Measures to mitigate torrential hazards in a typical alpine catchment area in Slovenia

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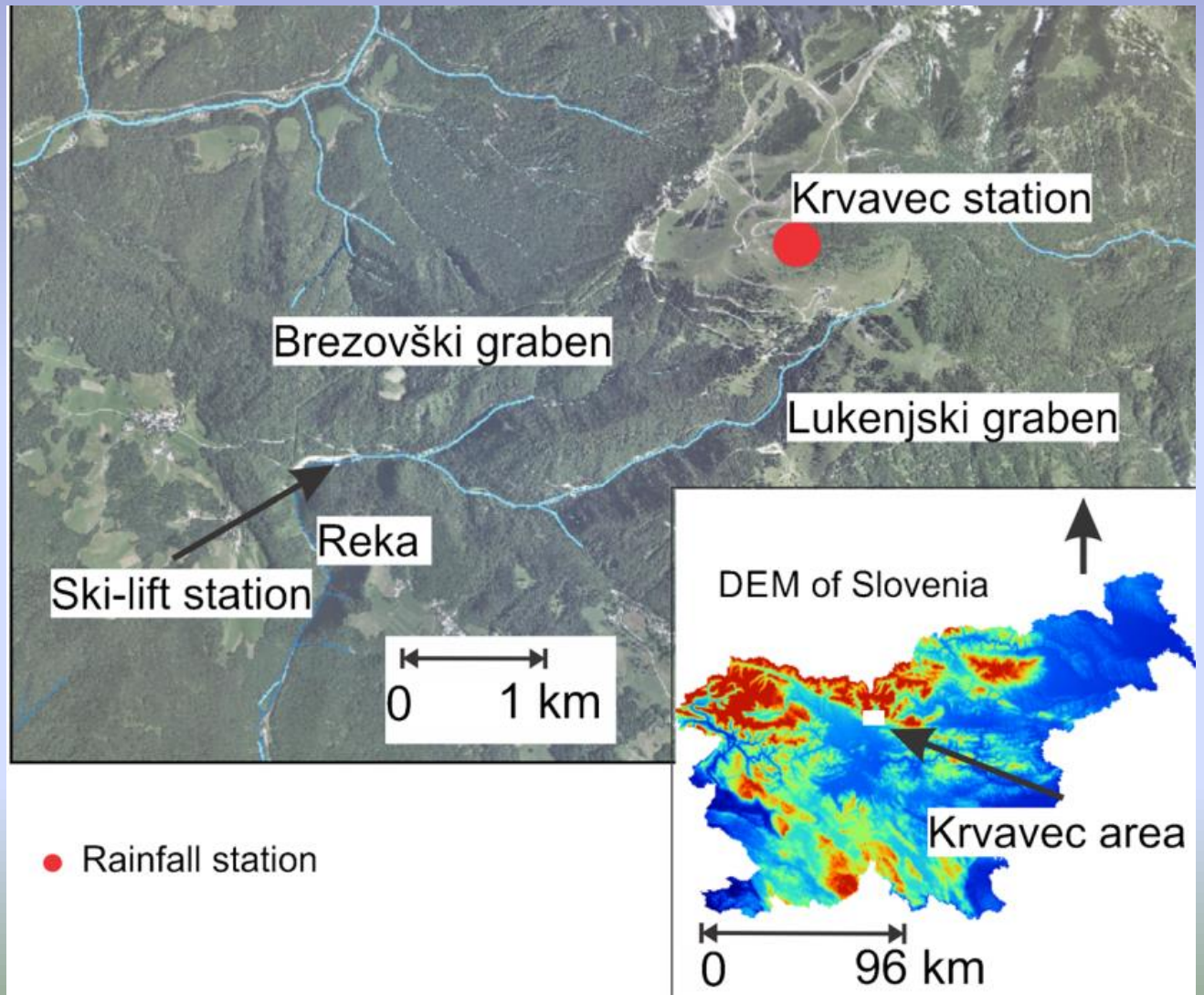
Slovenia

- 20.273 km^2
- Population aprox. 2.000.000

Krvavec resort – Kamnik – Savinja Alps

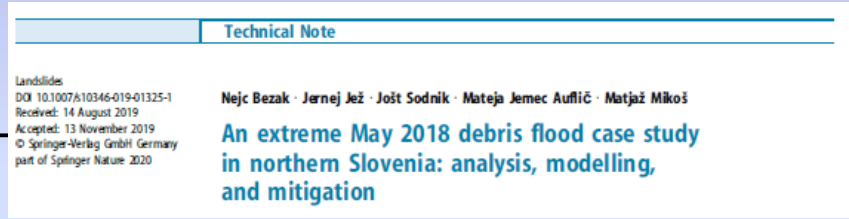
- 1450-1970 m.a.s.l., established in 1958



Introduction – about our case study

- Problematic torrential area with low maintenance investments in the past, unprofessional solutions
- Critical infrastructure of the resort and municipality exposed

May 2018 event


Technical Note

Landslides
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Nejc Bezak · Jernej Jež · Jošt Sodnik · Mateja Jemec Auflič · Matjaž Mikoš

An extreme May 2018 debris flood case study in northern Slovenia: analysis, modelling, and mitigation

- Immediate response of Slovenian Water Agency
- Plans and implementation
- Research of process and materials

- Floods August 2023

May 30th 2018 event

- 50 mm precipitation in 30 minutes ≈ 50 year return period
- Numerous landslides in the catchment area turned into mass flows – 10.000 m^3 of deposition + 10.000 m^3 in the channel

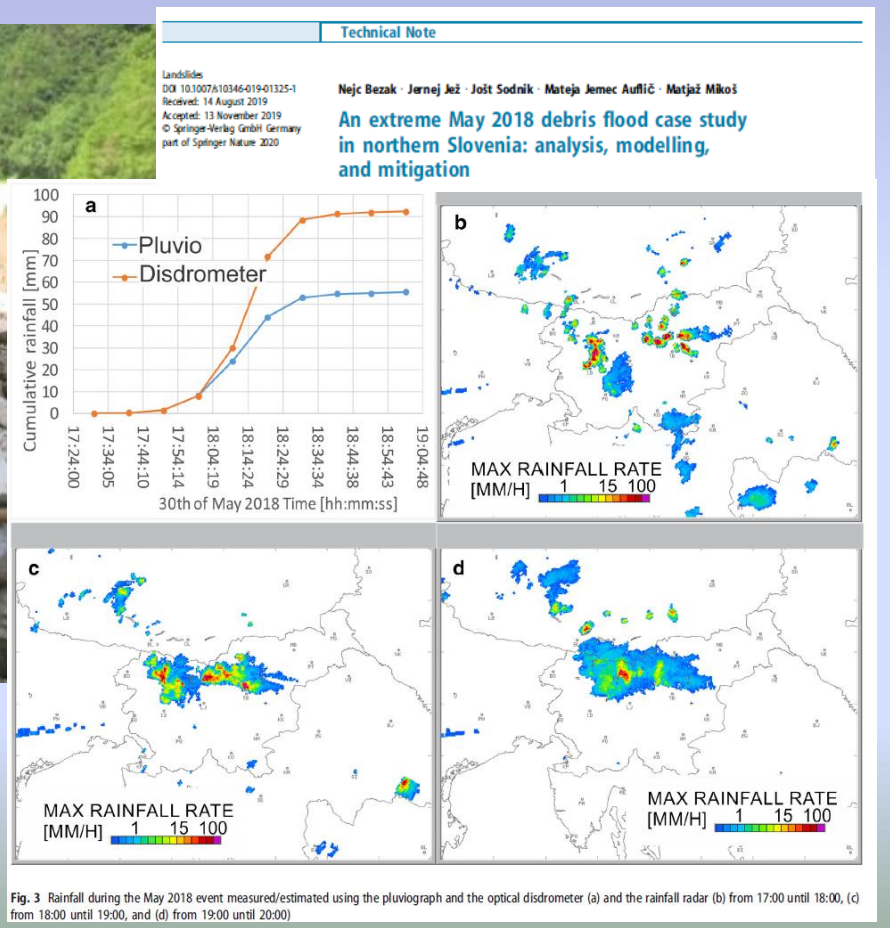
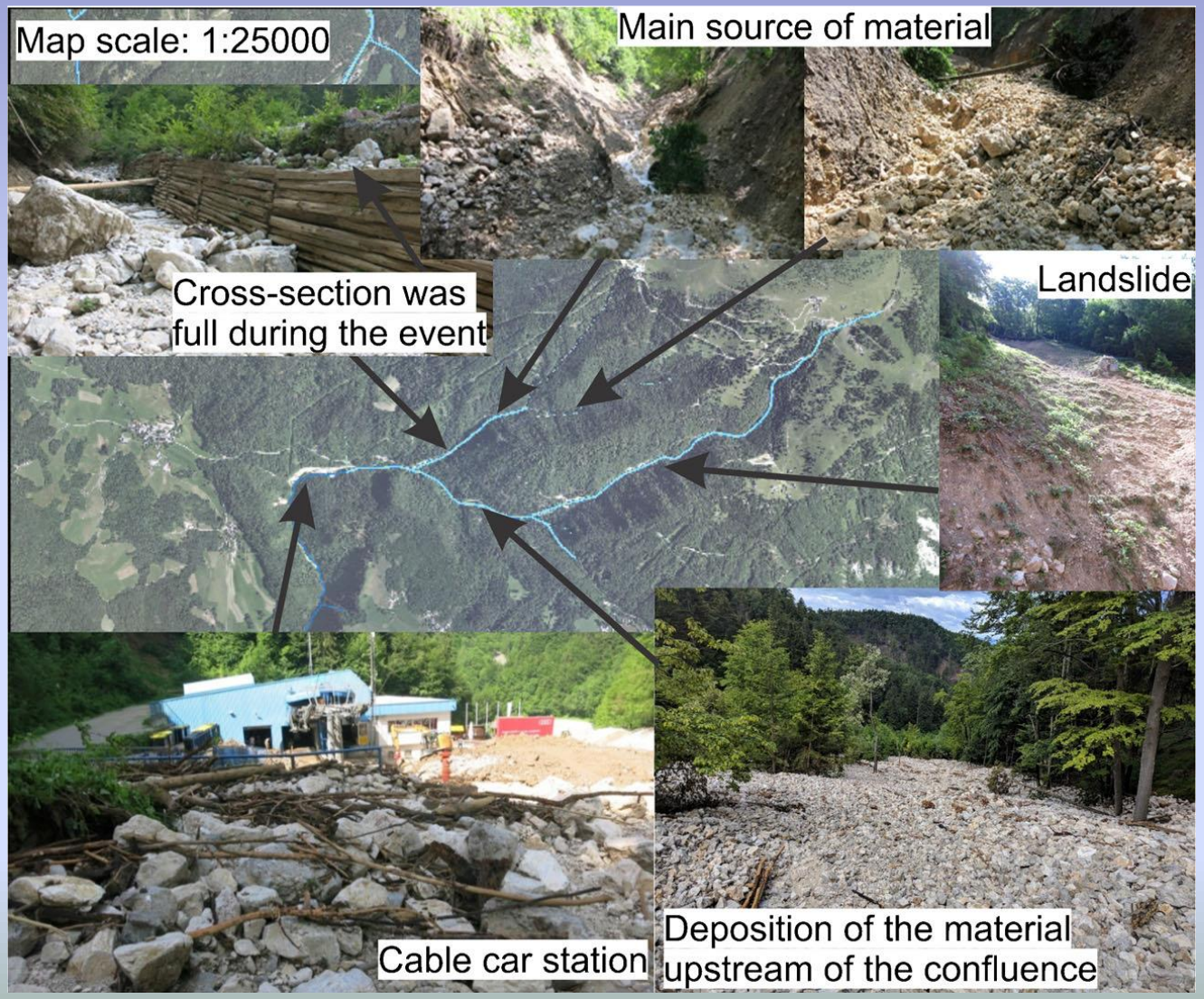
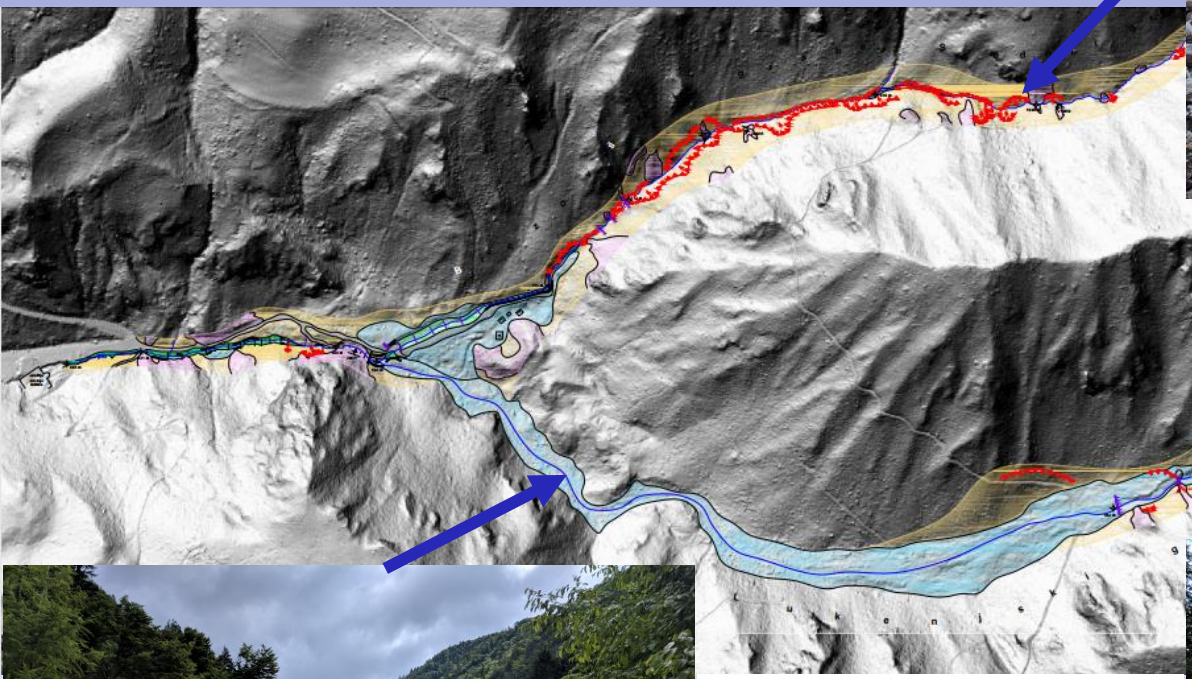


Fig. 3 Rainfall during the May 2018 event measured/estimated using the pluviograph and the optical disdrometer (a) and the rainfall radar (b) from 17:00 until 18:00, (c) from 18:00 until 19:00, and (d) from 19:00 until 20:00)

May 30th 2018 event



Geological settings of the catchment area

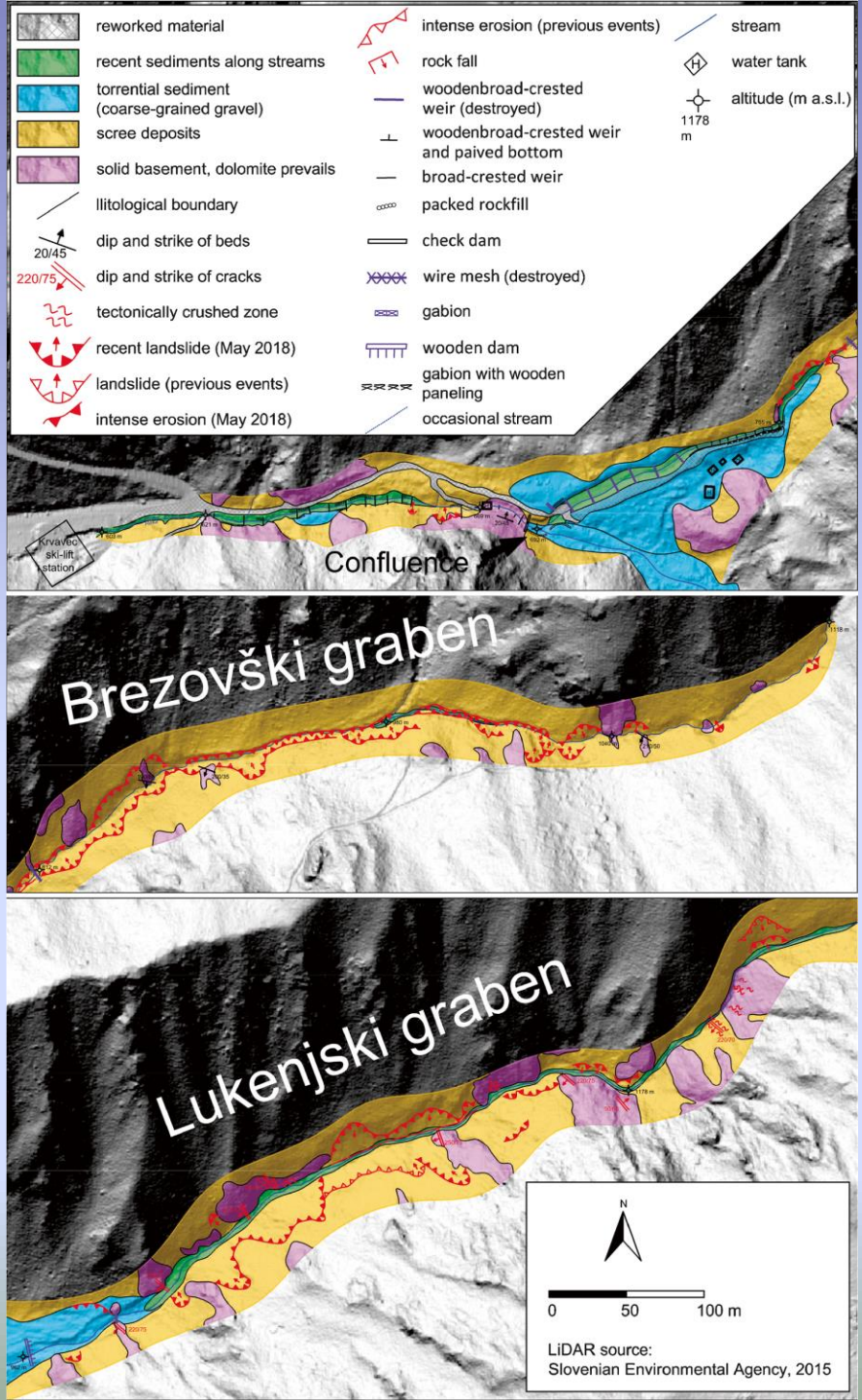


torrential sediment (coarse-grained gravel)

scree deposits

solid basement, dolomite prevails

Geological settings of the catchment area



Conceptual design (mitigation) – 3 phases

applied sciences

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Article

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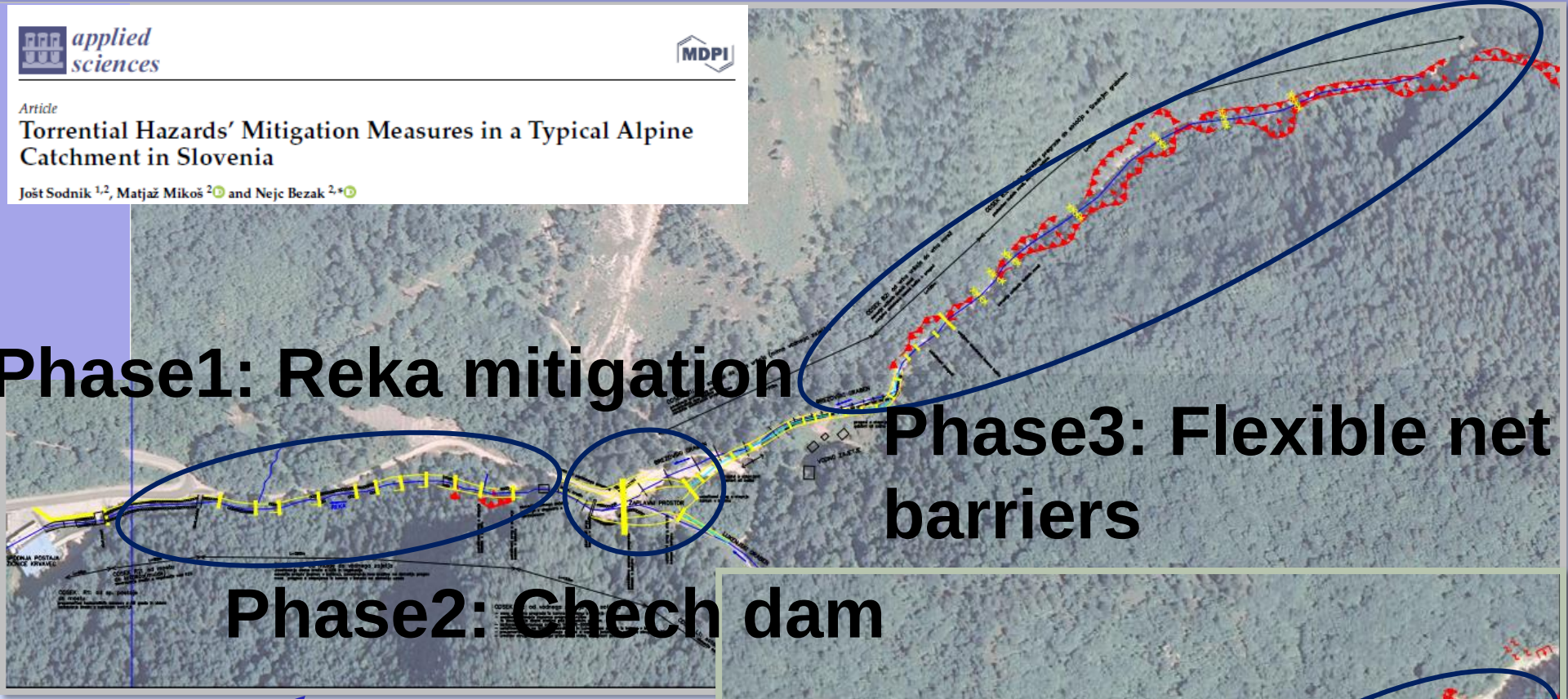
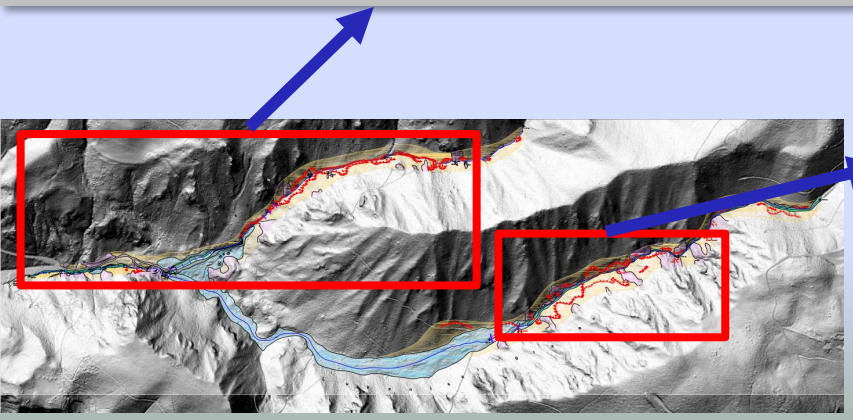
Jošt Sodnik [1,2], Matjaž Mikoš [2] and Nejc Bezak [2,*]

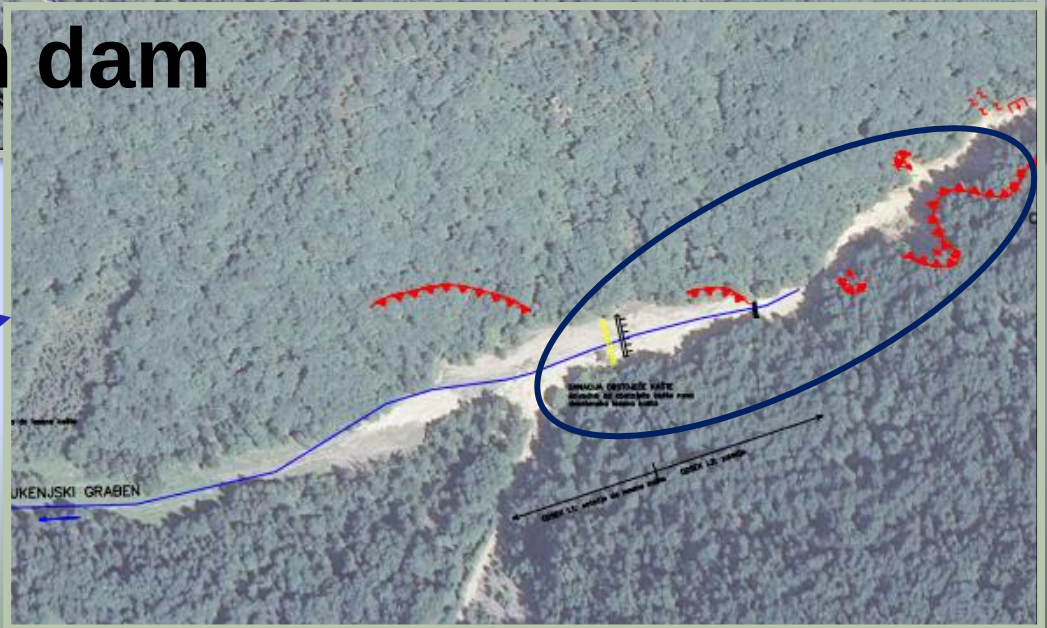


Phase1: Reka mitigation

Phase3: Flexible net barriers

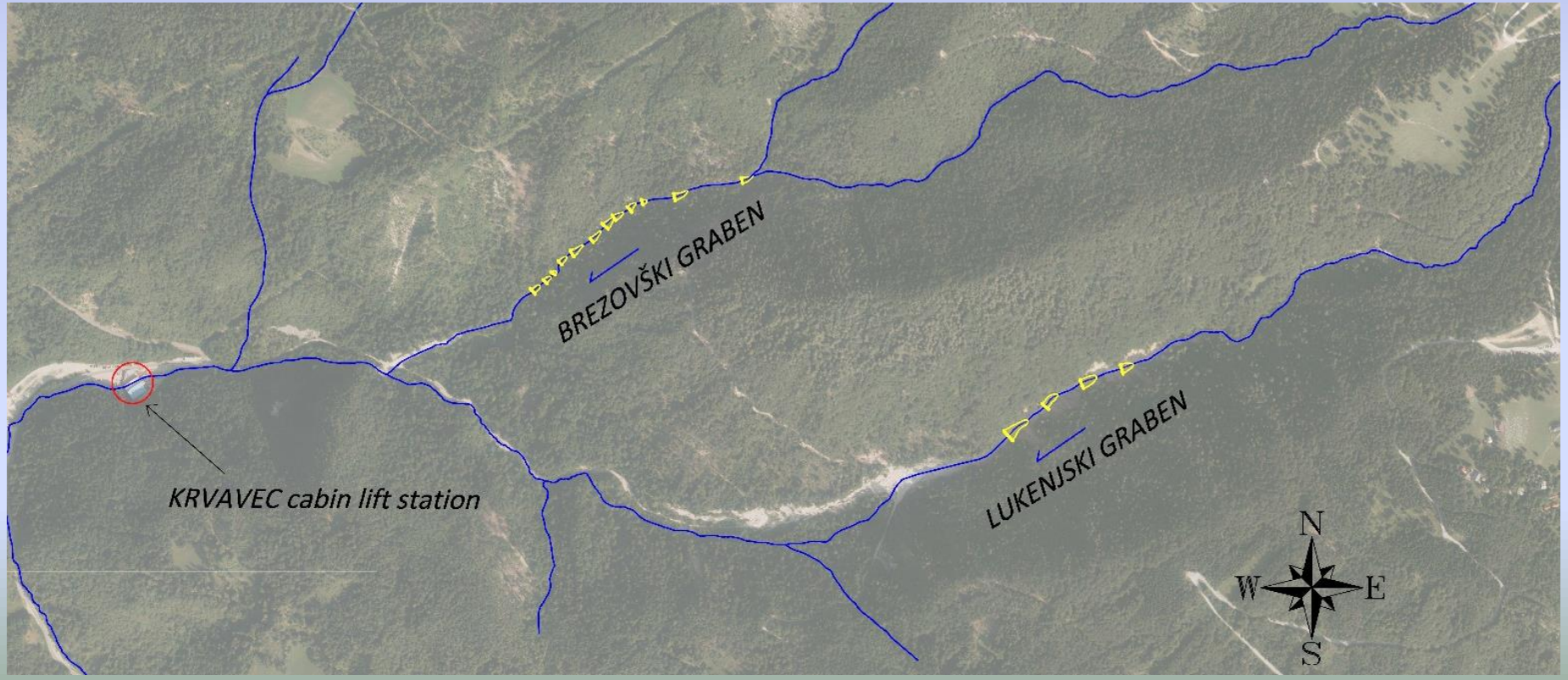
Phase2: Chech dam





Flexible net barriers – phase 3

- 12 + 4 new barriers
- Reducing channel slope
- Reducing intensity of erosion process
- Prevention of mobilization of larger magnitudes – debris flows
- Modified design of the barriers – based on Geobrugg VX type



Phase 3 – dimensioning process

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DEBFLOW ONLINE TOOL

Dimensioning of the flexible Debris Flow Protection System GEOBRUGG VX/UX - DEBFLOW

Project No.
Project name Krvavec Brezovski
Date/Author 15 07 2021 Sodnik

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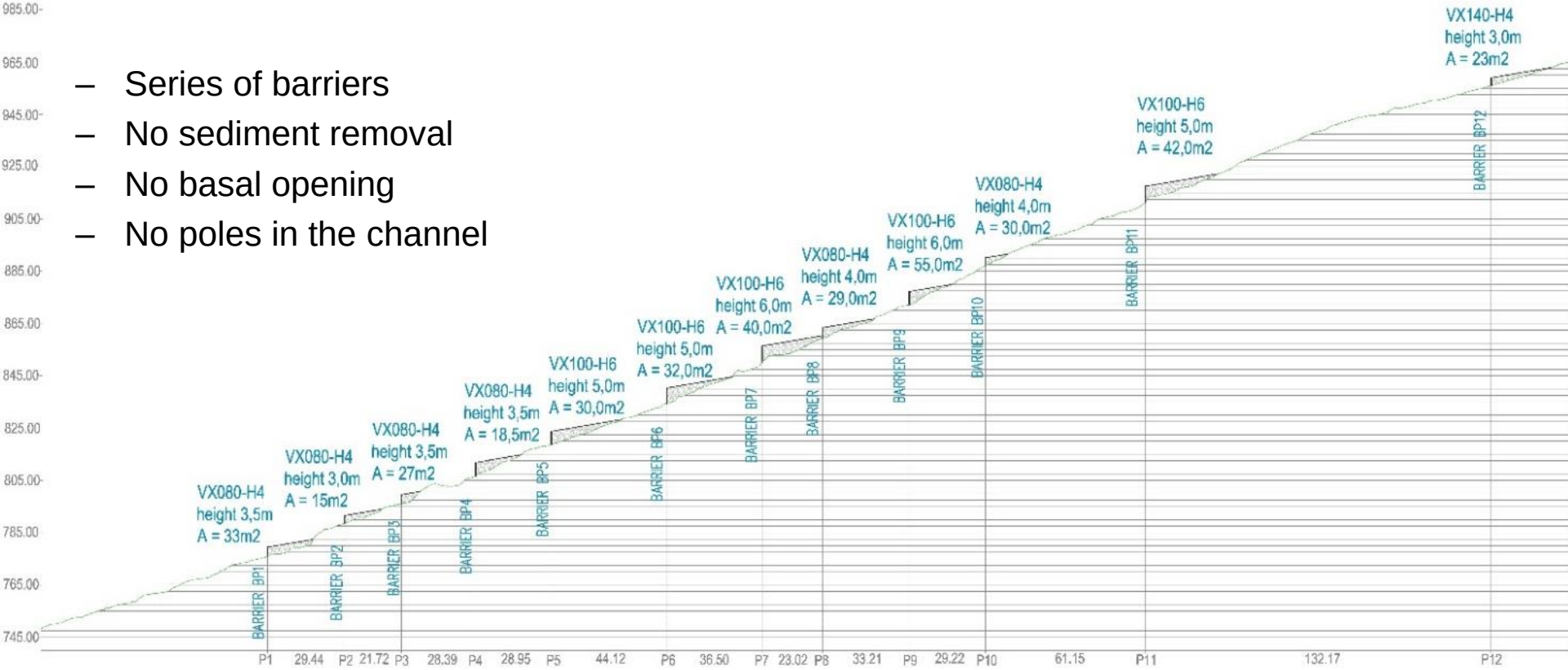
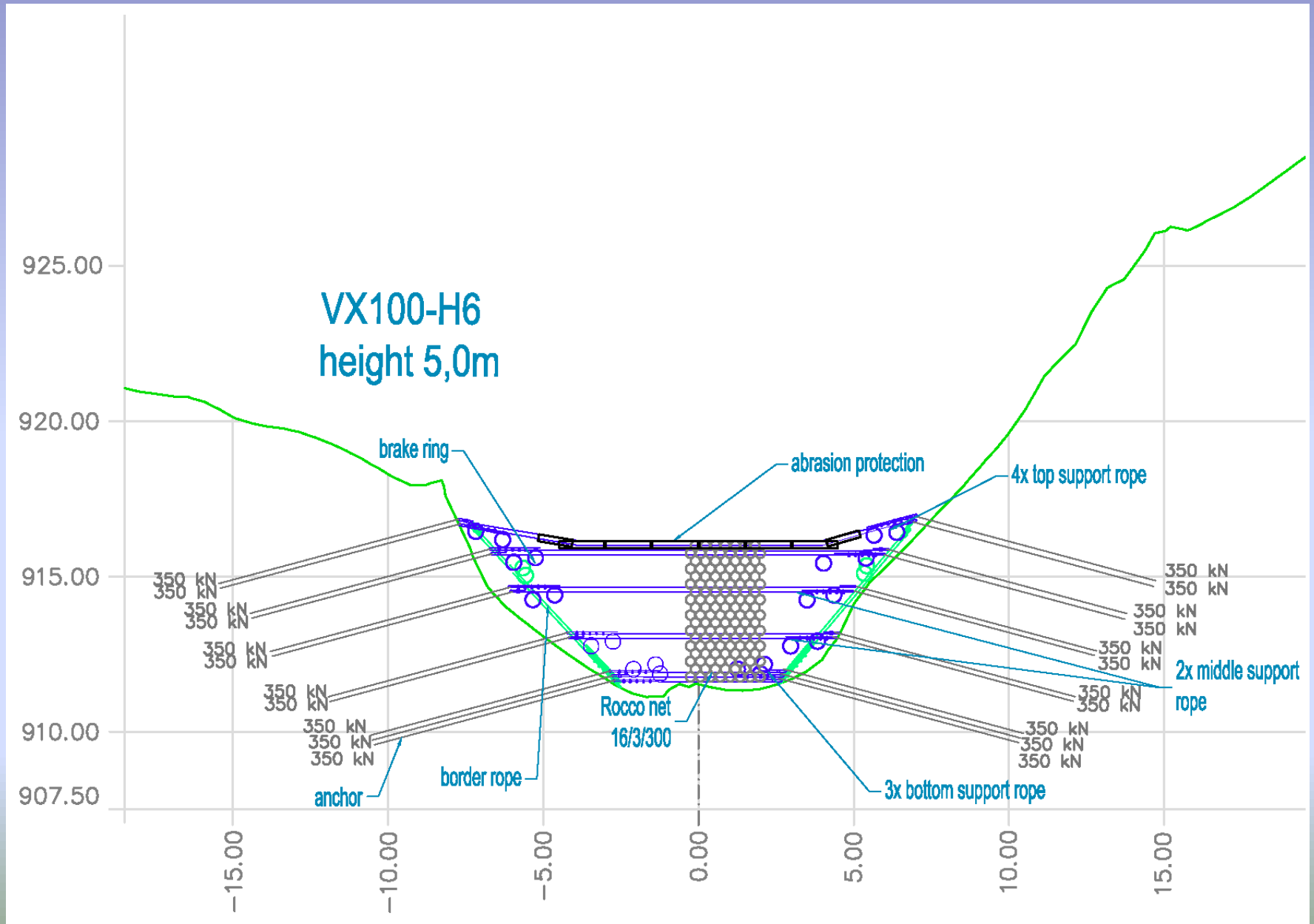
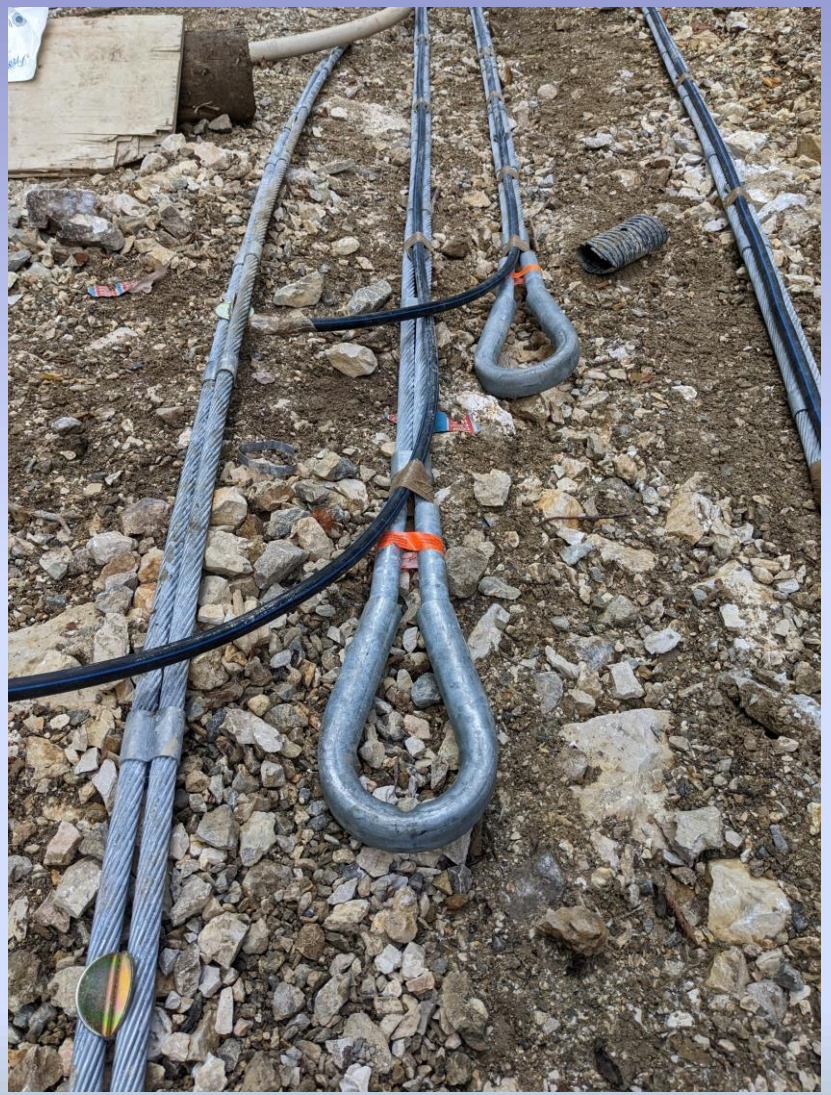
- Series of barriers
- No sediment removal
- No basal opening
- No poles in the channel



Phase 3 – example of a barrier



Phase 3 – Brezovški graben



Contractor: Hidrotehnik d.o.o. & Kaskader d.o.o.

Phase 3 – Brezovški graben

Phase 3 – Brezovški graben

Phase 3 – Brezovški graben

Phase 3 – Lukenjski graben

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Phase 2 – to be done

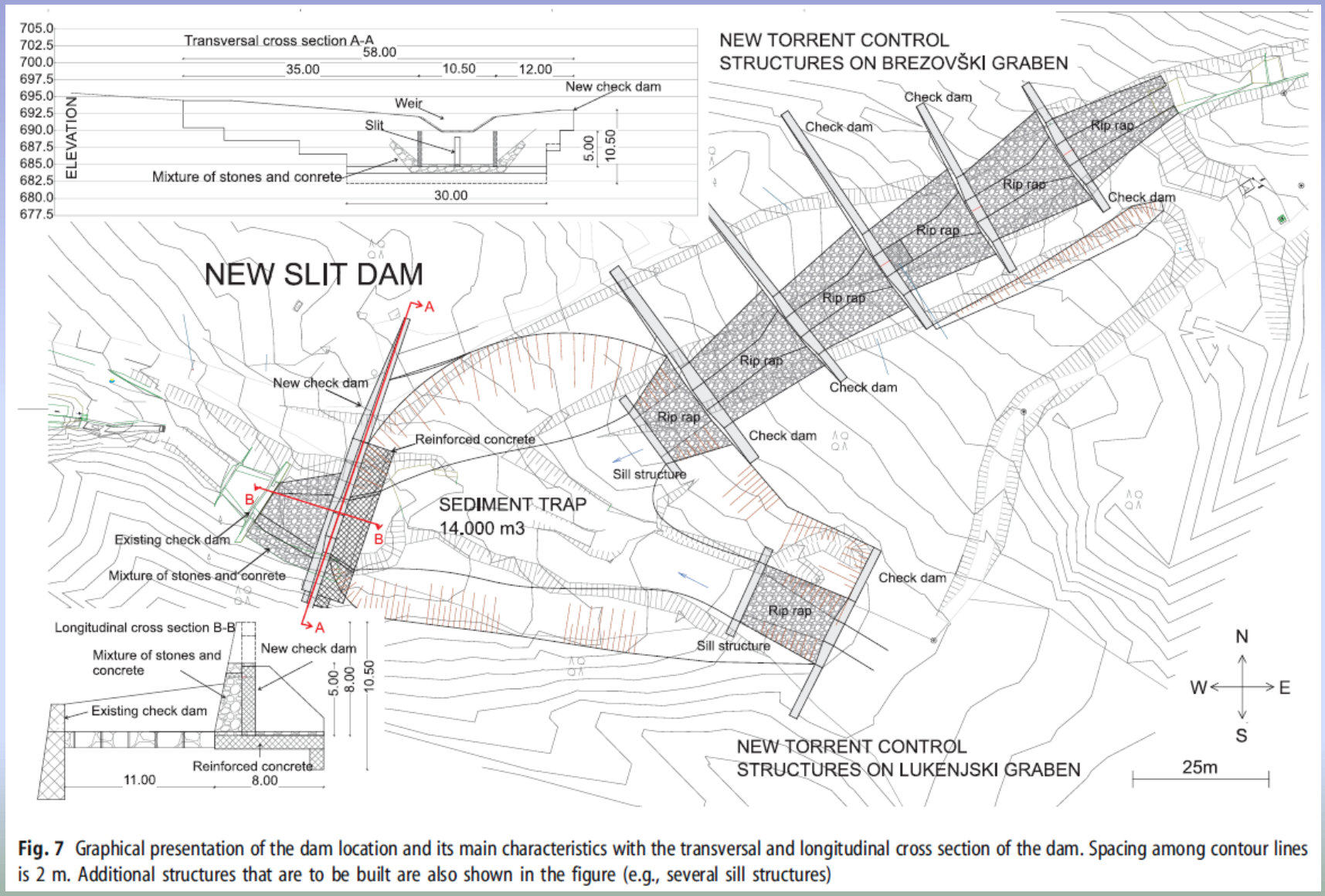

Fig. 7 Graphical presentation of the dam location and its main characteristics with the transversal and longitudinal cross section of the dam. Spacing among contour lines is 2 m. Additional structures that are to be built are also shown in the figure (e.g., several sill structures)

Research of the processes

- A field debris flow / mass flow observatory

- Geobrugg GUARD
  - Corrosion of the nets
  - Measurement of the debris flow impacts and forces in barrier ropes
- Drone field survey of the deposited material and erosion
- Concrete abrasion monitoring
  - Plates 50cm/50cm with 4 different types od concrete
  - Upgrade of the research on The Lower Sava River

August 2023 flood event

- 25-35% of Slovenia affected
- 500+ year return period discharges in some areas
- Aprox. 10.000 new landslides
- 10 billion € estimated damage (17% of GDP)

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https://doi.org/10.5194/nhess-23-3885-2023

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Brief communication: A first hydrological investigation of extreme August 2023 floods in Slovenia, Europe

Nejc Bezak[1], Panos Panagos[2], Leonidas Liakos[2], and Matjaž Mikoš[1]
[1]University of Ljubljana, Faculty of Civil and Geodetic Engineering, Ljubljana, Slovenia
[2]European Commission, Joint Research Centre (JRC), Ispra, Italy

- **Krvavec area**
  - 30 mm in 30 min
  - 165 mm in 12h - over 250 year return period
  - 196 mm in 24h
- Numerous new landslides and intensive erosion process
- Drone survey showed that 19.000m^3 of material was trapped by the barriers + additional aprox. 30.000m^3 was not eroded

August 2023 flood event

August 2023

May 2018

August 2023 flood event

August 2023 flood event – other areas

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Tempos
environmental civil engineering

Conclusions

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- A good practice example of a holistic solution in one torrential area
- Cooperation of Slovenian water agency, University and private sector in finding optimal solution (practice & science)
- New approach for hard accessible erosion prone torrential areas
- Good opportunity to learn more about debris/mass flow dynamics, erosion process and material weathering (concrete, steel) in real life environment.

Acknowledgements

- Slovenian Water Agency – DRSV (www.gov.si/en/state-authorities/bodies-within-ministries/slovenian-water-agency)
- Geobrugg - www.geobrugg.com

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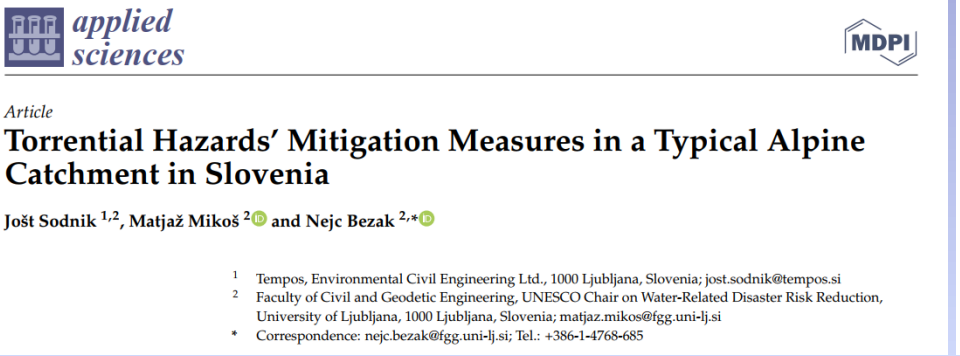

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Thank you for your attention