Geophysical Research Abstracts
Vol. 12, EGU2010-12879, 2010
EGU General Assembly 2010

Analysing rockfall processes on alpine rockfaces and the corresponding talus cones using Terrestrial Laserscanning

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In high mountain regions, rockfall plays a major role as a geomorphic process, both in terms of sediment budget and natural hazard. During the last two years, high-resolution Terrestrial Laserscanning (TLS) was applied to study
(a) detachment zones and sizes of rock fall events within steep rockfaces,
(b) characteristics of rockfall deposits such as surface roughness, size distribution and fragment morphology, and
(c) their influence on rockfall run-out length.

The investigations were carried out in three study areas located in the Northern, Central and Southern Alps (Val di Funes, Northern Dolomites/Italy; Horlachtal, Central Alps/Austria; Höllental, Northern Calcareous Alps/Germany). Within this project (funded by the German Science Foundation, DFG), rockfaces and corresponding talus cones were scanned twice a year with two scanning resolutions. Larger events were investigated by scanning large areas of rockfaces and talus cones from a great distance ($\sim$500 m). In contrast, detailed scans from shorter distances (<250m) were used to investigate the capability of the approach to detect smaller events.
With this approach, it was possible to record three large and several smaller events in the three catchments. The largest event occurred in the Dolomite Alps (Val di Funes/Italy) with a volume of nearly 3300 cubic meters (8900 tons). Both the detachment zone and the depositional zones could be defined very well by a cut-and-fill analysis of the digital elevation models generated from the TLS data.

In addition, ground based LIDAR data are also a very helpful tool to characterize the surface properties of talus cones and the runout distances of large boulders.
The surface roughness of talus cones in all three catchments was derived from the TLS point clouds by a GIS approach according to the roughness-length method. The resulting detailed rougness maps of the talus cones will help in the future to improve existing process models which are able to model runout distances on the talus cones using friction parameters.
It has often been mentioned that not only the surface roughness of the talus cone, but also the shape of the boulders itself have an influence on the runout distance. The interrelationship between rock fragment morphology (characterised by shape parameters) and runout distance was analysed at the site of a large rockfall event (>10 000 cubic meters) from the year 2003 in the northern Dolomite Alps. For these analyses, the axial ratio of 618 rocks (>50 cm long axis) in the depositional zone and their corresponding runout distance were measured using TLS data and the software RiscanPro. Results show a significant correlation between the axial ratio of the particles and their runout distance. Rocks with a “round” shape (axial ratio around 1) have a longer runout distance than elongated or irregularly shaped particles (axial ratio greater than 1).