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Natural and man-induced landslides formation factors in the Transcarpathia (Ukraine)

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Among all exogenous geological processes that develop in the Transcarpathian region, landslides are the most common ones. Considering the multifactorial nature of landslide formation and the difficulty of their prediction, landslides are a potential factor of emergency occurrence. According to the data provided by the State Emergency Service of Ukraine and the State Geological Information Fund of Ukraine, as of 01/01/2020, 3 288 landslides of 385.21 sq. km total area were mapped and entered in the region cadastre; six of those activated fully or partially on the area of 0.030096 sq. km. Therefore, the aim of this study is to identify the main and derived geological factors that determine the spreading and activation of landslides in the Transcarpathian region by employing spatial statistical analysis.

The initial information is represented by : 1) the database and landslide inventory map for the Transcarpathian region (compiled by the authors); 2) the relief horizontal corresponding to the topographical background of the scale 1:200 000, and 3) the tectonic disturbance map derived from a geological map of the scale 1:100 000. To establish the spatial patterns of landslide formation, the effects of the territory relief, its derivatives, structural and tectonic conditions on the distribution of landslides have been analyzed.

In addition, the region examined is the territory with a significant level of anthropogenic impact on the geological environment, which creates a number of man-made factors affecting the formation and activation of landslides, such as cutting of slopes, deforestation, slope plowing, excessive cattle grazing, mining activities, etc.

That can be exemplified by the destructive activation of an ancient landslide on the Tysa River right bank between Bila Tserkva and Velykyi Bychkiv villages. During the railway construction, the slope was cut to a height of 10–15 m, and landslide prevention works were not carried out. As a result, after a few years, a landslide developed there, which inflicted heavy costs of constructing a retaining wall. But the retaining wall was built on a shear body above the sliding mirror. In the spring of 2004, the displacement intensified, destroying the retaining wall. Periodically, a shift tongue blocks the Uzhhorod–Rakhiv highway roadbed.

The analysis shows that a significant number of landslides have not reached their baseline, i.e., under unfavorable conditions, their activation is possible.

Thus, the abovementioned anthropogenic activities tend to overlap natural landslide formation factors, increasing the risk of landslide hazards in the Transcarpathian region.

As a result, the spatial patterns of landslide occurrence have been determined by processing a large array of primary cartographic information. Subsequent mapping of the areas, based on the obtained reliable characteristic limit values of established landslide formation factors (steepness, altitude, the spatial orientation of slopes, connection with structural and tectonic heterogeneities) provides a forecast map for the most likely areas of landslide occurrence in the Transcarpathian region.

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