LANDSLIDE HAZARD ASSESSMENT IN SWITZERLAND

THE UPDATED GUIDELINES (2011)

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GENERAL FRAMEWORK

National regulations to restrict development on hazard-prone land were introduced since many landslide areas covering some 7% of the swiss territory were identified. The spatial planning federal law (1979) forces the cantons to determine areas endangered by natural hazards. Threatened areas are only suitable for building under strict conditions, if at all. The federal laws on hydraulic engineering and forests (1991) specify at a more operational basis the principles of the planning law and put the emphasis on an integrated approach to protect human life and substantial material assets from natural hazards. Aim is primarily to reduce the risks by the implementation of preventive measures (land-use planning, zoning, building codes, maintenance). Technical countermeasures should be applied only where uses at risk already exist or where new, more vulnerable, uses are unavoidable.
In order to deal responsibly with natural hazards, these must first be consciously recognized. Only when the hazards are clearly understood by the players involved, sustainable results can be achieved. In Switzerland, hazard maps are produced on a unified basis, first outlined in the federal recommendations of 1997 (OFAT et al. 1997). In order to integrate the present state of the art and the experiences gathered over the last decade, these recommendations have recently been updated (Raetzo & Loup, in preparation (2011)). They include, for instance: new intensity criteria for slides, a new procedure to assess the probability of earth and debris flows, etc. To ensure quality and reproducible results, minimal requirements for the hazard assessment depending on the study scale (hazard index map, hazard map, local study) are also set in the new guidelines. Considered processes are debris and rock slides, rock falls and avalanches, earth and debris flows (i.e. "landslides" according to Varnes).

HAZARD MAPS COMBINE INTENSITY AND PROBABILITY

Hazard is defined as the occurrence of a potentially damaging natural phenomenon within a specific period of time in a given area. Hazards are distinguished according to the type of hazard, source area, flow path and impact area. The hazard levels are determined using a standardized matrix which combines intensity (or magnitude) and probability (see Fig. 1).

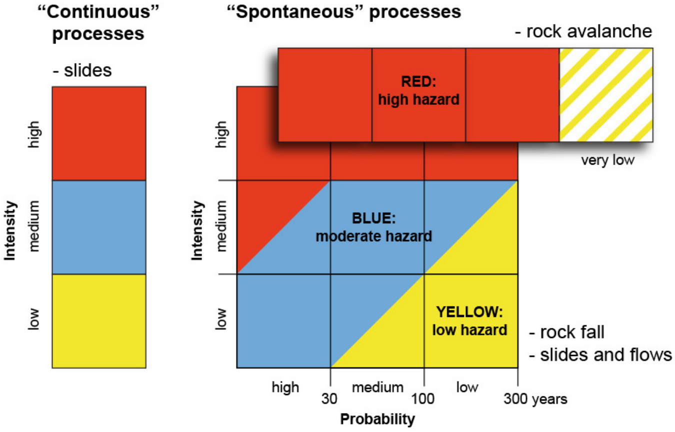

Fig. 1 Intensity-probability-matrix with the five possible hazard levels: red, blue, yellow, yellow-white and white (no danger).

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INTENSITY

The determination of the intensity is specific for each process (see Fig. 2). The new approach for landslides also consider velocity changes, differential movements and slide thickness.

Process	LOW Intensity	MEDIUM Intensity	HIGH Intensity
1. **Fall** - rock fall - *Felssturz* - rock avalanche	E < 30 kJ — —	30 kJ < E < 300 kJ — —	E > 300 kJ E > 300 kJ E > 300 kJ
2. **Slide** Active, continuous, slides	v ≤ 2 cm/year	2 cm/year < v < 10 cm/year	v > 10 cm/year or: displacement > 1 m per event
Velocity changes	**v < ca. 5 dm/y** →	**v < ca. 5 dm/y** →	
	v > ca. 5 dm/y →		
Differential movements (D)	**D < ca. 1 dm/10m** →	**D < ca. 1 dm/10m** →	
	D > ca. 1 dm/10m →		
Slide thickness (T)	← **T > 30 m**	← **T > 30 m**	
Spontaneous slides	e < 0.5 m	0.5 m < e < 2 m h < 1 m	e > 2 m h > 1 m
3. **Flows** *Hangmuren*	e < 0.5 m —	0.5 m < e < 2 m h < 1 m	e > 2 m h > 1 m
4. **Creep and Permafrost**	v ≤ 2 cm/year	2 cm/year < v < 10 cm/year	v > 10 cm/year
5. **Collapse** *Dolinen*	potential	observed	—

Fig. 2 Intensity criteria for landslides, with the considered additional parameters. Short arrow: change of 1 intensity class. Long arrow: change of 2 intensity classes. (E: kinetic energy, v: velocity, mean velocity for continuous slides, velocity during acceleration phases for changes, e: thickness of the unstable layer, h: thickness of debris deposit)

PROBABILITY

Unlike floods and snow avalanches, mass movements are usually non-recurrent processes: they often correspond to gradual ("continuous" slides) or unique (rock falls, debris flows) events. It is difficult to assess the return period of a massive rock avalanche, or to predict when a dormant landslide may reactivate; probability assessment remains thus uncertain. The return period, therefore, only has a relative meaning, except for events involving processes which can be correlated with recurrent meteorological conditions or for events documented by field evidences or historical data.
Probability of landsliding is defined according to three classes. The class limits are set at 30, 100 and 300 years and are equivalent to those applied for snow avalanches and floods. The probability scale does not exclude very rare events. Hazards with a very low probability of occurrence are usually classified as residual dangers under the standard classification.

REFERENCES

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