



LiDAR monitoring of retrogressive processes on the steep rockslope of a large landslide in the Japanese Alps

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Akakuzure landslide in Japanese Alps is located in a steep mountain slope experienced deep-seated gravitational slope deformation. The landslide is 700 m high (1200–1900 m a.s.l.), 700 m wide and 400000 m² in area with post-collapsed sediment ca 27 million m³ in volume. The steep rockslope (>40°) in the landslide shows anacinal structure consisting of sandstone interbedding with shale. Large volume of sediment produced from the landslide has actively formed an alluvial fan on the outlet of the landslide. The volume and processes of the sediment production in the upper part (ca.40000 m²) of the landslide were evaluated by geodetic surveys using techniques of airborne and ground-based LiDAR (Light Detection and Ranging). The airborne and ground-based LiDAR surveys were performed twice (2003 and 2007) and 3 times (2010–2011), respectively. Ground surface temperatures were monitored at 3 locations within the landslide from 2010 to 2011. Precipitation and air temperature have been also observed on a meteorological station near the study site. The average erosion depths in the observed rockslope reached 0.89 m (0.22 m/yr) during the first 4 years (2003–2007) and 0.55 m (0.18 m/yr) during the later 3 years (2007–2010). The erosion mainly occurred within the landslide rather than on the edge of the landslide (i.e. no significant retreat of the main scarp). Such large sediment production can be divided into three processes based on the depth of detachment. Deep detachment (>5 m in depth), significantly contributing to the retreat of the rockslope, happened to large blocks had located just above knick lines. During the observation period, at least five large blocks fell down, which appears to originate from sliding along the detachment zone steeper than 30°. Second, anacinal bedding-parallel blocks (1–2 m in depth) fell down, which mainly occurred around sandstone layers. Finally, thin detachment (<1 m in depth) widely occurred on the rockslope. On one part of shale layers, the erosion depth reached 0.35 m from 2010 to 2011. In Akakuzure landslide, numerous fractures of the bedrock, probably produced by gravitational deformation, play an important role to promote the rapid erosion, in addition to external triggers such as heavy rainfalls and frost actions.