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Large mass movements related to deglaciation effects in southern Peru (Cusco)

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The Andes of Peru are among the regions most severely affected by glacier and high-mountain hazards over the past 100 years. Large-scale disasters with thousands of people killed are on record, including ice/rock avalanches, debris flows, and glacier lake outburst floods (GLOF's).
Effects of climate change such as glacier retreat and formation of glacier lakes have been one of the drivers of hazards in the past. Now, there is an increasing concern about the destabilizing effect that recent and further warming has a on perennially frozen bedrock and on steep glaciers in the steep flanks of high-mountain peaks, with potentially severe consequences to ice/rock avalanches, which may impact existing and new lakes, producing far-reaching outburst floods. Risks are also changing due to the socio-economic development in the Andean region and need to be considered using integrative approaches.
Most research so far has concentrated on the Cordillera Blanca region where the most devastating disasters occurred during the 20th century. Very little is known about glacier and high-mountain hazards in the southern Peruvian Cordilleras of Cusco although some of the largest debris flows worldwide affected this region in recent years. In fact, very little is known about the nature, origin and exact dimensions of mass movements in this area, and long-term climatic records are neither available.
Here we analyze these recent events in the Santa Teresa region based on field work, satellite images, available meteorological data, and numerical modeling of mass movements. These studies are part of a larger effort towards an integrative risk management.
Most of the mass movements that caused disasters have their origin in glaciated catchments draining towards Santa Teresa with catchment sizes between about 100 and 300 km2, and glacier areas of 6 to 16 km2 per catchment. It is known that the enormous 1998 debris flow (ca. 25 million m3) that destroyed the Machu Picchu hydropower plant originated from a big landslide in deglaciated terrain which mobilized large sediment reservoirs after a period of intense rainfall. For other events on record, ongoing fieldwork studies and first modeling results are carried out to analyze their origin, trigger and characteristics. Satellite based studies on glacier lakes revealed a significant number of potentially hazardous lakes in the catchments that, together with big landslides, need to be integrated in a comprehensive risk management system which takes into account the high dynamics of such high-mountain environment under climate change.