## Interdisciplinary analysis of natural and anthropic vulnerability of the mountain slopes within the touristically developed areas of Brasov

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As a consequence of anthropization, the territories destined to tourism development within the Brasov depressional area and the surrounding mountain areas have become increasingly vulnerable to slope instability which also affects elements of the touristically developed patrimony (Bălteanu D., Rădița, A, 2001).

The purpose of this work is to highlight main causes of the damage to heritage monuments or other touristic development by the vulnerability of the morphological support, in this case the foundation ground. The morphological support i subject to the effects of geological and geomorphological processes (risk associated with natural phenomena of hydrologic and geomorphological nature) but especially the anthropic impacts related to heritage and changes produced over time (land overloading), and the recent tourist establishments (i.e. WARD, 1990, CHILTON et al., 1997, Mafteiu M., Ionescu I., 2001). A complex analysis can offer the necessary scientific and practical support to identify solutions for the rehabilitation and preservation of anthropic environment having scientific and patrimonial value, which are exposed to risk. An integrated interpretation (in hydrogeophysical and geomorphological terms) of these researches creates solutions for mitigating the risk factors and represents the basis of an efficient work methodology.

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## Surface ozone variability and land use change after extreme wind event

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Extreme wind event in November 2004 caused widespread destruction of slope forests in the Tatra National Park, Slovakia. Relevant changes of land cover motivated researchers to investigate the damaged forest ecosystem and its response to different environmental conditions (Fleischer, 2011). Surface ozone ($O_3$) is a minor but not negligible compound of the ambient air. Control strategies for reduction of $O_3$ precursor emissions have been applied in Europe during the last two decades. In spite of these reductions air quality indices suggest that highland sites are more vulnerable to health and environmental risk than lowlands where the most of emissions from road transport and industry are produced (Bičárová et al., 2013). Both anthropogenic emissions from long-range transport and biogenic precursors (BVOC) from forest vegetation play relevant role in the tropospheric photochemistry, especially in mountainous and rural locations. The purpose of this work is to describe the variability of $O_3$ before and after the windstorm of 2004 with different amount of local BVOC precursors from forest vegetation.

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## The avalanche denudation in Gorgany Mountain massive (Ukrainian Carpathians)

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In research of mountain areas relief is mainly characterized as an unchanging component of landscape. However, it is also a dynamic part of natural territorial complexes, that are characterized by relatively slow dynamics changes. Relief formation and dynamics are influenced by many processes, including mass movements. This genetic group of processes includes those related to snow activity, which may act as a relief-forming factor]. In dynamic geomorphology, snow activity is associated with two types of processes: nival and avalanche processes. Avalanche denudation was mostly investigated by the researchers of the soviet period. In 1981 B. P. Agafonov and S. A. Markov determined maximal avalanche denudation intensity at 0.31 mm/year. Considerable contribution was made by L. A. Kanayev and others, who studied avalanche denudation in the Tien Shan Mountains.

Avalanche processes are part of relief dynamics of mountain areas. They both directly and indirectly affect orographic characteristics of avalanche-prone surfaces, inducing the process of avalanche denudation.

The study area, Gorgany Mts, is characterized by fluvial-denudational relief. Those landforms prevail in mountains with an unstable snow cover. On those surfaces direct and temporal water flows transport fragmented, eroded material into river channels. As a result of such processes large and deep gullies develop that also function as avalanche paths.

Avalanches have a special influence on relief. Avalanche furrows that have appearance of parallel ridges form in transit zones. Through considerable crushing power , a large avalanche can destroy nearby slopes, and an avalanche formed by wet snow may form impact pits at slope base. Intensity of relief-forming processes is expressed by the rate of denudation that reaches 0.5-0.6 mm/year within avalanche-prone landforms of fluvial origin.

Based on relevant indexes and knowledge of the area with such avalanche complexes, it is possible to calculate approximate intensity of avalanche denudation in the study area. Methodology of avalanche denudation research is based on the mean value of maximum index of avalanche denudation intensity within natural avalanche complex. This index, according to earlier, soviet research in different mountain systems and morphologic structures amounts to 0.2 mm/year. To determine a corresponding index, it is necessary to define the area of natural avalanche complexes as the percentage of the general area of the investigated territory. Next, avalanche denudation intensity is calculated by multiplying the mean value of maximum avalanche denudation intensity and the calculated percent of the total area.

In our opinion, applying this methodology creates a problem related to expected index of avalanche denudation intensity and its extrapolation to different mountain systems. Extrapolation is inadvisable, because by using this methodology a calculation error will grow with increasing proportion of the area of avalanche complexes (so for the area of avalanche complexes amounting to 100%, the error of intensity of avalanche denudation will amount to 0.11 mm/year, or about 30%).

The Gorgany have 5 or 6 longitudinal ridges that are cut by deep transversal valleys. The width amounts to 40 km, and the length between Mizunka and Prut river valleys is about 75 km. The Gorgany are typified by a three-tier (separate Gorgan type) vertical morphological zonality, distinguished by P. M.Cys. The highest tier is treeless or with low forestation, with a presence of 35-45° landslide slopes. In the middle tier the steep slopes also prevail, but they are covered by forests. The lower tier is typified by accumulation and erosional terraces and a significant number of accumulation cones.

The Gorgany, considered an area with significant avalanche activity [7, 9], are characterized by relatively high altitudes (as for the Ukrainian Carpathians), and local relief of 500-1000 m. Avalanches form on slopes covered by debris, different grasses, occasionally juniper and dwarf pine. Here, snowpack thickness reaches 1.5-3 m. In accordance with genetic avalanche classification, prevailing types are blizzard and avalanche of snow-melting with winter-spring regime of their formation [7].

The study area was located in the Kotelec', Petros and Doriv river basins. Major peaks include Grofa (1748 m), Paren'ky (1736 m), Mala Popadya (1597 m), Velyka Popadya (1740 m). Basing on methodology of avalanche denudation research, we calculated avalanche denudation intensity index. Using imagery interpretation 22 avalanche natural terrain complexes with the total area of 5,12 km$^2$ in 2010 were distinguished within the study area of 50,65 km$^2$.

Total areas of avalanche complexes registered after 2005, 2007 and 2008 are also shown in Figure 1. In accordance with the calculations conducted with the proposed methodology, we obtained the following avalanche denudation intensity for the area of the Gorgans: 2005 – 0.01938 mm/year; 2007 – 0.01954 mm/year; 2008 – 0.01994 mm/year; 2010 – 0.02022 mm/year.





The process of avalanching influences the formation and dynamics of natural territorial complexes. This influence is most strongly manifested by the least resistant landscape components, but it also affects relief. These changes are caused by the process of avalanche denudation and depend on its intensity. The intensity of avalanche denudation in the Gorgans and the dynamics of avalanche influence on the formation of slope topography will grow in the future. Such conclusion can be drawn from imagery interpretation that testifies to the increase in avalanche area within the model area.

It is worth mentioning that within the study area, the formation of avalanches directly influences not only slope topography but also the formation of fluvial forms of permanent and intermittent watercourses.

Research of avalanche processes, including intensities of avalanche denudation is necessary, because that information gives an opportunity to analyze the dynamics and forecast possible further development of avalanche systems.

## Landslides in 3D – Taking stock of landslides, taking a look at the effectiveness of chosen methods

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Highland regions exhibit a high activity of exogenic processes which directly influence their relief. The Carpathians are heavily transformed by mass movements, especially landslides. 50 thousand landslides have been recorded in the area of 19,600 km$^2$, which amounts to 3 landslides per square kilometre, on average (Rączkowski, 2007). The material losses caused by the landslides made this subject a widely discussed one in both Polish and international literature.

The scale of the phenomenon calls for a review and evaluation of the methods used in landslide surveys and inventory. The traditional methods include: topographic map analysis, geomorphological and geological analysis as well as field mapping, recently greatly improved with the common application of GPS technology. In those cases the precision of acquired data depends on the knowledge and experience of the surveyor. Another widely used method of collecting terrain data is photointerpretation of the study area. The data on the relief is derived from a LPIS photogrammetric model, which serves as a base for generating a raster terrain DEM (Digital Elevation Model) and an array of maps such as tilt map or aspect map. The most up-to-date and the best method for landslide forms survey is the Light Detection and Ranging (LiDAR) laser scanning method. A cloud of points, obtained with this method, gives full detail on the parameters of the landslide, such as its range and volume. The advantage of this method stems from the properties of the laser which penetrates vegetation. This allows to achieve two outcomes: a numerical model of the terrain and a numerical model of its cover. By generating a terrain model with the cloud of points from aerial scanning, we can determine the position and height of a specific point with a precision of up to one centimetre. Such precision allows a more efficient monitoring of the landslide-susceptible slope surfaces, as we collect an exact image of ongoing movement, both horizontal and vertical. The analysis of the terrain models before and after landslide allows to determine the volume of the material that underwent movement.