



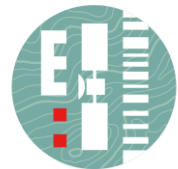
3rd International Workshop
3D Underwater Mapping from Above and Below

Monitoring a flooded open-cast mine with combining remote sensing techniques

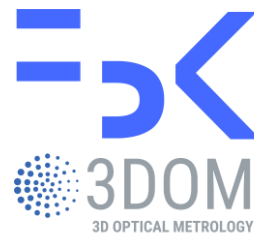
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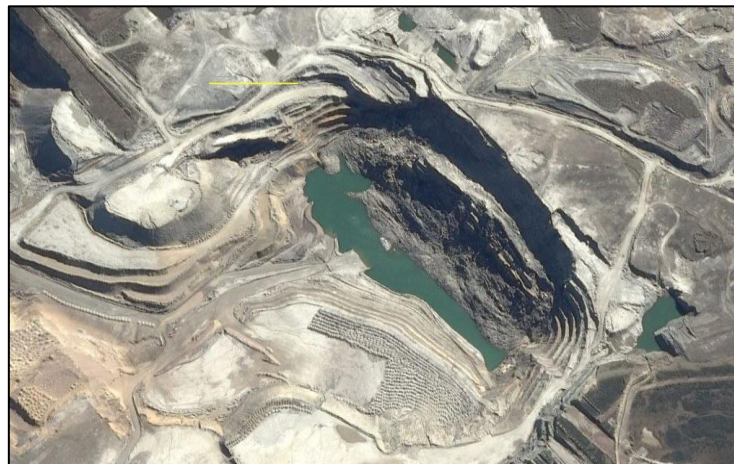


INTRODUCTION & AIM

- Open-cast mining can cause **long-term environmental changes** in surrounding areas.
- **Systematic monitoring** — especially of water reclamation — is essential to assess and predict geotechnical and hydrological risks.

To integrate remote sensing data for comprehensive monitoring of flooding and its effects in a reclaimed open-cast mine.

The Mina Pecket open cast coal mine (Chile), 2013



STUDY SITE

Post-Mining Excavation

- Location: Stanisław Mine, SW Poland
- Post-mining site under water reclamation
- Water source: precipitation & groundwater
- Clay soils form an impermeable layer

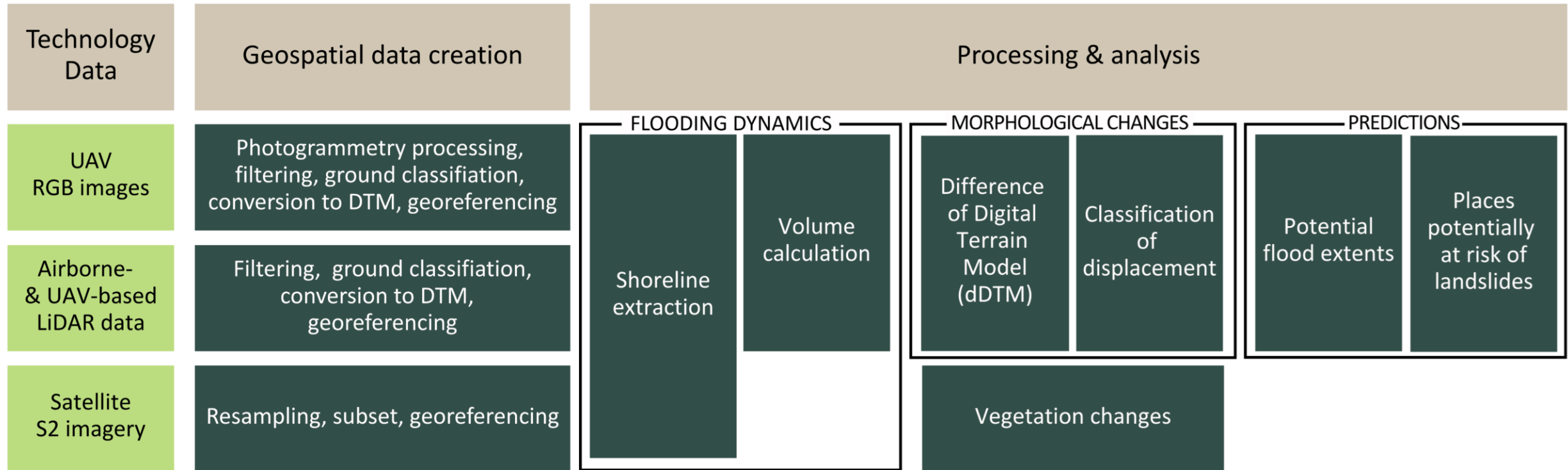


DATASETS

Technology	Date of measurement	Type of data	GSD / Resolution / Density
ALS	02.04.2019	LiDAR	8 pts/m ²
UAV	02.12.2022	RGB images	0.05 m
	13.09.2023	RGB images	0.05 m
	21.10.2024	LiDAR + RGB images	120 pts/m ²
Satellite	01.04.2019	S2 imagery (13 bands)	10
	06.11.2022	S2 imagery (13 bands)	10
	12.09.2023	S2 imagery (13 bands)	10
	26.10.2024	S2 imagery (13 bands)	10

Description of the used datasets.

METHODS



Workflow of the proposed methodology.

RESULTS

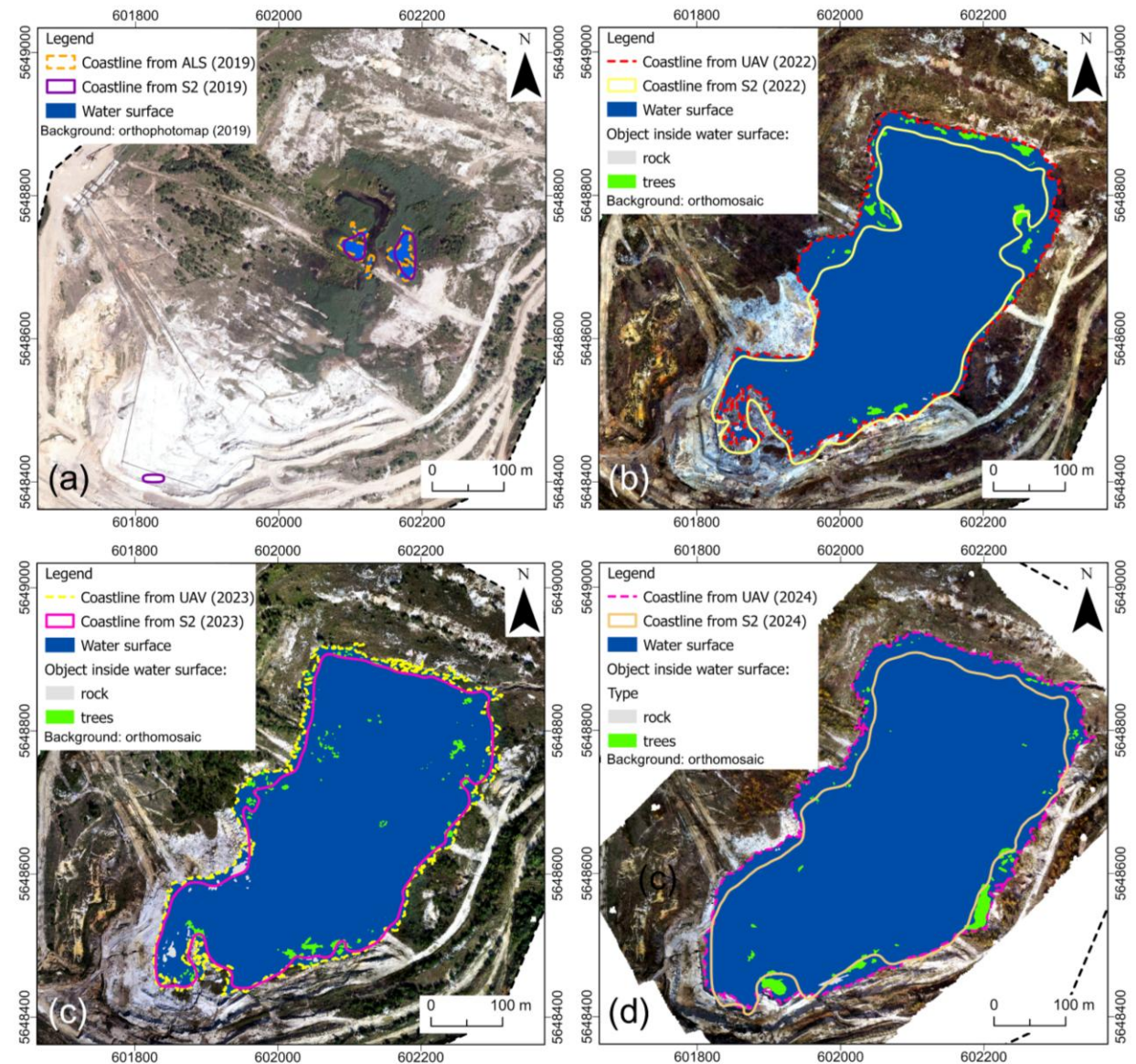
Flooding dynamics

Methods used for water surface extraction:

- RGB images & LiDAR data obtained from the UAV and ALS – manual segmentation
- Sentinel-2 imagery – NDWI index

Date	Sensor	Water area [m ²]	Increase volume [m ³]
2019	ALS	2332	-
	S2	2186	+469636
2022	UAV	116478	
	S2	102013	
2023	UAV	125780	+244561
	S2	114025	
2024	UAV	155862	-
	S2	132097	

Statistics presenting the dynamics of changes in a flooded open-cast mine.



Reservoir shorelines generated based on UAV, ALS and satellite data: (a) 2019, (b) 2022, (c) 2023, and (d) 2024.

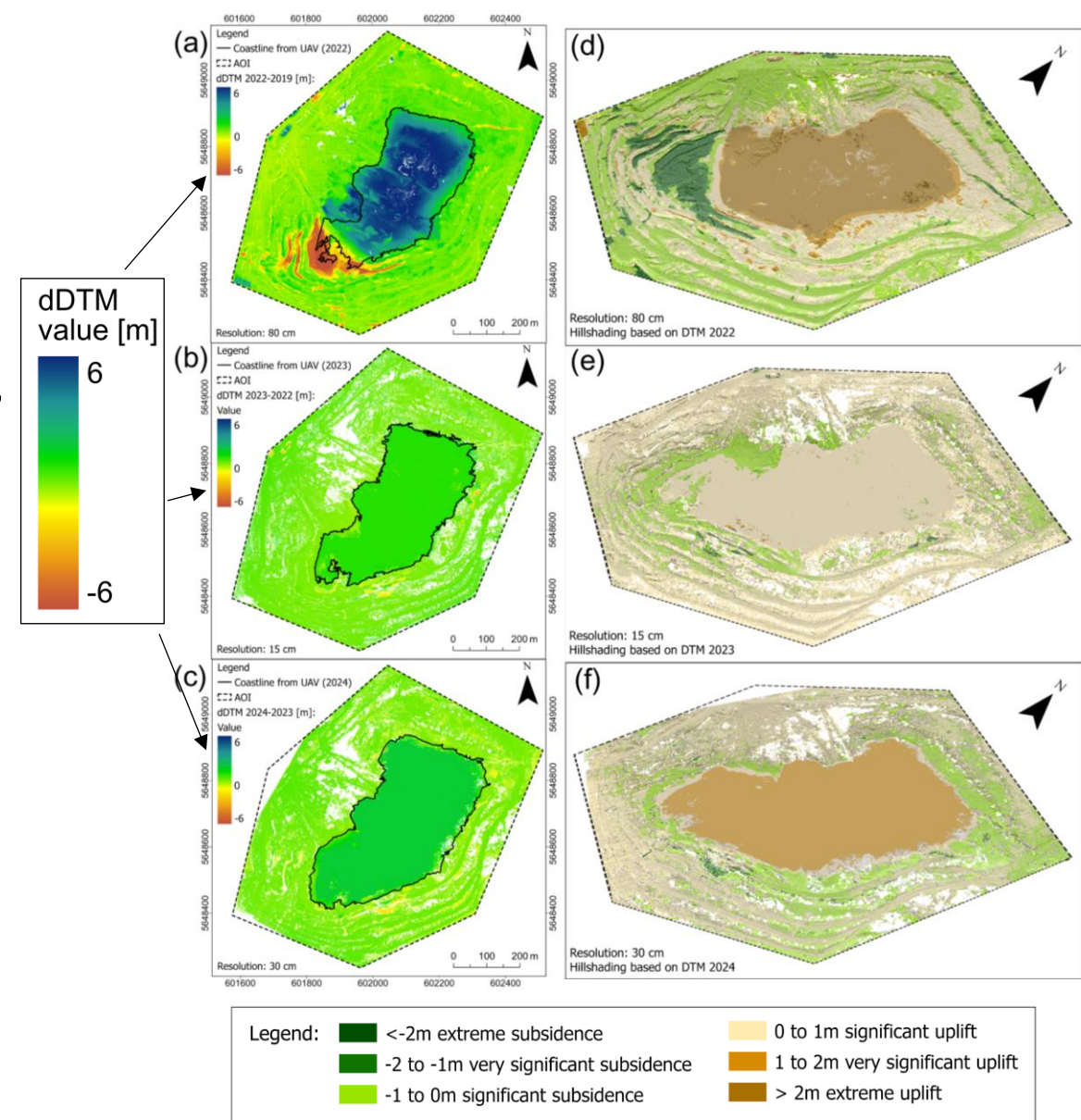
RESULTS

Morphological changes

- **Rising water levels:** water level increased by 0.8 m (2022–2023) and 1.8 m (2023–2024), triggering visible ground deformations
- **Mass movements detected:** largest occurred between 2019–2022, with displacements up to 8 m in some areas

Class	Value
Extreme subsidence	< - 2 m
Very significant subsidence	-2 to -1 m
Significant subsidence	-1 to 0 m
Significant uplift	0 to 1 m
Very significant uplift	1 to 2 m
Extreme uplift	> 2 m

Classification of morphological changes based on vertical elevation differences.

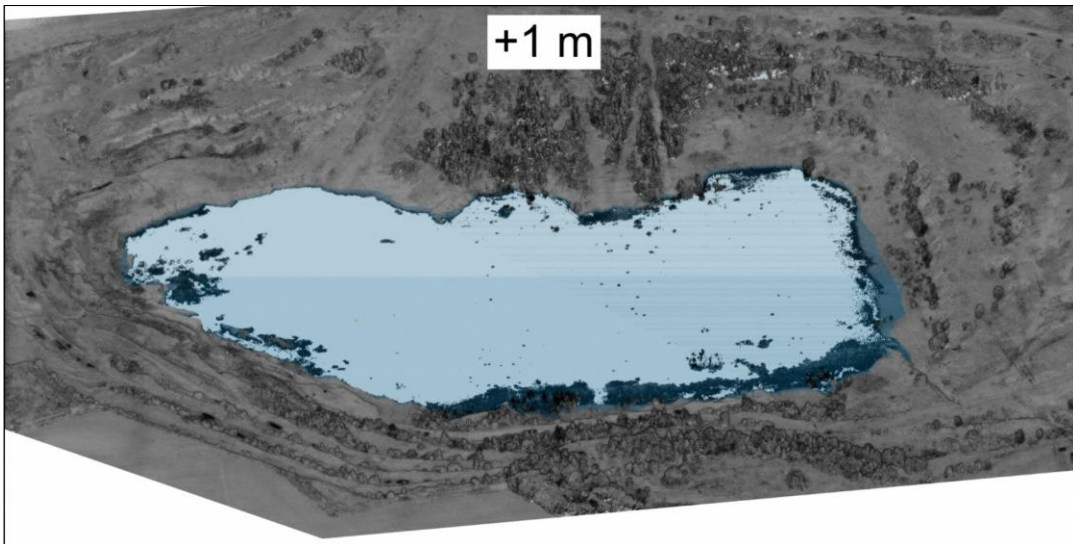


dDTM (a–c) and classification of displacement based on significance (d–f) for: (a, d) 2019–2022, (b, e) 2022–2023, and (c, f) 2023–2024.

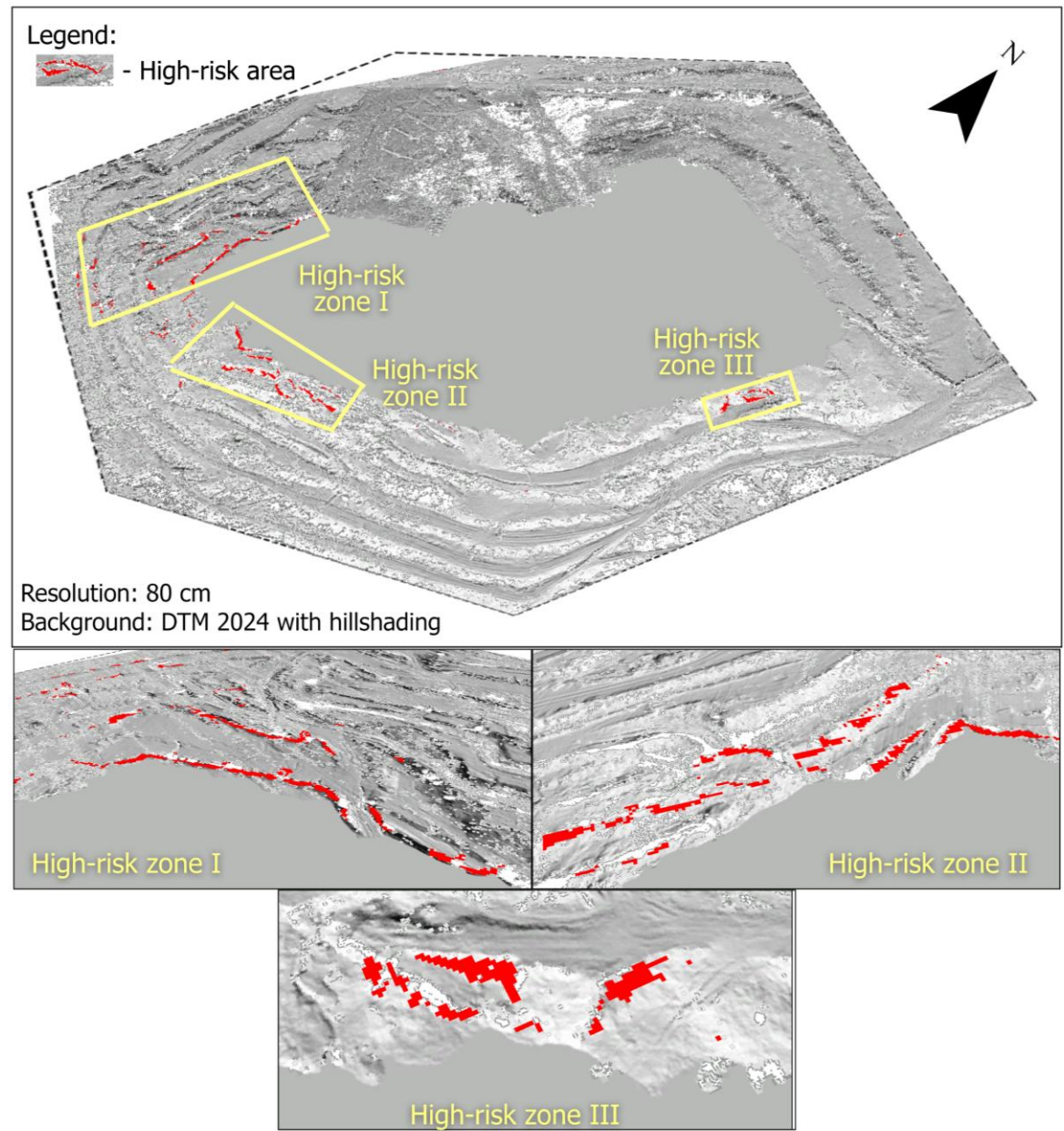
RESULTS

Predictions

- **Terrain deformation analysis:** significant uplift (>1 m) and subsidence zones (<-1 m) were extracted from dDTM layers
- **Integrated risk assessment:** zones overlaid with slopes $>20^\circ$ and low vegetation to identify areas prone to surface instability



Prediction of water surface cover on the 2024 DSM model after an increase.



High-risk zone detection based on DTM from 2024 analysis.

- **Combined UAV, airborne, and satellite data** enables **comprehensive monitoring** of flooded areas and restoration efforts.
- Integration of UAV, LiDAR, and Sentinel-2 data supports precise tracking of **shoreline, water volume, landforms, vegetation, and future landscape changes**.
- The modular methodology is **adaptable to diverse post-mining environments** and data sources.
- It aids **long-term decision-making** in reclamation planning, especially for water management.
- Future research will apply echo-sounder bathymetry to analyze **bottom changes** and **improve understanding of water reclamation**.



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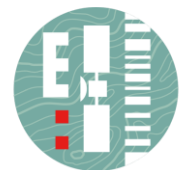
THANK YOU FOR YOUR ATTENTION!

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3DOM
3D OPTICAL METROLOGY

