Seismic diagrams identify rock-falls

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The rock-fall above Randa (Valais) occurred in 1991 in several stages and dislodged more than 30 million m^3 of rock. Credit: Kerry Leith

(PhysOrg.com) -- Based on the statistical analysis of 20 rock-falls in the Alps and the seismic signals recorded at the same time, ETH Zurich scientists have developed a new method allowing the volume and extent of a rock-fall to be determined within a few minutes. The method enables a quick hazard assessment to be made and means action can be taken swiftly.

Rock-falls are not a rare phenomenon in the Swiss Alps. They also repeatedly pose a threat to inhabited areas in this densely populated country. The Swiss have a lasting memory of the Randa rock-fall in the canton of Valais in 1991, which dammed up the river Vispa. If something like that happens in remote regions and goes unnoticed, it can endanger the lower-lying towns or transport routes.

Scientists at ETH Zurich and the Swiss Seismological Service have now developed a seismogram-based method that enables the extent of a rock-fall and possible complications to be estimated quickly – for example, whether rock fragments could block a road or railway line or could dam up a river.

Seismometer network supplies the basic data

Switzerland has a well-developed network of seismometers in the form of a broadband network (Swiss digital network) and strong motion network together with temporarily installed seismometers. The seismometers measure not only the earth movements triggered by an earthquake but also those caused by a rock-fall. The seismogram of a rock-fall records a characteristic picture of the event.

Engineering geologist Franziska Dammeier, a doctoral student at the Department of Earth Sciences at ETH Zurich, analysed the characteristic seismograms of 20 rock-falls that had occurred in the Alps in the past fifteen years. She correlated this data with the important parameters of the respective events, for example the volume and runout of the rock-fall. The volumes of the twenty selected rock-falls ranged from a rock-fall mass of 1000 cubic metres on the Eiger to 2 million cubic metres at Punta Thurwieser.

By correlating the rock-fall characteristics with five seismic parameters of the corresponding signals in all possible variants, the scientists attempted to identify their interrelationships. In doing so, important seismic rock-fall parameters were, for example, the duration of the seismic signal and the maximum amplitude of the ground velocity.

A hazard assessment can be made after only a few minutes

From these correlations, they developed several equations constituting a mathematical model on the basis of which they can determine very quickly the volume and runout distance of a rock-fall from its seismic signals. The scientists tested their method on events which they had not included in their model.

Dammeier acknowledges that although 20 rock-falls are representative, the results might change if even more events were taken into account in the model. The localisation also still contains inaccuracies amounting to an average discrepancy of 11 kilometres. Dammeier says “Up to five seconds can elapse before the seismic signal of a rock-fall becomes clearly recognisable, which makes it difficult for us to determine its precise location because this is done using the exact starting times of the seismic signal.”

The method presents the relationships between the influencing factors in a simplified form which therefore means that it cannot be extremely precise. Nonetheless it allows the hazard to be assessed quickly which can be lifesaving in the Swiss mountains.

More information: Dammeier, F., et al. (2011). Characterization of alpine rockslides using statistical analysis of seismic signals *Journal of Geophysical Research*, 116 (F4) DOI: 10.1029/2011JF002037

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