Tools and Technologies for Coastal Regional Sediment Management

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Regional Sediment Management…
Est 1999, CERB Charge

A systems approach to deliberately manage sediments in a manner that maximizes natural and economic efficiencies to contribute to sustainable water resource projects, environments, and communities = Healthy Systems

- Navigation, Flood Risk Mgmt, Ecosystem, Emergency Mgmt:
  - Short and long-term sustainable, resilient solutions
  - Coastal and Inland
- Recognizes sediment as a valuable regional resource
- Work across multiple projects, authorities, business lines
- Tools and technologies for regional approaches
- Relationship building for decision making & implementation
RSM Goals and Strategies

- Reduce Upland/CDF Disposal
- Bypass Backpass Sediments
- Reduce Erosion
- Stabilize Structures
- Reduce Channel Shoaling
- Reduce Runoff
- Ecosystem Habitat Restoration
- Save Capacity

- Keep sediments in the system
- Mimic natural sediment processes
- Reduce unwanted sedimentation
- Environmental enhancement
- Maintain & protect infrastructure
RSM Process

UNDERSTAND REGION (1)
- Sediment sources, project needs, processes, engineering actions, ecological considerations
- Resources, challenges & requirements

EVALUATE RSM STRATEGIES (PROJECT SCALE) (2)
- Efficient & effective use of sediments
- Project-level analysis (tools, models, technologies)
- RSM pilot projects

REGIONAL RSM STRATEGY (3)
- Integrate projects into Regional Strategy
- Identify authorities, funding, permit requirements, leveraging opportunities
- Prioritize: need, benefits, timelines

TAKE ACTION (4)
- Construct, monitor & adaptively manage
- Capture benefits & lessons learned
- Incorporate into standard practice

Communication, Collaboration, Innovation, Decision Making
Interagency, Stakeholders, Partners, Resource Agencies
National RSM Program Participation (2000-2018)
Where is the data? What format? When collected? How do I get it?
USACE Navigation Data Integration Framework (NDIF)

Data Management & Integrated Tools

Projects
- Navigation
- Shore Protection
- Ecosystem, etc

Sediment Budgets
- Sources
- Sinks
- Transport

Surveys
- Beach Profiles
- LIDAR
- Channel Surveys

Sediments
- Physical
- Biological
- Chemistry

Dredging
- When
- Where
- Volume

Placement Areas
- Capacity
- BU Type
- Activity

Forcing
- Waves
- Water-Levels
- Currents, Winds

Model
- Input Conditions
- Grids
- Results
Sediment Analysis and GeoApp (SAGA)

- Show distribution of sampling sites
- Filter sites based on sediment characterization testing
- View navigation channels or placements areas

- Compute Grain Size statistics with data not yet stored in SAGA (Sieve size distribution testing)

- Retrieve testing results
- View documents
- Access stratigraphy

Mapped Sites

Tools

Site Details

FRF

SAC, SPN

MVD

Visualize distribution of detected chemicals
Symbolize sites based on average grain size
Isolate sites based on attributes
Determine volume of material at specified depths
Surveys & Analysis Tools

- eHydro
- JALBTCX ArcGIS Toolbox
- Corps Shoaling & Analysis Tool (CSAT)

Integrate Beach Profiles, Data & Tools

elevations, volumes, shorelines, feature detection
Models for Coastal RSM

- Sediment sources and sinks
- Regional processes and trends
- Multiple interacting projects
- Connect beaches & inlets
- Connect rivers & reservoirs
- Navigation channel maintenance
- Evaluate local/regional RSM strategies
*Dredging Technologies Web Interface*

Selection Criteria, Model Requirements, Available Data, Guidance, Case Studies

**Problem Criteria**

1. **Dredge Type**
   - Hydraulic
   - Cutterhead
   - Hopper
   - Mechanical

2. **Location**
   - Dredging Location
     - Entrance Channel
     - Estuary
     - Harbor
     - Inlet
     - River
   - Placement Location/Type
     - Beach Nourishment
     - Beneficial Use
     - Capay
     - Confined Aquatic Disposal
     - Confined Disposal Facility
     - Open Water

3. **Problem Type**
   - Confined Disposal Facility Design
   - Containment Transport
   - Sediment Transport

4. **Models**
   - Sediment Transport
     - LITFAE
     - SFAE
     - PTM
   - Hydrodynamic
   - Confined Disposal Facility
   - Contaminant Transport
   - Health Risk Assessment
   - Sediment Assessment and Management
   - Water Quality

5. **PTM**
   - Particle Tracking Model, a Lagrangian particle tracker numerical model to simulate particle transport processes

6. **Input Parameters**
   - Computational Parameters
   - Simulation Temporal Details
   - Hydrodynamics
   - Native/Bed Sediment Characterization
   - Grid (Bathymetry)
   - Bed Porosity
   - Temperature
   - Salinity

7. **Output Parameters**
   - Mesh Data Output File (.mesh.h5)
   - Particle Output File (.particle.h5)

8. **Data changes (including image) based on selected model**
Sediment Budget Analysis System (SBAS)

Regional Scale

Texas Coast

Project Scale

East Pass, FL

Sediment Budget Portal & Tools

Sediment Budget Database

North Atlantic Coast Comprehensive Study

Mobile Bay

Fire Island Inlet to Montauk Point, NY

MS/AL Coast and Barrier Islands

Galveston Entrance

Moriches Inlet, NY (Moffatt & Nichol)
Regional Process and Analysis Tool (RPAT)

- Web service: view/download spatial data
- Ebb shoal feature extraction
- Region delineation
- Volume change
- Identify transport pathways and fluxes

Bypassing bar

WaveNet

- Download meteorological & oceanographic data
- Provide input for longshore sediment transport calculator
GenCade & SBAS Integration

GenCade

- Regional shoreline change, sand transport, inlet-sand sharing model
- Connects multiple beaches & inlets
- Multiple sources & sinks
- Regional trends
- Evaluate regional strategies

Automate Output to SBAS
- Volume change
- Transport rates
- Dredging and beach fill volumes
- Cells and fluxes
Nearshore Berm Research, Guidance, and Tools

SMT

Preliminary tool: educated decisions w/limited data Estimates

- Frequency of sediment mobility
- On/Offshore migration direction
- Dominant axis of wave direction to estimate alongshore migration

<table>
<thead>
<tr>
<th>$d_{50}$ (mm)</th>
<th>Frequency of Mobilization</th>
<th>Predicted Sediment Migration</th>
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<tbody>
<tr>
<td>0.1</td>
<td>16 – 38%</td>
<td>83% Offshore</td>
</tr>
<tr>
<td>0.2</td>
<td>14 – 30%</td>
<td>60% Onshore</td>
</tr>
<tr>
<td>0.3</td>
<td>12 – 26%</td>
<td>84% Onshore</td>
</tr>
</tbody>
</table>

http://navigation.usace.army.mil/SEM/SedimentMobility
Thin Layer Placement of Dredged Sediments - Wetlands

Predict response of coastal wetlands to dredged sediment placement
- consolidation
- settlement
- biomass
- sediment organic content
- carbon sequestration

Better design TLP projects
- achieve design marsh elevations

Advance state of practice
- reducing costs
- maximizing benefits

Provide Guidance

https://tlp.el.erdc.dren.mil
Thin Layer Placement of Dredged Sediments
Open Water Placement

Mouth of the Columbia River
(Lower Columbia River Solutions Group)

Mobile Bay
(Interagency Working Group)

Understand Behavior - Mobilization, Transport, Consolidation
Benthic Habitat - Reduce Impacts & Enhance
Shallow Emergent Tidal Marsh Habitat
Dredge Hole filling - Recover Hypoxic & Anoxic Zones
RSM/Beneficial Placement of Coastal Navigation Sediments
Where, when, volume? Where can we improve?

- 1998 to Present
- 200 - 300 Mcy/yr USACE
- 175 Mcy/yr Coastal Navigation
- 33% or 57.6 Mcy/yr Placed Beneficially

*Inland Navigation 2017/2018
449 projects placed >1.5 Bcy sand US beaches since 1920’s
- Federal coastal storm damage reduction projects
- Beneficial placement of navigation sediment on beaches
- State/Local/Private beach nourishment projects
Communication, Collaboration, Decision Making

Web-Based Decision Support Tools

RSM-University Workshops & Training

- Thin-Layer Placement 2017
- Reservoir Sediment Mgmt 2017/18
- Sediment Budgets 2018
- Sediment Tracers 2018
- Interagency Meetings

Lessoned Learned
Regional Sediment Management = Resilient Healthy Systems

Regional Sediment Budgets
Local Actions = Regional Benefits

Regional Strategies
Improved Relationships

Data Management and Access

Nearshore Placement
Thin-Layer Placement

Fine Sediment Losses

Ecosystem Restoration

Riverine & Reservoir Mgmt