



Temporal dimension and activities of landslides

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Hazard assessment of landslides implies the determination of the magnitude or intensity of an event with respect to the temporal dimension. Mass movements often correspond to continuous phenomena or unique events (e.g. shallow slide, rockfall). It is sometimes difficult to make an assessment of the probability or to predict a landslide. The Swiss Federal regulations are dealing with this processes related to a risk management and a land use planning. For other natural hazards such as floods or snow avalanches low probabilities or high return periods, reaching 300 years, are used in land management. In terms of a uniformed risk management the landslides of the mountainous regions must be classified with similar probabilities (1-30; 30-100 and 100-300 years of return period). In the last century hazard assessment of landslides did not normally include a specific probability class. A map of landslide phenomena represents the basic document in the hazard assessment process and provides signs and indications of slope instability (with velocity classes) as observed in the field. The map also represents phenomena related to dangerous processes (like landslide damming of a river) and delimits the exposed areas.

In August 2005 a meteorological event with up to 250 mm rainfall in two days triggered several hundreds of landslides causing the death of four persons in Central Switzerland. In several cases the slopes failed without precursory signs and the people below were surprised by the fast moving landslides. Due to heavy rainfall or snowmelt, landslides and debris flows are frequent in Switzerland. Comparable events occurred in the last years, namely 2002, 2000, 1999 and others before. Regarding the high risk for human life and for property new assessment methods are considered for

landslide processes. Landslides must be classified according to the estimated depth of the slip surface and the long term velocity of the movements. These depth and velocity parameters are not always sufficient to estimate the potential danger of a landslide. A high intensity class is usually assigned to shear zones or zones with clear differential movements. A high probability may also be assigned if significant reactivation phenomena have been observed. Geological maps and the register of past events are therefore analysed and in a few cases a return period of crisis events and a threshold value related to the total displacement can be attributed. For larger landslides changes in the activity over decades or centuries are the critical parameter. An acceleration of several centimeters or decimeters over weeks or months is used for the classification in a higher hazard level. For some landslides the sudden acceleration is linked to the rainfall intensity or the total precipitation amount over a long period (e.g. Falli Hölli slide with a maximum recorded velocity of 6 m/day). Using a simple or sometimes complex relation, a return period can be assigned to the corresponding acceleration. For other landslides numerical models (e.g. trajectory computations, safety factors, 3D modeling) and neural networks may be used to determine the extent of areas endangered or to present quantitative data on the stability state of a potentially unstable area

All these techniques and hazard level assessment processes should aim at considering appropriate hazard conditions in land planning so as to reduce risk levels, but without a complete quantification of such risks.