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

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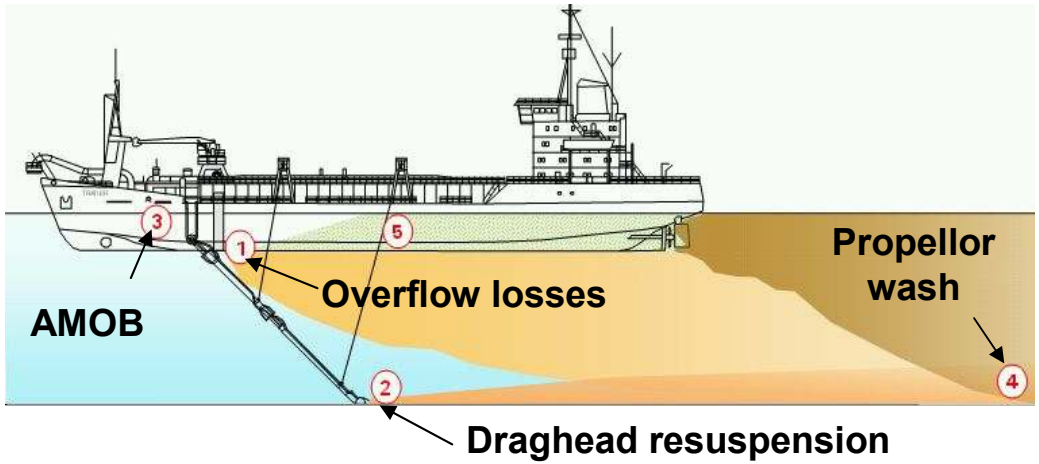
Co-funded by RWS, CROW-FCW and DUT

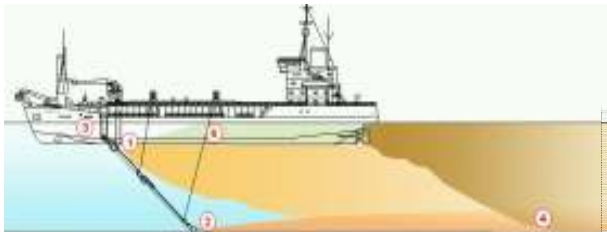
Environmental impact of dredging

- Dredging activities often criticized for adverse environmental impacts

Sources of Turbidity near TSHD



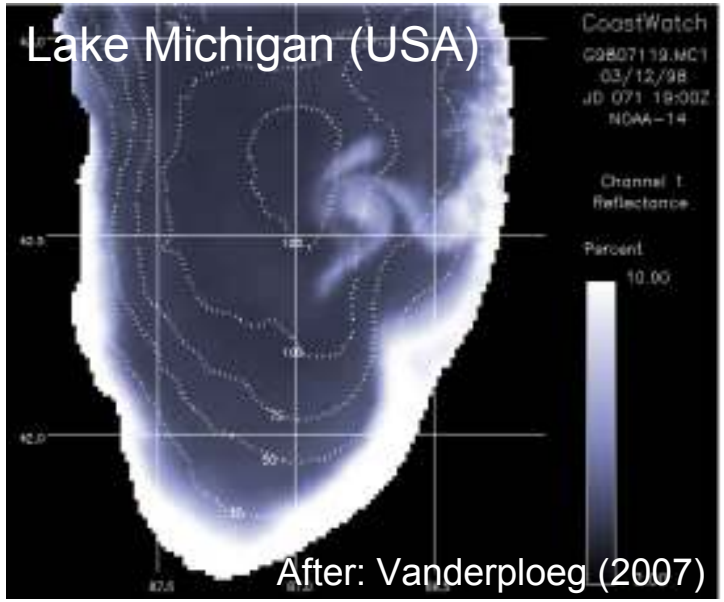
- Will ‘The day after we stop dredging’ mark the onset of a world without sediment plumes?



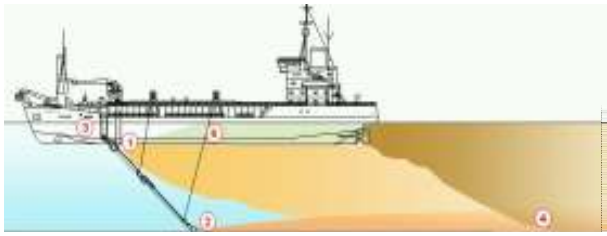
Contents of this talk

- 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

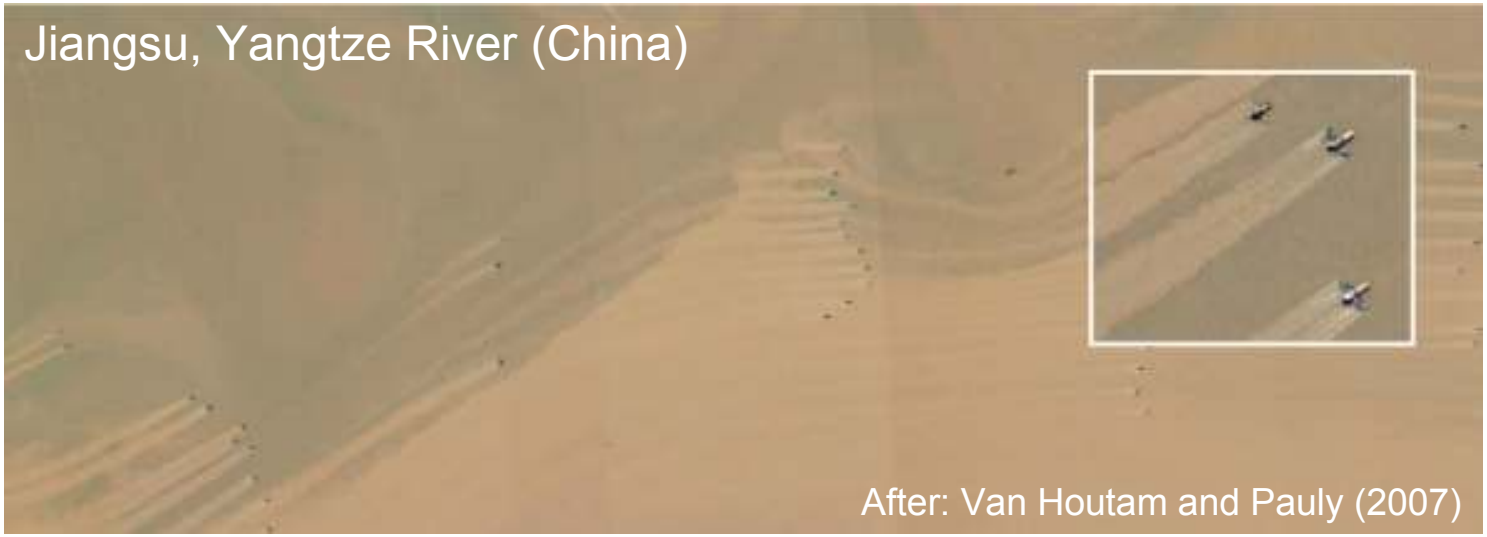
Natural processes



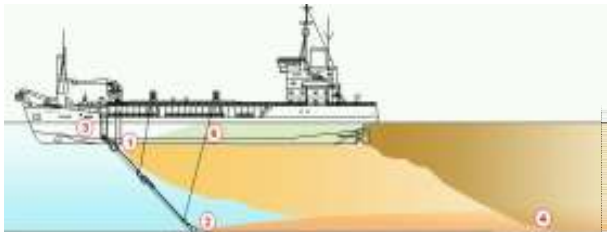
- Plumes driven by storm events (Lake Michigan) resp. river discharges (Mississippi River)
- Major scales (time and space)
- Suspended concentrations (15-30 mg/l) similar to dredging-induced levels



Fishing

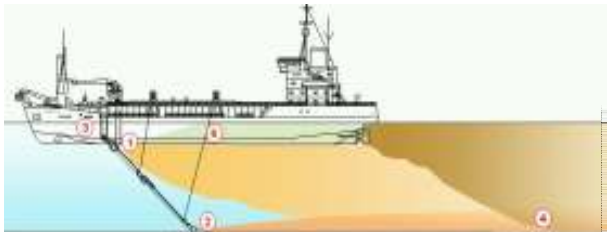


- Trailer mudtrails found at many locations worldwide
- Plume typically O(10^2) m wide, O(10^3) m long
- Scale aspect in large number of trailers
- No measured concentrations reported yet



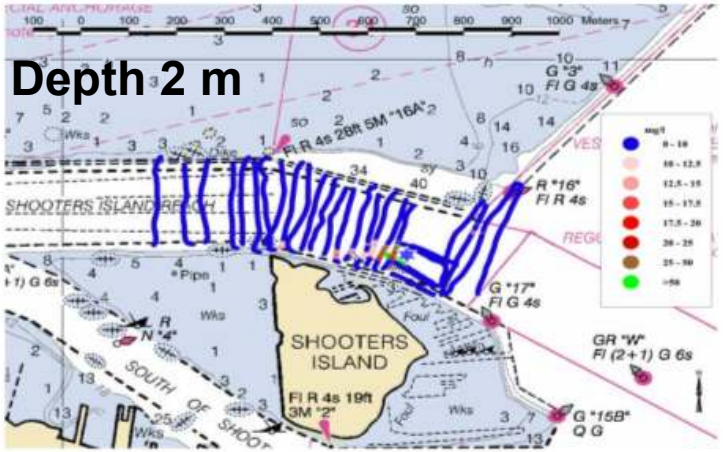
Shipping operations

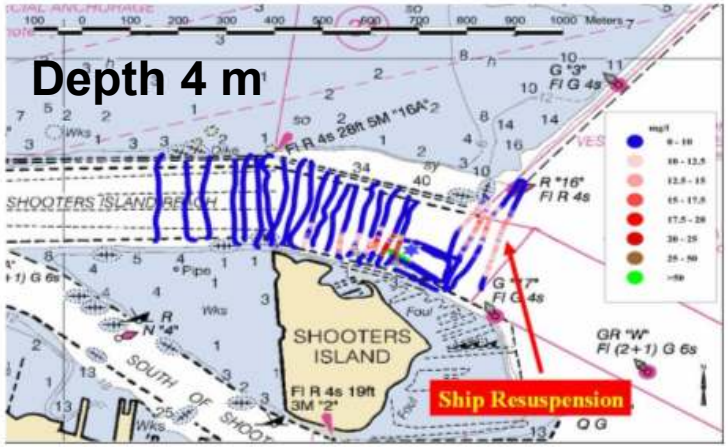
- Various studies (Pennekamp et al., 1991; Clarke et al., 2007a) report high concentrations
- Maximum turbidity generated when ship is changing direction and/or speed
- In areas of busy navigational traffic, annual shipping-induced turbidity similar to dredging-induced

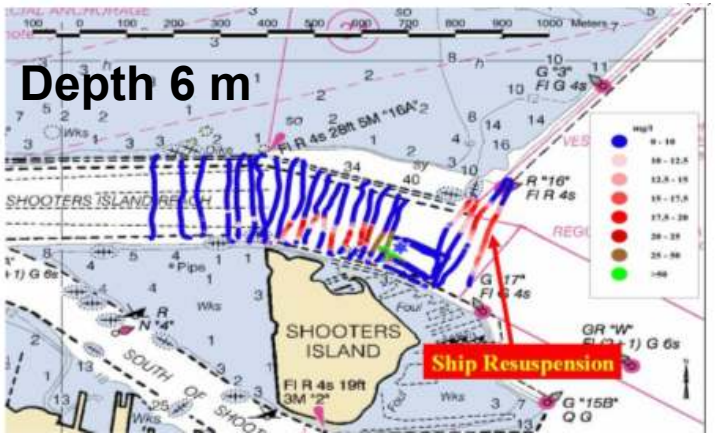


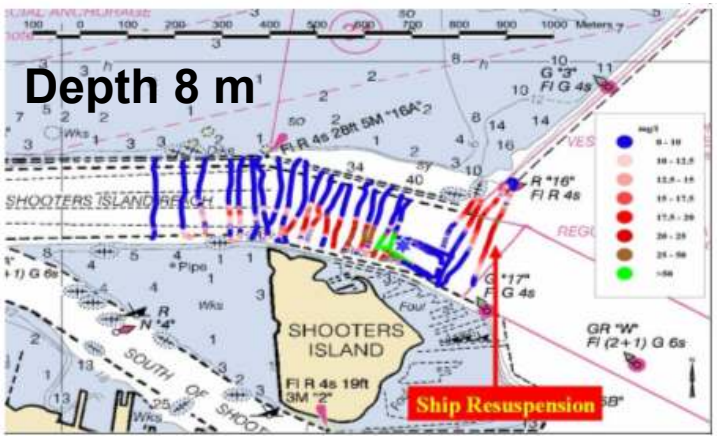
Shipping operations

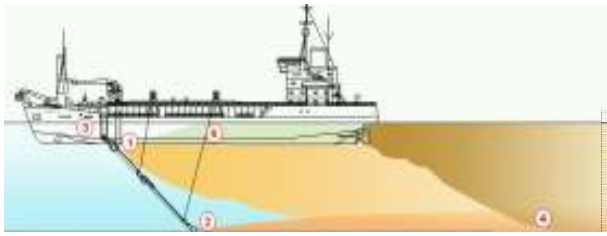
- Simultaneous measurement of dredging- and shipping-induced sediment concentrations (Clarke et al., 2007b)





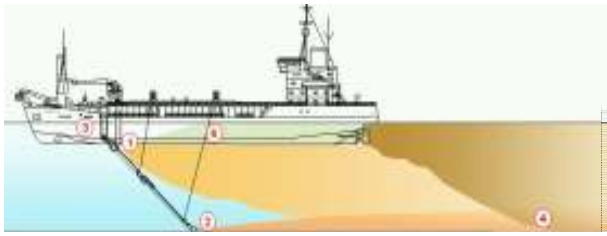






Dredging in perspective

- 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 Program

- 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

Bremerhaven, GER (June 2006)

Organization

- TSHD *Cornelia*, Bremerhafen, 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

Rotterdam, NL (May 2007)

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)

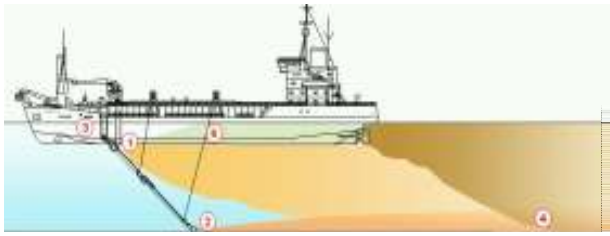

TSHD Oranje

Den Helder, NL (Sept 2007)

Organization

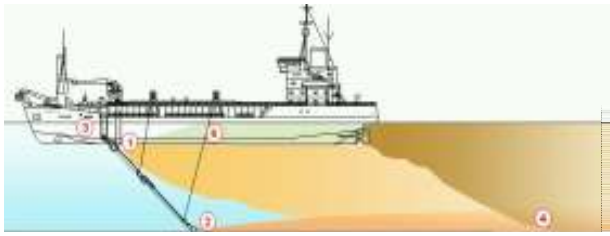
- TSHD *Geopotes 15*, Den Helder, Sept 17-19
- RWS Survey vessel *Zirfaea*
- Partners involved
  - RWS (De Kok and many others)
  - Dredging Research Ltd (Rogers)
  - Delft Hydraulics
  - SSB Partners
- Follow-up on Rotterdam (2007) experiment
- Objective: Collection of near-field & far-field passive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


TSHD Geopotes 15



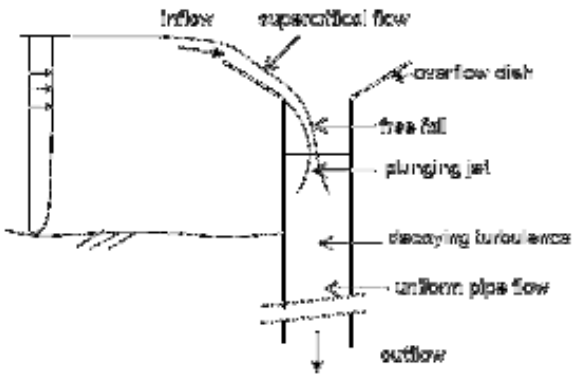
Overview collected data

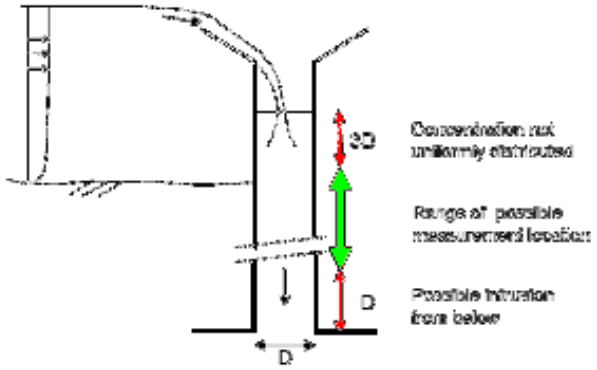
	B'haven (2006)	R'dam (2007)	DH (2007)
Overflow losses	√	√	√
Draghead resuspension		√	
Propeller wash		√	
Passive plume near-field (benefits green valve)		√	√
Passive plume far-field			√
Support data (board instruments, soil, …)	√	√	√



Overflow sampling: Challenges

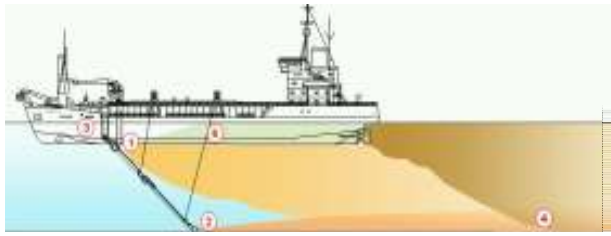
- Theoretical challenge: Single-point measurements representative for full cross-section?
  - Free overflow: Sufficient mixing if sampling between 3D from top end and 1D from bottom end (Svasek, 2006)



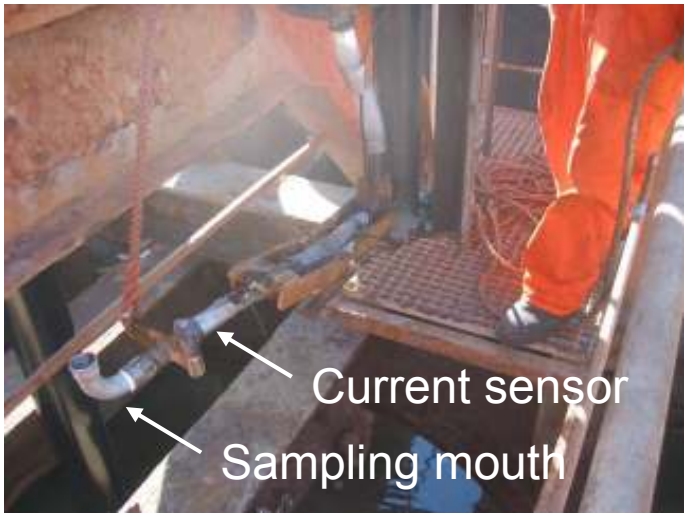


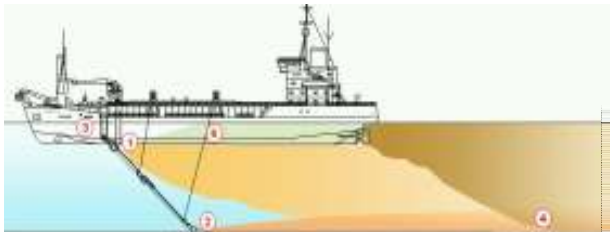
After:
Svasek (2006)

- 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



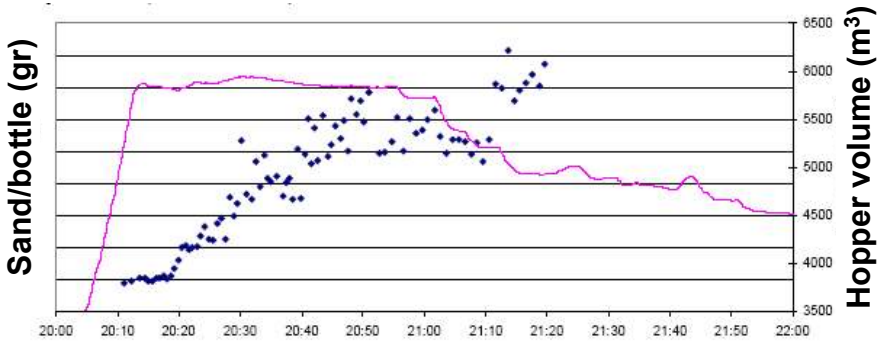
B'haven 2006: Pump sampler

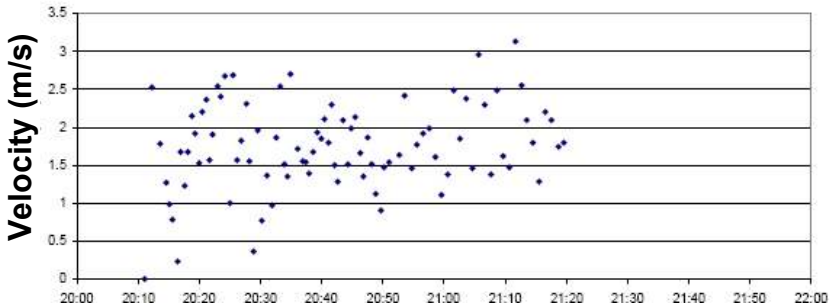




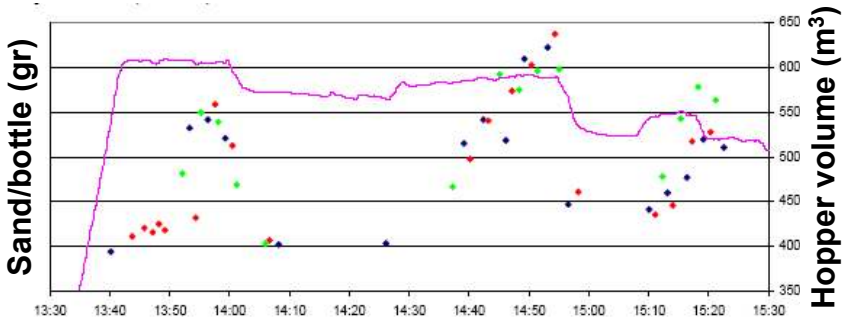
Overflow measurements

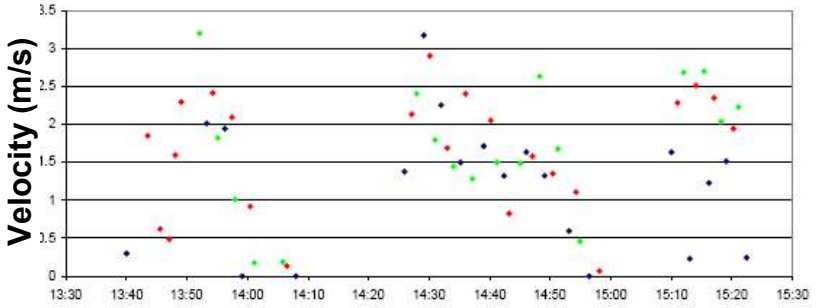
Trip 158 - fine sand
Fixed position, high freq





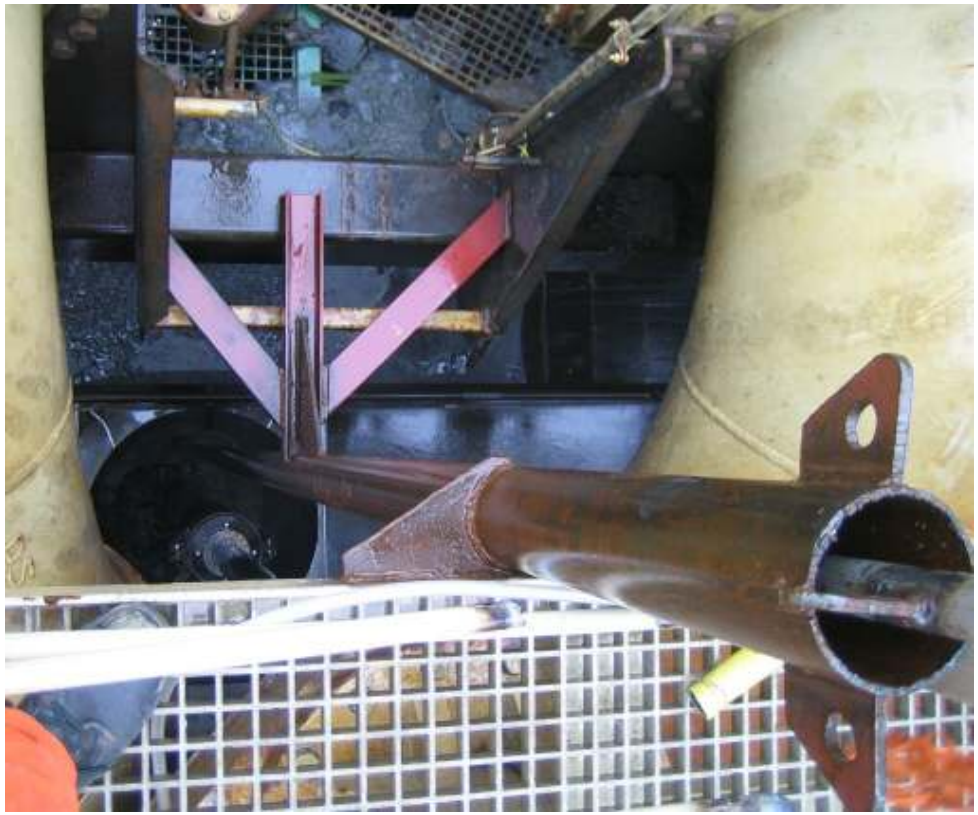
Trip 157 (mud)
Sampling 30/60/90 cm from wall





- 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

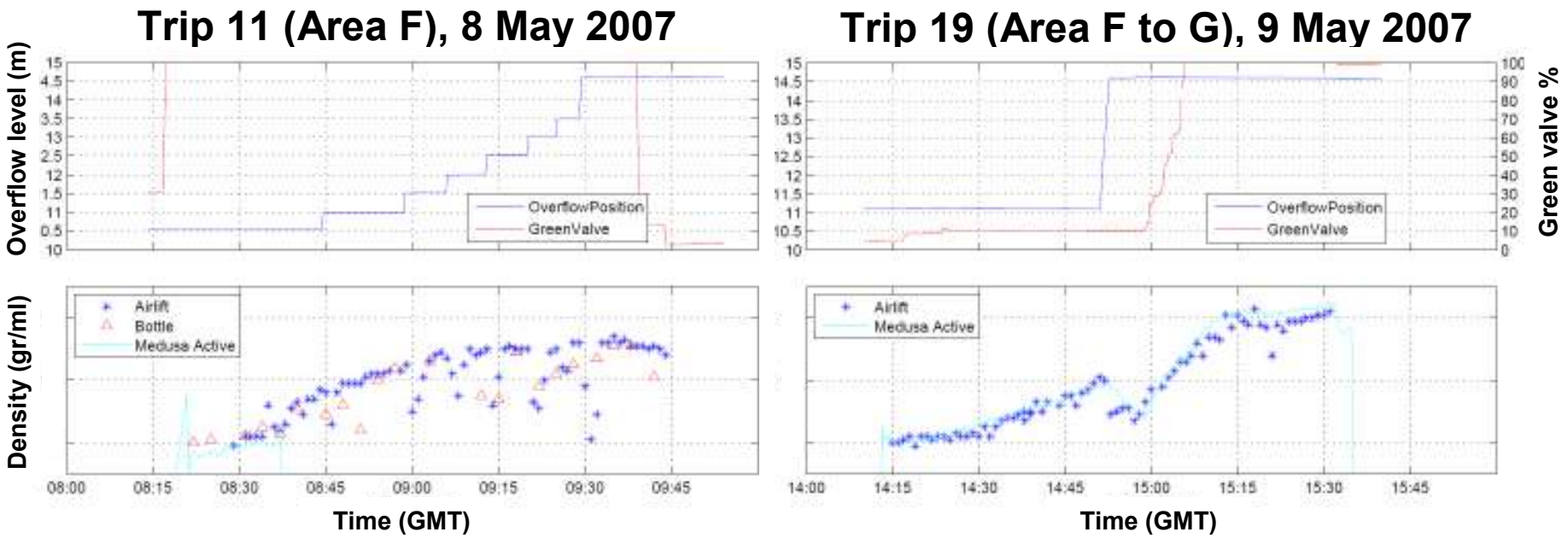
R'dam 2007: Airlift/Medusa



MEDUSA sensor

- 500 ml samples
- Frequency 1 minute

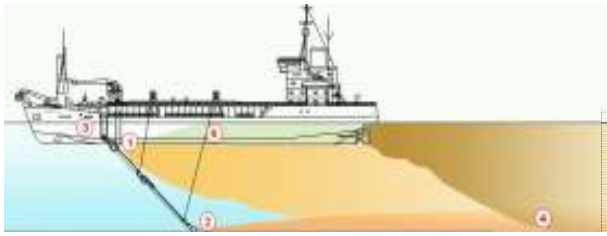
Overflow measurements



- 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

Deployment in overflow



Conclusions

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

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?