The Day after we stop Dredging: A World without Sediment Plumes?

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Environmental impact of dredging

- Dredging activities often criticized for adverse environmental impacts

Sources of Turbidity near TSHD

- Draghead resuspension
- Overflow losses
- AMOB
- Propellor wash
- Draghead resuspension

- Will ‘The day after we stop dredging’ mark the onset of a world without sediment plumes?
Contents of this talk

• Relative assessment: Dredging in perspective
  – Natural processes
  – Fishing
  – Shipping operations

• Absolute assessment: Turbidity by dredging
  – TASS program
  – Field trials 2006-2007
  – Sampling of overflow losses

• Conclusions
Natural processes

- Plumes driven by storm events (Lake Michigan) resp. river discharges (Mississippi River)
- Major scales (time and space)
- Suspended concentrations (15-30 mg/l) similar to dredging-induced levels
Fishing

Jiangsu, Yangtze River (China)

Drivers of suspended sediments (2)

- Trailer mud trails found at many locations worldwide
- Plume typically $O(10^2)$ m wide, $O(10^3)$ m long
- Scale aspect in large number of trailers
- No measured concentrations reported yet

After: Van Houtam and Pauly (2007)
Various studies (Pennekamp et al., 1991; Clarke et al., 2007a) report high concentrations. Maximum turbidity generated when ship is changing direction and/or speed. In areas of busy navigational traffic, annual shipping-induced turbidity similar to dredging-induced turbidity.
• Simultaneous measurement of dredging- and shipping-induced sediment concentrations (Clarke et al., 2007b)
• Natural processes and man-induced activities generate turbidity levels similar to dredging
• Insight in (variability of) these levels crucial for specification of sound environmental limits on the impact of dredging activities
• Such specification also demands insight in resilience of ecological systems & good skills to predict dredging-induced turbidity
• SSB-Funded TASS program aims to develop these predictive skills
• TASS = Turbidity Assessment Software
• Objectives of TASS program
  – Gain insight in dredging-induced turbidity to minimize environmental impacts and to facilitate realization of projects (tender phase & construction)
  – Develop & validate model to enable prediction of turbidity around dredgers
    • Phase 2 (2000-2005): Variety of dredging plant
    • Phase 3 (2006-2010): Focus on TSHD
  – Share proven knowledge with third parties
• Phase 3 activities aim for collection of high-quality field data and validation of TASS software
Organization

- **TSHD Cornelia**, Bremerhaven, May 17-19 & June 7-13
- Partners involved
  - Svasek (Ruiter / Les)
  - SSB Partners (many)
- Follow-up on Cornelia (2002) experiment
- Objectives:
  - Quantify sediment flux in overflow to validate TASS model
  - Establish guidelines for design of overflow measurements for TSHDs of different size
Organization

- TSHD *Oranje*, Rotterdam, May 2-3 & May 7-11

- Partners involved (random order)
  - Medusa Explorations (Koomans et al)
  - RWS (Otten and many others)
  - Dredging Research Ltd (Rogers)
  - HR Wallingford (Spearman et al)
  - Delft Hydraulics (Jeuken et al)
  - TNO-NITG (Van Os)
  - SSB Partners (many)

- Objective: Collection of TASS validation data (various components)
Organization

- TSHD *Geopotes 15*, Den Helder, Sept 17-19
- RWS Survey vessel *Zirfaea*
- Partners involved
  - RWS (De Kok and many others)
  - Dredging Research Ltd (Rogers)
  - Delft Hydraulics
  - SSB Partners
- Follow-up on Rotterdam (2007) experiment
- Objective: Collection of near-field & far-field passive plume data
## Overview collected data

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<td>Overflow losses</td>
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<td>Draghead resuspension</td>
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<td>Propeller wash</td>
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<td>Passive plume near-field</td>
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<td>(benefits green valve)</td>
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<td>Passive plume far-field</td>
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<td>Support data (board instruments, soil, …)</td>
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Overflow sampling: Challenges

- Theoretical challenge: Single-point measurements representative for full cross-section?
  - Free overflow: Sufficient mixing if sampling between 3D from top end and 1D from bottom end (Svasek, 2006)

- Technical challenge: Collect samples at various locations from overflow (hostile environment)
  - Bremerhaven 2006: Suction tube with two submerged pumps, mounted on vertical plate in overflow
B’haven 2006: Pump sampler

Measurement of overflow losses

Current sensor
Sampling mouth
Submerged pumps
Overflow measurements

Trip 158 - fine sand
Fixed position, high freq

Trip 157 (mud)
Sampling 30/60/90 cm from wall

• Scatter small as compared to overall signal
• Uniform concentration profile over cross-section
• Sampling frequency 1/min sufficient to resolve signal
• Air bubbles cause occasional failure of system

Example results Bremerhaven (2006)
Measurement of overflow losses

R’dam 2007: Airlift/Medusa

- 500 ml samples
- Frequency 1 minute

MEDUSA sensor
• Any ‘outliers’ directly related to operation of overflow or reported malfunctioning of equipment
• Good agreement between MEDUSA and airlift
• Bottle samples seem to match with airlift
Den Helder 2007: Flexible airlift

Measurement of overflow losses

Suction mouth

Collection of overflow samples

Deployment in overflow

Air supply
Conclusions

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Certainly Not!

- Evaluate impact of dredging in context of other drivers of suspended sediments
- Environmental constraints should be based on thorough insight in ‘autonomous’ fluctuations in turbidity level AND resilience of ecosystems (EcoShape program)
- Series of large-scale field-trials has resulted in:
  - Robust methods to quantify overflow losses
  - Good quality data for validation model to predict turbidity near TSHD and evaluation benefits green valve
Questions?

Suspended sediment or air bubbles?