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A debris flow monitoring and warning system based on initiation mechanism of debris flow

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Disastrous debris flows occurred frequently in southwestern China in the last decade. It is well known that loose soil is one of the essential condition for debris flow initiation. Based on the analysis of 116 disastrous debris flow events, covering a wide spectrum of climate types and landforms, occurred in Mainland China in the last 100years. It is found that earthquakes and droughts could strongly influence the development of debris flows through increasing the loose soil volume and reducing the triggering rainfall. A series of laboratory experiments were carried out in Dawazi gully and Aizi gully to study the initiation mechanism of debris flow. The results of a direct shearing test, rheological test and back-analysis using soil mass stability calculations indicate that the mechanisms responsible for triggering a debris flow involved decreases in the static and dynamic resistance of the soil. there are two critical steps in the initiation processes: (i) During the process of the soil mass changing from a static to a mobile state, its cohesion decreased sharply. This would have reduced the soil strength and the kinetic energy during slipping, eventually triggering the debris flow. (ii) When the soil mass began to slip, the velocity and the volume increment of the debris flow fluctuated as a result of the interaction of soil resistance and the sliding force.
A stepwise multi-parameter model is built for debris flow hazard monitoring and warining system. Monitoring starts when early warning is issued and it continues with debris flow early warning, triggering warning, movement warning and hazard stages. For early warning, historical archives of earthquake and drought are used to choose a derbis flow-susceptible site for further monitoring. Secondly, weather forecasts provide an alert of possiblenear warning. Hazardous precipitation, model calculation and debris flow initiation test, pore pressure sensors and water content sensors are combined to check the critical rainfall and to publically announce a triggering warning. In the final two stages, equipment such as rainfall gauges, flow stage sensors, vibration sensors, low sound sensors and infrasound meters are used to assess movement processes and issue hazard warnings. The proposed debris flow monitoring and warning system has been applied in Aizi valley which continuously monitors the debris flow activities.