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Slope movement hazards of the mining-dumps in the Dorog Basin, Hungary

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The Dorog Basin was a mining area in northern central Hungary for more than two centuries. Tunnel mining and quarrying of Eocene coal was the main industrial activity in the basin from the mid-19th century until the late 1990s. Extensive quarrying of the Cretaceous marl and Triassic limestone for the cement industry is also present in the area, along with pits of sand and fire clay and travertine quarries. Though the waste treatment is controlled by law and strict directives, the morphology and the material characteristics of the waste heaps are often enough to increase the chance of slope failures. As the mining waste heaps and tailings are often adjacent to residential and agricultural areas, they are considered as hazard sources. The combined use of remote sensing and machine learning methods can help to evaluate the stability of the waste heaps and select the sites where further hazard assessment is needed on the field.

The slopes of the area were sorted into six stability categories (scarps, transitional slopes, debris, low-lying accumulation areas, hilltops, stabile slopes) with random forest machine learning classification. The sample areas for the analysis were selected based on geomorphological mapping in the area and the re-evaluation of the recorded landslides from the landslide inventory. The classifier (Rstudio) analysed one lithological and two to six morphometric predictor variables. We tested several sets of different variables and selected the best performing set, which included the slope angle, profile curvature, TWI, mean upslope area, and the normalized height morphometric indices.

After the classification, the distribution of the stability categories was computed for three different areas: the mining waste heaps, the remediated quarries, and the natural slopes. The mining waste sites and the quarries were delineated using the national mining waste inventory, satellite images and topographic maps. Then a likelihood ratio analysis was done to calculate the relative frequencies of the stability categories in the different area types. It was expected that the stability category representing the slope debris at rest will be the most frequent in the waste heap areas. The statistical analysis reinforced this hypothesis by resulting a 54% larger likelihood compared to the natural slopes. It was also revealed that the most dangerous category, the scarps, are less likely on the waste heaps than on the natural slopes, which is a reassuring result. However, the transitional types (slopes that are still in movement) are more likely by 25% on the waste heaps. Even this slightly increased likelihood makes the local villages more prone to hazardous events, so

an increased concern is also justified.

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