CHANGES IN GEOMORPHIC EFFECTIVENESS OF DEBRIS FLOWS IN THE HIGH TATRA MTS WITHIN THE LAST SIX DECADES (ON THE EXAMPLES OF THE VELICKÁ DOLINA VALLEY AND THE DOLINA ZELENÉHO PLESA VALLEY)

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Introduction

Debris flows are one of the most dynamic and intense exogenic geomorphic processes in the cryonival morphogenetic system of the Slovak Carpathians, in particular in the High Tatra Mts. They belong to the group of gravitational (slope) processes. Debris flows, representing a serious natural hazard, have often significant destruction effects and that is why they play key role in changes of the land cover pattern. The mapping of the spatial distribution of debris flows is the fundamental supposition for the location prognosis of their possible activation.

The aim of the study is to contribute to the knowledge on the geomorphic response to debris flow activity in the High Tatra Mts, namely on the example of two model areas – the Velická dolina Valley and the Dolina Zeleného plesa Valley. On the basis of the multitemporal trend analysis of remote sensing imagery there was assessed an occurrence of debris flows and development of their operation in the model areas in time and space with a special attention to the changes in their geomorphic effectiveness within the period 1949–2006. The authors try to refer to the close relation of the occurrence of this phenomenon to extreme precipitation events.

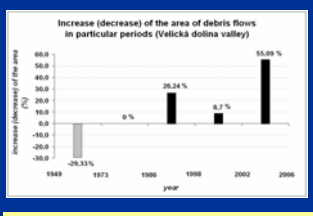
Methodology

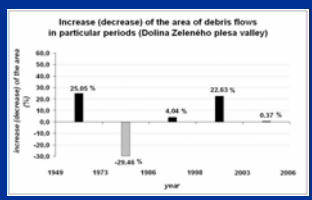
The course of acting and geomorphic effectiveness of debris flows in selected model areas in period 1949–2006 was assessed on the basis of *multitemporal trend analysis of remote sensing data* the same area over longer time intervals with multiple imagery. Key materials for detection of a spatial distribution of debris flows in this period represented airphotos taken in 1949, 1973, 1986, 1997 and 2003, ortophotos from 1998, 2002, 2003 and 2006 and digital elevation model (DEM). Data on extreme precipitation to assess the relation of an occurrence of debris flows to extreme rainfall events in the evaluated period were gained from databases of the Slovak Hydrometeorological Institute in Bratislava. All operations and outputs were realised in the environment of the program ArcGIS 9.2.

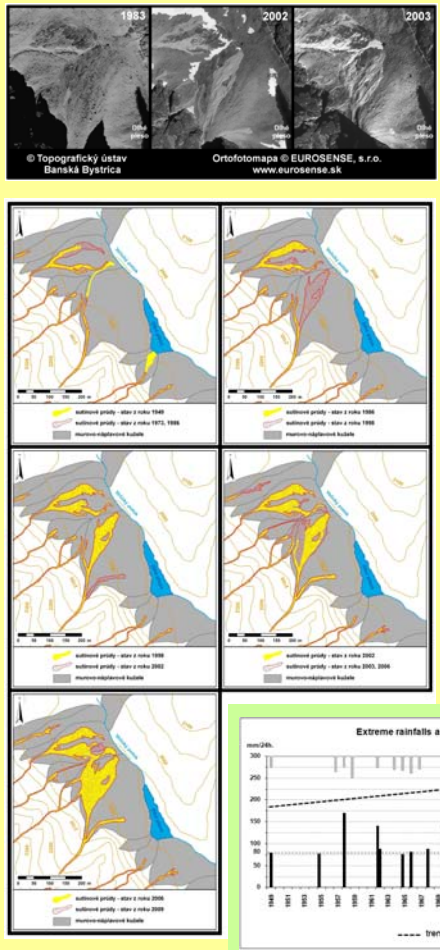
The first step of the assessment, based on the detection of areas of accumulation parts of debris flows on talus cones, was a processing the maps (digital layers) of spatial distribution of debris flows from years when the used photos were taken.

The next steps were a quantification of selected parameters of debris flows, identification of the number of their changes (gains and losses) and calculation of their areal extent in temporal intervals between years of the origin of interpreted photos, i.e. 1949–1973, 1973–1986, 1986–1998, 1998–2002/2003 and 2002/2003–2006, using statistical tools of GIS.

The last step was an outline of temporal trends of geomorphic effectiveness of debris flows within the whole assessed period 1949–2006. Computer aided visual interpretation was based on the *backdating* approach. Its basic principle is that the maps of spatial distribution of debris flows elaborated on the basis of older images are compared with the template – the map of debris flows (reference data layer) detected on the newest image of the time sequence (i.e. from 2006), while areal changes in distribution of debris flows were identified.



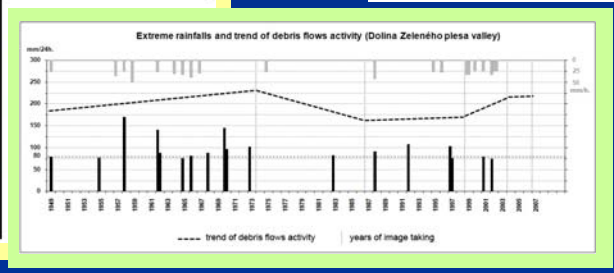


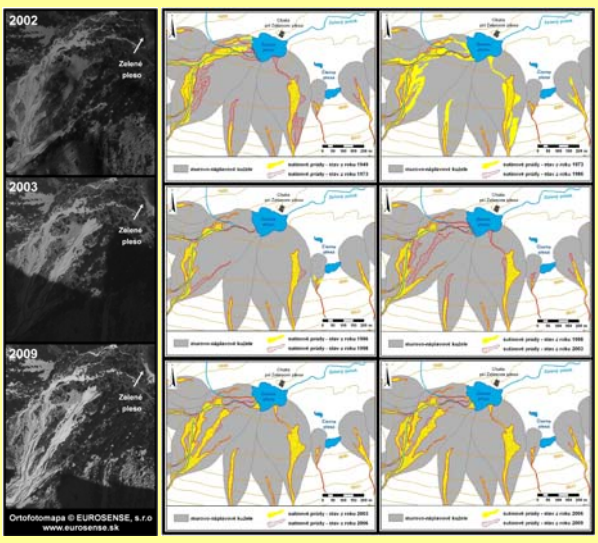


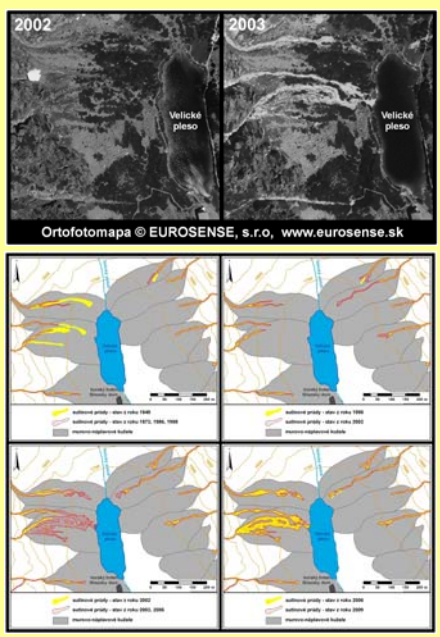
Zelené pleso lake with debris flows

Debris flows upper Dlhé pleso lake

Geomorphic effectiveness of debris flows in Velická dolina valley







Conclusion

Debris flows represent one of the most dynamically and the most intensely acting exogenic geomorphic processes in the High Tatra Mts and at the same time they constitute the dominant high-energy slope process in the cryonival morphogenetic system of this mountain massif. They operate exclusively above the upper timber line where destruct relatively extensive areas. Their geomorphic effects are most marked on talus cones.

Temporal trends of the geomorphic effectiveness of debris flows in the whole studied period 1949–2006 indicates that it was changing in individual time intervals in the model valleys.

Development of geomorphic effectiveness of debris flows in particular intervals of the period 1949–1986 was in valleys rather different, sometimes even opposed. It is connected with the local character of extreme precipitations in this period. However, in the period 1986–2006 there was recorded simultaneous increase of the activity and geomorphic effectiveness of debris flows in both valleys. It corresponds obviously with the first manifestations of the climate change, expressing itself by the increased frequency of extreme rainfall events, as well as the increased intensity of these events. The extreme events occur in the Tatra Mts mostly in the summer period. Just summer torrential rains are the main cause of debris flow generation in this mountain massif. The increasing frequency of extreme meteorological-hydrological events conditions the rise in the number of debris flow events, the rising intensity of precipitation results in the increase of the geomorphic effectiveness of particular debris flows.

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