Toward preliminary hazard assessment using DEM topographic analysis and simple mechanic modeling

M. Jaboyedoff (1,2), F. Baillifard (2,3,5), R. Couture (4), J. Locat (5), P. Locat (5) and J.-D. Rouiller (2)

Corresponding address: (1) *Quanterra, Ch. Tour-Grise 28, 1007 Lausanne, Switzerland, / Tel: +41+79-752-35-15 / michel.jaboyedoff@quanterra.org*
(2) CREALP (Research Center on Alpine Environment), Sion, Switzerland, (3) Lausanne University, Lausanne, Switzerland, /4) Geological Survey of Canada, Ottawa, ON, Canada, (5) Laval University, Québec, Qc, Canada

The increasing availability of digital elevation models (DEM) makes it possible to perform quick slope hazard assessments using semi-automatic procedures. The main morphological and structural features of a landscape can, for example, be identified using a DEM, taking into account its mesh size.

The geomorphological concept of base level, which is defined by the lowest level that can be eroded by a stream, can be useful for landslide identification and hazard assessment. Assuming that erosion by landsliding can affect only a limited thickness of the slope – i.e. from 0 to approximately 50 m – during a period of 1,000 to 10,000 years, a short-term local base level is thus defined. This concept means that all slope volumes that are not supported at their bottom can slide rapidly or slowly down towards the valley.

The computation of the base level uses the streams as invariant levels of the topography. The base level is thus anchored to the lines defined by the streams. Depending on the position of the upper part of the streams compared to the crest, the highest crests of the mountain range can also be considered as invariant. At the term scale of landslide activity, only rock-falls can affect the flanks of the crest. Large landslides occur rarely, because of the low force involved: only large landslides affecting the entire slope can affect crests. If necessary, an erosion function can be used to undercut the slope in order to cause its destabilization.

The calculation of the short-term local base level is derived from the procedure used to trace the background of a physical signal such as an X-Ray diffraction spectrum. Different possibilities which can be divided into two categories exist: 1) static procedures, which converge to a base limiting short term local base level, and 2) dynamic approaches that take erosion processes leading to a dynamic base level depending on the duration of the process of “base level definition” into account.

Let us consider that all the slope volume located above the short-term local base level can slide on this base level surface. Different procedures allow to compute the “weight” of the pixels (volume in excess above the base level) that potentially bring additional stress directly or indirectly on a pixel situated below. This leads to a first, simple approximation of the force acting on each pixel. The procedure for computing the involved pixels is based on a routine similar to the one for watershed analysis. The streams can be determined artificially by a routine, in order to avoid the problem of the sedimentation and/or to take into account the erosion by the streams.

Results indicate a good agreement between highly stressed zones and observed active rockfalls areas. In order to refine the hazard assessment, the highly stressed zones can be matched with other parameters such as fracturing or estimated water table level. The rock-fall activity indicated by active scree deposits must also be crossed with the results of the above method that indicates the high likelihood of large rock-falls.