SUSTAINABLE SEDIMENT MANAGEMENT AND DREDGING SEMINAR
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Dredged Material Management Decisions (D2M2)
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Outline

1) Introduction to D2M2
2) How D2M2 can add value
3) Typical D2M2 process
4) Screenshots from case studies
5) Example results & insights
6) Concluding thoughts
Introduction to D2M2

- D2M2 Acronym: “Dredged Material Management Decisions”

- D2M2 History:
  - Developed in 1980s by USACE HEC.
  - Code initially maintained by HEC, then by David Ford Engineers.
  - Used on the Columbia river, in the SF Bay region, & others.
  - The ERDC EL Risk & Decision Science team recently modernized & expanded the tool.

- Current POCs: Matthew Bates & Igor Linkov
Introduction to D2M2

What is it, what does it do?

- A system optimization tool for sediment dredging & placement.
- It uses multi-objective, linear programming, system network optimization.
- It finds optimal (efficient) solutions for when & where to move sediment between many dredging reaches & placement areas.
- It incorporates system operational details & constraints such as:
  - Site availability & timing, acquisition, lease renewal, resting periods
  - Volumes to be dredged over time, bulking factors, equipment types
  - Direct & O&M costs, environmental benefits, user-defined objectives
How D2M2 can add value

• Traditional approaches rely on staff experience & expert knowledge to decide how much of what to place where & when…
  • This is usually good, but perhaps not perfect.

• D2M2’s recommendations can consider all capacities, interactions, & constraints over decades, even for large, complex systems with many sites across a region (e.g., for a DMMP or capacity analysis).

• It compares countless potential solutions, evaluating which versions even slightly outperform others.

• If applied to the $1B+ national dredging program, even a few % savings can be substantial.
How D2M2 can add value

- Traditional approaches typically look at few promising alternative plans…
  - This is usually good, but exploring new scenarios, variations, and alternate futures is time consuming.

- Once the D2M2 system model is built, individual elements can easily be tweaked to explore different scenarios.

- This quick scenario & sensitivity analysis is helpful for informing internal discussions and for dialoging with stakeholders.

- It makes it possible to quickly estimate a cost/benefit of different management strategies, policy changes, or operational changes.

- And it enables “what if” analysis for uncertain future conditions.
How D2M2 can add value

- D2M2 models can be single objective (e.g., minimize total cost), but are designed with multi-objective systems in mind.
- The available objectives are not hard coded, but can support any metrics for which sufficient data is available, e.g., from multiple stakeholders.
- Using a formal approach based on D2M2 adds transparency & replicability, which can to help justify the analyses & defend the results.
Typical D2M2 process

- A D2M2 model is a system network of:
  - Dredging reaches, placement sites, transfer sites, routes between site pairs, optimization criteria, specific site data, and tradeoff weights to calculate optimal and alternative solutions.

- A case study model can be built:
  - Directly through the graphical user interface of the D2M2 tool.
  - Using an ArcGIS plugin that leverages existing spatial data (e.g., national channel framework, polygons for placement areas, etc.).
  - Through an Excel upload template into which all data is copy/pasted.
Typical D2M2 process

D2M2 user interface showing a simple system network model
Typical D2M2 process

Basic steps to modeling with D2M2:

- Identify dredging sites and volumes over time.
- Identify placement sites and capacities.
- Identify any transfer sites (e.g., where material or cost curves transition).
- Identify site details related to placement & transfer site costs, benefits, timelines for availability, O&M, material reuse, constraints, etc.
- Develop links/routes between possible dredging and placement site pairs.
- Develop cost & benefit curves that estimate the results of moving sediment from site A to site B.
- Optionally, develop multiple weighting or system configuration scenarios.
- Run the model with those scenarios & visualize results.
Screenshots from case studies:

D2M2 ArcGIS plugin building the Houston Ship Channel model from existing USACE spatial data
Screenshots from case studies:

D2M2 Excel upload template with data for the Long Island Sound model

<table>
<thead>
<tr>
<th>Link Name</th>
<th>Equipment</th>
<th>Source site name</th>
<th>Destination site name</th>
</tr>
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<tbody>
<tr>
<td>Link #1</td>
<td>Pump-off Hopper</td>
<td>Port Jefferson/Mount Sinai</td>
<td>Jacobs Beach</td>
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<tr>
<td>Link #2</td>
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<td>Port Jefferson/Mount Sinai</td>
<td>Norton Basin/Little Bay borrow pts</td>
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<tr>
<td>Link #3</td>
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<td>Port Jefferson/Mount Sinai</td>
<td>Plum Island</td>
</tr>
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<td>Port Jefferson/Mount Sinai</td>
<td>Central Long Island Sound</td>
</tr>
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<td>Port Jefferson/Mount Sinai</td>
<td>Western Long Island Sound</td>
</tr>
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<td>Westerly Municipal Beaches</td>
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<td>Town of Brookhaven Landfill</td>
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<td>New London</td>
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<td>Byldenburgh Road Landfill Complex</td>
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Screenshots from case studies:

D2M2 graphical user interface with an (incomplete) SF Bay model
Screenshots from case studies:

Data used (externally) to develop site scores for multiple criteria, for the Gulf Intracoastal Waterway model.
Screenshots from case studies:

Logical site connections for the Gulf Intracoastal Waterway model
Screenshots from case studies:

Viewing & editing data for the Houston Ship Channel model
Screenshots from case studies:

Running the Houston Ship Channel model
Example results & insights

Output reports for the Long Island Sound model and exported data from the GIWW model results.
Example results & insights

Linear costs but non-linear potential resource impacts in the LIS model results
Example results & insights

Costs, environmental impacts, and beneficial use scores across six model scenarios with different sites included and weighting.

Relative Environmental Impacts

Relative BU Scores
Example results & insights

Placement sites used under two different GIWW weightings.
Concluding thoughts

- What value do you see D2M2 adding to your work?
- What barriers to you see to using D2M2 at your district?
- What value and barriers do you see for promoting the use of D2M2 at the national level?
- I would be happy to teach you how to use D2M2 or build a D2M2 model of your region with/for you.

- Thank you!
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