Landslide and erosion inventory mapping based on LiDAR data: A case study from Istria (Croatia)

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The Istrian Peninsula, in the western part of Croatia, belongs to an undeformed part of the Adriatic Plate. The central part of Istria is the area of the Eocene flysch basin, i.e. “Gray Istria“, which is prone to weathering and active geomorphological processes. The siliciclastic rocks of the basin are homogeneous hemipelagic marls (Globigerina marls with a maximal thickness of 150 m) overlain by gravity-flow deposits or flysch-type rocks. The high erodibility of the Istrian marls led to the formation of steep barren slopes and badlands exceptionally susceptible to slope movements. This research presents the application of Light Detection and Ranging (LiDAR) data for the landslide and erosion inventory mapping at a large scale. Airborne laser scanning (ALS) was taken in March 2020 for the pilot area in the City of Buzet. Based on the characteristics of the acquired LiDAR Point Cloud, a bare-earth digital elevation model (DEM) with 30 cm resolution was created. Different topographic derivative datasets such as slope, hillshade, contour lines, roughness, curvature, flow accumulation and stream power index maps were created to interpret the LiDAR data. Visual identification and mapping of landform features were done on the study area (20 km^2) at a large scale (1:500) to produce detailed landslide and erosion maps for implementation in the spatial planning system. After preliminary visual interpretation of LiDAR DTM and field verifications, it was concluded that three types of landforms could be mapped, i.e. badlands, unstable slopes and landslides. Badlands were first identified on the digital orthophoto maps 1:5.000 as areas with sparse or no vegetation, and then the boundary of the entire affected slope was mapped in detail on the LiDAR DTM morphometric derivatives. Additional field checking showed that badland boundaries based on digital orthophoto images and LiDAR DTM have significant deviations. Badlands dominantly appears in the form of plane forms on steep slopes and less often as linear forms such as erosion gullies or torrent beds. Unstable slopes were categorised as areas with dense sliding where the exact landslide boundaries could not be mapped due to the coalescence of landslides or poor contrast between affected and unaffected areas due to the intense erosion. Landslide identification on the LIDAR DTM morphometric derivatives is based on recognising landslide features (e.g., concave main scarps, hummocky landslide bodies and convex landslide toes). A digital orthophoto map from 2020 was used during landslide identification to check the morphological forms along roads and buildings, such as artificial fills and cuts, which can have a similar appearance to landslides on DTM derivatives. Sliding is most often along contacts between weathered and fresh flysch-type rock, especially at places with concentrated surface runoff (e.g., near roads), which typically cause small and shallow landslides. The final result of the visual interpretation of LiDAR DTM derivatives is multi-hazard inventory map which can be implemented in the spatial planning system of the city of Buzet.

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