MONITORING DREDGING FOR SAFETY & IMPACTS ON ECOSYSTEM

05/08/2022

Aziah North, KONGSBERG

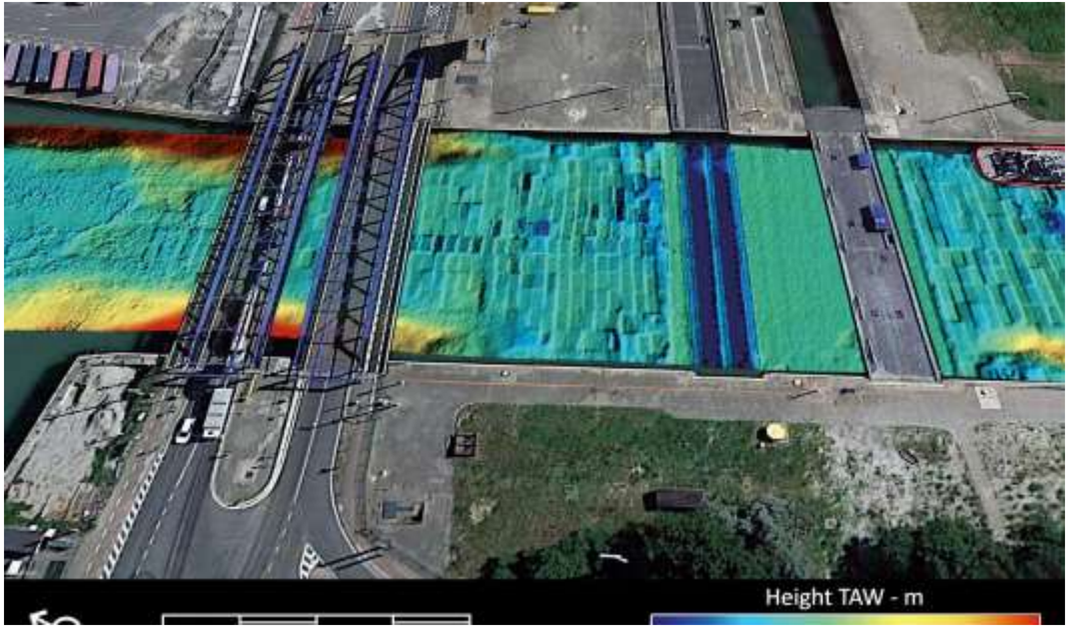
KONGSBERG's Business areas

MARINE CIVIL ENGINEERING projects

- Dams, Hydro Power Stations, Offshore Wind Farms
- Marine Construction & Inspection
- Bridges, Culverts, Tunnels
- Ports, Harbors & Marine terminals
- Hydrographic Surveys & Dredging
- River/Stream Monitoring

Dredge Monitoring in Real Time

THE VANDAMME LOCK AT ZEEBRUGGE Submitted by Marc Roche & Koen Degrendele | SPF Economie - Service Plateau continental



Key Point:

- to increase overall productivity and safety of personnel and equipment

Challenges with on-site issues:

- slope failure
  - undetected occurrence of slipped back material
  - high risk to surrounding areas
- production losses - over dredging or re-dredging
- Disturbance in organic layers, releasing toxic gases; turbidity; contaminants

Dredging Operations and Risk Assessments

Types of Operations:

- Maintenance dredging for ports and harbours
- Reclamation and mining dredging
- Removal of contaminated materials; beach replenishment

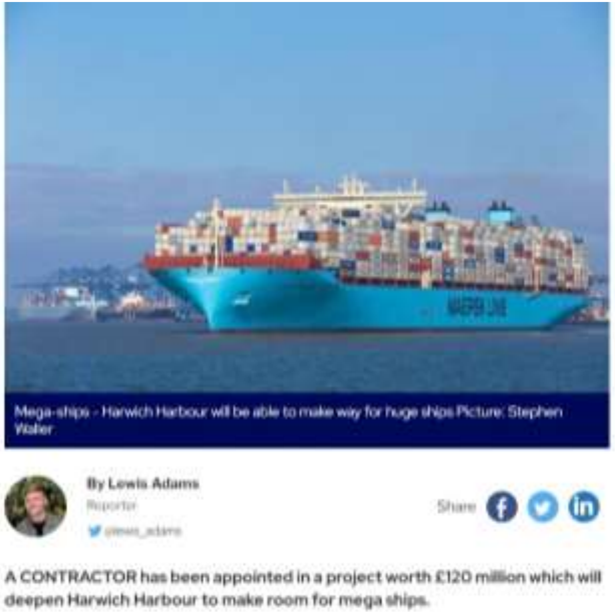
Each type has different risks.

Planning is key to contain costs and ensure safe operations.

Example – dredging risk

Ports of Harwich and Felixstowe

Example – dredging risk



Mega-ships - Harwich Harbour will be able to make way for huge ships Picture: Stephen Waller

By Lewis Adams

Reporter

Share

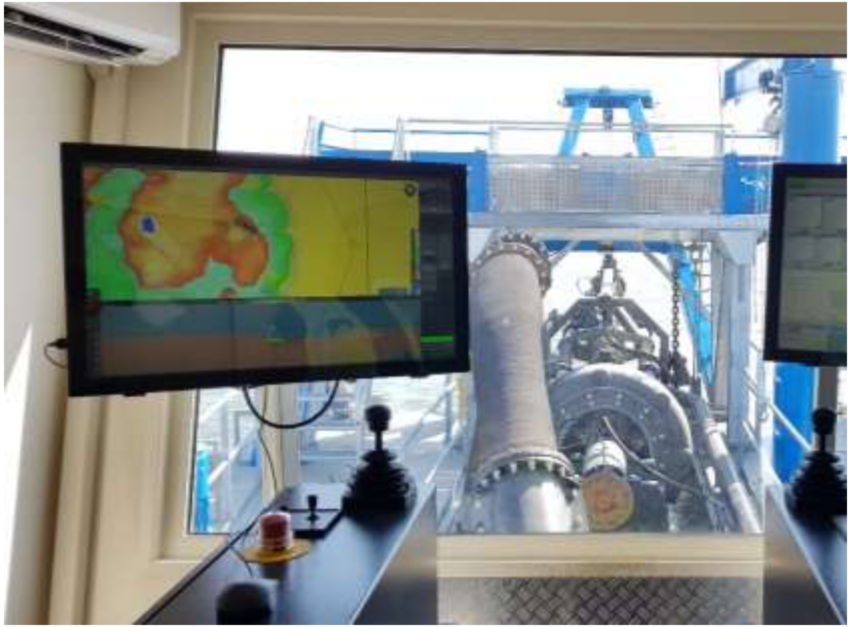
A CONTRACTOR has been appointed in a project worth £120 million which will deepen Harwich Harbour to make room for mega ships.

KONGSBERG

Minimizing Risk by Providing Visibility

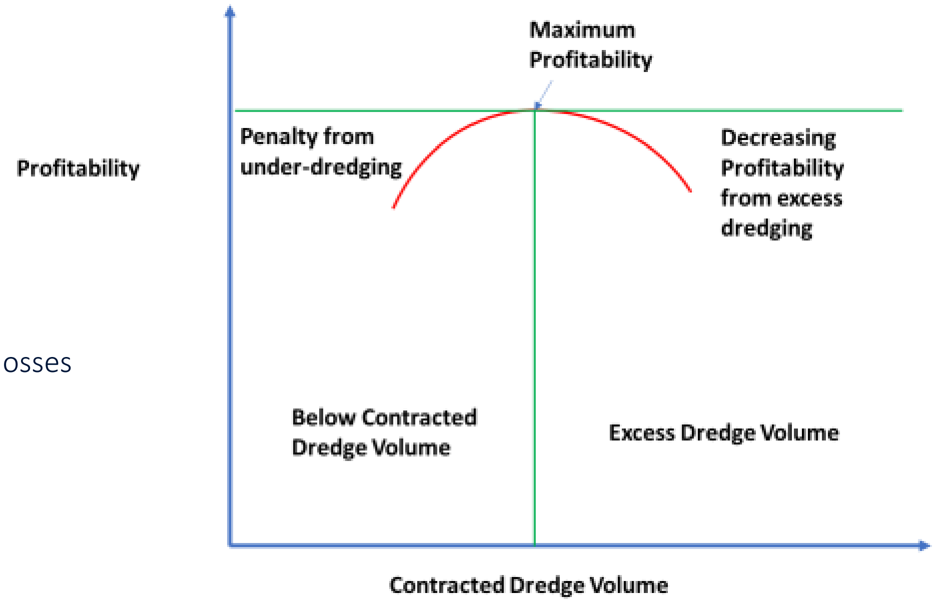
Providing visibility during operations to the operator:

- Prevents dredging beyond the legal limit
- Minimizing damage and dredging losses
- Provides early detection of slope failure
  - Near-shore borrow areas (lakes, rivers, inland waterways)
  - Erosive sand-water mixture flows down-slope during suction dredging
- reduction of sediment cloud when dredging in one step
- energy reduction of the dredger - lower carbon footprint



Challenges for Dredge Operator

- Compliance with best practices and approvals / permits
- Skills and expertise gained over time
- If no sensors to provide visual feedback, operates blind
- Assessment after dredging often shows two results:
  - under dredging requiring more cost and delay
  - over-dredging with excess operating costs and dredging losses
- Lack of visibility to slipped back material



Sonar for Real-Time Dredge Monitoring

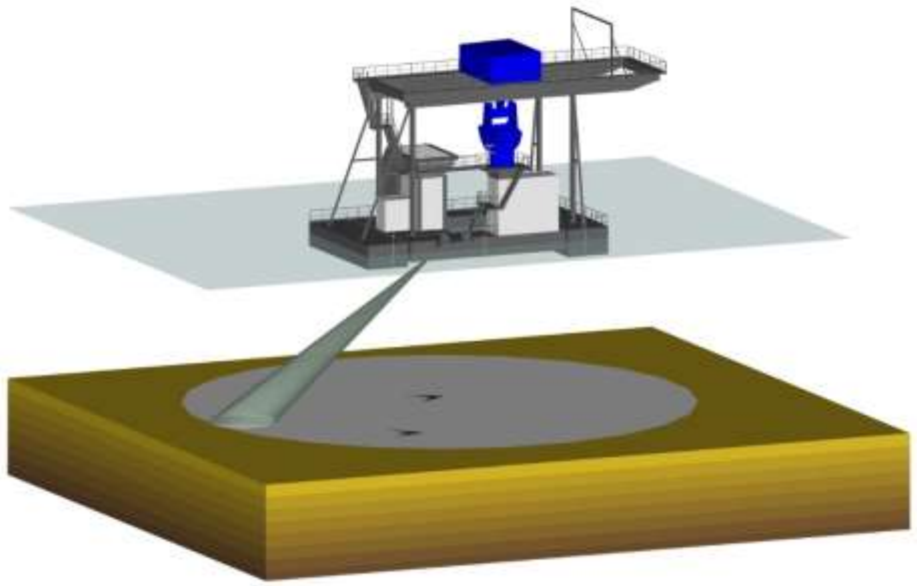
- Used in turbid / zero visibility water
- Generates depth data, quality bottom images

When integrated with accurate positioning system:

- Creates Digital Terrain Model
- 3-D visualization of operating surface in near-real time.
- Gives operator visibility of over-dredging, landslides

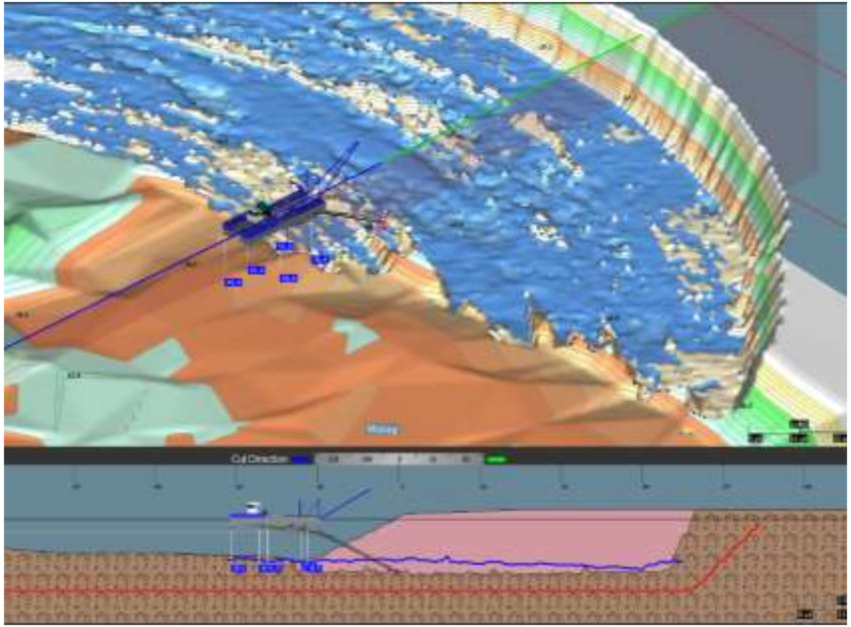
360° DAS scan

Scans the bottom of the work site and provides a high-resolution three-dimensional terrain model.



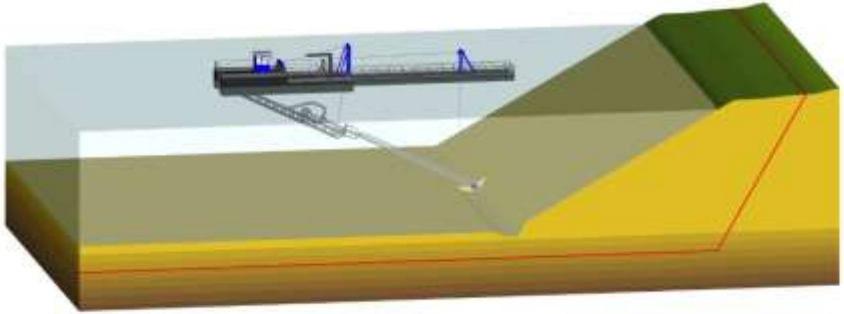
Making the Dredging Operation Visible

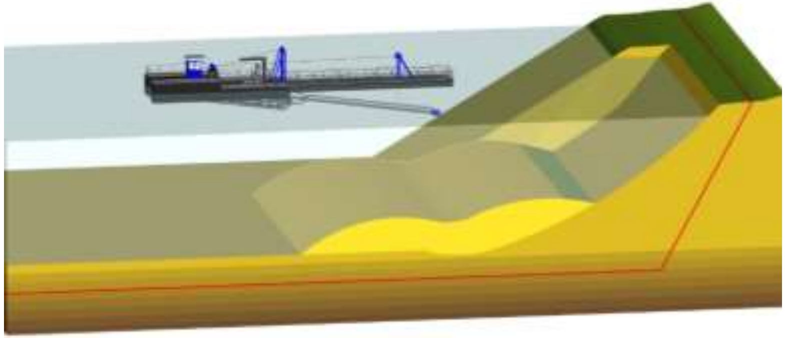
- Real-time Data, real-time sonar soundings
  - Position, heading of dredger using GPS / RTK
  - Position of loosening tool using inclinometer
  - Water depth using echosounders and sonars
- 3-D view of dredging progress based on digital terrain model (DTM)
- 2-D view of dredging operation with pre-set design horizon / dredging boundary
  - Design horizon in red
  - DAS sounder data in blue
  - Position of loosening tool on screen



Dredging losses

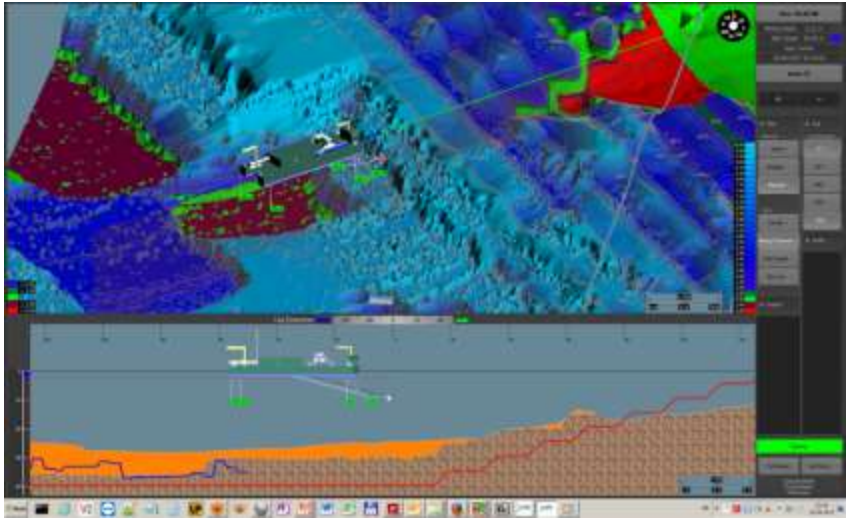
- Slope failures, slip back material undetected
- Equipment performance
- Dredging limits not defined – over dredging or under dredging
- Lack of existing data





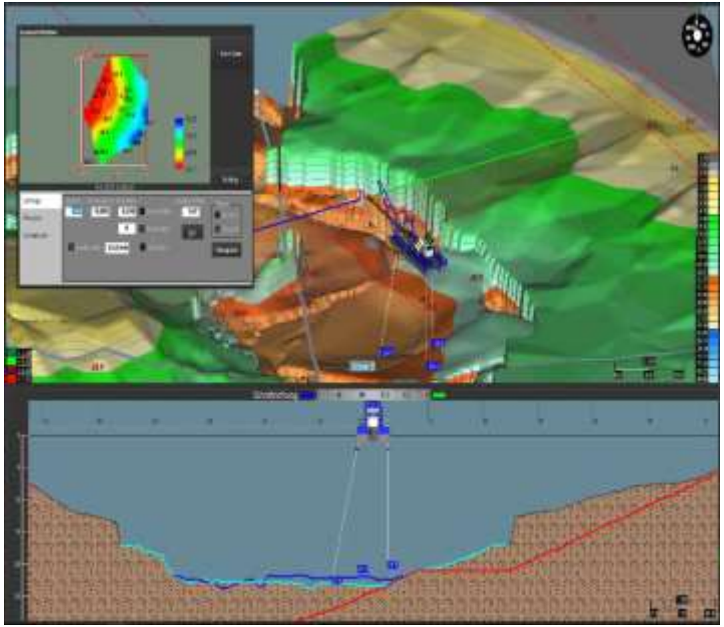
Operator Awareness of Slipped Back Material

- Orange shows recorded dredged material.
- Blue line is current sounding, showing material has slipped back
- Operator can react to slip back while still on site instead of having to redeploy after the slipped material is found by a separate survey



Visualizing Operations With 3-D Scanning Sonar

Performance specifications



- Rugged design suitable for challenging environments
- Transducer and rotator encased in oil filled adiprene dome; protected from solids / debris in water column
- 360-degree scanning sonar scans in horiz., vert. planes
- 2.8 deg conical beam with vert. coverage from -90 to +5 degs
- Range 0.2m - 300m, range resolution of 10mm at max setting
- Steps of 0.225 deg to 7.2 deg
- Down to 30m hydrostatic depth – good for fast-flowing water
- 20kg in air; 11.5 kg in water; .21m dia X .39, ht.

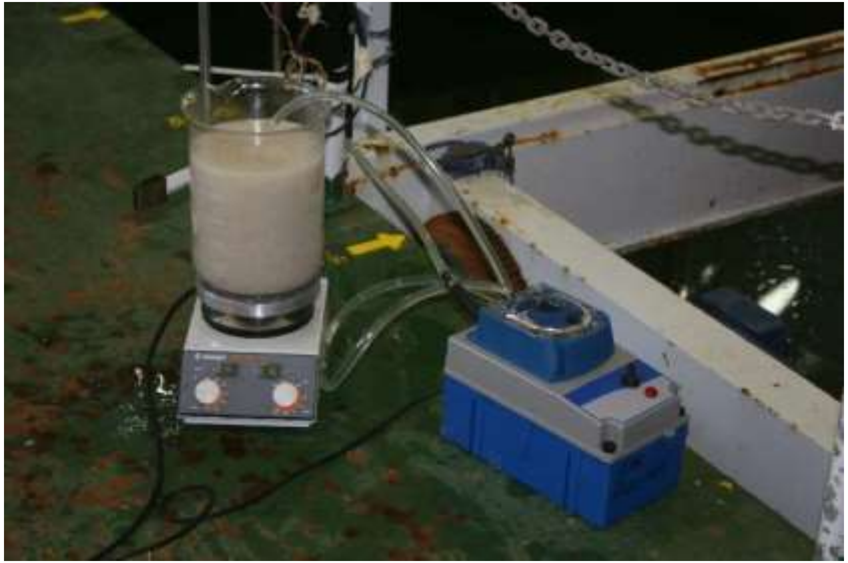
Mitigating Turbidity Impacts During Dredging

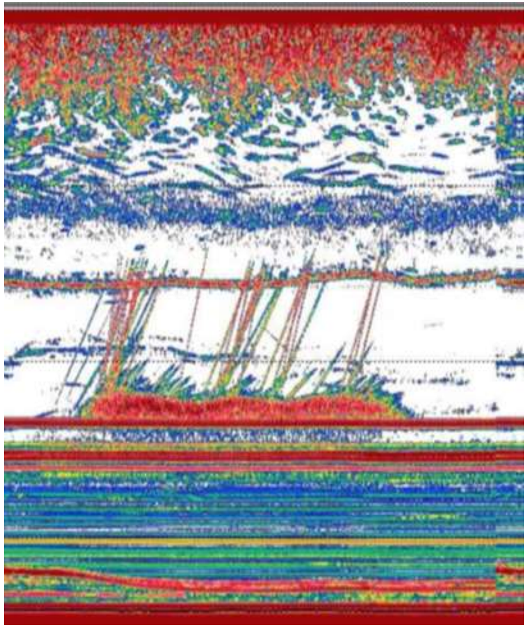
Image credit: https://www.iwr.usace.army.mil/About/Technical-Centers/NDC-Navigation-and-Civil-Works-Decision-Support/NDC-Dredges/

- Requires managing suspended solids released at site or entering sensitive areas
- Sonar using FM pulses has longer range than optic sensors
- Acquisition, analysis and verification of data is crucial
- Data must be manageable, easily understood, real-time
- Software functionality:
  - Turbidity measurements, bottom morphology
  - Layout plans, real estate boundaries, tolerance ranges
  - Slope angles, target and actual slopes
  - Remaining material thickness, estimation of dredged quantities for output assessment

Turbidity Monitoring with Acoustics

Image: experimental set-up injects different particles into water column and transmits chirp pulses for back-scatter





Observing sediment plumes in a controlled experiment with EK80 broadband echosounder during a preliminary experiment in the Delta Flume

(Deltares, Delft, NL)

Preliminary data

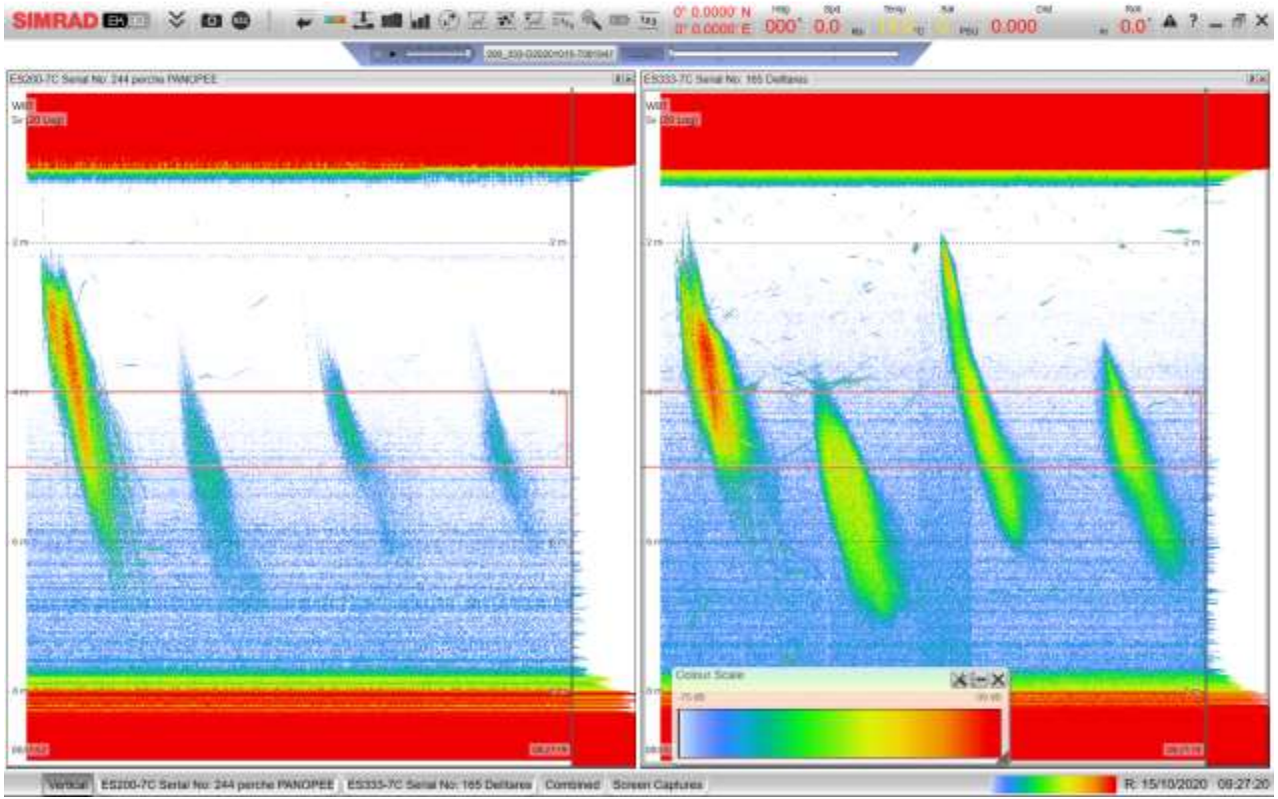
Material

Kongsberg/Simrad EK80 FM mode :

- 200kHz transducer [160-260] kHz
- 333kHz transducer [280-450] kHz
- 1ms pulse
- Calibrated with Tungsten Carbide sphere
- Steered 25°
- 8 m above floor
- 20g of sediment with four concentrations
  - >250 µm
  - [212:250] µm
  - [180:212] µm
  - [125:180] µm

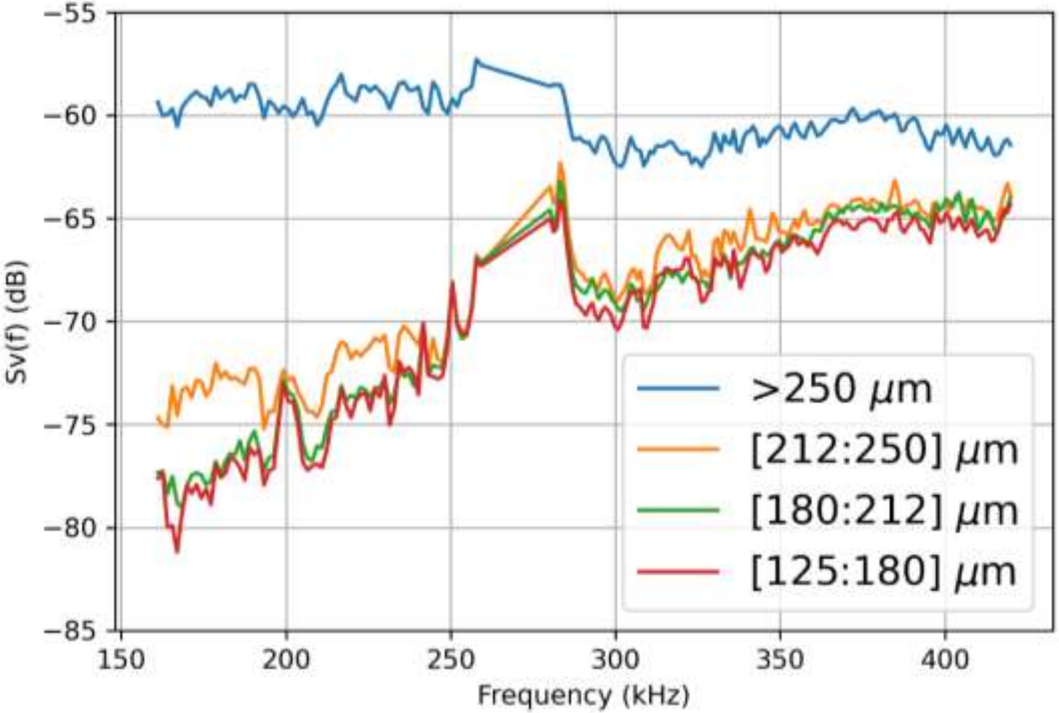
Preliminary data

Four sediment plumes of different grain size observed with an EK80



Preliminary data

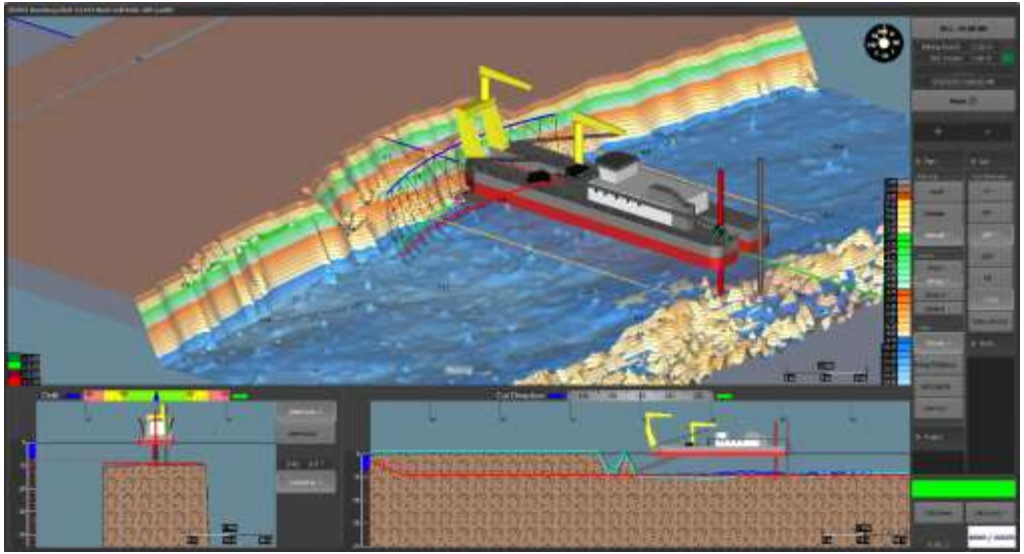
Frequency response of sediment plumes extracted with Ifremer MOVIES3D software



Integrated volume backscatter in the layer from 4 to 5 m displayed on the echogram

Preliminary data

Summary – Benefits of Real Time Monitoring



- Improve safety aspects of operation
- Minimize risk of damage from operator error
- Reduce operating costs of over-dredging or re-dredging
- Minimize slope failure risk
- Improve work-flows and quality control of dredging process
- Gain real time awareness of transportation and deposition of suspended sediments

KONGSBERG

Thank you

Aziah.North@km.kongsberg.com