Maintenance dredging: Towards smart, sustainable, and circular strategies

Arash Sepehri
Alex Kirichek
Marcel van den Heuvel
Mark van Koningsveld
Presentation Outline

1. Introduction

2. Smartness, Sustainability, and Circularity in Port Maintenance

3. Research Methodology

4. Results

5. Conclusion

7. The Way Forward
1. Introduction

- What is maintenance dredging?
- Why do we maintain water depth?
- What strategies are there for maintenance?
- How do we select these strategies?
- What are the trade-offs?
- How the trade-offs can be quantified?
- What are the applications?
- How to implement?
2. Smartness, Circularity, and Sustainability in Port Maintenance

- **Port maintenance**
- **Smartness**
- **Sustainability**
- **Circularity**

**Why?**
- Optimizing dredging operation
- Real-time tracking of disruptions

**How?**
- Controlling turbidity plumes
- Mitigating emissions
- Beneficial re-use of the dredged material

**How to quantify it?**
- Simulation
- Data-driven decision-making
- Environmental regulations

In this presentation
3. Research Methodology

- Simulating dredging and seagoing activities
- Monitoring the interactions between these activities and disruptions

**Input parameters**

**Vessel-related**
- Position (geographical location)
- Capacity
- Loading/unloading rate
- Velocity

**Port-related**
- Berth capacity
- Terminals traffic
- Terminal capacity
- Cubic meter of sediment to be dredged
- Tonnage of handled container
4. Results

Reference: De Boer et al., (2023), Simulating for sustainability: Alternative operating strategies for energy efficiency
4. Results

- Sailing empty to berth
- Loading sediment
4. Results

- Sailing full to relocation
- Relocating sediment
## 4. Results

<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>Sailing full to the berth</td>
</tr>
<tr>
<td>01:00</td>
<td>Unloading containers</td>
</tr>
<tr>
<td>02:00</td>
<td>Sailing empty to the offshore</td>
</tr>
<tr>
<td>03:00</td>
<td>Waiting for the seagoing vessel to finish unloading</td>
</tr>
<tr>
<td>04:00</td>
<td>Loading sediment</td>
</tr>
<tr>
<td>05:00</td>
<td>Sailing full to reallocation</td>
</tr>
</tbody>
</table>

### Sediment Tonnage

- **Earth Container**
- **Earth Soil**

### Sediment Volume

- **m³**

---

*Map showing locations of berth, offshore, and reallocation.*
5. Sustainable Port Maintenance

Determining the energy consuming sectors of the vessel

Calculating the energy consumed for different setups (trailing velocity, etc.)

Finding the optimal setup for equipment

Reference: Janssen, D. (2023), Physics-based energy estimation during the loading phase of a TSHD.
# 6. Circular Port Maintenance

<table>
<thead>
<tr>
<th>Section</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Problem identification</td>
<td>Need for material?</td>
</tr>
<tr>
<td>2. Port requirement</td>
<td>Port authorities' purpose?</td>
</tr>
<tr>
<td>3. Manage dredged material</td>
<td>Mud, clay, or sand?</td>
</tr>
<tr>
<td>4. Dredging company requirement</td>
<td>Equipment?</td>
</tr>
<tr>
<td>5. Characteristics of the project</td>
<td>Economic and environmental considerations?</td>
</tr>
<tr>
<td>6. Execution</td>
<td>Do the job!</td>
</tr>
</tbody>
</table>

**Reference:** De Boer et al., (2022), *OpenCLSim: discrete event dredging fleet simulation to optimise project costs*
7. Conclusion

- Seagoing and dredging interaction can be formulated.
- Delays of both seagoing and dredging can be minimized.
- Port processes can be optimized during a port call.
- Trade-offs can be identified (cost, emission, etc.).
- Trade-offs can be quantified and used to decide strategies and equipment settings.
- Data sharing with clients integrates the project processes.
8. The Way Forward

**Sustainable port maintenance**
- Minimizing turbidity
- Mitigating greenhouse gas emission

**Smart port maintenance**

**Circular port maintenance**
- Beneficial re-use of dredged material

**Maintenance Strategies**

- **Sediment Reallocation**
  - Trailingsuction Hopper Dredger

- **Sediment Remobilization**
  - Water Injection Dredger

- **Sediment Bypassing**
  - Sediment Wash-out Jet System
  - Stationary Submersible Pumping System

- **Anti-sedimentation measures**
  - Sediment Trap
  - Air Bubble Screen
  - Current Deflecting Wall

---

 TU Delft  
 Van Oord  
 Marine ingenuity
Contact me via
a.sepehri@tudelft.nl
arash.sepehri@vanoord.com

thank you!