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MAPPING THE KINEMATICS OF THE BLAUBACH LANDSLIDE (AUSTRIA) USING DIGITAL PHOTOGRAMMETRY

V. Kaufmann (1) and G.K. Lieb (2)

(1) Institute of Geodesy, Graz University of Technology, (2) Institute of Geography and Regional Science, University of Graz (E-mail: viktor.kaufmann@tugraz.at, Fax: +43 316 873-6337)

The Blaubach landslide (12°08'E, 47°12'N, northern margin of the Hohe Tauern range, Austria) is located in the upper part of the catchment area of the Blaubach torrent. The latter follows an important Eastern Alpine fault. The area of interest is built of tectonically fractured rock favoring fluvial erosion, debris flows, and other types of mass movements triggered by widespread deep reaching gravitational slope deformations. The Blaubach landslide is characterized by high surface movement and a front with several secondary slides, which are free of vegetation and provide high quantities of material to the torrent below. This natural hazard has induced the construction of protective measures such as retaining walls in the torrent bed since 1950. However, as of yet no numerical data have been available concerning the surface kinematics of the landslide, such as flow/creep velocity, surface height change, or volumetric change. The Austrian Forest Engineering Service of Torrent and Avalanche Control therefore launched a project related to these questions. One task was to reconstruct the morphodynamics of the landslide area using historical multi-temporal aerial photographs.

Aerial photographs at various image scales between 1:9,300 and 1:45,800 of 11 different data acquisition periods between 1953 and 1999 were acquired from the Austrian Federal Office of Surveying and Mapping. The photographs were scanned using the UltraScan 5000 of Vexcel Imaging Austria in order to facilitate digital photogrammetry. A special software package ADVM (Automatic Displacement Vector Measurement), originally developed at the Institute of Geodesy for monitoring debris-covered glaciers and rock glaciers, was used to automatically derive three-

dimensional displacement vectors, both area-wide and dense, based on advanced image matching techniques. The digital photogrammetric method applied is based on quasi-orthophotos. This approach supports the fusion of multi-temporal aerial photographs irrespective of the geometrical differences in scale and orientation of the photographs.

As a result, high-resolution digital terrain models were obtained for all periods, thus facilitating the computation of the changes in surface height and volume of the landslide in the course of the past 46 years. Maximum changes in surface height due to surface deformation were measured at +10.0 m and -15.0 m. A mean annual sediment load of 12,000 m^3/year was estimated as an input to the Blaubach torrent for the 1990s. An average of 39,900 three-dimensional displacement vectors were obtained for all time periods calculated. Numerical and graphical representations of the results obtained show that the landslide was active throughout the observed time span, with maximum creep velocities of up to 1.6-1.8 m/year for the time period 1953-1962. For 1991-1999 a maximum creep velocity of 1.3 m/year was measured.

In conclusion, slope deformation and creep velocity of the Blaubach landslide could be measured successfully with high spatial and temporal resolution using digital photogrammetric methods applied to time-series of aerial photographs from a public archive. However, the digital method proposed only works satisfactorily if the available photographs are of good quality and have distinct photo textures and if the landscape observed does not change too much in its surface representation during observation periods.