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The application of combined terrestrial laser scanning and 3D topographic modeling to the characterization and monitoring of unstable slopes.

N.J. Rosser, S.A. Dunning, D.N. Petley, M. Lim and R.J. Allison.

International Landslide Research Centre, Department of Geography, Science Laboratories, South Road, Durham, UK. DH1 3LE. (n.j.rosser@dur.ac.uk / Fax: 00 44 191 334 1801 / Phone: 00 44 191 334 1918)

This paper presents results derived from the development of an innovative laser based survey technique for rapidly characterising large unstable slopes. The approach provides highly accurate data for monitoring slope mass movements in both space and time. It is argued that the study of steep, unstable terrain is inherently unsuitable for conventional aerial survey platforms due to poor viewing angles, occlusion and shadowing. Additionally, traditional methods of deriving digital surface models for survey data rely upon statistical interpolation between surveyed points conventionally from a planimetric perspective, which is not sensitive to surface detail and is incapable of modelling steep to overhanging slopes accurately. This approach uses a combined, new, rapid and cost effective ground based laser survey technique, and models the data with modelling software capable of handling truly 3D surfaces.

Results from projects undertaken on coastal cliffs on the North East coast of the UK, the Ota-Mura landslide, Japan, and data collected from scans of large scale debris flows in the Bhutan Himalaya are presented. Developments in the range, speed and precision of terrestrial scanning systems has allowed data capture at a far higher resolution than aerial techniques at speeds which are now becoming economically feasible. The combined system, here developed from a need for a highly detailed spatial and temporal understanding of coastal cliff erosion, provides a method of surface modelling which is particularly suited to providing high levels of detail on steep to near vertical rock slopes. The software uses view dependant triangulation algorithms to minimise surface occlusion and retain detail from the original data, without the need for any statistical interpolation. Results generated from the system give the geometry of rockfall to a 3D resolution of < 0.00001 m^3 across, for example, a 23,000 m^2 rock face, and allow direct measurement of rock-slope discontinuities. In addition work is presented which integrates the data as the basis for mapping, provides comparison to other forms of slope monitoring data, aids laboratory experimental design, and provides the geometrical basis for computer based numerical modelling of slope mass movements.