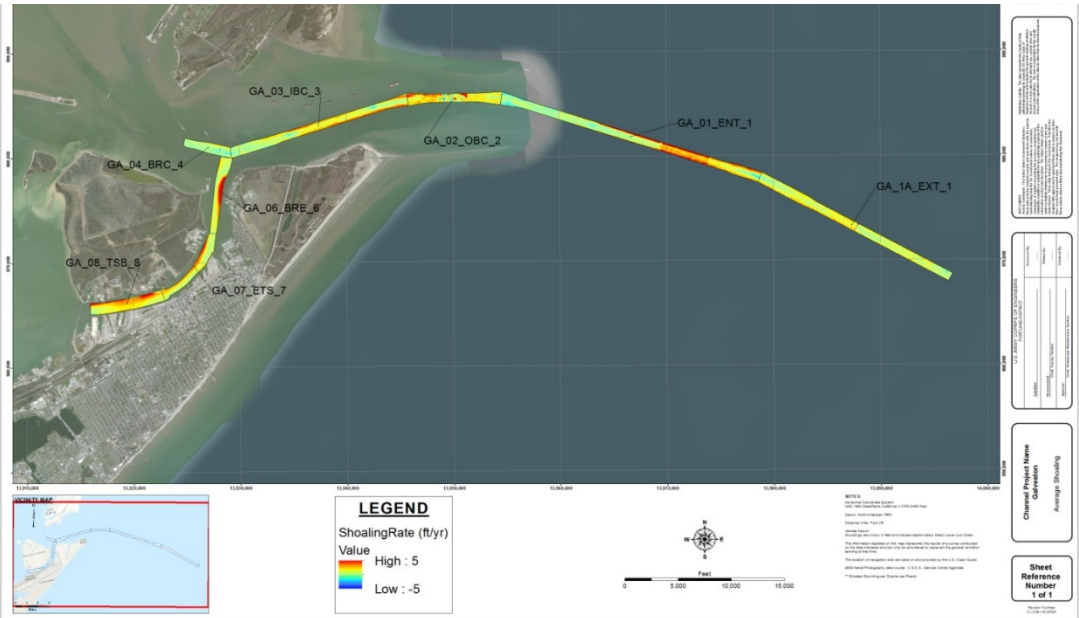
Example Studies

The CSAT has been run for USACE navigation channels that are high or medium tonnage around the coastal U.S.

Products

Average, maximum, and minium shoaling rates are calculated for the different channel reaches. Volume tables are generated for varying depth and time increments which are used to provide predicted dredging requirments.

Average annual shoaling rate - spatial understanding of shoaling magnitudes (warm colors - higher shoaling rates; cool colors - lower shoaling rates).



Benefits

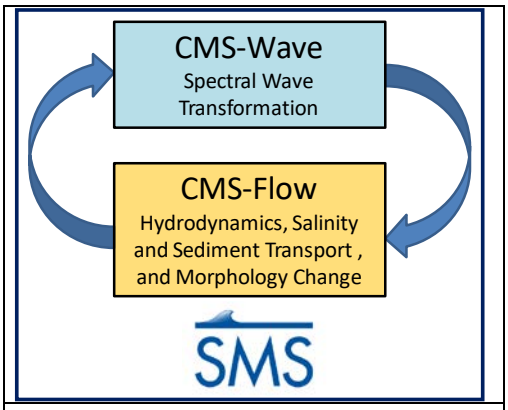
The shoaling rates are used to predict future volumes required for dredging at various depth and time intervals. The forecasted shoaling volumes from CSAT are combined with the detailed Waterborne Commerce annualized tonnage figures with the Channel Portfolio Tool (CPT), enabling a straightforward, quantitative comparison of cargo supported by dredging to any specified target depth to the requisite dredging costs

POC: Lauren Dunkin Lauren.M.Dunkin@usace.army.mil

Coastal Modeling System (CMS)

Description

The Coastal Modeling System (CMS) is a suite of coupled two-dimensional numerical models for simulations of waves, hydrodynamics, salinity and sediment transport, and morphology change. The CMS is identified by the USACE Hydraulics and Hydrology - Coastal Community of Practice (CoP) as a preferred model for Coastal Engineering and Coastal Navigation studies. The CMS can be used for research on nearshore hydrodynamics and sediment transport. Ongoing research includes bed-load dispersion, mixed cohesive/non-cohesive sediment transport, modeling long-term morphology change, cross-shore sediment transport, coastal structure breach evaluation, and incorporation of dredging operations. The CMS can be run as a stand-alone executable, and is interfaced and distributed through the Surface-Water Modeling System (SMS). The CIRP wiki website, http://cirpwiki.info/wiki/CMS, contains technical documentation, user guidance, step-by-step instructions, utility links, and many other model resources.



Coastal Modeling System flow chart.

Example Studies

CMS has been applied at more than 70 project sites in the US and 7 international project sites. Examples documented in CMS publications include Grays Harbor, Washington; Mouth of the Columbia River, Washington/Oregon; Port Orford, Oregon; Ocean Beach, California; Southeast Oahu Coast, Hawaii; Shark River Inlet, New Jersey; Field Research Facility, Duck, North Carolina; St. Augustine Inlet, Florida; Matagorda Bay, Texas; Mississippi Sound and Barrier Islands; Hazaki Oceanographic Research Facility, Japan; Gironde Estuary, France; Rosetta promontory, Egypt.

Products

The CMS has been verified and validated with analytical, laboratory, and field data sets that document idealized and applied studies on waves, current, sediment transport and morphology change. Technical transfer has been conducted through 40 onsite workshops, 5 DOTS trainings, and 4 webinars. Publications on the CMS include more than 50 TRs and TNs, more than 30 JPs, users manual, and wiki website.

Benefits

The CMS provides coastal engineers and scientists a PC-based, easy-to-use, accurate, and efficient tool to assist in designing and managing coastal engineering and navigation projects. The CMS represents a wide range of nearshore physical processes. Using the CMS, District engineers and scientists can conduct integrated and coupled calculations of waves, currents, water levels, sediment transport and morphology change in and around inlets, ports and harbors, navigation channels, and beaches for high resolution short- (weeks) to long-term (seasonal to multiple years) project scales.

POC: Honghai Li Honghai.Li@usace.army.mil
Chris Massey Chris.Massey@usace.army.mil

Coastal Modeling System (CMS)
CMS-Flow

Description

CMS-Flow is a two-dimensional finite-volume hydrodynamic and sediment transport model in the Coastal Modeling System (CMS). The model solves the depth-integrated mass conservation and shallow-water momentum equations of water motion on a non-uniform Cartesian grid. Three sediment transport formulations are available in the sediment module: a sediment mass balance method, an equilibrium advection-diffusion method, and a non-equilibrium advection-diffusion method. Within the CMS, CMS-Flow is coupled with the wave transformation model, CMS-Wave. During the coupling process the wave radiation stress and wave field information calculated by CMS-Wave is supplied to CMS-Flow for the hydrudynamic and sediment transport calculations. Currents, water levels, and morphology changes are fed back to CMS-Wave to increase the accuracy of wave transformation predictions.

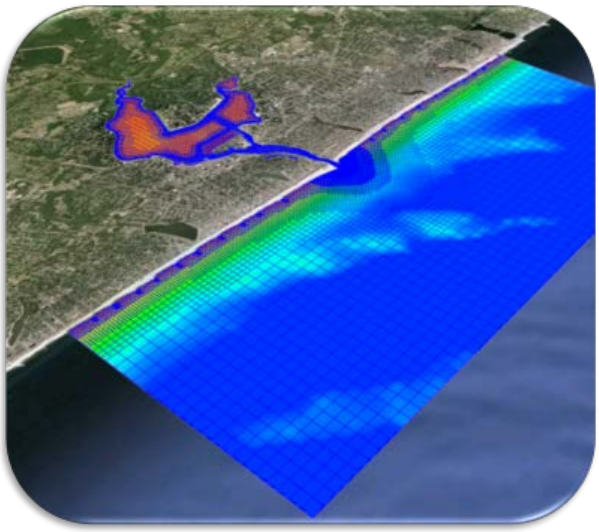


Figure 1. CMS-Flow grid representing Shark River Inlet, NJ.

Example Studies

CMS-Flow has been applied in numerous studies on all United States coasts, as well as international sites.

Products

Overview of features, technical manuals, publications, link to a companion wiki page and software can be found at the following site: http://cirp.usace.army.mil/products/cms.php.

Benefits

CMS-Flow provides coastal engineers and scientists a PC-based, easy-to-use, accurate, and efficient tool to assist in designing and managing coastal engineering and navigation projects by facilitating the following:

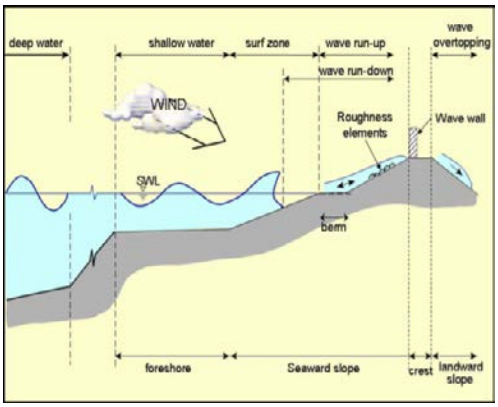
- Integrated and coupled hydrodynamic and sediment transport calculations in and around inlets, ports and harbors, and associated navigation channels and coastal structures such as jetties, breakwaters, groins and seawalls.
- High resolution short- (weeks) to mid-term (seasonal to multiple years) project scale simulations.
- Representation of a wide range of nearshore physical processes and structures (weirs, culverts, porous rubble mounds, and tidal gates).

POC: Honghai Li Honghai.Li@usace.army.mil

Coastal Modeling System (CMS)
CMS-Wave

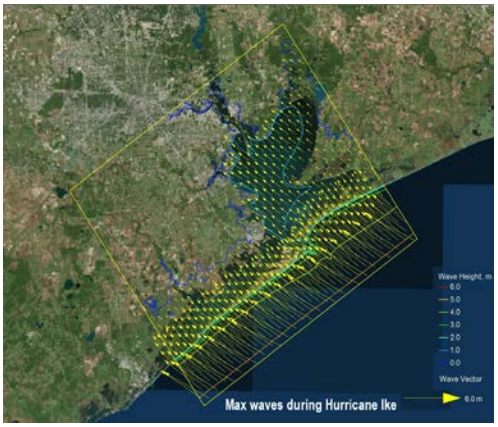
Description

CMS-Wave is a two-dimensional spectral wind-wave generation and transformation model for calculating wave diffraction, refraction, reflection, wave run-up, wave setup, and wave transmission and overtopping of structures. This full-plane wave model is applicable to islands, lakes, estuaries, and coastal inlets. To expedite the computations for applications with large domains and long-term simulations, model has a “fast mode” for desktop PCs with multiple processors. The model was developed under the Coastal Modeling System (CMS), it has been fully operational since 2006 and has a graphical-user interface (GUI) for grid generation and visualization in the Surface-water Modeling System (SMS).



Example Studies

CMS-Wave has been used successfully in several recent RSM applications, including: (1) Regional sediment budget for the West Maui coast, HI (2016), (2) Operational tool development for shoaling reduction at the junction of Gulf Intracoastal Waterway and Corpus Christi Ship Channel, TX (2016), (3) Identificaiton of alternatives to reduce shoaling in the lower Matagorda Ship Channel, TX (2016), (4) Alternatives to reduce shoaling in the Gulf Intracoastal Waterway at West Galveston Bay, TX (2015), (5) RSM studies of Matagorda Ship Channel and Matagorda Bay system, TX (2013), and (6) Beneficial use of dredged materials for beach nourishment in Ocean Beach, CA (2013).



Products

- “Hawaii Regional Sediment Management (RSM): Regional Sediment Budget for the West Maui Region” 2016. Coastal and Hydraulics LaboratoryTechnical Report ERDC/CHL TR-16-5. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- “Alternatives to Reduce Shoaling in the Gulf Intracoastal Waterway and Prevent Erosion of Bay Islands along the North Shoreline of West Galveston Bay” Coastal and Hydraulics LaboratoryTechnical Note 2015. ERDC/CHL CHETN-XIV-44. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- “Regional sediment management studies of Matagorda Ship Channel and Matagorda Bay system, Texas” 2013. Coastal and Hydraulics LaboratoryTechnical Report ERDC/CHL TR-13-10. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

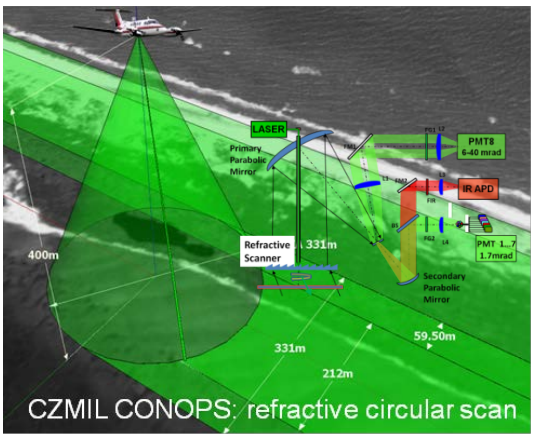
Benefits

Computationally efficient, easy to use, extensively validated physics-based spectral wave model fully integrated with flow and sediment transport models, particle tracking model (PTM),and Boussinesq model (BOUSS-2D). Applicable to most common wave processes in coastal engineering applications. Extensive documentation on model theory, numerical implementation, GUI, and wold-wide application exmaples are available from CIRP website: http://cirp.usace.army.mil

POC: Lihwa Lin Lihwa.Lin@usace.army.mil
Zeki Demirbilek Zeki.Demirbilek@usace.army.mil

Coastal Zone Mapping and Imaging Lidar (CZMIL)

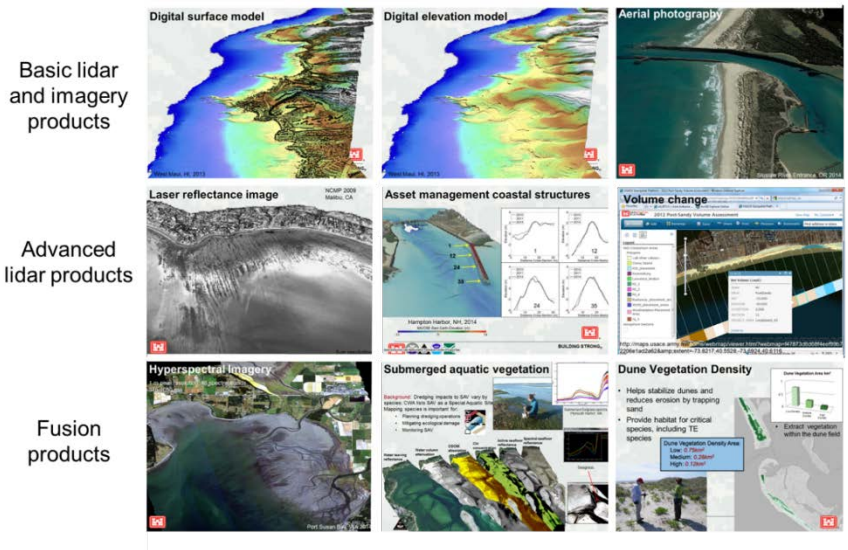
Description



The Coastal Zone Mapping and Imaging Lidar is a new sensor development effort within the National Coastal Mapping Program that is executed by the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTC). During the past 5 years, the NCMP has produced high-quality, high-resolution information products from airborne lidar bathymetry, topography, and accompanying RGB and hyperspectral imagery data: 1-m bathy/topo rasters, 1-m bare earth rasters, 20-cm RGB image mosaics, 1-m, 36-band hyperspectral image mosaics, 1-m landcover classifications, 2-m bottom reflectance images, and shoreline vectors. All of these products have been generated from data collected by airborne lidar bathymeters designed to measure primarily water depth, and using available COTS software packages in a cumbersome processing flow that challenges the throughput of the programs, or applies them in a non-standard manner to achieve desired results.

Products

CZMIL is an integrated lidar and imagery sensor suite and software package designed for highly automated generation of physical and environmental information products for the coastal zone, including those currently generated for the NCMP, along with water column attenuation, chlorophyll concentration, CDOM concentration, and automated bottom classification. Below are examples of data outputs that are available from over 20,000km of mapped shoreline along the Gulf, East, and West coasts, Great Lakes, and the Hawaiian Islands:



Benefits

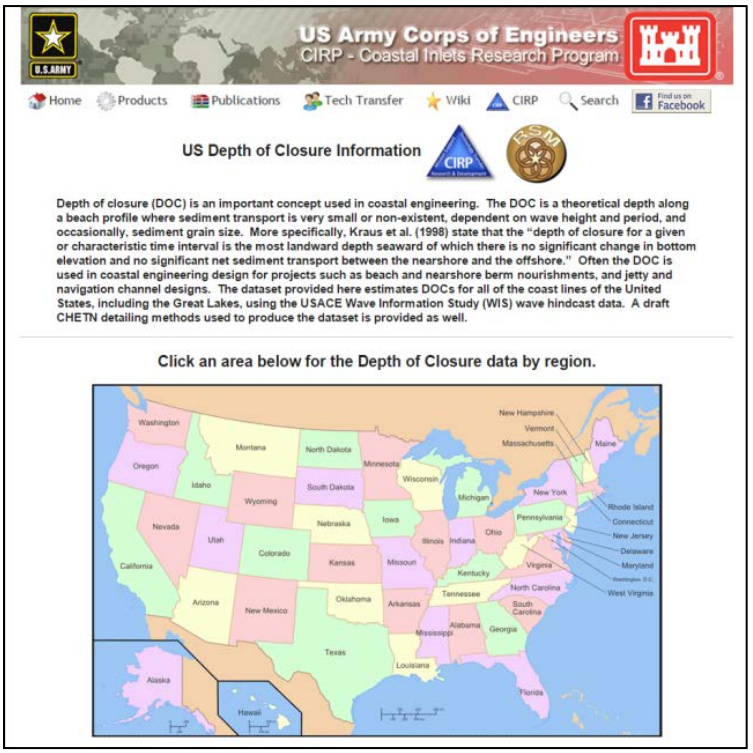
The new sensor suite and accompanying software will improve the speed of data and product delivery, the quality of information products derived from fused lidar and imagery datasets, and the performance of the lidar sensor in problematic areas like turbid water and in the surf zone.

POC: Jennifer Wozencraft Jennifer.M.Wozencraft@usace.army.mil

Depth of Closure Database

Description

Depth of closure (DOC) is an important concept used in coastal engineering. The DOC is a theoretical depth along a beach profile where sediment transport is very small or non-existent, dependent on wave height and period, and occasionally, sediment grain size. More specifically, Kraus et al. (1998) state that the "depth of closure for a given or characteristic time interval is the most landward depth seaward of which there is no significant change in bottom elevation and no significant net sediment transport between the nearshore and the offshore." Often the DOC is used in coastal engineering design for projects such as beach and nearshore berm nourishments, and jetty and navigation channel designs. The dataset provided here estimates DOCs for all of the coast lines of the United States, including the Great Lakes, using the USACE Wave Information Study (WIS) wave hindcast data. A CHETN detailing methods used to produce the dataset is provided as well.

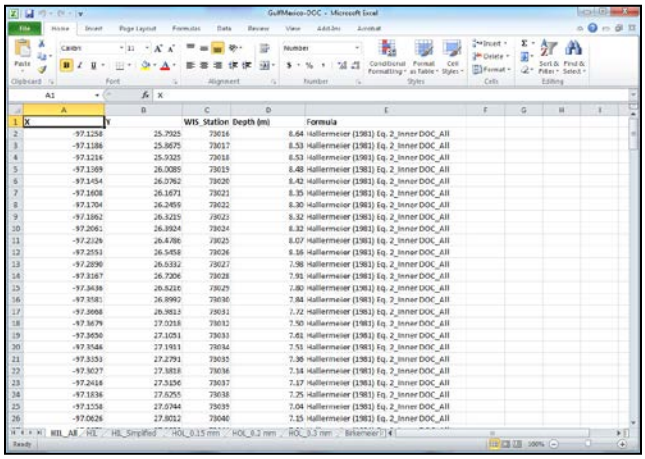


Example Studies

Districts have been using the Depth of Closure Database as a resource during the planning and designing phases of their coastal engineering projects.

Products

The data base is available on the CIRP and RSM websites (cirp.usace.army.mil and rsm.usace.army.mil, respectively). The database is available as an Excel spreadsheet, downloadable from either website. Both the yearly DOC for each WIS station and the cumulative DOC for each WIS station are calculated. It is also available as a part of the Sediment Mobility Webtool. A CHETN has also be written (Brutsché et al 2016) that details the calcuation methods of the data.



Benefits

The DOC database gives the District engineers and planners a range of estimates of the Depth of Closure for their project area.

POC: Katherine E. Brutsché Katherine.E.Brutsche@usace.army.mil
Brian C. McFall Brian.C.McFall@usace.army.mil

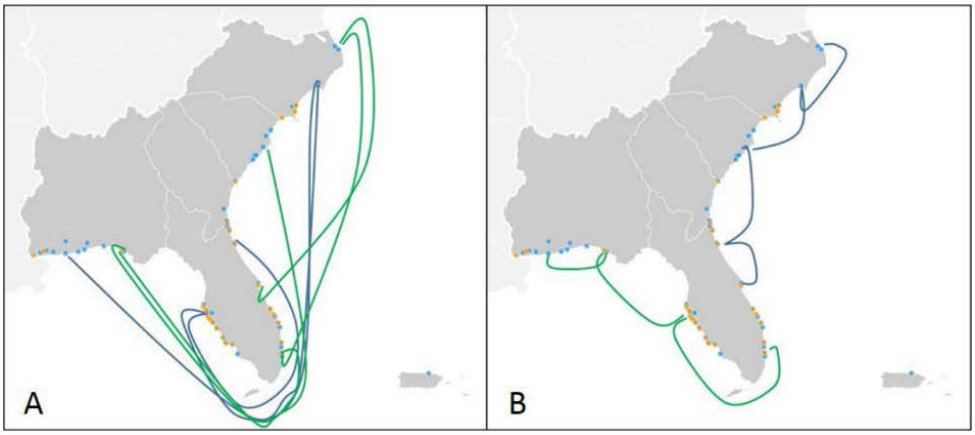
Dredge Fleet Assignment/ Scheduling Optimization Model

Description

The ERDC Dredging Innovations Group (DIG) program utilized its Dredge Fleet Assignment/Scheduling Optimization Model in collaboration with the RSM Economic Value pilot project across SAD in order to identify additional efficiencies in the USACE Navigation (NAV) and Flood Risk Management (FRM) programs over the course of the dredging season. The model uses established optimization methods from the Operations Research field to determine dredging schedules that maximize dredged volume while keeping mobilization costs to a minimum. The model also satisfies local constraints such as scheduling windows due to environmental restrictions and suitability of particular dredge plants for specific projects.

RSM Economic Value Pilot at SAD

The model has been applied across the South Atlantic Division (SAD) and resulted in significant reductions in dredge mobilization costs. In the SAD pilot study, mobilization costs are reduced by more than half relative to those incurred in the present real-world SAD dredging program (from 16 – 21% of total program costs to approximately 5 – 8% of total costs). Combined SAD dredging for both NAV and FRM totals around $250M annually, and with full implementation of the results from the Dredge Fleet Optimization model, the division could save $20-40M on mobilization costs alone. This was in addition to the roughly $100M in additional value achieved through the RSM implementation for the Navigation and FRM business lines across all of SAD.



Schematic representation of an inefficient dredge plan seasonal itinerary (A) and an idelaized seasonal dredged plant itinerary with optimzal scheduling (B). Figure represents two dredge plans with seasonal schedule indicated by colored paths (blue, green) and SAD dredging project locations indicated by blue (NAV) and orange (FRM) circles.

Products

Work on this product is ongoing. Please visit the RSM website for more information: http://rsm.usace.army.mil. Alternately, check on the status of the Dredge Fleet Assignment/Scheduling Optimization Model via ERDCpedia: https://wiki.erdc.dren.mil/ERDCpedia

Benefits

The Dredge Fleet Optimization Model provides a quantiative way to evaluate the cost-effectiveness of various approaches to dredging program execution. It can also serve as as starting point for exploring the most promising candidate groups of projects for regional contracting and helps to quantify the constraining effects created by environmental work restrictions – and provide guidance for future research.

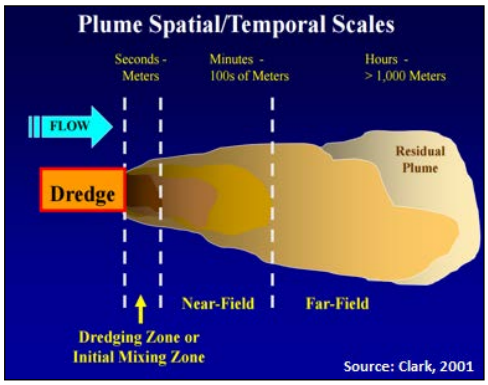
POC: Kenneth Ned Mitchell Kenneth.N.Mitchell@usace.army.mil

Ecological Data Synthesis Tool

US Army Corps of Engineers
Galveston District

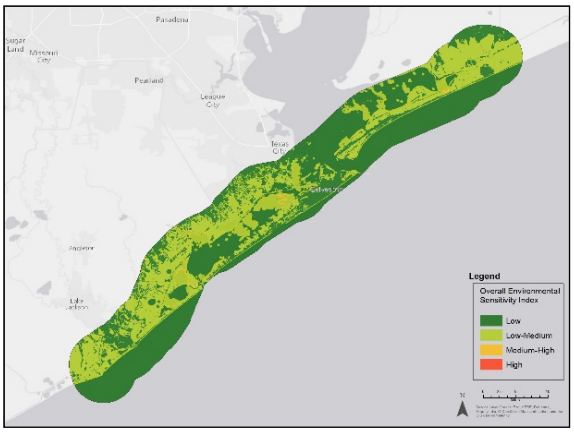
Description

The Ecological Data Synthesis Tools is a spatially-explicit visualization tool that combines ecological resource layers into a single layer representing relative environmental sensitivity of dredging impacts to provide decision support. The tool incorporates multiple geospatial ecological data layers such as oyster reef habitat and submerged aquatic vegetation, and utilizes existing studies and data to scale the relative risk of each ecological resource to dredging and/or placement activities. The integrated impacts are then weighted across all layers providing an indication of the relative risk of negative project impacts on the environment. The tool was developed as a planning tool to assist Dredged Material Management Plans (DMMP) and Preliminary Assessments (PA) project development teams to prioritize efforts and resources in areas of high environmental concern.



Example Studies

Prior to dredging and dredge material placement activities, determining areas of potential environmental impact within and near a project area is essential. This planning tool provided an environmental sensitivity assessment for proposed dredging and placement activities for the Gulf Intracoastal Waterway (GIWW) from High Island to Brazos River in Galveston Bay as requested by the Galveston District (SWG). The assessment included four specific ecological resources of concern as identified by SWG; potential threatened and endangered species habitat, wetlands and wildlife refuges, oyster reef habitat, and potential submerged aquatic vegetation habitat. An overall environmental sensitivity index was developed from these four ecological resources and provided SWG with a geospatial data layer displaying the area of high to low environmental sensitivity to dredging and placement activities.



Products

Ecological sensitivity layers can be visualized on the web through the CE DREDGE Decision Support Tool viewer, incorporated into GIS applications, and/or used as valuable graphics for inclusion in PA/DMMP reports. The ecological sensitivity data can also be integrated into the Dredged Material Management Decisions (D2M2) Optimization tool as part of the multi-criteria decision analysis.

Benefits

This visualization tool benefits Districts by providing quantitative, data informed methods to determine environmental sensitivity indices from dredging impacts. In addition, the tool weighs competing environmental impacts (positive/negative) and provides standardized, repeatable, transparent decision support while facilitating assessment of multiple environmental factors in one location.

POC: Safra Altman Safra.Altman@usace.army.mil

eHydro

US Army Corps of Engineers®
Portland District

Spatial Data
MOBILE DISTRICT

Description

The eHydro application enables Districts to produce consistent survey plots, channel tabulations, and metadata from survey soundings. The application also uses a framework of channel boundaries, project depths, stationing and channel quarters, ensuring consistent and reliable reference. eHydro is based on ESRI® ArcGIS software, and reads HYPACK™ hydrographic survey data to produce least depths for channel quarters, channel condition reports and indices, planning quantities, and metadata files. The application also applies background imagery and feature data to produce condition plots. Data for outside reporting, such as condition reports and indices, soundings and contours, are automatically uploaded to an enterprise server for outside dissemination. The software and user procedures are designed to easily integrate in a District's normal survey data processing workflow.

Issue

Navigation channel condition information is critically needed by users outside normal hydrographic survey functions. USACE Districts routinely produce channel plotsheets and channel quarter tabulations for outside navigation interests and for NOAA from hydrographic survey data. However, the format, data content, frequency of availability and age of the data varies with each District.

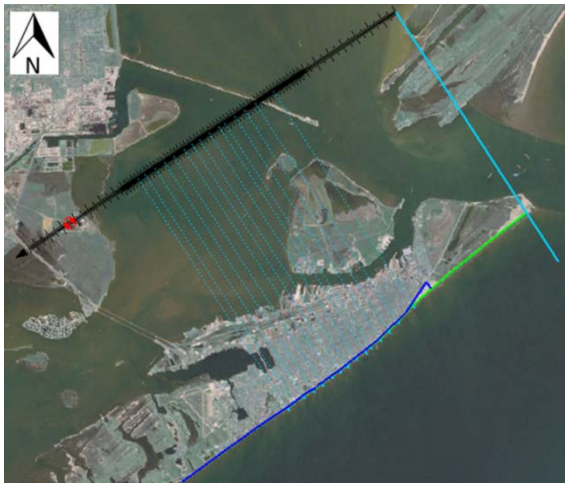
Benefits

This research will reduce the time and costs required to produce channel plotsheets and channel quarter tabulations.

POC: Anthony Niles Anthony.R.Niles@usace.army.mil

GenCade

Description



GenCade is a numerical model which combines the engineering power of GENESIS and the regional processes capability of the Cascade model. GenCade calculates shoreline change, wave-induced longshore sand transport, and morphology change at inlets on a local to regional scale for one to 100 years and can be applied as a planning or engineering tool. GenCade is operated in the Surface-water Modeling System (SMS) 11.1 and higher, bringing functionality of a georeferenced environment together with accessibility of other U.S. Army Corps of Engineers numerical models. GenCade was officially released in 2012, and several versions of the executable have been released since that date. Background documentation and the GenCade executable are available through the CIRP Website (http://cirp.usace.army.mil/products/gencade.php).

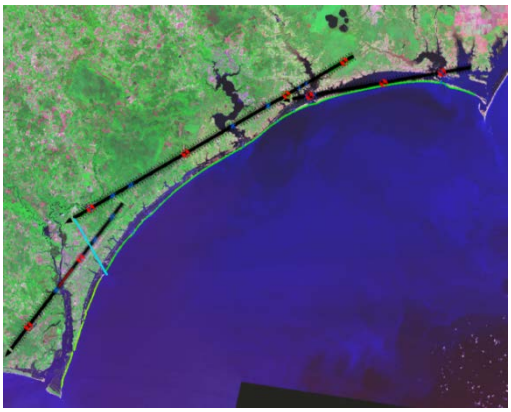
Example Studies

GenCade has been applied on both regional and local scales. For RSM studies, GenCade has been successfully applied to Onslow Bay, NC; Galveston, TX; Matagorda, TX; and Sargent Beach, TX.

Products

GenCade help is available through workshops, webinars, and the GenCade wiki (http://cirpwiki.info/wiki/GenCade). Interested Districts may also request GenCade training through the DOTS program. Slides, supplemental material, and audio/video files from a webinar conducted in 2012 are available on the CIRP website (http://cirp.usace.army.mil/techtransfer/webinars/16Oct2012-webinar.php).

A series of GenCade technical reports provide model theory, standard benchmark cases, a user's guide, an application, GenCade recommendations for simulations, solutions to common setup mistakes, and a quick start guide. Additionally, several technical reports that describe applications are available. All reports can be accessed on the CIRP website.



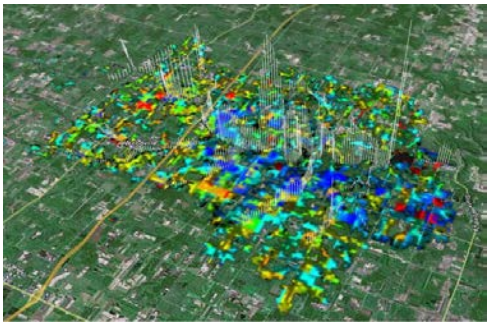
Benefits

GenCade is a model that can be run on a typical desktop PC. It typically takes 1-2 minutes to run a full year in the simulation, so a modeler can view results very quickly. GenCade answers questions about shoreline change and sand transport and can be used to model different structural and beach fill alternatives.

POC: Ashley Frey Ashley.E.Frey@usace.army.mil

Gridded Subsurface Hydrologic Analysis (GSSHA)

Description



Mass of a dissolved nutrient, in-field (colors) and in-stream (lines), and Spring Reservoir (teal arrow). Woodville, WI.

The Gridded Subsurface Hydrologic Analysis (GSSHA) model was created by the Coastal and Hydraulics Laboratory to perform complex studies of atmospheric, land-based, wetland, riverine, and coastal systems to help predict and mitigate watershed management problems**.** GSSHA is a multidimensional modeling technology that uniformly couples overland, surface, and subsurface flow for accurate watershed simulation**.** Features include two dimensional (2-D) overland flow, 1-D stream flow, 1-D infiltration, 2-D groundwater, and full coupling between the groundwater, shallow soils, streams, and overland flow. Sediment and constituent fate and transport are simulated in the shallow soils, overland flow plane, and in streams and channels. GSSHA can be used as an episodic or continuous model where soil surface moisture, groundwater levels, stream interactions, and constituent fate are continuously simulated. GSSHA's new features include parallel processing and improved in-stream sediment transport and automated calibration. More information about GSSHA can be found online: http://chl.erdc.usace.army.mil/gssha

Example Studies

GSSHA fully couples ground and surface water interactions an can model both aird and humid environments. Coupling of the watershed hydrology to the river and reservoir portions of the code allows it to be used for complete assessment of sediment fate, from erosion on the uplands to deposition in the reservoir. The fate of associated pollutants can also be tracked through the coupled system. It has been applied successfully to many sites including effectively forcasting inland flooding effect during Hurricane Irene in New York City and Long Island on August 25th, 2011. GSSHAs outputs included depth and location and were animated using Google Earth and shown to the leadership of New York City to inform evacuation plans.

Products

GSSHA 5.7's new features include parallel processing and improved in-stream sediment transport and automated calibration. More information about GSSHA can be found online or by contacting the POC (listed below).

Benefits

The scalability of GSSHA is a key component of its robust watershed modeling power. CHL engineers use it for large studies, such as the management of military training lands, and for smaller projects where detail at the street level is critical, such as urban flooding. GSSHA also does the following:

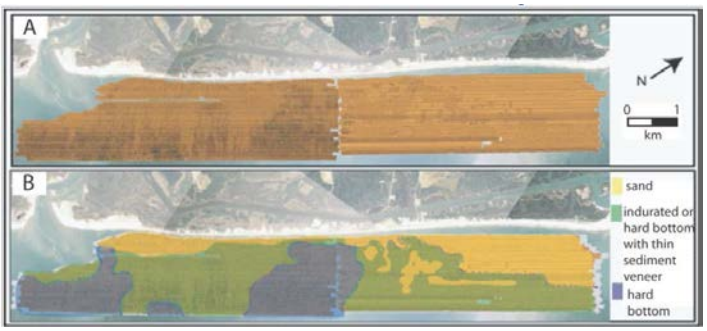
- Tracks the fate of associated pollutants through the coupled system
- Provides soil moisture, runoff, and flooding predictions that can be used to asses fire threat, irrigation needs, and effects on natural systems
- Analyzes future conditions and management scenarios—such as land use changes and wetland restoration
- Helps develop Best Management Practices (BMP) and Total Maximum Daily Load (TMDL) values for flood control, sediment transport, and pollutant transport
- Utilizes unique boundary conditions to simulate coastal flooding due to storm surge

POC: Aaron Byrd Aaron.R.Byrd@usace.army.mil

Integrated CHIRP Sub-Bottom Profiler and Dual Frequency Sidescan Sonar

Description

Understanding sediment dynamics in aquatic systems is a critical component of the USACE's mission. For example, the volume of sand in a nearshore profile has significant impact on shoreline stability, and the type of sediment characterizing the seafloor influences not only the type and distribution of benthic habitats but also influences sediment transport. Traditional sediment characterization techniques, such as estimates of sediment volume derived from repeated bathymetric mapping or characterization of aquatic habitats by sidescan sonar alone, neglect the subsurface geology and thus provide an incomplete picture of a region. To address this gap, the Coastal and Hydraulics Laboratory's Coastal Observation and Analysis Branch (under the Coastal Field Data Collection Program) has acquired an Edgetech 2000-CSS: a Compressed High Intensity Radar Pulse (CHIRP) sub-bottom profiler integrated with a dual simultaneous frequency CHIRP sidescan sonar. Sidescan sonar generates spatial maps of surficial sediment type (e.g., rock, sand, mud) via variations in the reflection of high-frequency acoustic pulses off of the seafloor. The Edgetech 2000-CSS has a dual-frequency side-scan sonar (300 kHz/600 kHz), allowing simultaneous characterization of surficial bottom type (see figure).



Applications

Cross- and alongshore variations in the total nearshore volume of transport-relevant sand, as defined using chirp seismic data, have been shown to be strongly related to decadal-scale shoreline change rates in many coastal regions, including along the Outer Banks of North Carolina as well as along Fire Island, NY. Along the northern Outer Banks in particular, nearshore sand volumes as defined by CHIRP profiles provided greater prediction accuracy of heightened shoreline erosion than did simply estimating sand availability along a more traditional, depth of closure-defined volume estimate.

Products

The Edgetech 2000-CSS is comprised of the following: full spectrum sub-bottom control and amplifier, topside controller with dual monitors, a four-transducer SB-512i CHIRP towfish with a frequency range of 500 Hz – 12 kHz, integrated with a 300/600 kHz dual simultaneous frequency CHRIP sidescan sonar, communication tow/cable, optional catamaran towing vessel, a single-beam and/or interferometric swath bathymetry system that can be simultaneously operated.

Benefits

The CHIRP sub-bottom profiler allows for high resolution and deep penetrating power through substrates and yields powerful regional insights (e.g. structural controls on draining systems by indentifying where subsurface channels still influence modern drainage patterns, optimizing colleciton of borehole data to characterize a region). The integrated sidescan sonar allows for detailed seafloor surface mapping, simultaneous collection of data allows for quantificaiton of the seafloor type, sediment resources, and sediment dynamics of a region. These integrated data play a critical role in quantifying the sediment dynamics of region.

POC: Heidi M. Wadman Heidi.M.Wadman@usace.army.mil
Jesse E. McNinch Jesse.Mcninch@usace.army.mil

Large-scale Sediment Transport Facility (LSTF)

Description

Dredged sediment is a resource useful in beach nourishment, improving coastal resilience, and maintaining growing wetlands. As numerical models expand in capability, datasets must be improved so that the models can be validated. Often, these critical data required to improve the understanding of coastal sediment transportation are deficient. Field data often lacks hydrodynamic conditions and is challenging to track sediment because of mixing with native sediment. The Large Sediment Transport Facility (LSTF) is located at the Coastal and Hydraulics Laboratory in Vicksburg, MS, and is the only basin in the western hemisphere capable of simulating an infinite shoreline. The LSTF can produce large-scale laboratory waves, pump and recirculate longshore current, measure the quantity of sands that moves along the beach, and contains a fully programmable instrumentation bridge and data acquisitions system.

Products

The LSTF is being utilized to address several cutting-edge research questions.

Mixed Sediment Berm Transport - A research effort that aims to fill in knowledge gaps by conducting a physical model study of mixed sediment berms. Mixed sediment berms will be constructed in this facility and subjected to a range of hydrodynamic forcing conditions to allow the material to transport downstream. The cross-shore and longshore sediment transport rates of sand and fine material will be measured as well as the wave and current hydrodynamic forcing conditions to improve predictive capabilities. This is the first large-scale, three-dimensional physical model to ever measure the transport of mixed sediment nearshore berms.

LTSF is employed for study of mixed sediment nearshore berm transport

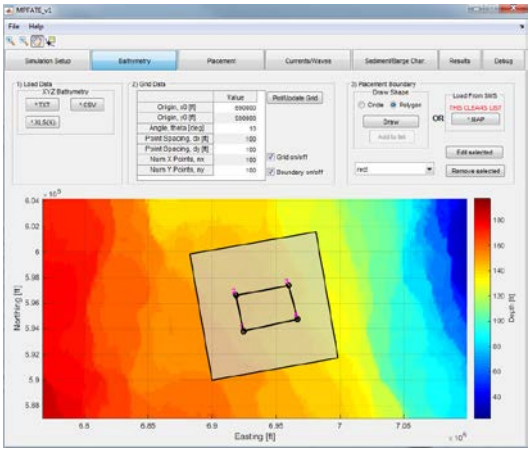
Benefits

For the Mixed Sediment Berm Transport study, the transport rates of sand and fine material simulating dredged mixed sediment nearshore berms are being measured in a large-scale, three-dimensional physical model using a range of hydrological forcing conditions. The study will measure critical data that is necessary to improve the understanding of dredged mixed sediment nearshore berm migration. This and other studies that utilze the LSTF will help to create a complete dataset to validate numerical models for application to District navigation projects.

POC: Brian C. McFall Brian.C.McFall@usace.army.mil
Duncan B. Bryant Duncan.B.Bryant@usace.army.mil

MPFATE, GTRAN, and LTFATE

Description



Dredged sediment management often incorporates regional sediment management objectives and principles. Multiple models have been developed to support dredged sediment management. This fact sheet describes three models developed under the Dredging Operations and Environmental Research program. The General TRANsport (GTRAN), Multiple-Placement FATE (MPFATE) and Long-Term FATE (LTFATE) numerical models are tools available to assist in the development of sediment management plans and regional sediment transport initiatives. Although these tools can be applied individually, often they are applied together.

GTRAN is a numerical tool to estimate sand transport under combined wave-current forcing at single points in space. GTRAN does not perform the bookkeeping required to calculate erosion and accretion, but when applied to a distribution of points over a region, can indicate sediment transport pathways and relative trends of erosion and accretion. GTRAN applies pre-determined hydrodynamic solutions developed through application of wave and current models, to resolve transport magnitude and direction at each point for a selected time domain.

MPFATE is a numerical tool to determine the accumulation of sediment resulting from dredged sediment placement by barge or hopper dredge. Through applications of MPFATE, the user can determine the evolution of a dredged sediment placement site under varying dredged material management schemes. MPFATE output (dredged material mound configuration and composition) is frequently used as input to the LTFATE or GTRAN models.

LTFATE is a fully three-dimensional numerical model applied to quantify the erosion, transport, and deposition of sediment by currents and waves over large areas and/or long times. LTFATE is a hydrodynamic and sediment transport model that includes the effects of waves and currents on the transport processes. The model simulates transport of multiple classes of sediments (sands, silts and clays) and includes morphology change and composition change due to transport.

Example Studies

The three models have been applied at numerous sites. Three examples where models were applied in conjunction with each other include Grays Harbor, Savannah River, and James River.

Products

Products demonstrating the application of models applied in support with each other include technical reports (Grays Harbor) and a journal publication (Savannah River).

Benefits

These tools address how sediments will move in a complex system with currents and waves. Although the original application was for dredigng, the GTRAN and LTFATE models have been generalized to be applicable to all open water sediment transport issues composed of sand, silt and clay.

POC: Joseph Gailani Joe.Z.Gailani@usace.army.mil

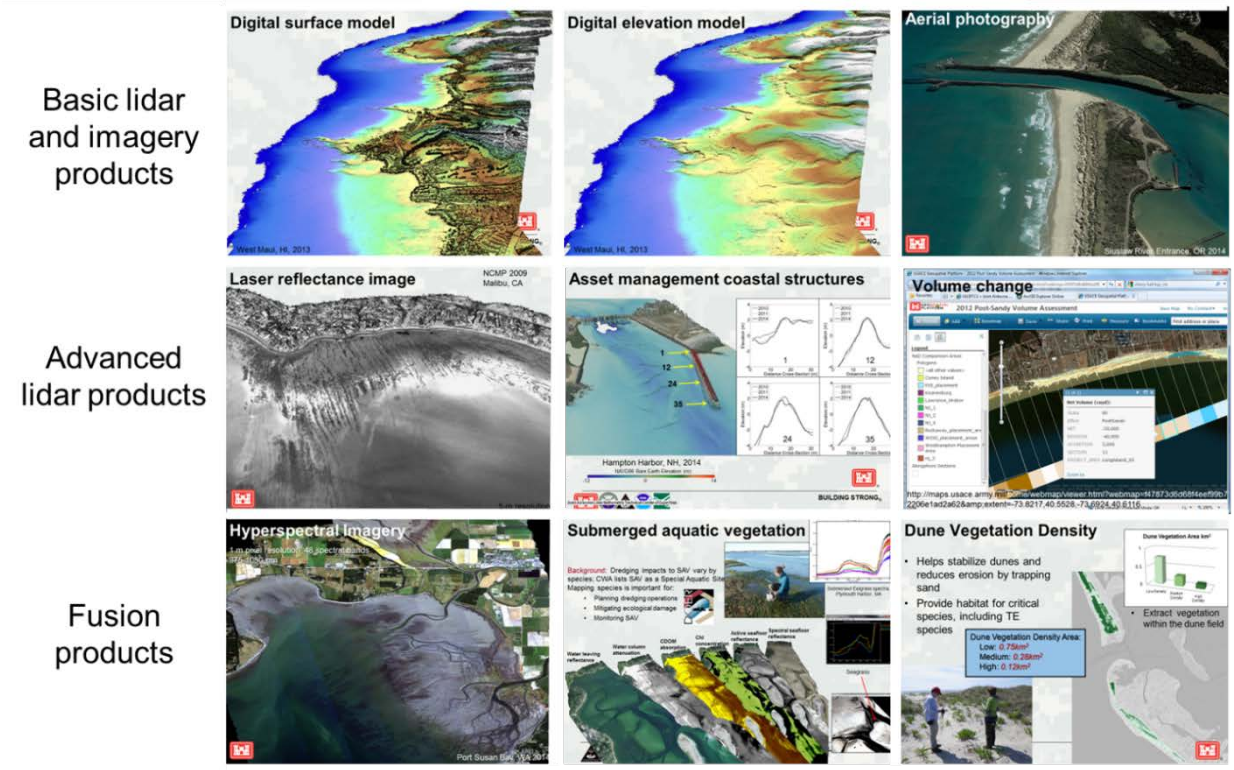
National Coastal Mapping Program (NCMP)

Description

The U. S. Army Corps of Engineers (USACE) National Coastal Mapping Program (NCMP) provides high-resolution bathymetric and topographic lidar elevation data, as well as hyperspectral and true-color aerial imagery along a 1-mile swath of the coastal U.S. on a recurring basis. USACE Headquarters funds the NCMP to support regional sediment management, construction, operations, and regulatory functions in the coastal zone. The NCMP is executed by the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), using its in-house survey capability called the Coastal Zone Mapping and Imaging Lidar (CZMIL).

Products

Since 2004, the NCMP has mapped over 20,000 km of shoreline along the Gulf, East, and West coasts, the Great Lakes and the Hawaiian Islands with repeat coverage in many areas.



The USACE National Coastal Mapping Program takes data beyond point clouds to advanced lidar products and products derived from the fusion of lidar and hyperspectral imagery. The products in the boxes above are the standard product suite for the National Coastal Mapping Program which have been evolving since 2004 to meet the needs of the USACE.

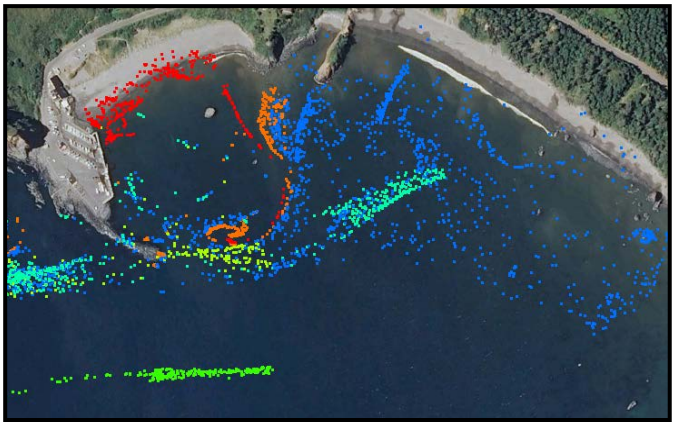
Benefits

Data and products support a number of activities in the coastal zone, including navigation channel and structure condition assessment, post-storm damage assessment, regional sediment management, floo modeling, planning studies and engineering design, emergency management, environmental restoration design, and environmental assessment.

POC: Jennifer Wozencraft Jennifer.M.Wozencraft@usace.army.mil

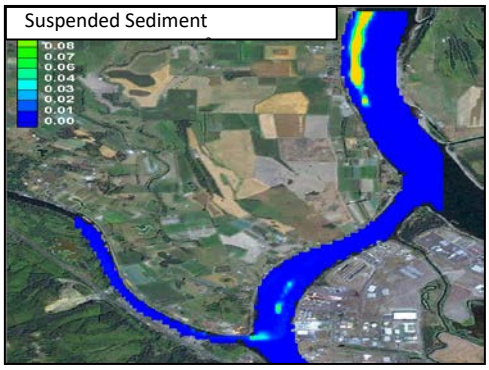
The Particle Tracking Model (PTM)

Description



The Particle Tracking Model (PTM) is a Lagrangian particle tracker designed to determine the fate of multiple constituents (sediment, chemicals, debris, biota, etc.) released from local sources (dredges, placement sites, outfalls, propeller wash, etc.) in complex hydrodynamic and wave environments. Each local source is defined independently and may have several constituents. Model results include the fate of each constituent from each local source. PTM simulates particle transport using pre-calculated, periodically saved hydrodynamic (and wave) model output from state of the art models. PTM uses processes vital to constituent transport including but not limited to advection, diffusion, settling, deposition, and resuspension. The PTM interface is in the Surface-water Modeling System, which provides a user-friendly environment for input development, model execution, data analysis, and visualization.

Example Studies



- Coos Bay dredged sediment placement study (Portland District)
- Port Orford breakwater sediment transport study (Portland District
- James River dredged sediment placement study (Norfolk District)
- West Maui region nearshore sedimentionation (Honolulu District)

Products

Guidance, Model access, and PTM documentation can be found at the following sites:

- https://doer.el.erdc.dren.mil/ptm.html
- http://spatialdata.sam.usace.army.mil/DredgingTechnologies

Benefits

PTM supports environmental risk assessment, beneficial sediment use and habitat protection. The computational efficiency of PTM permits simulation of multiple predictive scenarios to determine transport pathways and exposure in environmentally sensitive areas, thereby identifying options which can ultimately reduce anticipated expenditures, risk, and consequences in coastal, estuaries, and inland waterways. In addition, PTM is independent of any one specific hydrodynamic model, allowing the user flexibility with regard to hydrodynamics.

POC: Tahirih Lackey Tahirih.C.Lackey@usace.army.mil

Radar Inlet Observing System (RIOS)

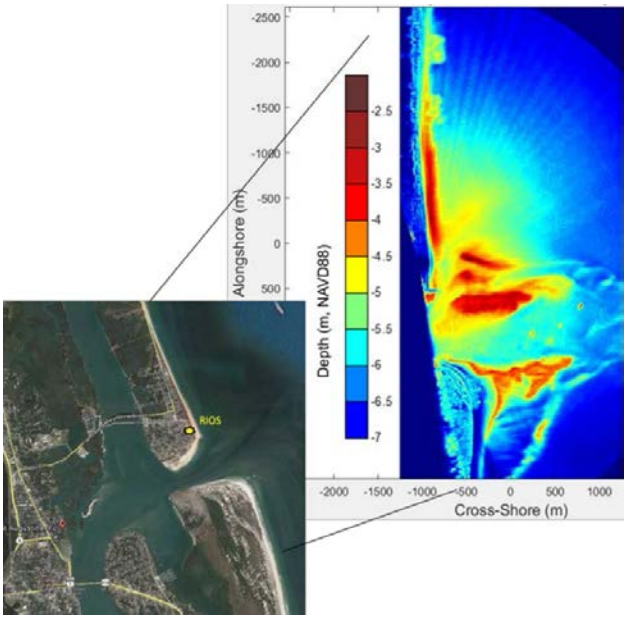
Description

RIOS utilizes X-band radar to measure wave breaking and wave speed. Wave observations are then used to calculate depths through bathymetry inversion and scaling. These measurements are particularly suited to determine the location of channels and shoals across shallow, coastal environments such as tidal inlets. The system is fully automated, and can provide updated results every hour.

RIOS at location, St. Augustine Inlet, FL

Applications

The Corps – from both its civil works and military support obligations – need to know the navigability of tidal inlets. Considerable resources are spent annually surveying inlet channels but these efforts are limited by stretched funds and personnel, dynamic channels that may change substantially during storms, and reduced access by traditional surveying vessels either due to treacherous sea conditions or denied regions. Other remote sensing techniques are not viable options in these coastal and brown-water settings where bubbles and turbidity levels are high and signals designed to transit through the water column are often greatly attenuated. We are tackling these challenges on two fronts: 1) utilizing a radar signal that measures wave behavior, instead of trying to send a signal through the water, and estimating depths from wave conditions, and 2) improving bathymetry inversion algorithms that are more suited for radar data and the altered wave behavior found near very shallow settings. RIOS is currently configured to measure the position of inlet channels and shoals continuously (hourly) through all conditions, 24-7, and to make results available online within 30-minutes of collection.



Map view of RIOS-measured depths around St. Augustine Inlet. Note the nearshore berms visible in RIOS data (located -2000 y-axis).

Products

RIOS provides the following products hourly:

- Ascii data file of estimated depths across domain
- Georectified images of wave breaking conditions that identifies navigation conditions near channel entrance
- Time-averaged (detided) georectified image of wave breaking conditions that identifies shoals across the domain.
- Shoreline position within domain
- Nearshore berm monitoring

POC: Jesse McNinch Jesse.Mcninch@usace.army.mil

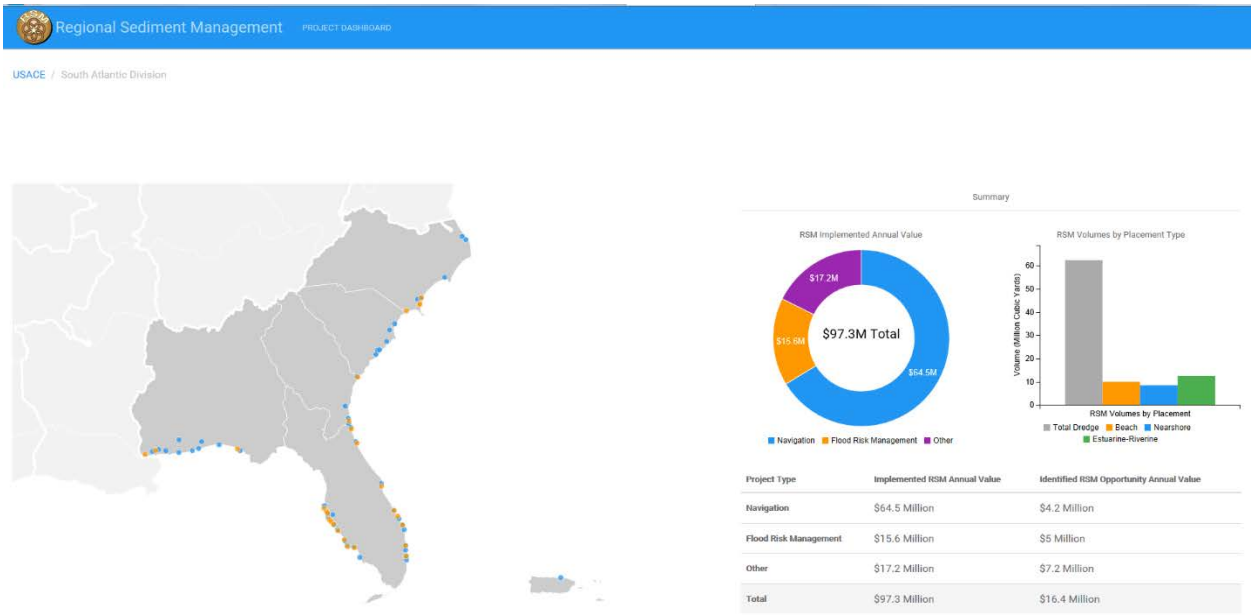
RSM Economic Value and Dredge Fleet Scheduling Optimization Pilot

Description

The Regional Sediment Management (RSM) Economic Value and Dredge Fleet Scheduing Optimization Pilot (OP) was developed as a pilot study with the South Atlantic Divison (SAD) to quantify the economic value of applying RSM principles and practices across multiple projects and business lines (Navigation and Flood Risk Management) as well as identify additional efficiencies that can be gained by evaluating the dredge plants assigned to navigation projects and the planned schedule over the course of the dredging season. The result is an actionable and optimized RSM strategy that will most efficiently execute the Navigation (NAV) and Flood Risk Management (FRM) program budgets which maximizes the amount of dredging while also increasing the amount of RSM opportunities implemented to create value for the nation. The OP provides placement options and associated project costs for NAV and FRM for projects throughout SAD, providing decision-makers with the information they need to manage and execute RSM projects.

Products

The products for the RSM OP include a web application (currently available at sajgeo.saj.usace.army.mil/rsm-dash, will be migrated to the USACE Navigation Portal at navigation.usace.army.mil) and a report.



Project Type	Implemented RSM Annual Value	Identified RSM Opportunity Annual Value
Navigation	$64.5 Million	$4.2 Million
Flood Risk Management	$15.6 Million	$5 Million
Other	$17.2 Million	$7.2 Million
Total	$97.3 Million	$16.4 Million

Benefits

All coastal NAV/FRM projects in SAD were analyzed and $97 million in annual value was calculated from implemented RSM strategies and identified an additional $16 million in opportunities. Annual value to USACE Federal projects was estimated at $65 million for the NAV program, $16 million for the FRM program. Non-Federal value to partners and stakeholders which is provided at no extra cost to the Federal government was valued at $17 million annually. In addition to fiscal efficiencies, RSM projects foster positive relationships and provide for more resilient and sustainable projects and programs.

POC: Clay McCoy Clay.A.McCoy@usace.army.mil
Kenneth Ned Mitchell Kenneth.N.Mitchell@usace.army.mil

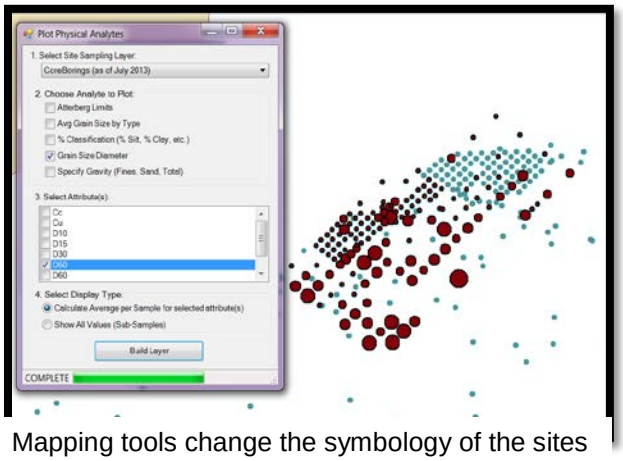
Sediment Analysis & Geo-App (SAGA)

Description

Analysis of sediment resources is not a standardized process. It is also often time-consuming due to the lack of a consistent archive method and data storage format. As a result, most analyses are completed with dated techniques that cannot fully realize the potential of the digital dataset. The Sediment Analysis and Geo-App (SAGA) database and application were developed to address this problem.

SAGA database and geoprocessing tools used to assist in the identification of potential borrow areas.

SAGA database and tools provide a comprehensive user interface to assist in the data entry, organization, and presentation of sediment sampling events and testing results. Supporting both coastal and riverine environments, SAGA is an archive for borings, grab samples, wells, monitoring areas, and river gages, and any associated information to the sampling activity. Per site, a user can retrieve information available for the site, including digital documents, record of the drilling log, lithology, and results of sediment testing for physical, biological, and chemical charateristics.



Mapping tools change the symbology of the sites based on grain size diameter.

The SAGA database and reporting tools are available as a resource on the Navigation portal accessed through, http://navigation.usace.army.mil/SEM/Analysis. This read-only portal is publically available and allows all users to retrieve sediment property details. Users can download data entry templates and ArcGIS Desktop tools through USACE's GeoPlatform, http://geoplatform.usace.army.mil/home/item.html?id=43303eada70f45b5bc25322662f85140

Example Studies

The SAGA contains data from the USACE Louisville District (LRL), Memphis District (MVM), New Orleans District (MVN), St. Louis District (MVS), Vicksburg District (MVV), Omaha District (NWO), Philadelphia District (NAP), Charleston District (SAC), Jacksonville District (SAJ), Mobile District (SAM), Galveston District (SWG), and ERDC's Field Research Facility (FRF).

Benefits

Primary benefits of SAGA include providing a standard data schema, a home for data storage, and an easy access point for data discovery. The objective of the SAGA database is to provide the District with rapid assessment tools to make informed decisions regarding physical characteristics of a project. SAGA is designed to fit into the Data Intergration Framework (DIF); therefore, components and data can easily be leveraged by other tools or applications that could benefits from access to characteristics of sediment data.

POC: Rose Dopsovic Rose.Dopsovic@usace.army.mil

Sediment Budget Analysis System (SBAS)

Description

The Sediment Budget Analysis System (SBAS) is a tool run within ArcGIS 10.1 and higher which provides the framework for formulating, documenting, and calculating sediment budgets, including estimation of uncertainty and reliability of the budget. A sediment budget is created to develop an understanding of sediment sources, sinks, transport pathways, and magnitudes for a selected region over a specific period of time. It is a balance of volumes of sediments entering and leaving a defined section of coast which results in erosion or accretion in the area.

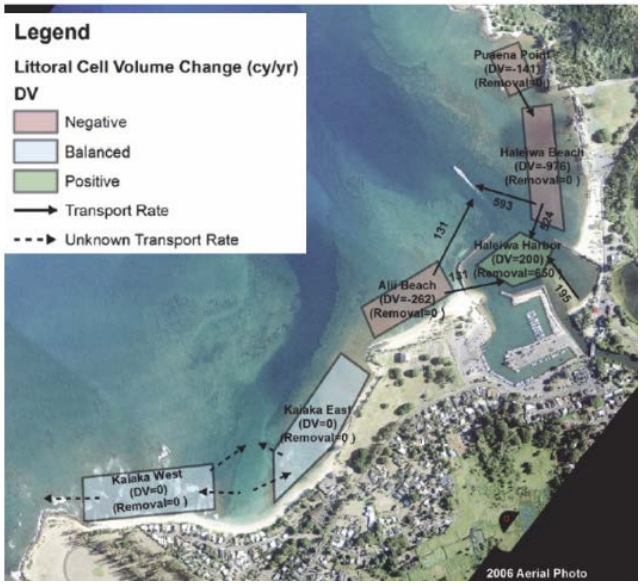
SBAS is available on the Regional Sediment Management (RSM) Website (http://rsm.usace.army.mil) under Tools & Databases. The newest version of the tool is called SBAS-A Desktop Tool. The link opens the Geospatial Platform where the tool can be downloaded. ArcGIS 10.1 or higher must be installed in order to use the SBAS tool. Older versions of the tool (ArcGIS AddIn and the stand-alone PC version) can be downloaded on the CIRP Website (http://cirp.usace.army.mil/products/sptools.php).

Example Studies

SBAS has been used to successfully illustrate sediment budgets for RSM for more than 15 years. Some recent applications using SBAS include Assateague Island and Ocean City Inlet, MD; Saco Bay, ME; Galveston, TX; and North Illinois from Wilmette, IL, to the Illinois-Wisconsin border.

Products

The RSM and CIRP Websites include several Technical Notes and Journal Papers describing how to develop and calculate a sediment budget. The RSM and CIRP Websites also have documentation on how to create a sediment budget in the older versions of SBAS. A user's guide which describes how to set up and use the tool is included in the download of the newest version of SBAS. There are also many Technical Notes and Technical Reports describing sediment budget studies using SBAS.



Benefits

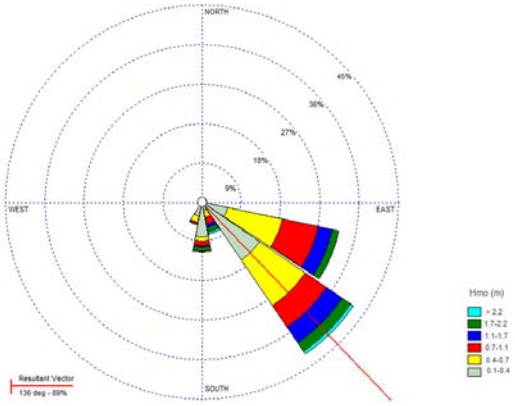
Sediment budgets provide an understanding of the magnitudes and pathways of sediment transport at inlets and adjacent beaches over a given time period. SBAS helps Districts formulate sediment budgets, because the color-coded, visual capabilities provide an integrated picture of the processes and allow for variations in the budget to be examined quickly.

POC: Ashley Frey Ashley.E.Frey@usace.army.mil

Sediment Mobility Tool (SMT)

Description

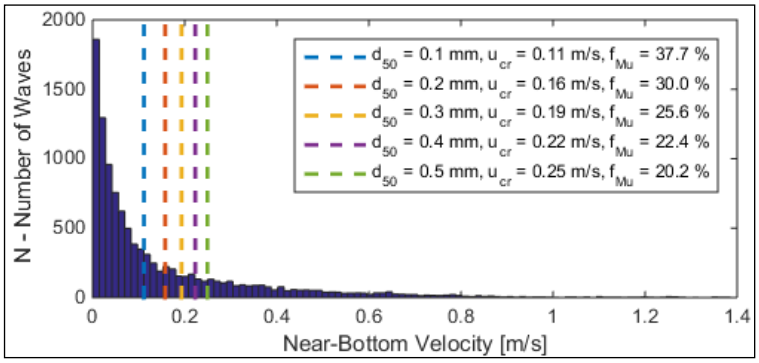
The Sediment Mobility Tool (SMT) is a scoping level tool for siting nearshore placement areas of dredged sediment. The tool uses Snell's Law to transform WIS hindcast wave data to the nearshore site. The depth of closure, which is a specified depth along a beach profile where net sediment transport is very small or nonexistent, is calculated using several commonly used empirical equations which are described by Brutsché et al. (2016). The frequency of sediment mobility is calculated using both linear and nonlinear stream-function wave theories using procedures described by McFall et al. (2016). The cross-shore sediment migration is calculated using an empirical relationship described by Larson and Kraus (1992). The wave rose provides an axis of wave dominated transport at the nearshore site.



Example Studies

The SMT has been successfully applied in the following locations:

- Duck, NC
- Milford, CT
- Burns Harbor, IN
- Illiniois Beach State Park, IL
- Vilano Beach, FL



Products

- Web application
- Technical Note: Brutsché et al. (2016)
- Technical Note: McFall et al. (2016)

Benefits

The STM addresses the key questions about placing the dredged material in the nearshore of:

1. Will the sediment move?
2. Where is the sediment likely to go?

By addressing these questions, Districts can garner support from stakeholders and the public for projects.

References

Brutsché, K. E., J. Rosati III, C. E. Pollock, and B. C. McFall. 2016. *Calculating depth of closure using WIS hindcast data*. ERDC/CHL CHETN-VI-45. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Larson, M. and Kraus, N. C. 1992. *Analysis of cross-shore movement of natural longshore bars and material placed to create longshore bars*. Technical Report DRP-92-5. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station.

McFall, B. C., S. J. Smith, C. E. Pollock, J. Rosati, III, and K. E. Brutsché. 2016. *Evaluating sediment mobility for siting nearshore berms*. ERDC/CHL CHETN-IV-108. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

POC: Brian C. McFall Brian.C.McFall@usace.army.mil

Katherine E. Brutsché Katherine.E.Brutschel@usace.army.mil

Steady-State Spectral Wave Model (STWAVE)

Description

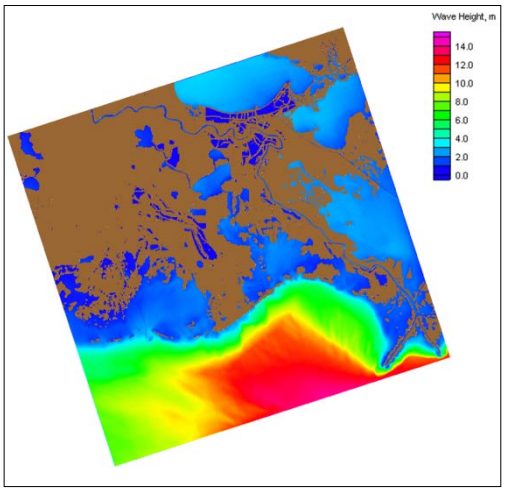
Coastal environments are in a constant state of flux due to wave action. Waves move sediments, erode shorelines, drive currents, disrupt navigation, and excite harbor oscillations. To design and manage successful coastal engineering projects in complex environments, ERDC Coastal and Hydraulics Laboratory (CHL) developed a numerical wave modeling technology called the Steady-State Spectral Wave model (STWAVE). STWAVE is a robust numerical model for simulating nearshore wind-wave growth, propagation, and transformation. STWAVE can simulate:

- Depth- and current-induced wave refraction and shoaling
- Depth- and steepness-induced wave breaking
- Parametric wave growth due to wind
- Wave-wave interactions and whitecapping
- Wave dissipation due to bottom friction and vegetation.

STWAVE is available as a free download or is commercially bundled with the Surface Modeling System (SMS) software package available from Aquaveo, LLC. SMS provides a custom interface to the STWAVE model, offering a graphical user interface for model setup, execution, and visualization of model results. STWAVE is tightly coupled to the hydrodynamic circulation model ADCIRC as part of the Coastal Storm Modeling System (CSTORM-MS).

Example Studies

Estimating nearshore wave information is a critical component of many coastal engineering projects, e.g. predicting shoreline change, designing and maintaing coastal structures, and simulating coastal storm events. STWAVE is used to tranform offshore wave information obtained from wave buoys or global- or regional-scale wave hindcasts or forecasts to the nearshore coastal area.



Products

Details of the STWAVE v6.0 model, including capabilities, governing equations, model controls, and input/output files, are availble in the ERDC/CHL Special Report SR-11-1. The recent implementation of wave dissipation by vegetation is described in ERDC/CHL Technical Note CHETN-I-85.

Benefits

Performing physical model studies or collecting field data is not always a feasible option, and, as a result, the use of numerical models for simulating complex coastal hydrodynamics has become a universal practice. STWAVE is an easy-to-use, accurate, and efficient wave modeling technology to assist engineers in representing the complex changing coastal environments to manage successful projects.

POC: Jane McKee Smith Jane.M.Smith@usace.army.mil

USACE RSM and Beneficial Use Database: Navigation Sediment Placement

Description

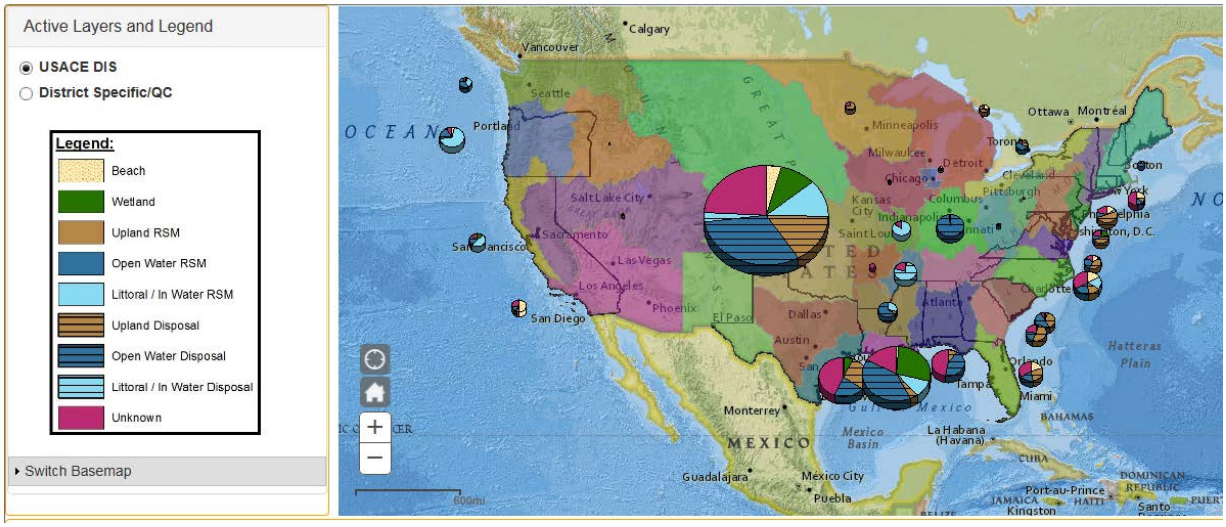
Federal navigation projects were inventoried to determine the extent to which Regional Sediment Management (RSM) goals and beneficial use of dredged material have been implemented across the USACE Districts at the project, District, and Division levels. Data from the USACE Institute for Water Resources (IWR) Navigation Data Center's Dredging Information System (DIS) were utilized and considerably refined using District managed information and data. A web-application, a District Specific/Quality Checked (QC) database, and a database of USACE DIS data specific to this project were produced.

Results

Of the approximately 200 to 300 Mcy of sediment dredged annually by USACE, this project considered roughly 215 Mcy removed annually from navigation projects from 1998 to 2016. The DIS estimates beneficial placement at 25% of the total volume dredged. However, the refined District Specific/QC database indicates that 35% or 75 Mcy/yr of coastal navigation sediment is placed beneficially. The DIS reported volume of unknown disposal type is 45.2 Mcy/yr while the refined District Specific/QC database identifies 10.7 Mcy/yr.

The number of dredging events and "RSM" events (placed sediment beneficially) increased markedly once the USACE DIS was refined, supplemented, and quality checked.

The database is currently being updated with data through 2017, including the incorporation of inland navigation projects.

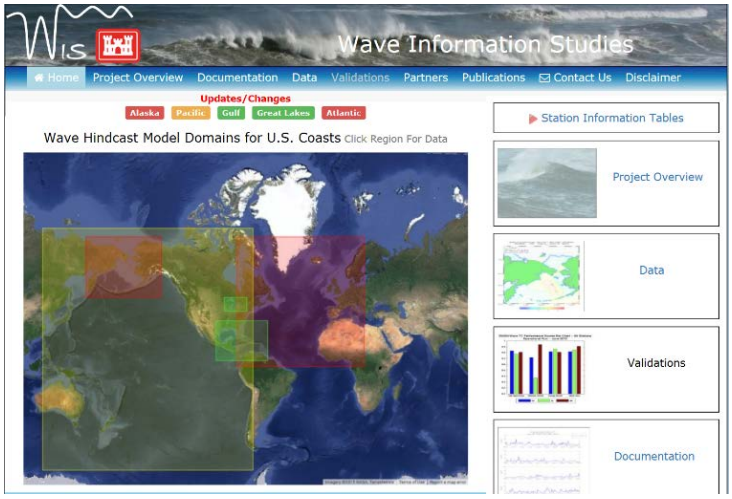


POC: Linda Lillycrop Linda.S.Lillycrop@usace.army.mil

Wave Information Studies (WIS)

Description

The objective of the Wave Information Studies is to provide high-quality coastal wave hindcast model estimates, wave analyses products and decision tools nationwide. Wave estimates are hindcast using high quality wind fields, ice fields where appropriate and the latest wave modeling technology. To satisfy the Corps requirement for risk-based designs, at least 20-30 years of continuous wave climatology data are required. Hindcast datasets provide hourly wave information for locations every few miles along the coast. The long-term hindcast wave data are accessible through the WIS website.



Applications

Knowledge of the climatology of the atmosphere and waves is required for planning, design, construction, and maintenance of USACE projects in the coastal zone. Such information is scarce due to the lack of point source measurements at locations over time periods long enough to be statistically significant. This lack of information is a critical problem for USACE operations, and project maintenance near the coast. To fill this need the WIS effort has been established to provide long-term (decades) of validated wave estimates along all US coasts including the Great Lakes.

Products

The WIS work effort uses proven discrete spectral wave models and the base available input wind fields to produce wave estimates (height, wave period, and direction) and directional spectral estimates for pre-selection output locations along the coast. Forecasting varies greatly across temporal and spatial scales and as a result multiple techniques and wind field methodologies are used within WIS. The large-scale basins (Atlantic, Pacific, Gulf of Mexico and Western Alaska) use one technique and wind field specification (Swail et al., 2006, Cox and Swail (2001). The Great Lakes domain uses the Coastal Forecast System Reanalysis (CFSR, Saha, et al. 2010). Details of these wind field methodologies are found at the WIS website. In arctic regions (the Great Lakes, and Alaska) the spatial and temporal evolution (and decay) of shore-fast ice and for the Alaskan waters the migration of northern ice packs must be accurately estimated and implemented. WIS is continually udating and improving as new technologies are created and deemed appropriate for analysis. Presently, WIS has migrated toward 3rd Generation wave models (e.g. WAM, Komen et al 1994, Wavewatch III™, Tolman, 2014, SWAN, The SWAN Team, 2014) for any spatial domain (e.g. Atlantic, Gulf of Mexico, Pacific, etc.). The WIS effort has completed a full update of the Atlantic and Pacific Oceans, the Gulf of Mexico, Western Alaska and all five Great Lakes. WIS products are available at the WIS website: http://wis.usace.army.mil/

Benefits

WIS provides a national resource of long-term wavefield climatologies for U.S. coastal waters that synthesizes observations, multi-decade hindcasts and sotrm event archives to meet tomorrows coastsal engineering needs of today.

POC: Robert Jensen Robert.E.Jensen@usace.army.mil