Life Cycle Assessment of Sediment Placement Alternatives

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Motivation

- Current sediment management decisions are based primarily on short-term & local risks that favor travel-intensive solution (e.g., landfill).
- Many types of long-term and distributed impacts from dredging and placement operations are not explicitly considered in dredging decision making.
- Life Cycle Assessment has been successfully applied in many other settings to account for a fuller range of environmental impacts (e.g., emissions from transport, harm from leachate, etc.).
- We demonstrate assessment of full life-cycle environmental impacts of sediment placement alternatives near Long Island Sound, NY/CT.
- This type of analysis can inform our own sediment management decisions and discussions with stakeholders & agencies.
LCA Process Overview

1. Goal and Scope Definition
   - Define goal and scope
   - Collect data

2. Inventory Analysis
   - Create/import flows
   - Process inventory
   - Implement characterisation factors

3. Impact Assessment
   - Choose LCIA method
   - Compare alternatives
   - Sensitivity analysis

4. Results and Interpretation

Diagram:
- Raw material and energy consumption
- Emissions to air, water, and soils

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LCA for Dredging in Long Island Sound

LCA Project Goal:
- Comparing dredged material disposal alternatives.

LCA Project Scope:
- System boundary: from just after DM is brought to surface until it reaches its final resting place.
- Functional unit: 100K cubic yards of sandy dredged material.
- 50 year maintenance period.
- Comparing open-water, upland, and island creation alternatives.
- Includes assessment of impacts from:
  - Tug, truck, & rail transportation, several types of heavy-equipment rehandling, long-term monitoring, dewatering site creation & use, land occupation & land-use changes, a portion of production impacts from equipment and materials used…
Assumptions

- Sediment is not contaminated.
- Process up until disposal is constant (i.e., all alternatives use similar bucket dredges).
- The land from island creation will eventually become forested.
Process Inventories

Beneficial Uses
Near-shore BU, at left

Upland BU, at right

100% Beneficial Near
Shore w/ transform

100% Beneficial Upland w/ transform

100% DM Beneficial Use - Upland

9 tkm
Transport, barge, diesel powered/ton/NA

1 m³
Excavation, skid-steer loader/RER S

1E3 kg
DM Beneficial Use - Near Shore w/ Transportation

2.29 m³
Excavation, hydraulic

2.29E-6 kg
Hydraulic digger/RER/U

0.499 M³
Electricity, medium

0.997 M³
Refinery gas, burned in

0.329 M³
Electricity, high voltage

0.49 kg
Diesel, at regional

0.53M M³
Electricity, production mix

0.499 kg
Diesel, at refinery/RER U

1.12% Transport, 70 t, 18 ft

0.997 M³
Refinery gas, burned in

0.329 M³
Electricity, high voltage

0.49 kg
Diesel, at regional

0.53M M³
Electricity, production mix

1.12% Transport, 70 t, 18 ft
Conventional disposal
Upland disposal, at left

Open water, at right
Life-Cycle Inventory Details

- **SimaPro** software with *EcoInidicator 99 (v2.08)* inventory assessment used to analyze all scenarios in terms of emissions constituents.
- **Hierarchist** weighting method (emphasizes land use and fossil fuels)
  - Human health (40%), ecosystems (40%), resource use (20%).
Results:
Comparison Across Disposal Alternatives

Open water has least total life-cycle environmental impact, next island creation

Note: The chart compares disposal alternatives and indicates that open water has the lowest total life-cycle environmental impact. The method used is Eco-indicator 99 (H) V2.08 / Europe EL 99 H/A / Single score.
Results:
Impact of Distance on Island Creation

Distance is variable with total impact, but island benefit & construction impacts are fixed.
Results:
Impact of Distance on Open Water Placement

Distance is the most important factor for open water life-cycle impacts.
Results:
Impact of Distance on Upland Placement

Rail transport is more fuel/energy efficient per mile than truck transport, for upland placement.

Comparing product stages:
Methods Eco-indicator 99 (H) V2.08 / Europe E1 99 H/A / Single score
Project 2 – Capping in Genland Fjord, Norway

Project Purpose:
- Compare performance of OpenLCA software
- Compare results with PhD thesis of Magnus Sparrevik, Norway
- Extend open source LCA software with VoI & other new methods

LCA Goal:
- Compare remediation alternatives: Natural recovery, Capping with clay, Capping with limestone, Capping with activated carbon
- ReCiPe method

LCA Scope:
- System boundary: Production of capping materials, transport, capping operations, and contaminant release
- 90 year time period, inner fjord: 23.4 km²
Building the model with OpenLCA

Process diagram in OpenLCA
Conclusions and Next Steps

- Useful for identifying and systematically considering long-term and distributed environmental impacts.
- A good source of inputs for D2M2 and other dredging decisions.
- Favors placement alternatives that involve lesser handling and transportation, or included beneficial uses.
- Can help in negotiating with agencies that want intensive solutions.

Next Steps: Extend LCA inventories to include comparison of dredging.
- Merge LCA with Value of Information analysis to explore uncertainty.
- Help districts apply these techniques to negotiate with stakeholders or make progress towards national & agency sustainability goals.
Thank You,
Any Questions?
References


