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Performance and design of the debris-flow alarm system in the Alpine Illgraben catchment

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We present the design and first analysis of the performance of a warning system from the very active Alpine Illgraben debris-flow catchment and fan area. The catchment (9.5 km2), located in the Canton of Valais, Switzerland, is characterized by frequent and voluminous sediment transport and debris-flow events. The residents in Susten (municipality Leuk), tourists, and other land users, are exposed to a significant hazard. The warning system consists of four modules: community organizational planning (hazard awareness and preparedness), event detection and alerting, geomorphic catchment observation, and applied research to facilitate the development of an early warning system based on weather forecasting. The detection system presently provides automated alert signals near the active channel prior to (5–15 min) the arrival of a debris flow or flash flood at the uppermost used channel crossing. It is intended to provide data to support decision-making for warning and evacuation, especially when unusually large debris flows are expected to leave the channel near populated areas.

At three frequently used channel crossings, optical and acoustic alert signals were installed which are activated by the detection system installed further up in the channel. Events are detected if the ground vibration signal and/or the flow depth exceed a predefined threshold value. First-year results of the detection and alert module in comparison with the independent automated debris-flow observation station (operated by the WSL since 2000) are generally favorable. Twenty automated alerts were issued in the first year of operation (2007), which triggered flashing lights and sirens at all major footpaths crossing the channel bed, for three debris flows and 16 flood flows. Only one false alarm occurred. In the second year (2008), nine automated alerts were emitted, for three debris flows and five flood flows. One false alarm was produced. The events help to fill a data base for optimizing the entire system. The major difficulty we encountered for detecting and alerting is related to the variability and complexity of the events (e.g. multiple surges), which can be largely solved by increasing the duration of the alarm. The results of the Illgraben warning system have been generalized and are being implemented and evaluated at other sites in the Swiss Alps.