ARRS project J1-2477: Erosional processes on coastal flysch cliffs and their risk assessment

ARRS code: J1-2477

Project type: Basic research project

Leader: assoc. prof. dr. Timotej Verbovšek

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Project team:

First and last name	Organisation
Timotej Verbovšek	FNSE
Boštjan Rožič	FNSE
Marko Vrabec	FNSE
Galena Jordanova	FNSE
Matej Dolenec	FNSE
Petra Žvab Rožič	FNSE
Primož Miklavc	FNSE
Ema Hrovatin	FNSE
Klemen Kregar	FCGE
Klemen Kozmus Trajkovski	FCGE
Matjaž Mikoš	FCGE
Nejc Bezak	FCGE
Tamara Kuzmanić	FCGE
Karmen Fifer Bizjak	ZAG

Coastal cliffs in flysch represent steep and unstable slopes, prone to erosion, as flysch is composed of alternation of softer marlstones and harder sandstones. Consequently, it is difficult to characterize due to its heterogeneity. There are several processes acting on the cliff – most importantly the erosion, being results of precipitation and intense rainfall, also the influence of the sea by abrasion, tidal action and wave energy, and other factors as the wind and rockfall.

The scientific problem and goal of our project is the fact that systematical quantitative measurements of erosion and morphological changes of the cliff have not yet been performed. To understand the processes of cliff changes, all influencing factors should be quantified. With modern methods of geological mapping and geodetic methods (photogrammetric ranging, terrestrial laser scanning and satellite PSInSAR methods), we are

able to determine the temporal and spatial changes of unstable regions very precisely.

A special challenge will be the quantification of risk assessment, which will be one of our main research topics and novelties. We would like to upgrade the methodology of risk assessment, presented by Rio & Gracia (2009) for the coastal cliffs. They have defined two factors; the Hazard Index and Impact Index, which combine into the Risk Index. We chose this approach as all influencing factors are quantified, and we will improve their methodology by using additional parameters, such as fracture orientation and spacing, plus the physically measured erosion rates.

Another contribution will be also the study of sapping effects, as softer marlstone layers are eroded more quickly than harder sandstone beds, resulting in sapping (undermining) the more resistant layers above, leading to dangerous rockfalls. Relationships between the fracture spacing and bed thickness have been investigated, however sapping remains underinvestigated. Final novelty will be the integration of all methods, with also the practical aim of testing their applicability.

Described processes have also a socio-economic impact. Very problematic is a large number of visitors all year-round and numerous bathers during the summer, which walk and lie directly at the base of cliffs. Another problem pose the residential buildings, built very close to the cliff edge, and some terraces have already been undermined.

Current research are focused in the investigation of the recent collapse of the flysch slope in Strunjan, where we have performed photogrammetric measurements with UAV and calculated the volume of the collapse (2000 m^3) by calculating the difference from two dates (2018 to 2020). Also, a 3D model of the collapse has been made (https://skfb.ly/6PQQD).

Project program will be taken in the following working packages (WPs) and tasks (WTs)

- WP 1. Project management and coordination throughout the complete project timeline
- WP 2. Geological field work and analyses
  - WT 2.1 Geological mapping and profiling.
  - WT 2.2 Fracture orientation and spacing investigation.
  - WT 2.3 Mass movement and landslide mapping.
  - WT 2.4 Field sampling for mineralogical, geomechanical and slake durability tests.
- WP 3. Geodetic field work and analyses
  - WT 3.1 Photogrammetric (PG) measurements with a remote Unmanned Aerial Vehicle (UAV).
  - WT 3.2 Terrestrial laser scanning (TLS).
- WP 4. Laboratory analyses
  - WT 4.1 Geomechanical laboratory tests of rocks.
  - WT 4.2 Mineralogical analyses.
  - WT 4.3 Analysis of influence of hydrometeorological factors on the cliff activity.
- WP 5. Analyses of results and modeling
  - WT 5.1 Analyses of geological field investigations and results from WP 2.
  - WT 5.2 Analyses of geodetic field investigations and results from WP 3.
  - WT 5.3 Precipitation and erosivity analysis.
  - WT 5.4 Satellite PsInSAR analyses.

    - WT 5.5 Rockfall modeling.
- WP 6. Integration and synthesis of results.
- WP 7. Dissemination of the project results.

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