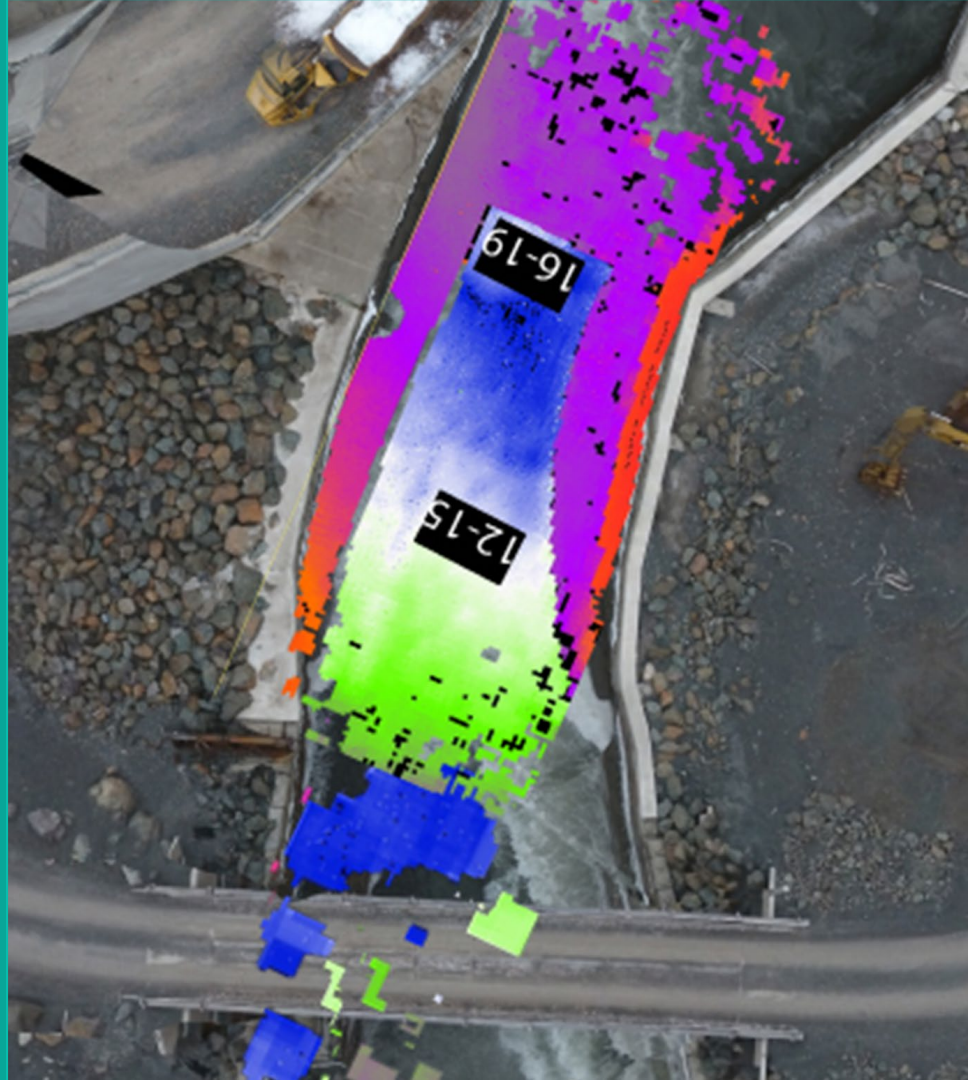
Photo credit: Northwest Hydraulic Consultants

Siltation Management of Dam Reservoirs through Dredging

Konrad Mech
Sales Director, Coasts, Ports and Inland Waterways



Presentation Flow:

- Key Issues in Reservoir Dredging
- Factors Affecting Acoustic Instruments – A Review
- Real Time Dredge Monitoring Using Acoustics
- Case Study 1: Run of River Hydroelectric Reservoir Siltation Management
- Case Study 2: Run of River Hydroelectric Reservoir Siltation and Trash Monitoring
- Case Study 3: Reservoir Siltation Over Time
- Case Study 4: Surgical Dredging: Mechanical Backhoe Dredge Monitoring
- Case Study 5: Surgical Dredging: Clam Shell Dredge Monitoring

Key Issues in Reservoir Dredging

Sediment Management Strategies

- Reduce sediment yield
- Route incoming sediments
- *Remove or redistribute sediments*
  - *Dredging*
- Adaptive Strategies

Key Issues in Reservoir Dredging

Reservoir Dredging: A Practical Overview
(WEDA Technical Report, April 2021)

- Use when drawdown is undesirable
  - may degrade downstream channel
  - impact to fish and wildlife habitat
  - Potential damage to riverside infrastructure and property

Human error to blame for release of water at Cleveland Dam that left two dead

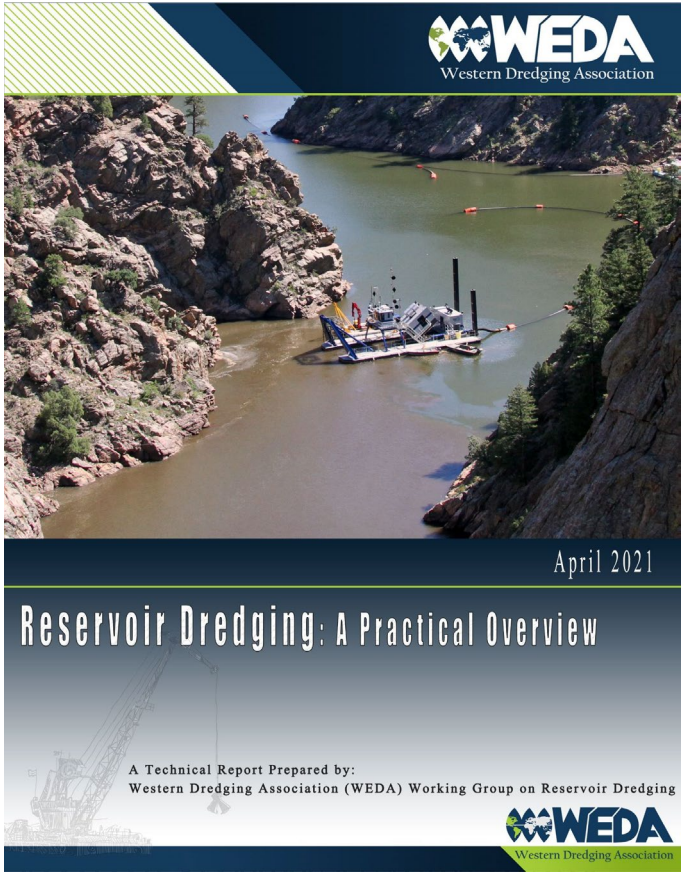
Metro Vancouver says last Thursday's spill at the Cleveland Dam was caused by a human error related to programming of the control system for the spillway gate.

Source: Vancouver Sun, Oct 8, 2020

WEDA's Technical Report: "Reservoir Dredging: A Practical Overview"; WEDA, 2021

Key Issues in Reservoir Dredging

- Reservoir location, accessibility
  - Dredge transport costs
- Volume, physical layout of material to remove
  - Bathymetric survey
  - Vessel accessibility
- Water depth
  - mechanical or hydraulic dredge
- Material types and processing
  - mechanical or hydraulic dredge
- *Potential damage to structure (surgical dredging)*
- Transport and final disposition
  - Potential economic value of material (cost offset)



Factors Affecting Acoustic Instruments – A Review

Frequency / Range / Turbidity

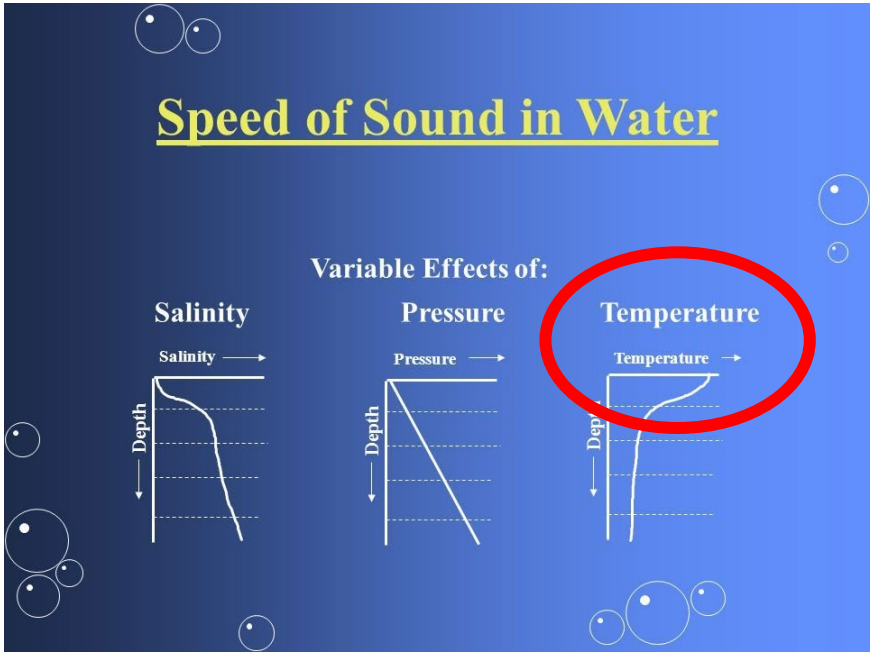
- Low frequency = long range, low resolution, good penetration
- High frequency = short range, high resolution, signal attenuation

Temperature Differential in Water Column

- High T distorts signal path

Salinity (seawater incursion near coasts?)

Beam Width ~ Cost



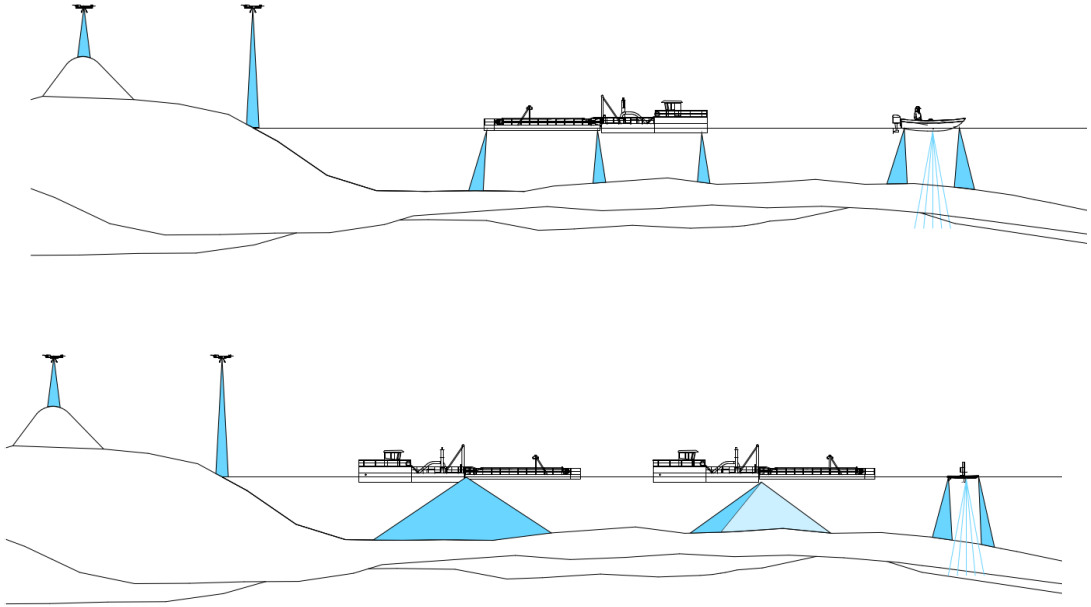
Real Time Dredge Monitoring Using Acoustics

When?
- What is the trigger to dredge?

What?
- Periodic survey
- *Real time siltation monitoring*
- *Real-time dredge monitoring*
- Post-dredge survey

How?
- Manned survey vessel
- Unmanned survey vessel
- *On the dam structure*
- *On the dredge itself*

What technology?
- Single beam echosounder
- Multibeam echosounder
- Fixed, dual axis sonar



Shallow Survey USV/ASVs

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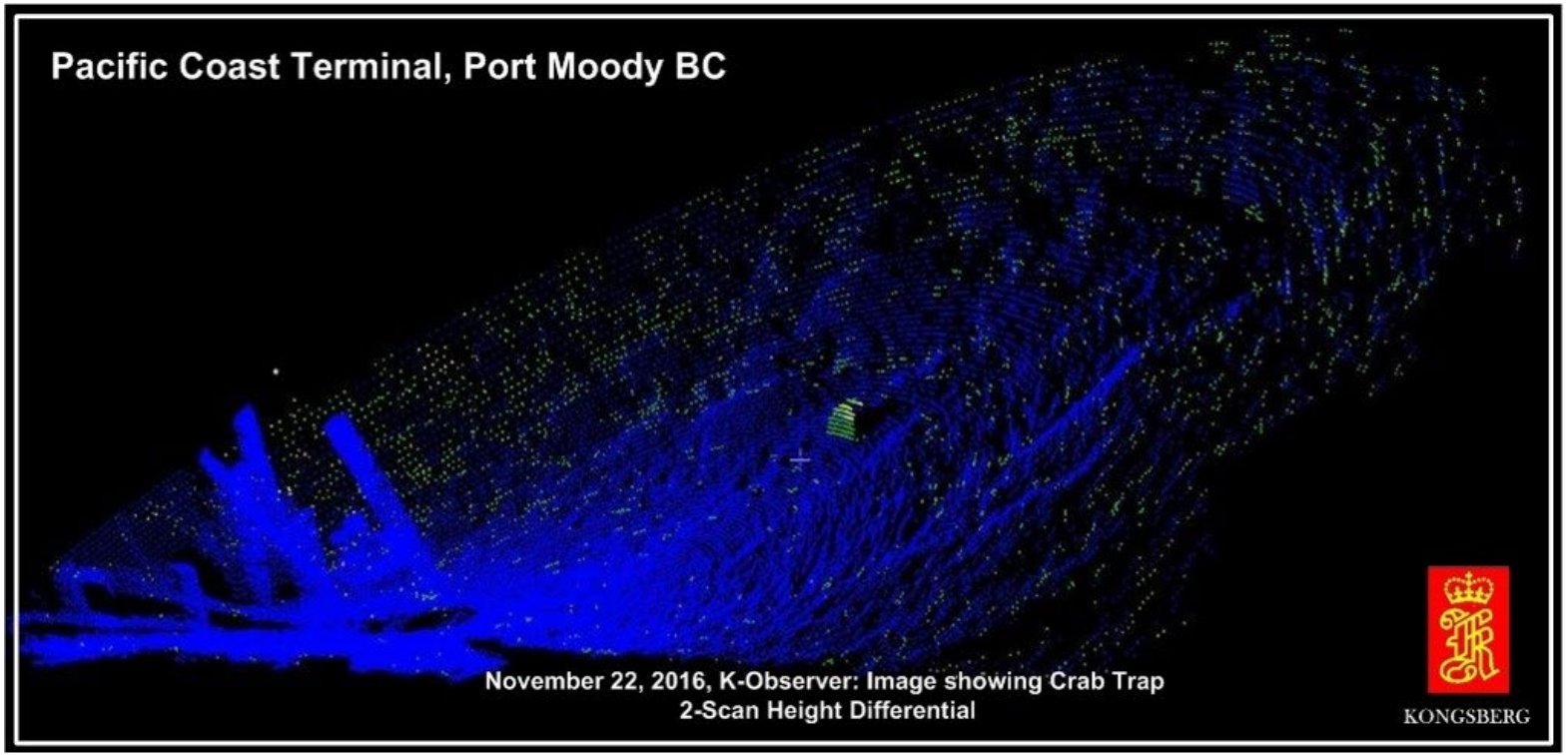
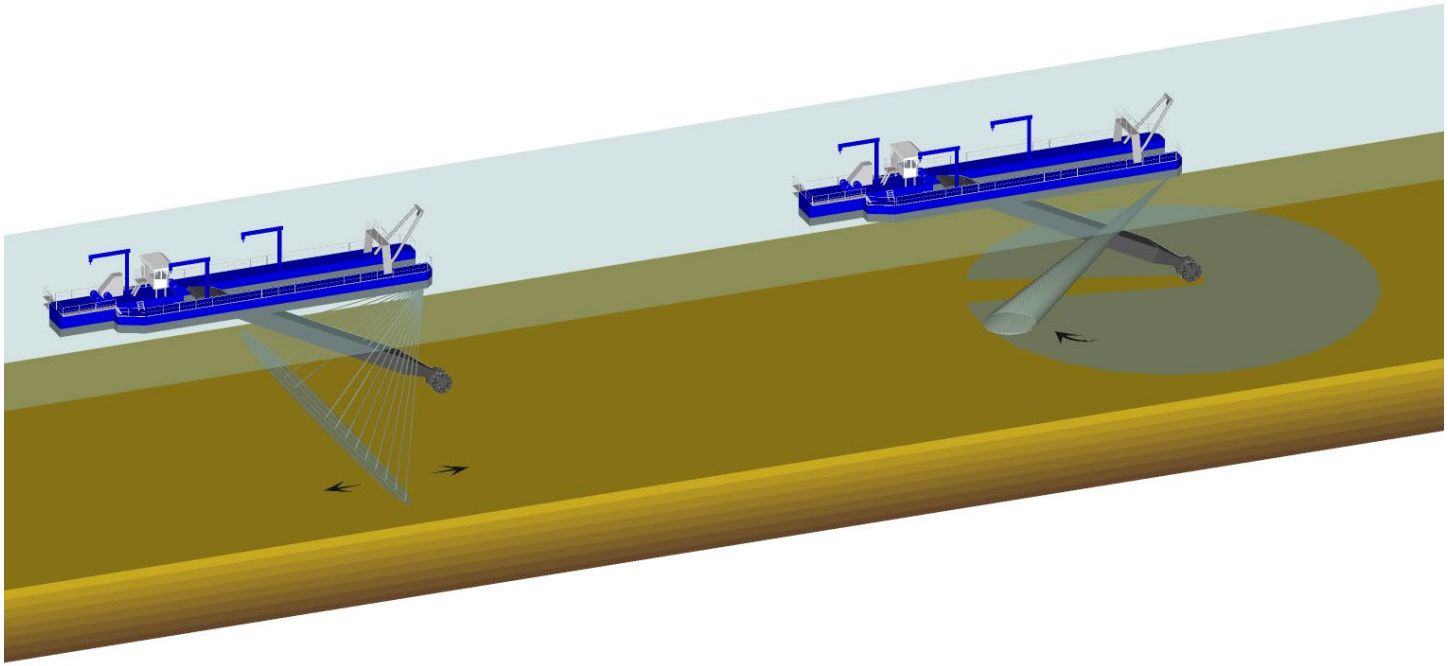
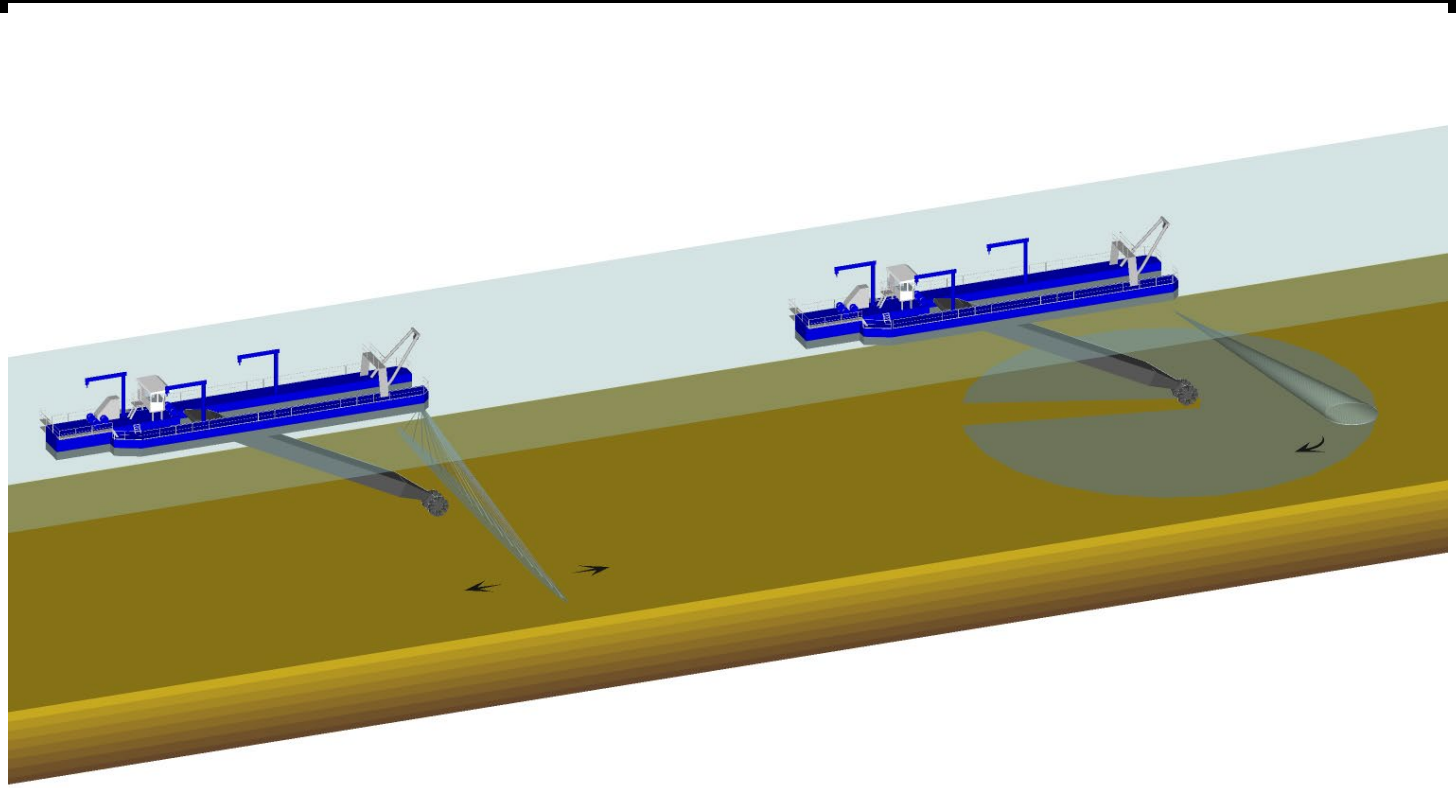
Dual Axis Sonar – Fixed, Continuous Operation







DAS (360° Scanner Dual-Axis-Sonar)

Acknowledgements – Case Studies 1, 2 and 3

Andre Zimmermann, Principal Geomorphologist, Northwest Hydraulic Consultants, Vancouver, BC, azimmermann@nhcweb.com
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Case Study 1: Run of River Hydroelectric Reservoir Dredging

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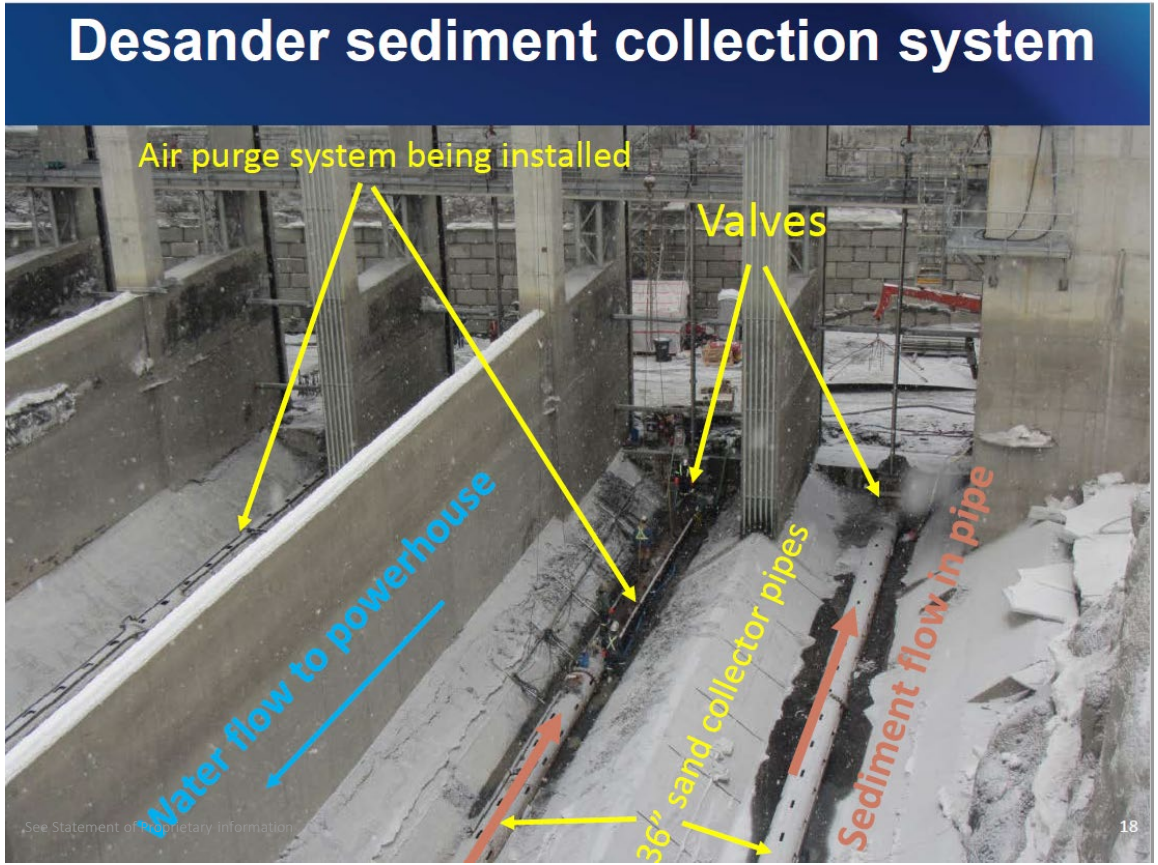

Case Study 1: Run of River Hydroelectric Reservoir Dredging

Case Study 1: Run of River Hydroelectric Reservoir Dredging

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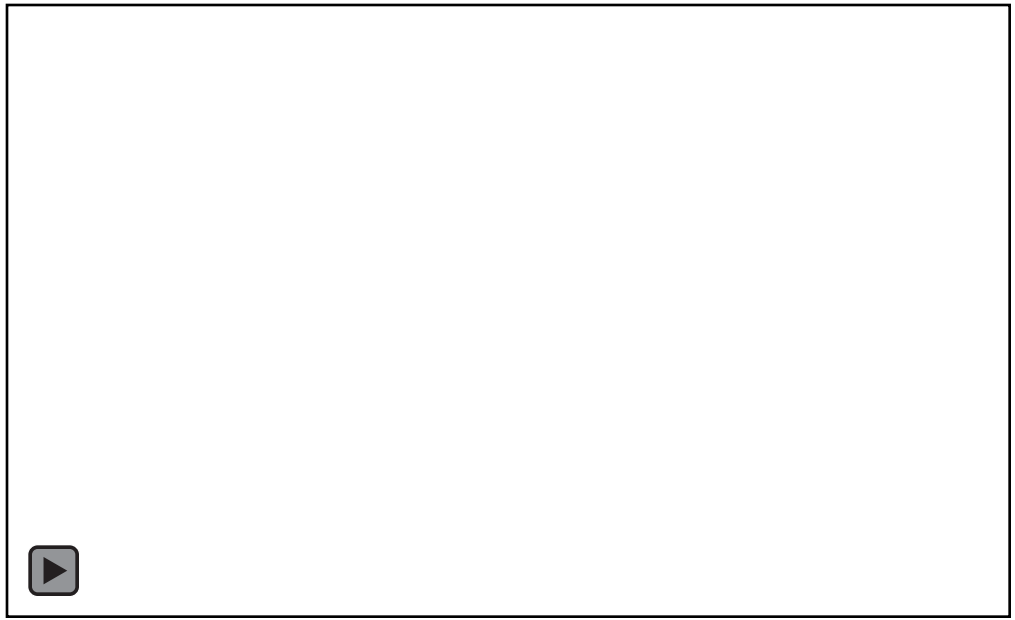
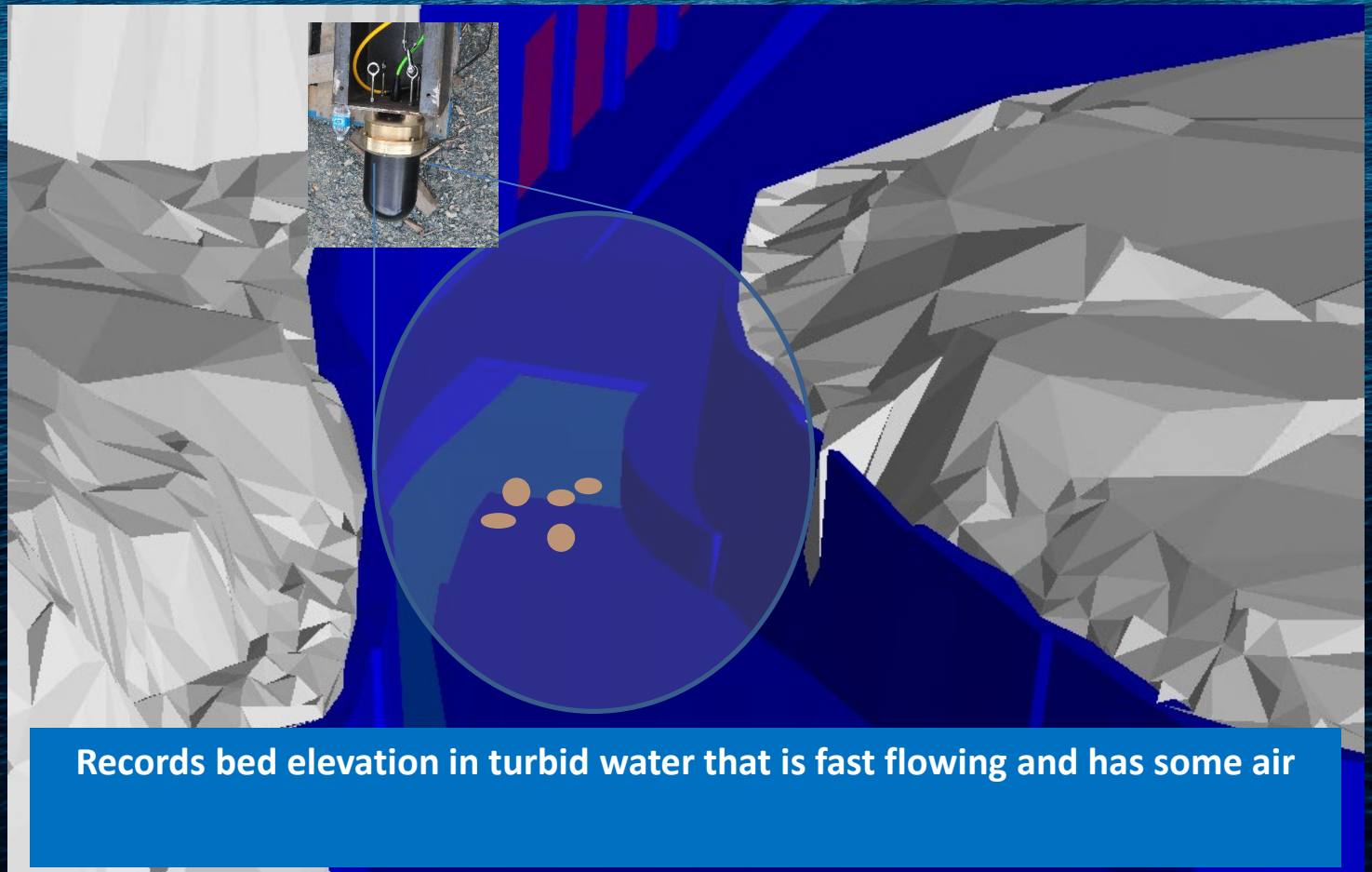
20 scans within 30 hours, showing sand waves and dredging activity

Case Study 1: Run of River Hydroelectric Reservoir Dredging



Case Study 1: Dual Axis Sonar in Sluiceway

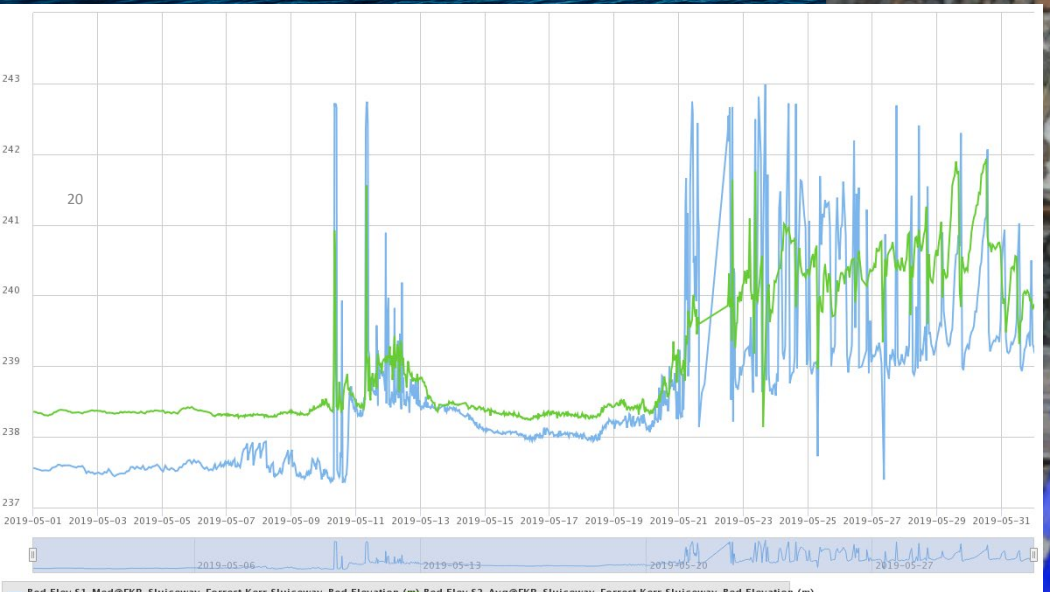


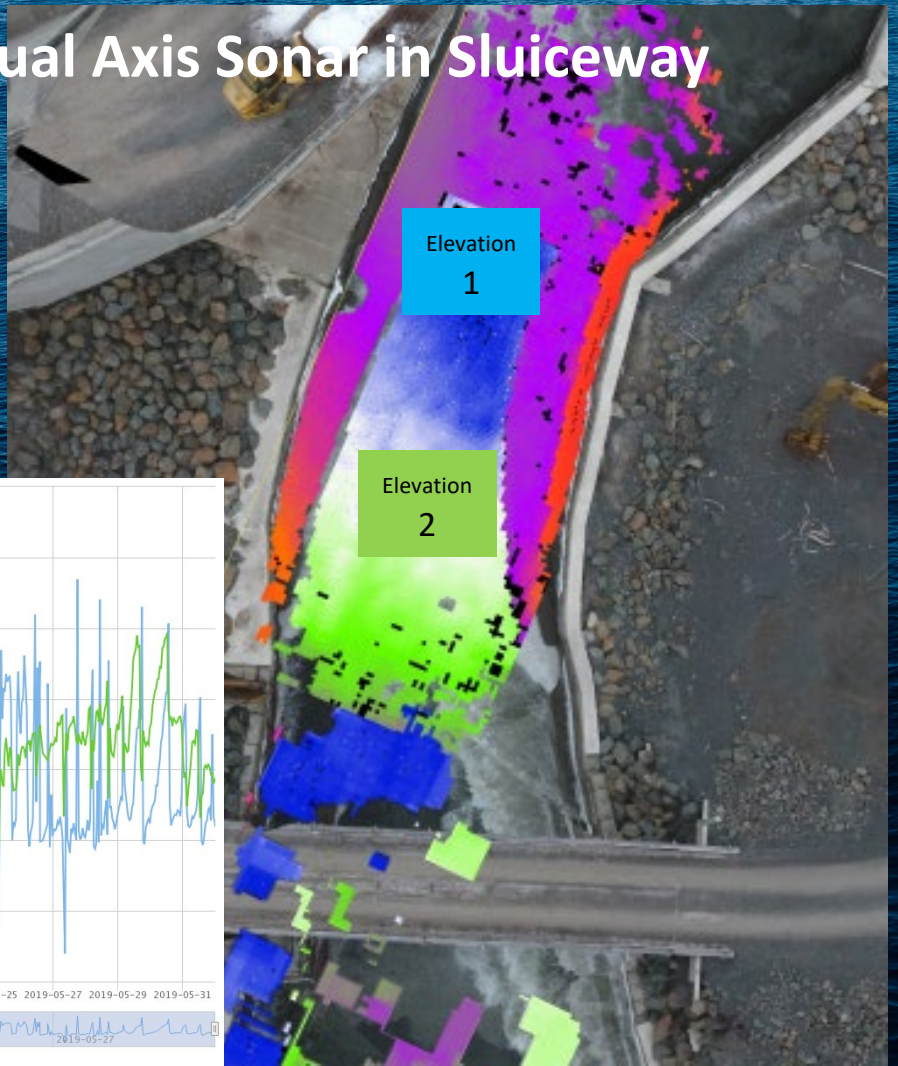
Records bed elevation in turbid water that is fast flowing and has some air

Case Study 1: Dual Axis Sonar in Sluiceway

Case Study 1: Dual Axis Sonar in Sluiceway

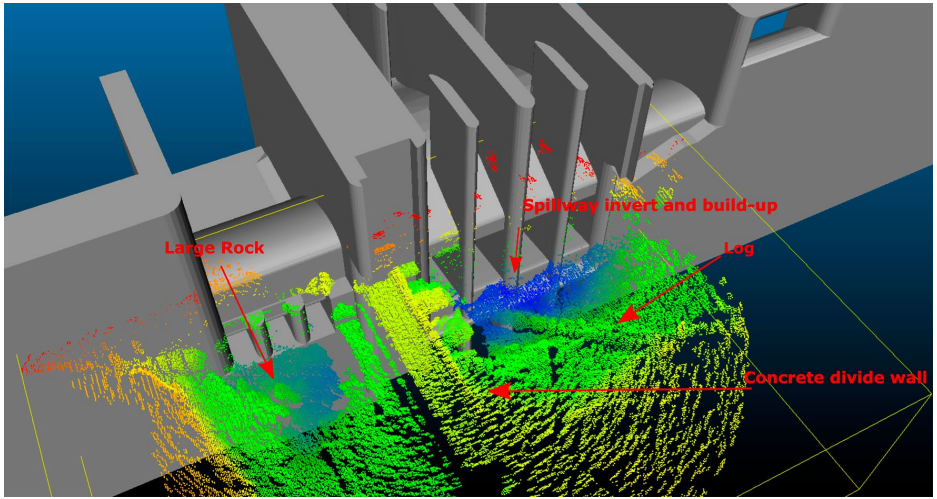
Sonar data goes to control room to be monitored in real-time





Cowlitz Falls is located in Southwestern Washington and operated by Lewis County Public Utility District (LCPUD)

Case Study 2: Run of River Hydroelectric Reservoir Siltation and Trash Monitoring



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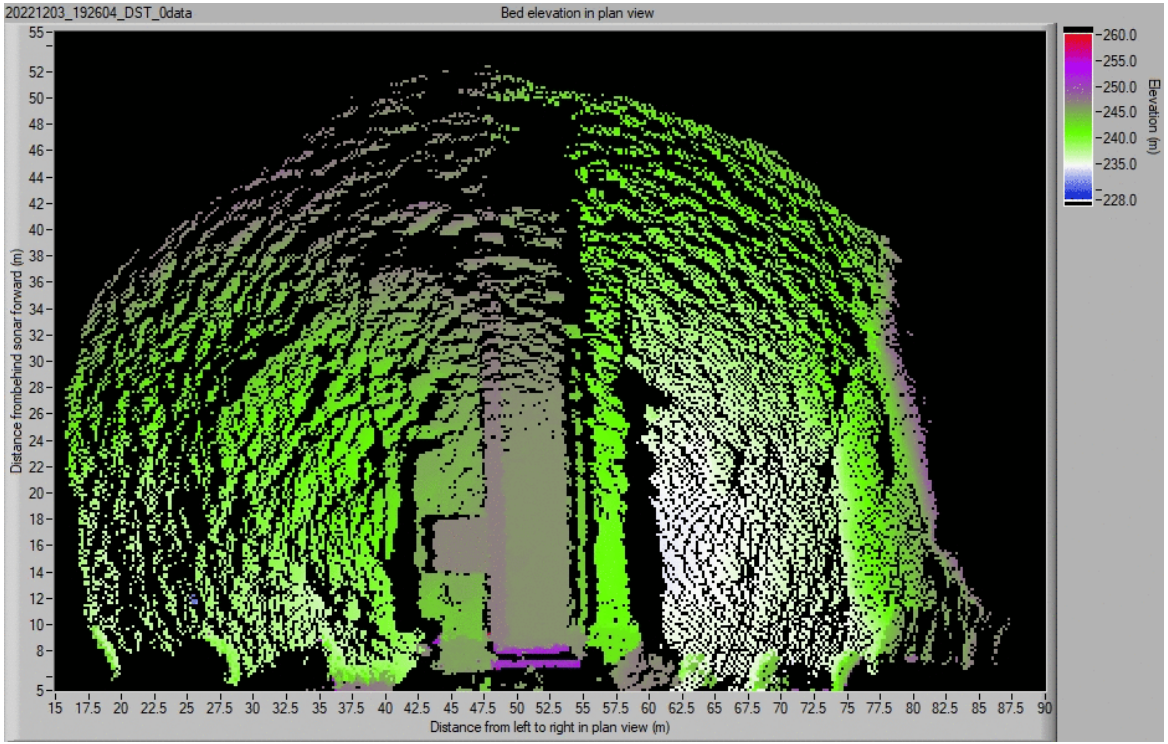
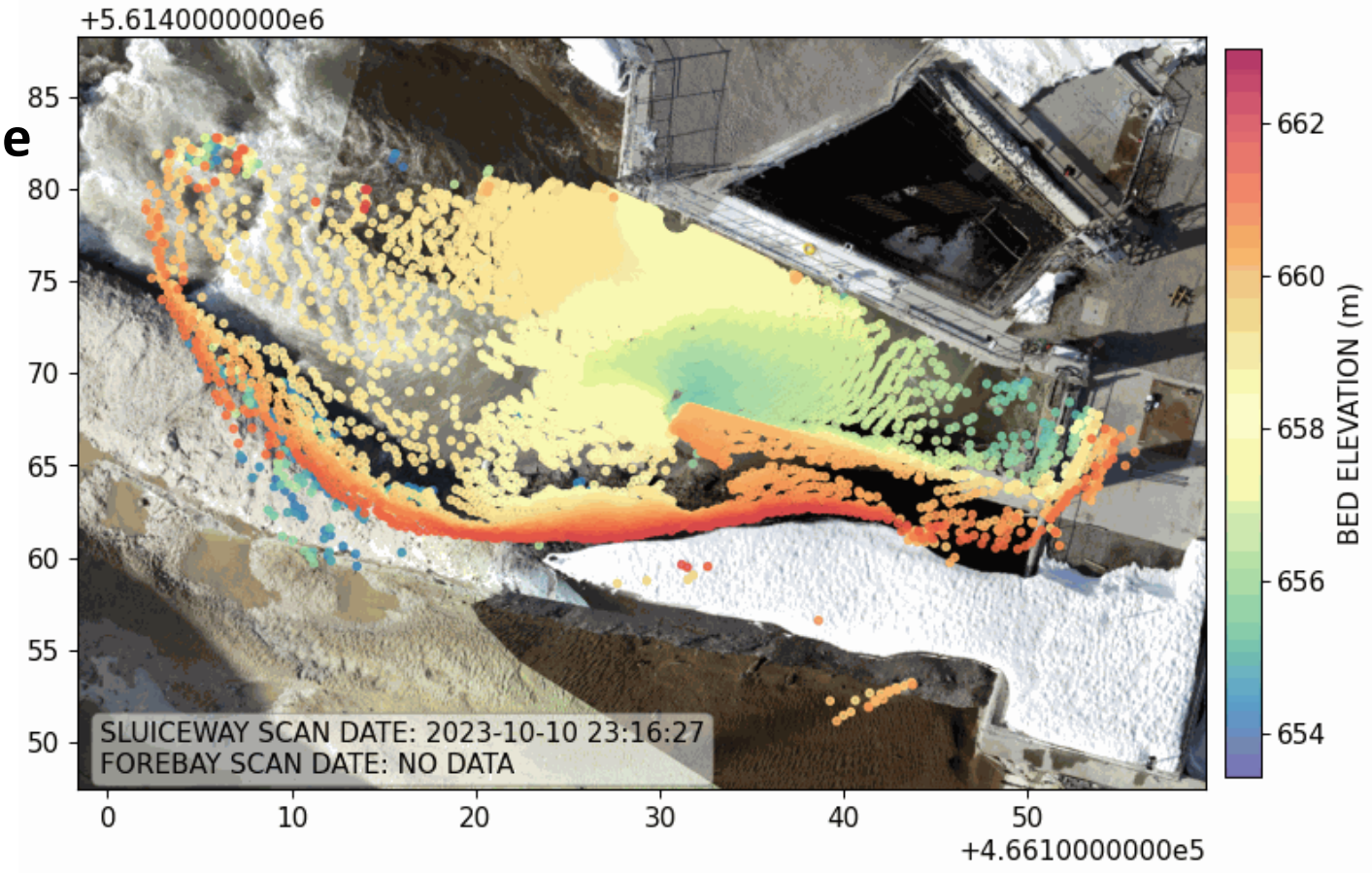


Case Study 3: Siltation Over Time

Case Study 3: Siltation Over Time



Acknowledgements – Case Studies 4 and 5

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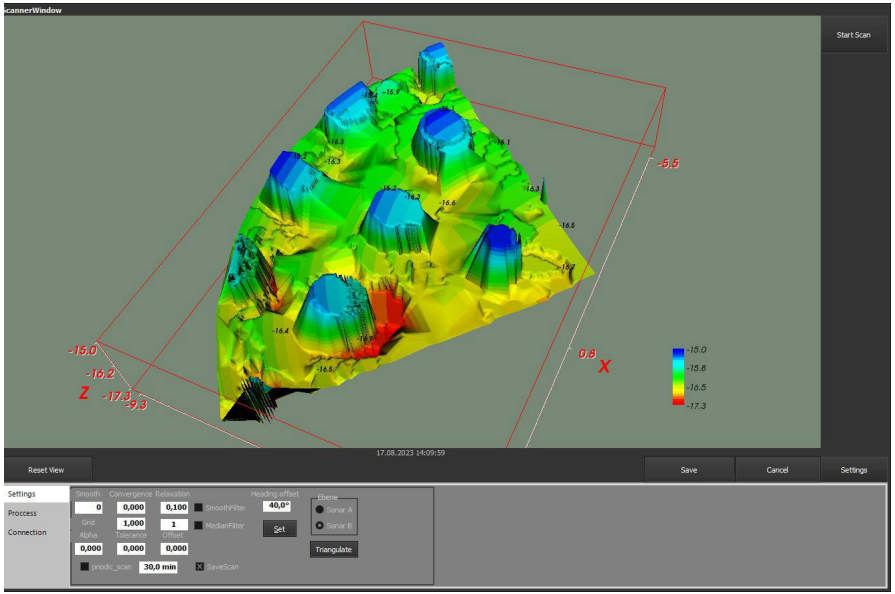
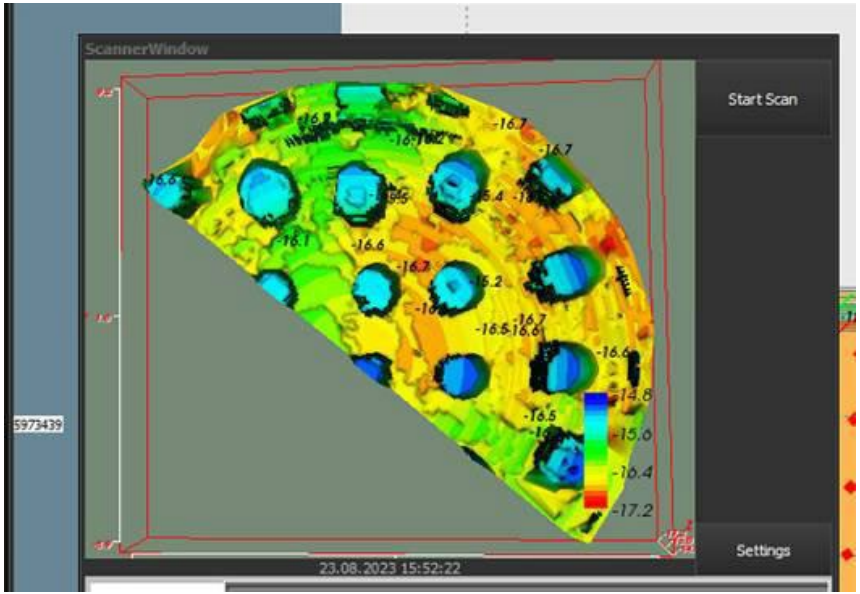
Ilona Schutter, Surveyor, SPE GmbH, Hamburg, Germany, schutter@spe-electronics.de

Case Study 4: Mechanical Backhoe Dredge Monitoring

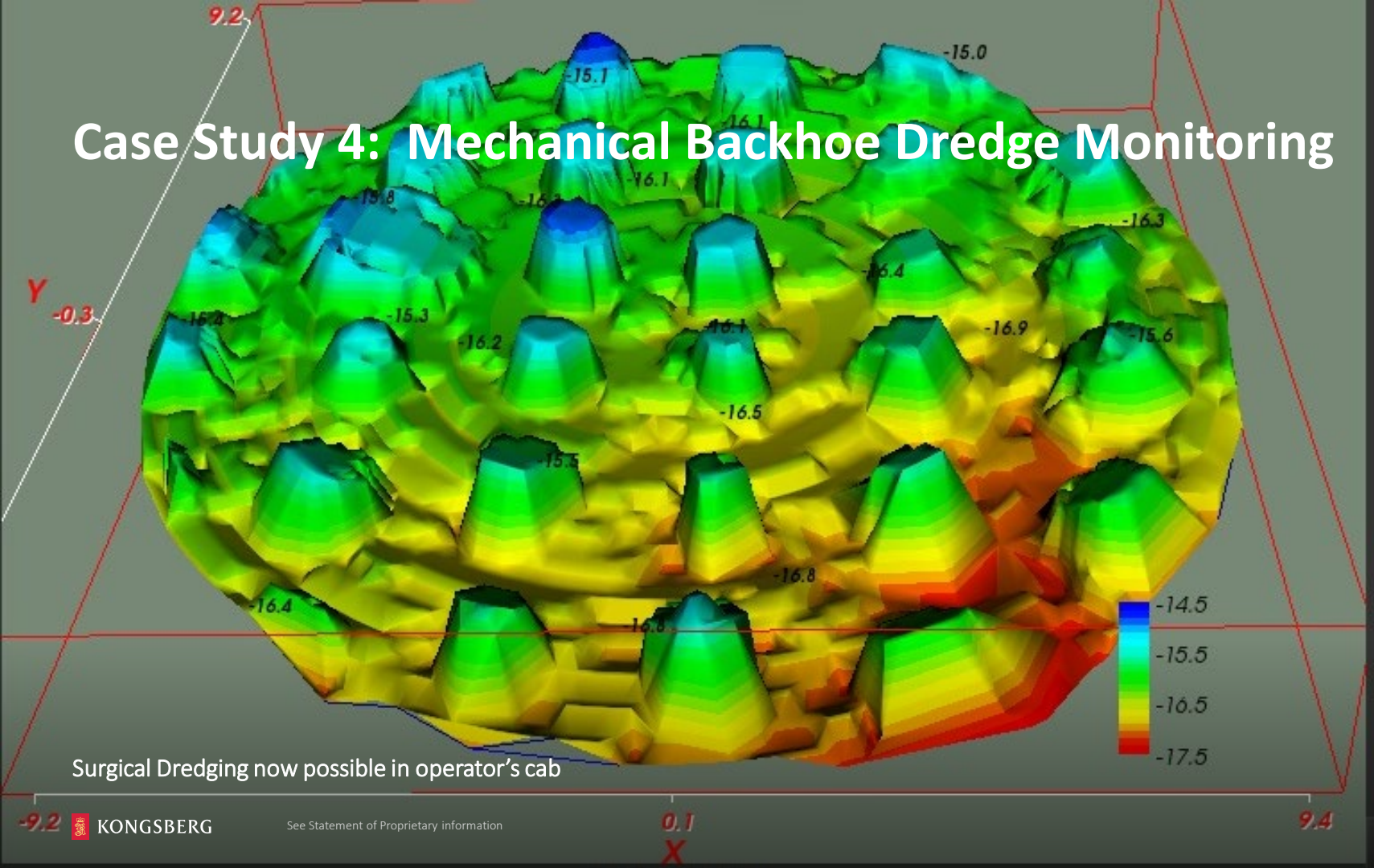
Surgical Dredging now possible in operator’s cab

Case Study 4: Mechanical Backhoe Dredge Monitoring





Case Study 4: Mechanical Backhoe Dredge Monitoring



Surgical Dredging now possible in operator's cab

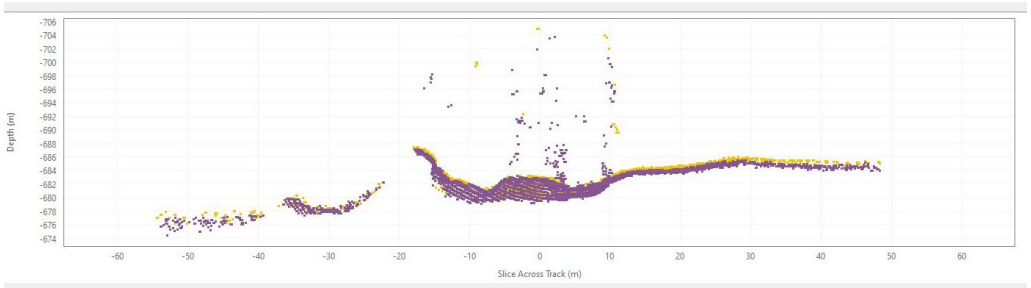
Settings

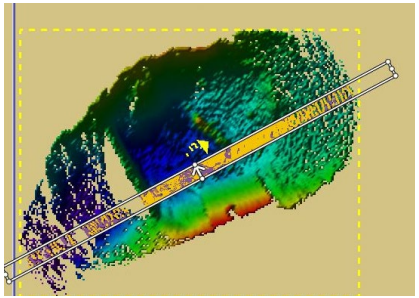
Surgical Dredging

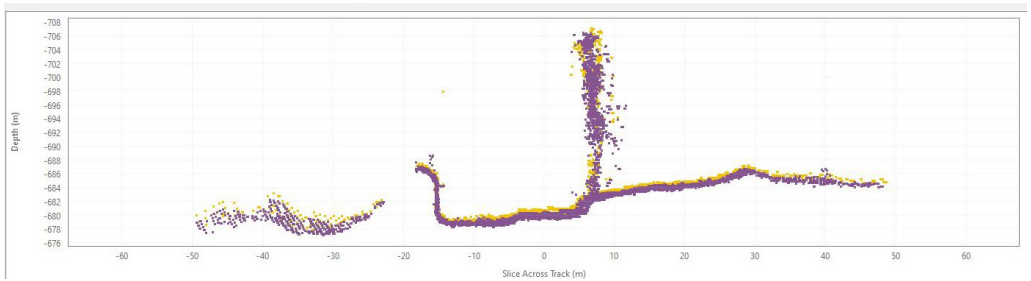
Case Study 5: Clamshell Dredge Monitoring

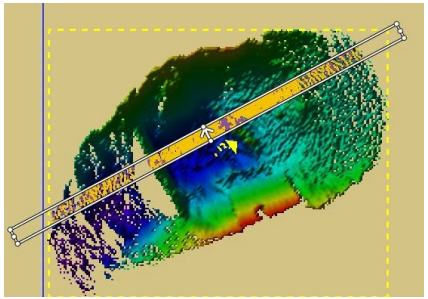
Surgical Dredging

Case Study 5: Clamshell Dredge Monitoring



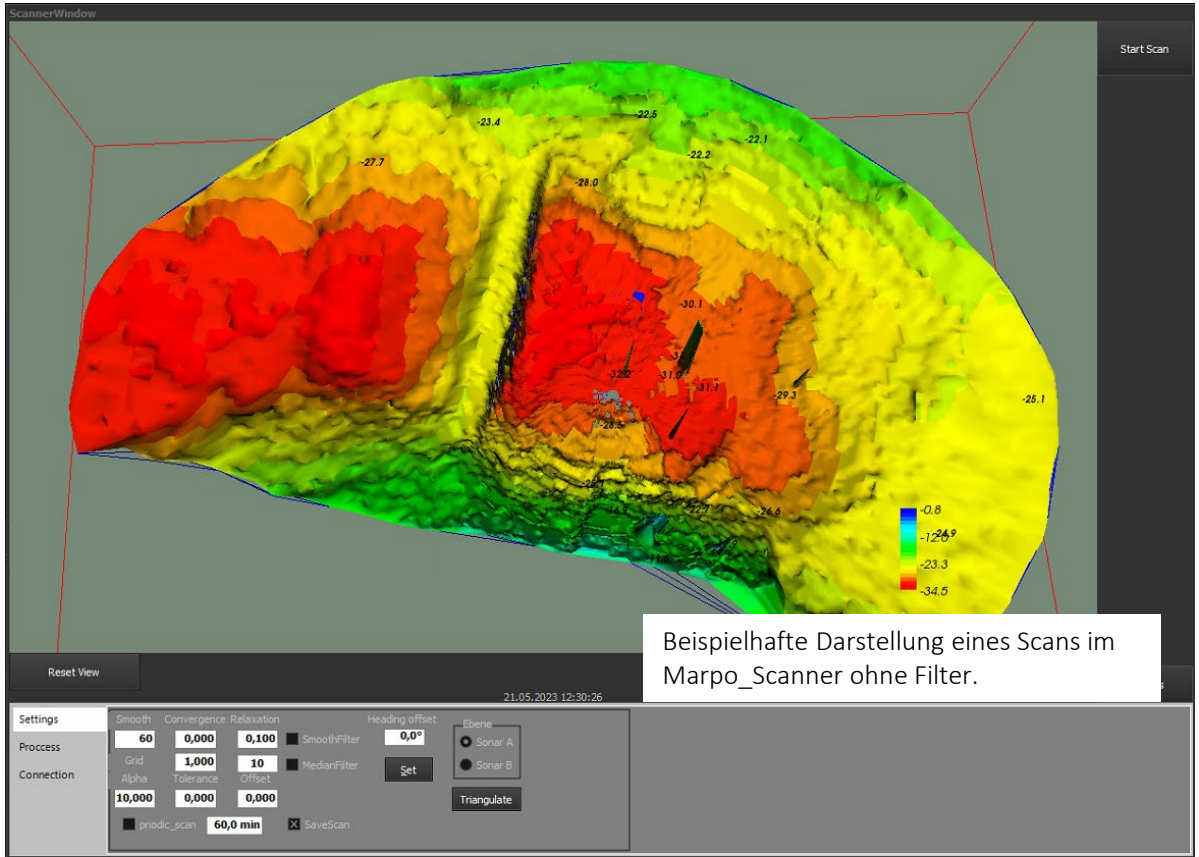






- Surgical Dredging

Case Study 5: Clamshell Dredge Monitoring



Beispielhafte Darstellung eines Scans im Marpo_Scanner ohne Filter.

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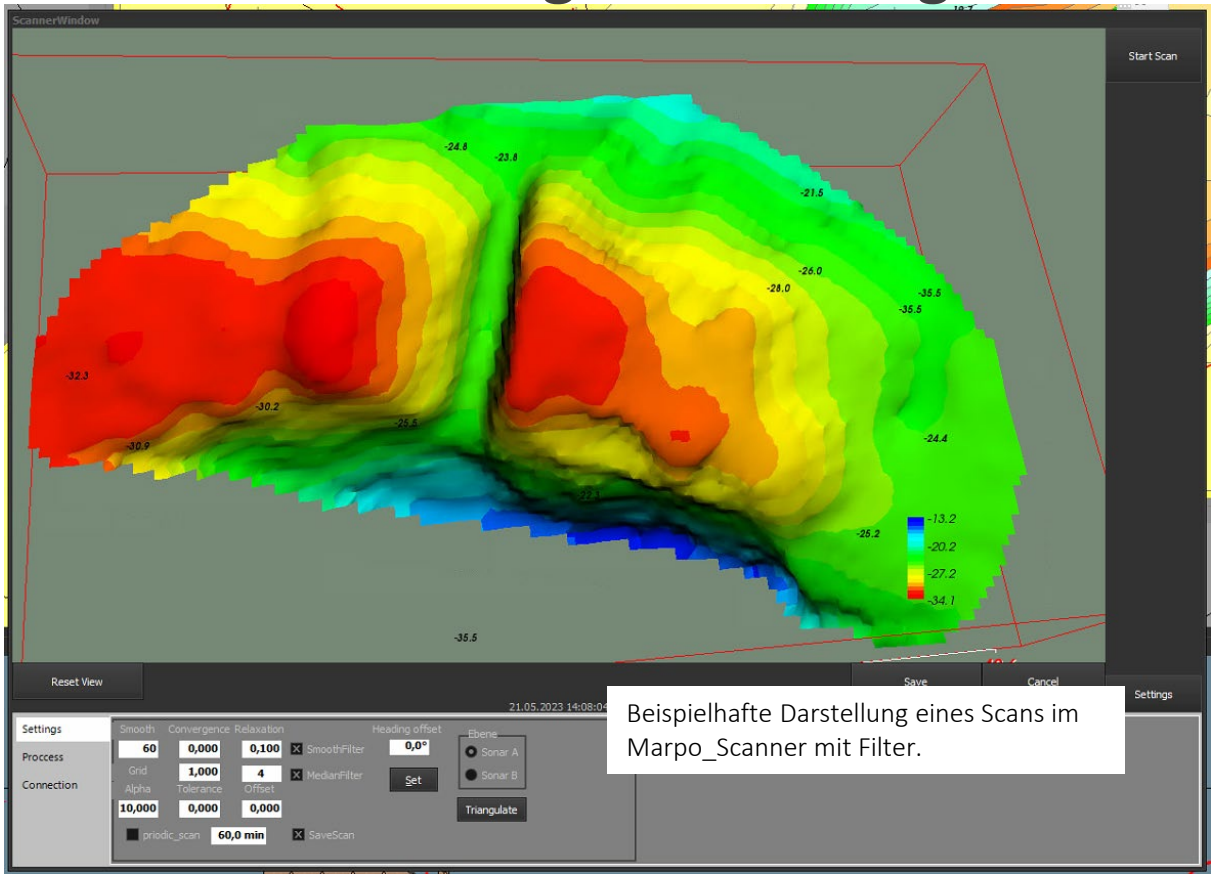
- Surgical Dredging

Case Study 5: Clamshell Dredge Monitoring



Beispielhafte Darstellung eines Scans im Marpo_Scanner mit Filter.

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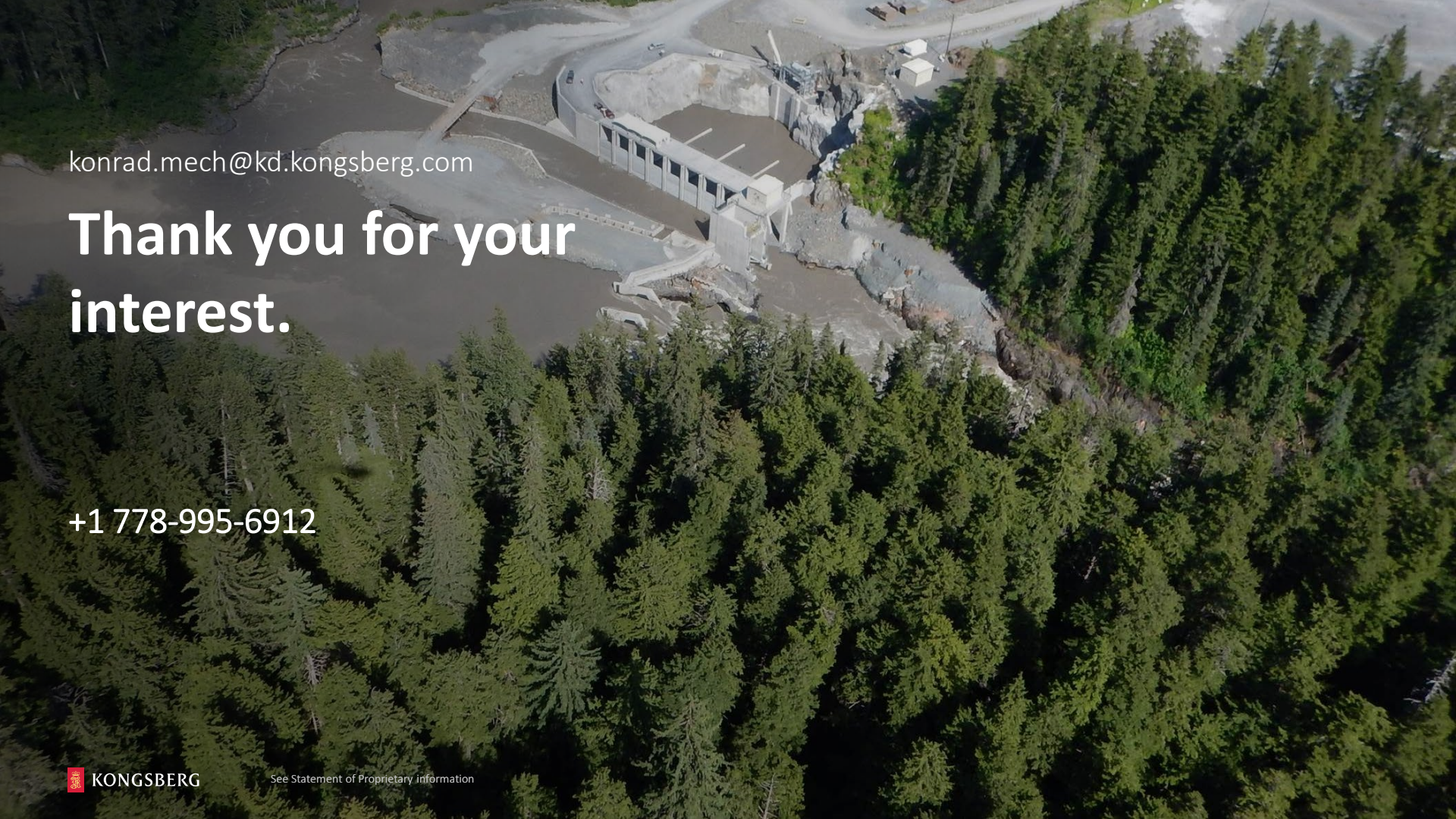
Summary

- Pre- and post-dredge survey becoming easier
  - Smaller, lighter craft
  - Lower cost systems

- Real-time monitoring of reservoirs means:
  - Mounting fixed sensors on the structure
  - Full understanding of rates of siltation
  - Trigger for dredge activity to minimize impact on operations
  - Increased safety for downstream conditions

- Real time monitoring during dredging means:
  - Mounting fixed sensors on the dredge platform
  - Reduced risk of damage to dam structure
  - Increased operator confidence
  - Lower costs due to higher efficiencies



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Thank you for your interest.

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