Geophysical Research Abstracts
Vol. 12, EGU2010-648, 2010
EGU General Assembly 2010

The influence of site conditions on the ability to measure change from sequential laser scan surveys

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The application of Terrestrial Laser Scanning (TLS) to monitor and quantify rock slope change has enabled significant improvements, at both the temporal and spatial scale, of understanding of rock slope change behaviour. However understanding the errors and accuracy associated with each application of the technique is crucial to ensure the real world scenario is accurately replicated and interpreted in the data. This is particularly important in the application of TLS to quantify slope change and to delimit detached object volumes from complex surfaces. A multitude of factors affect data quality, with errors associated with data collection, processing and interpretation as well as the limitations of the instrument itself.

This paper recognises that site specific environmental conditions place limitations on scan surveys so that ideal TLS data collection scenarios are not always achievable and that therefore errors associated with these need to be quantified and considered in the data interpretation. This paper presents the results of a series of laboratory and field experiments designed to quantify the error, and identify its key sources, associated with a long-term monitoring programme of coastal cliffs in north east England. A key aim is to identify the minimum size of rockfalls that can be accurately detected at the cliffs with the methodology applied.

Key limitations to the scan set-up design at the study site are:
- scanning time limited by the tide
- seaward length of the foreshore platform determining scanning range
- cliff height – high angles of incidence occur at the tops and edges of scans
- geological variation up the cliff affecting relative relief across the cliff
- non-uniform reflectivity

Of these, key to determining the accuracy of rockfall volume calculation are scan range, incidence angle and surface complexity and the errors associated with these were tested. We simulated worst case scenarios to identify the limits of these errors, testing high incidence angles, extremes of ranges and extremes of relative reliefs that represent the different scales of morphological features found at the cliffs.

The results enable us to quantify scan set-up, processing and instrument error. The experiments identify sources and magnitude of error, the spatial variability of error caused by each parameter individually and the effects of combinations of parameters, and identifies the optimum data collection set-up for the field sites used. Considering the effects of the scan site limitations, the accuracy of rockfall calculations and minimum size reliably identifiable is attained and this knowledge is applied to a 7 year dataset of rockfall activity collected at the field site. The results have implications for the manner in which we examine change from laser scans and proposes considerations with regards survey resolution, range and incidence angle for natural surfaces of variable texture.