Geomorphological settings and types of landslides in the city of Buzet identified using LiDAR digital terrain model

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GEOMORPHOLOGICAL SETTINGS AND TYPES OF LANDSLIDES IN THE CITY OF BUZET IDENTIFIED USING LIDAR DIGITAL TERRAIN MODEL

GEOMORFOLOŠKI OKOLIŠI I TIPOVI KLIZIŠTA NA PODRUČJU GRADA BUZETA IDENTIFICIRANI PRIMJENOM LIDAR DIGITALNOGA MODELA RELJEFA

Petra Jagodnik[1]*, Sanja Bernat Gazibara[2], Marko Sinčić[2], Hrvoje Lukačić[2], Željko Arbanas[1], Snježana Mihalić Arbanas[2]

[1]University of Rijeka, Faculty of Civil Engineering, Radmile Matejčić 3, 51 000 Rijeka, Croatia
[2]University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Pierottijeva 6, 10 000 Zagreb
*corresponding author: petra.jagodnik@gradri.uniri.hr

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This study presents the results of landslide detection and mapping at a large scale, performed in the area of the city of Buzet in central Istria. The research was conducted within the frame of scientific research project "Methodology development for landslide susceptibility assessment for land-use planning based on LiDAR technology" (LandSlidePlan, HRZZ IP-2019-04-9900). The study area (20 km^2) consists of Eocene flysch sediments, composed of a rhythmical alternation of marl and carbonate sediments in the lower part of the complex, and thinly bedded carbonate-siliciclastic turbidite sediments in the upper part (BERGANT *et al.*, 2003).

For the first time, the detailed geomorphological landslide inventory map (GUZZETTI *et al.*, 2012) is created for the area in the flysch environment in central Istria, using innovative remote sensing technology that proved to be effective in mapping landslides (GÖRÜM, 2019; JAGODNIK *et al.*, 2020a). Identification and mapping of landslides was carried out based on the visual interpretation of topographic datasets derived from the bare-earth LiDAR (Light Detection and Ranging) Digital Terrain Model (DTM) at a 0.3 m spatial resolution. Airborne laser scanning was performed in March 2020, with an average point density of 16 points per m^2.

In the study area, more than 1,160 landslides are identified and delineated with high geographical accuracy and thematic certainty due to the clear visibility of landslide features on LiDAR DTM derivatives. However, it was quite a challenge to identify and map individual landslides in areas of gully erosion and badlands, which represent the typical geomorphological phenomena in the flysch environment of central Istria (GULAM *et al.*, 2014). Landslide density is 58 landslides per km^2. Most of the landslides are debris slides, and debris slide-debris flows (HUNGR *et al.*, 2014), which are the main types of landslides in flysch deposits (JAGODNIK *et al.*, 2020b). Landslides are predominantly small and shallow. Their sizes are in the range between only 4 m^2 to 8 ha.

Generally, there are three typical geomorphological settings of landslides in the study area: (i) complex gullies; (ii) agricultural fields; and (iii) artificial slopes along the roads. Gullies are the predominant environment for the occurrence of landslides, with approximately 65 % of identified landslides being situated in gullies. Such specific geomorphological setting of landslide phenomena confirmed that there is a significant interplay between mass movements and fluvial processes in the investigated area. Therefore, in the future research, the results of this study will be used for testing the relevance of gully and badland phenomena as conditioning factors in landslide susceptibility modelling at a large scale.

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