DAMSAFE

Pilot project on dam safety and water management in Karnataka

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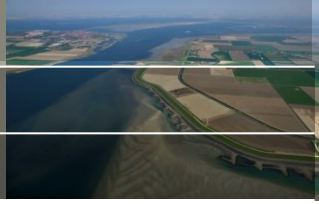
Content



- Dams and dikes in the Netherlands
- Introduction to the DAMSAFE project in Karnataka, India
- PS-InSAR dam deformation measurements
- Online monitoring and real time dam stability calculation
- Conclusion

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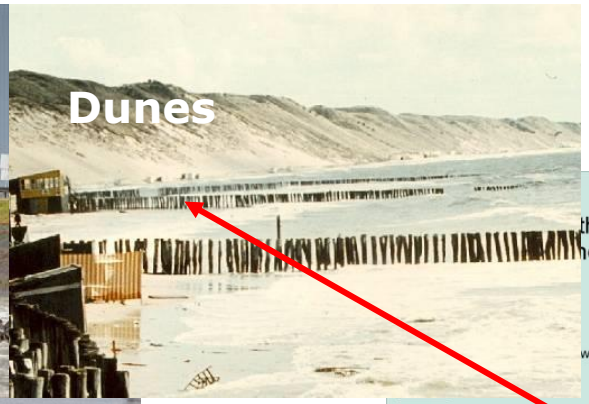
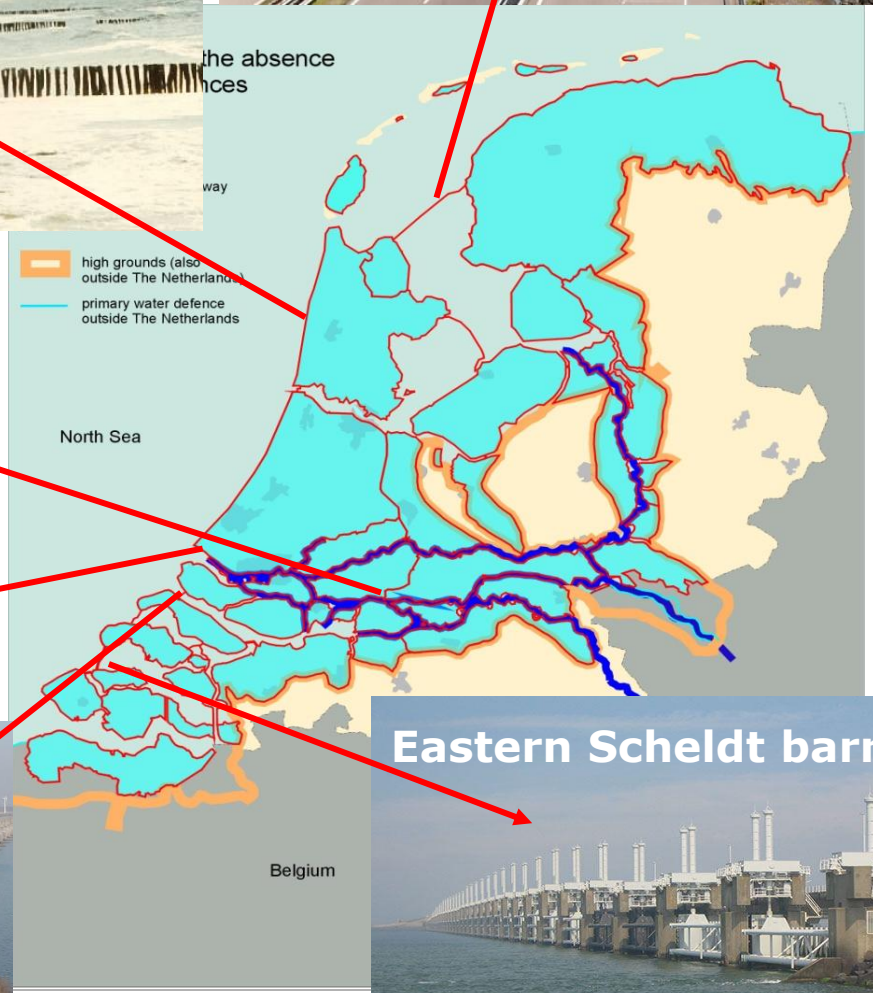
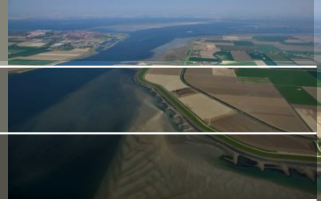
Flood defence the Netherlands





DAMSAFE pilot project in a nut shell



- Demonstrate innovative technologies for dam safety and water management on a site in Karnataka.

- Main stakeholders:
  - Karnataka Water Resources Department (KaWRD)
  - Central Water Commission (CWC)

- Technologies:
  1. Online monitoring by Royal Eijkelkamp
  2. PS-InSAR satellite imaging by SkyGeo
  3. Dam safety analyses software by iPresas
  4. FEWS-DAM integrating software by Deltares

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What do we want to achieve concretely?

Technologies: → / Solutions: ↓	PS-InSAR satellite imaging	In-situ monitoring system	Dam safety assessment software	Delft-FEWS software
1. Real time optimization of reservoir performance	**Save water**			
2. Optimize dam O&M (offline, risk based)	**Lower cost of O&M**			
3. Real time dam safety & flood risk forecasting	**Better crises decisions**			

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Bhadra (masonry) dam and spill way

Saddle (embankment) dams and revetment

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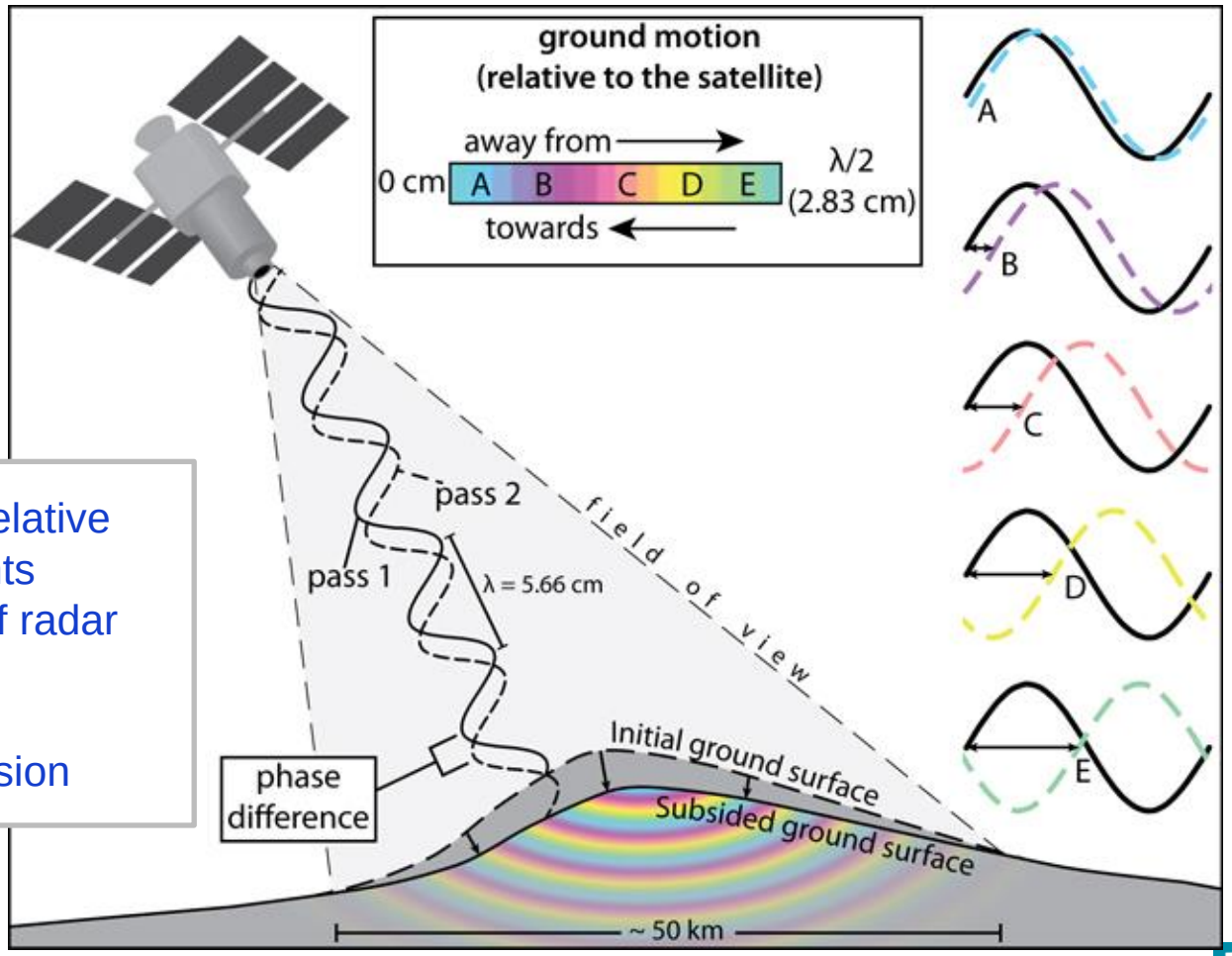
Spillway channel

Basic technical principle of InSAR

The shifts in the phase of the reflected radar waves between subsequent satellite images can be measured. This is used to obtain the high precision.



Measuring relative displacements as fraction of radar wavelength

→ *mm* precision

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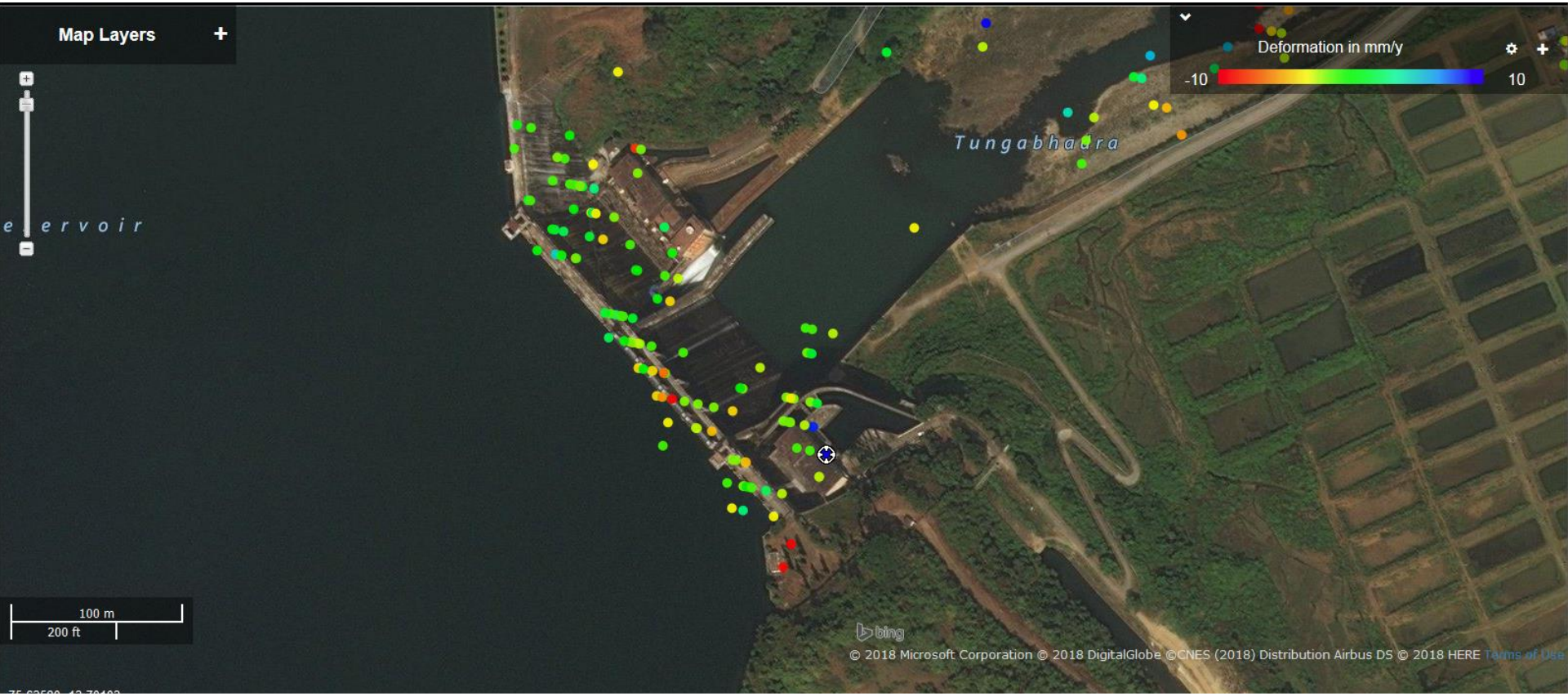
Basic technical principle of InSAR

Advantages:

- High precision of < 1 *mm/year*
- Large scale monitoring:
  Images are 30x50 *km* or bigger
- No site access required
- No hardware required
- High spatial density of measurements compared with alternative methods
  - Low resolution: 1 per 100 m^2
  - High resolution: 1 per 10 m^2

Deformation Bhadra main dam



Acquisition period September 2016 – March 2018

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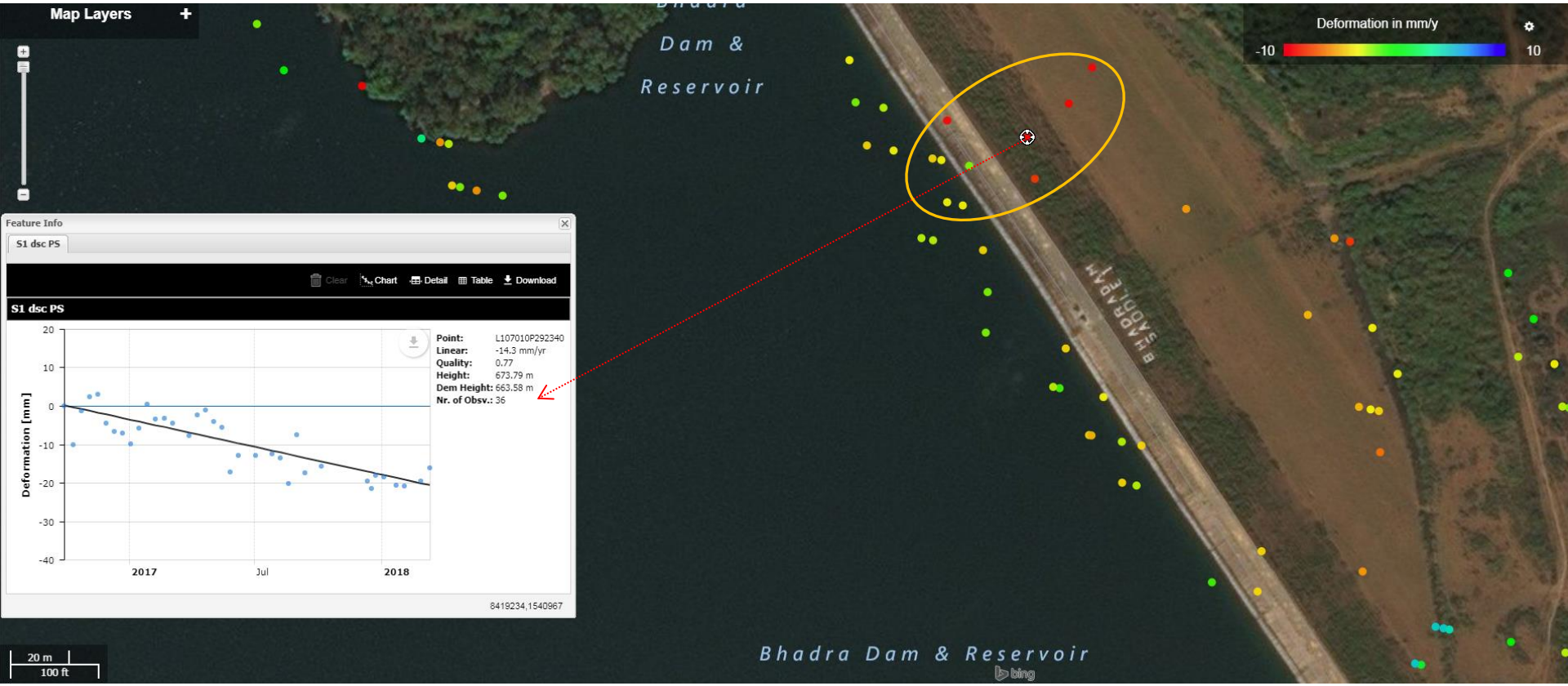
Deformation Bhadra saddle dams



Acquisition period September 2016 – March 2018

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Monitoring plan reservoir

Weather Station

Surface water level

Dike monitoring

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Monitoring plan dams

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Impression of the installation

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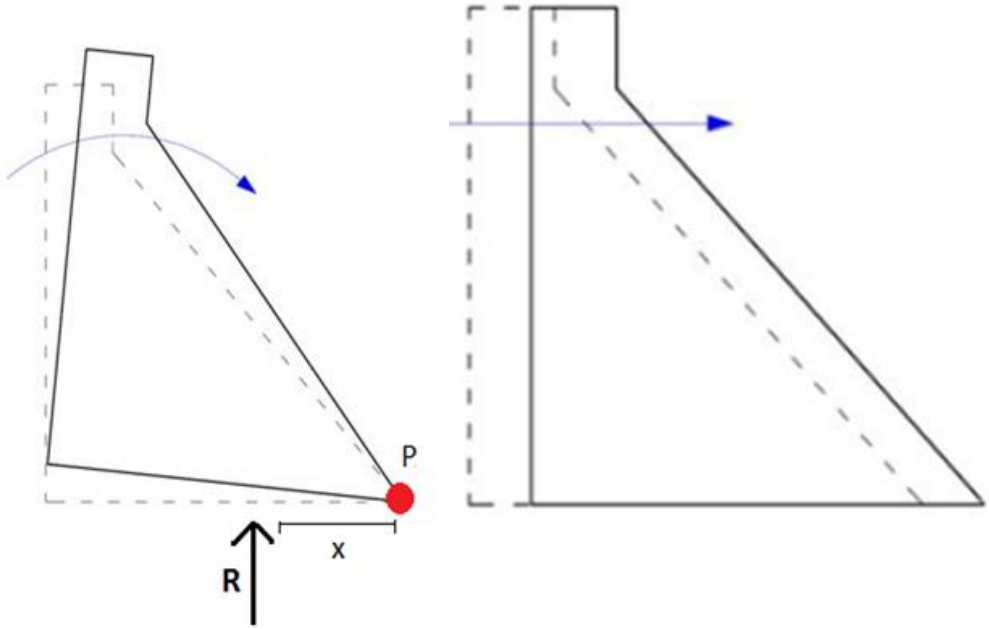
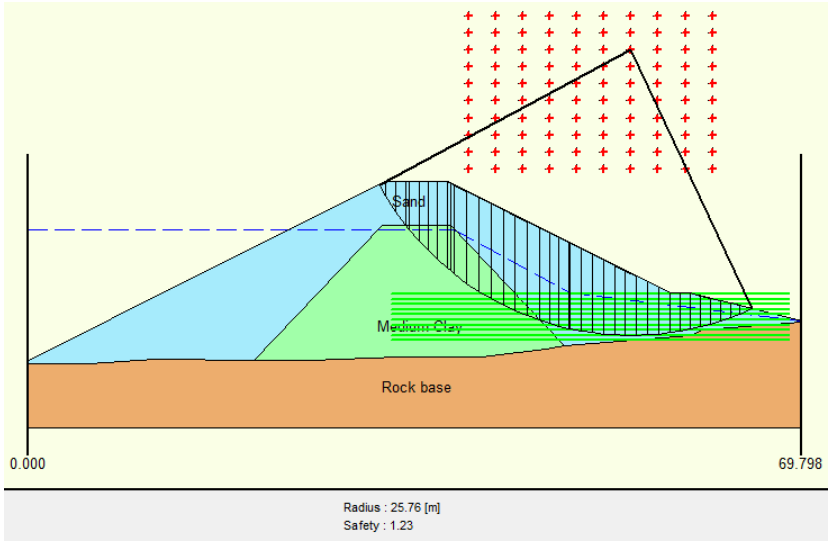
Dam Failure mechanism





Main Dam (masonry) overturning

Main Dam (masonry) Horizontal sliding

Saddle dam (earthen) Macrostability

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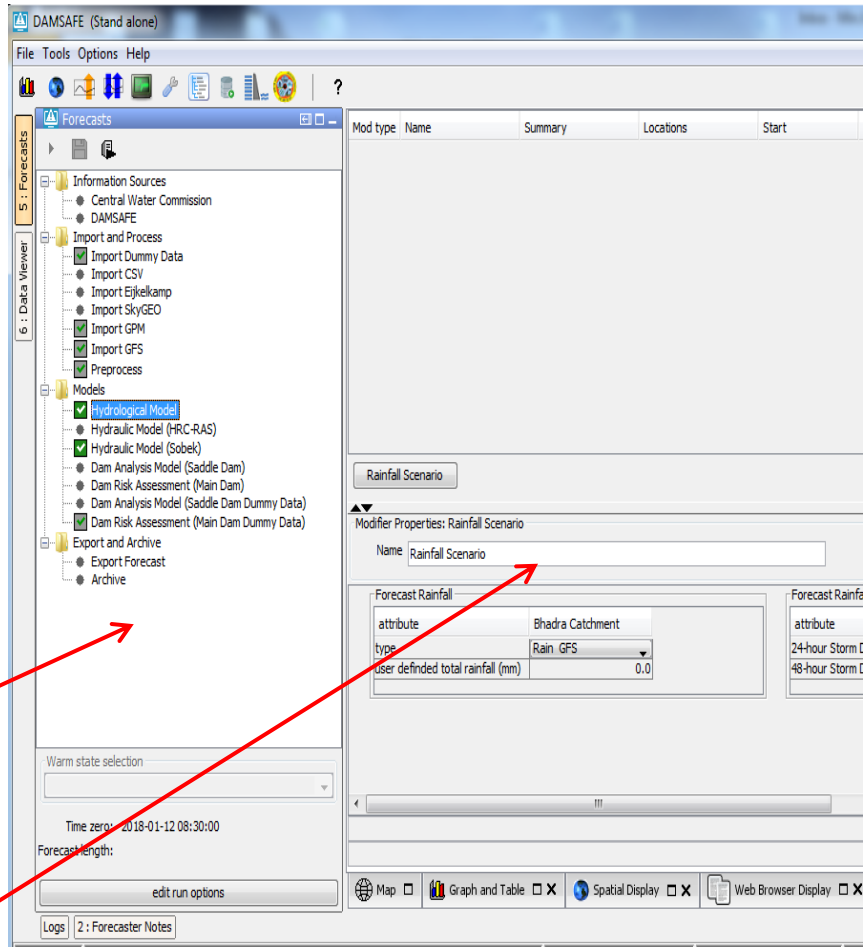
Integration with Delft-FEWS

1. Link different data feeds:
   - Eijkelkamp
   - SkyGeo
   - GFS and GPM
   - Earth2Observation
   - CSV (Offline data)
2. Link different models
   - Hydrological model (HEC-HMS)
   - Hydraulic model (Sobek)
   - Dam analysis model (Dam-live)
3. Create forecasting trees and specify different scenarios



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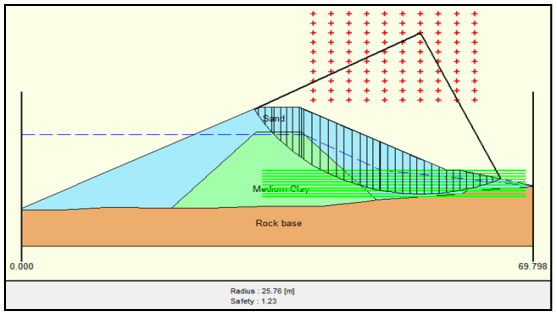
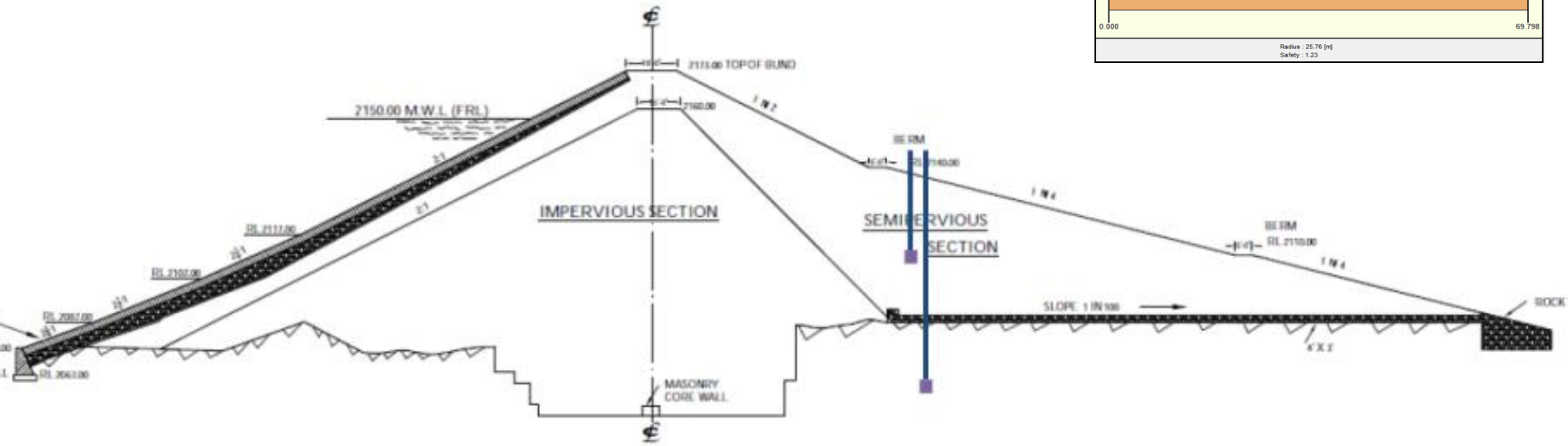
Pore water pressure sensors saddle dam 1

Macro stability failure mechanism





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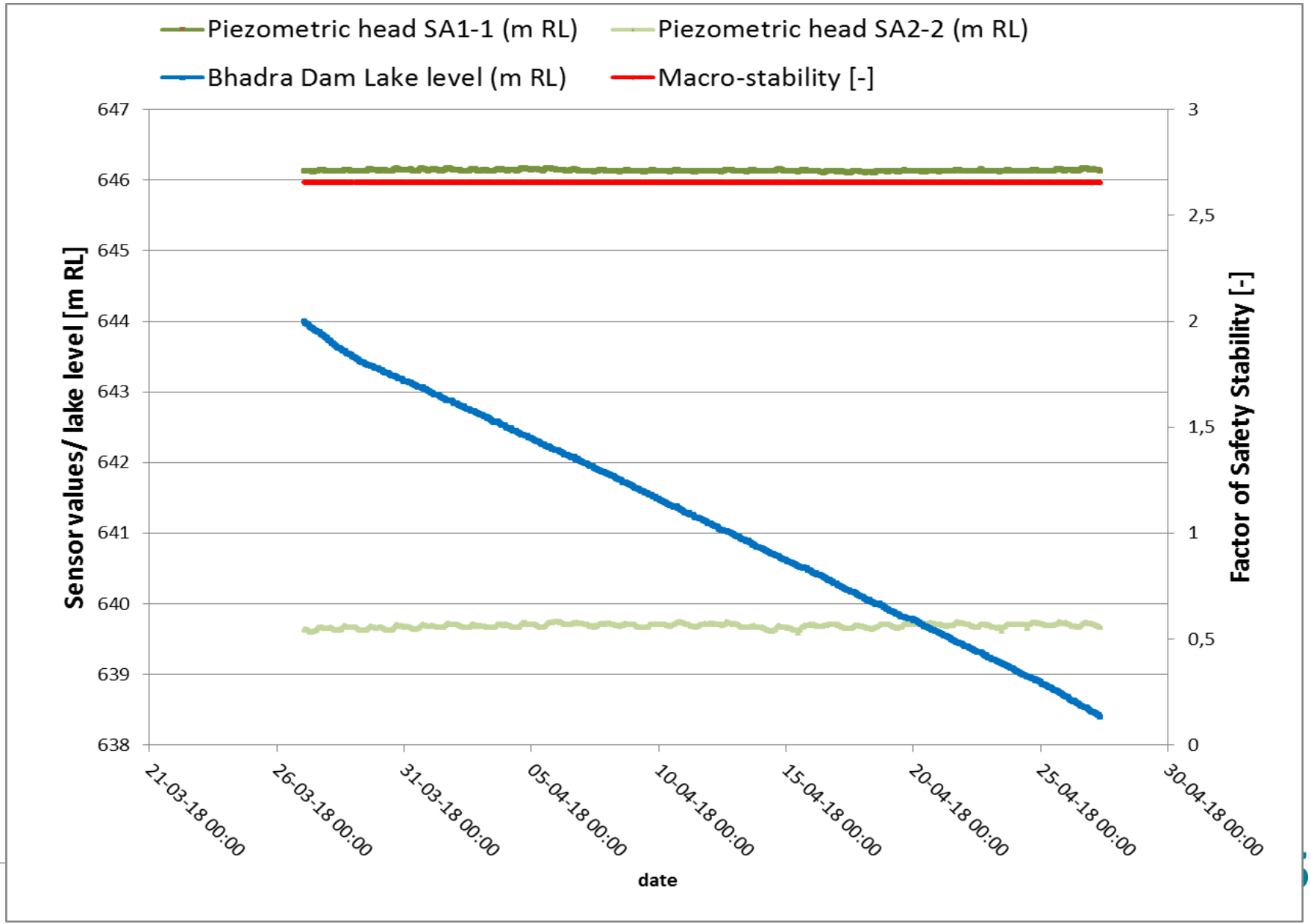
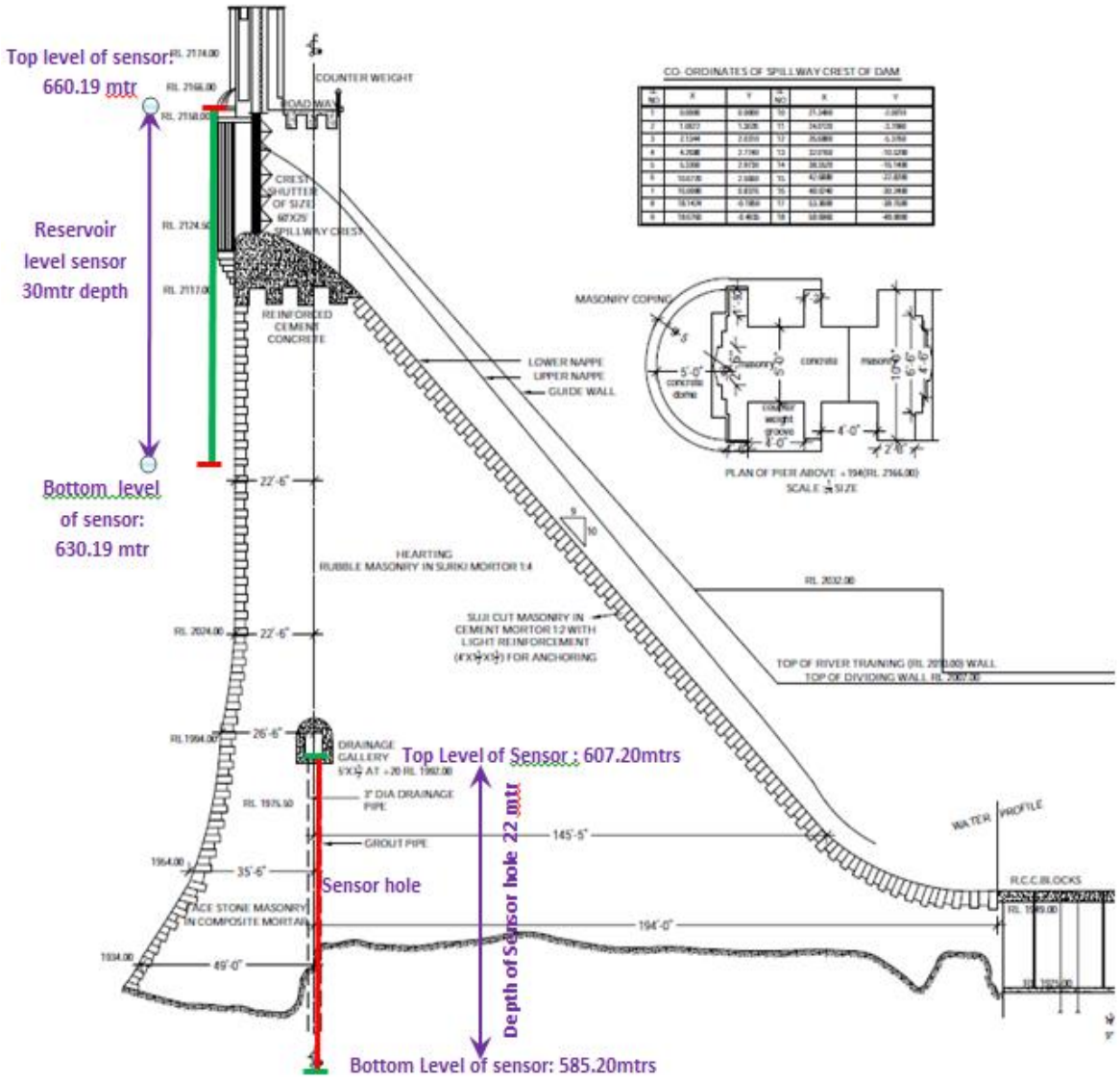
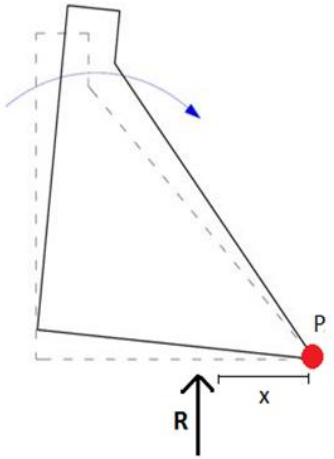
Real time stability evaluation main dam

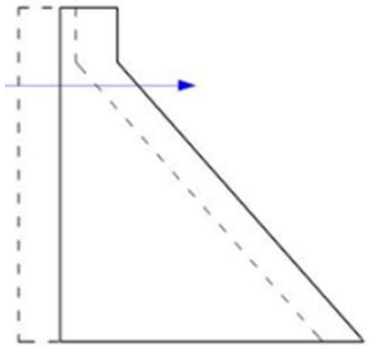


Water level and pore water pressure sensors





Overturning failure mechanism



Sliding failure mechanism

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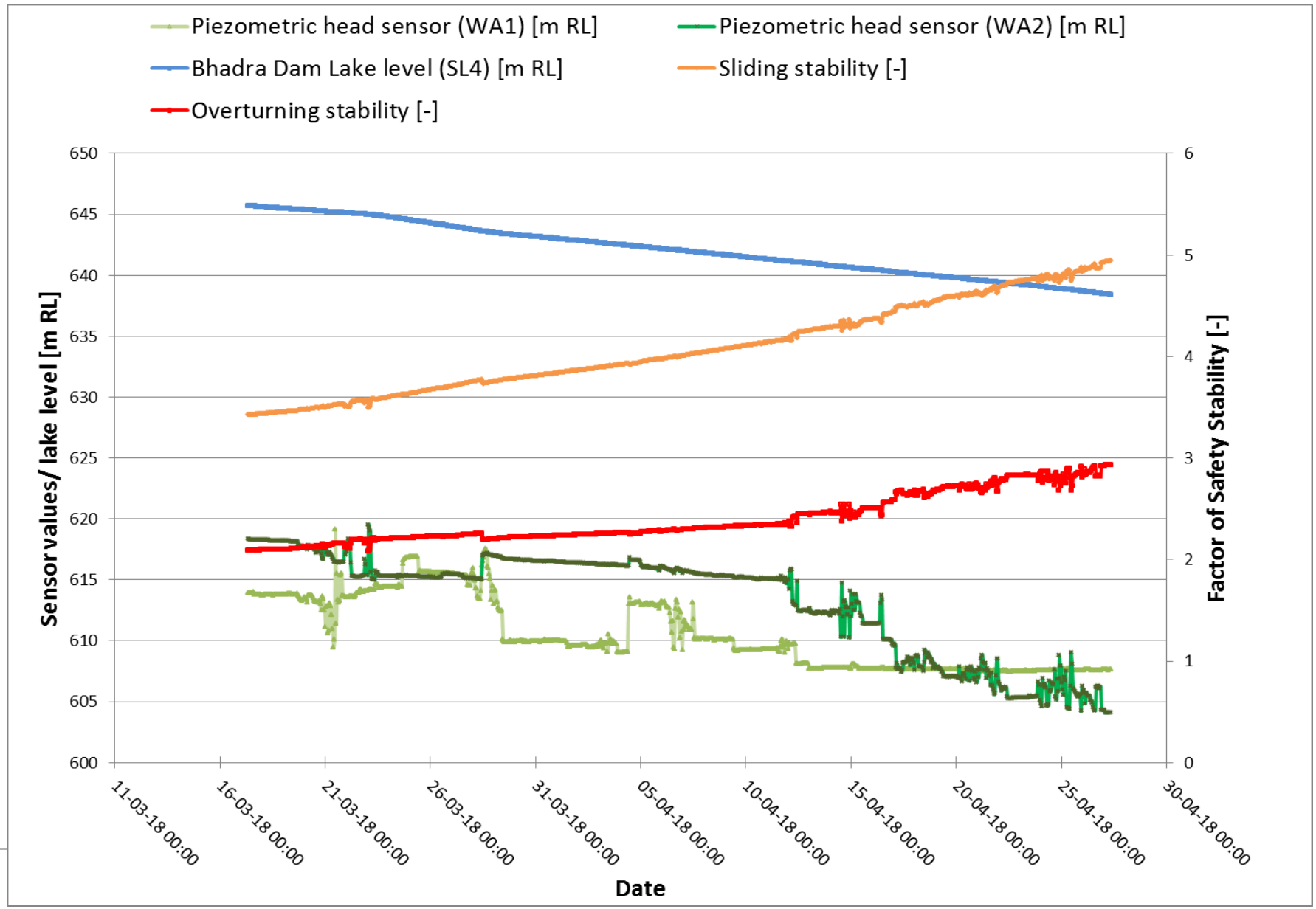
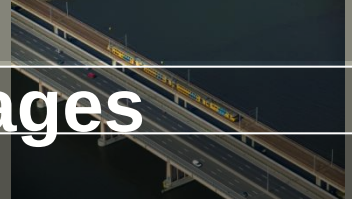
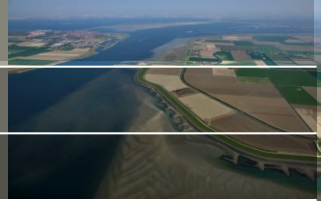
Real time stability evaluation main dam



Conclusion / take away messages





- PS-InSAR (radar) measurement are able to detect anomalies in the dam deformation pattern indicating a possible deterioration process enabling optimization of Operation and Maintenance (O&M).

- The integration of in-situ measurements with numerical calculations using the Delft-FEWS software platform is used to calculate the stability of the dam in real time enabling the dam owner to control flood risk.

- A next step will be the correlation between observed water levels in the reservoir and the pore-water pressure measurements. The forecasting of expected water levels at the dam will then allow for forecasting of dam stability days ahead.

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Thank you!