

## **A warning system for natural hazards in summer at the Illgraben.**

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The Illgraben is one of the most active debris flow channel in the Alps (Rickenmann et al. 2001). Regularly recurring debris flows (~5 per year reach the Rhone River) endanger the village and infrastructure, and create a hazard for residents and tourists. To reduce the risk the Dienststelle für Strassen- und Flussbau (Road and River Engineering Service), Canton of Valais, commissioned a project to explore the hazard and propose protection measures. Besides technical measures the study proposed an alert concept for the village of Susten. One project outcome includes protection measures, including the development of the alert concept, which is realised in four phases: reconnaissance, design, implementation, and optimisation.

The Swiss Federal Institute for Forest, Snow and Landscape WSL operates an automated observation station, for debris flow research, at the Illgraben (Hürlimann et al. 2003). Experience from this installation provides a sound scientific basis for the development of a warning system for Illgraben channel.

The overall concept consists in a 4-stage alarm approach, including (i) permanent informational and organizational measures within the community, (ii) an instrumented detection system, (iii) systematic and periodic observation of the channel, (iv) meteorological observations for early warning and emergency measures. Four different event types are defined: I: low precipitation, small event; II: low precipitation, large event; III: high precipitation, small event; and IV: high precipitation, large event.

Because of inadequate early warning conditions, type II events are not covered by the alert concept and considered a residual risk. Small events following low precipitation (type I) are important because they endanger people such as children playing in the channel and hikers near or in the channel. Within the stage 1 of the alert concept, warning lights are planned to indicate when a debris flow has been detected in the channel, following successful experience with flood warning for artificial lakes. Frequently used locations close to the channel will be equipped with warning signs. Additional preventive measures include media communications and leaflets to call attention to the danger or risk for people.

For event types I, III and IV we have defined four advance warning levels with corresponding measures. Preventive measures (level 0) will be taken independently of any event, their target is the reduction of the risk potential. For early warning levels 1 and 2 (1 day, and 1 h before an expected event, respectively) for large event situations, the emergency agencies have to be informed and people evacuated from the danger zone. Warning level 3 corresponds to the alarm triggered by debris flows detected as close to the source area as possible. Detection instrumentation includes vibration and flow height sensors, and is able to automatically detect an event, relay

information to responsible persons, and activate warning installation (e.g. the warning lights). Regular observation and surveying of the channel (e.g. in an extreme case the formation of a landslide lake) provide information for the early warning level status.

Building on WSL's long term experience with avalanche warning (Bründl et al. 2004, Rhyner et al. 2002) and the recently started pilot project IFKIS-Hydro the proposed concepts are planned to be extended to other hazard areas. This will be coupled to an intense research effort on triggering and flow mechanisms of debris flow, for which the data collected in the alarm concept will provide an important basis. The detection system, channel observations, comparison and development of simulation tools (McArdell, 2004), and eventually meteorological early-warning concepts are applied research topics at the WSL.



Figure 1. The picture shows the huge fan of the Illgraben with the village of Susten in the east and the Pfywald area on the right hand side. The Illgraben divides the fan in these two parts and discharges to the Rhone river. In the background the mountain sides of the Illhorn (2716 m a.s.l) show high erosion activity (picture: Ch. Graf, WSL).



Figure 2. The picture shows the upper catchment of the Illgraben containing many potential debris flow initiation zones due to very high erosion rates. In the background you can see the huge fan with the village of Susten (picture: Ch. Graf, WSL).

## REFERENCES

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