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Integrated LiDAR, geophysical and geotechnical monitoring of an active inland landslide, UK

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The British Geological Survey have established a long-term landslide field observatory with Loughborough University in the north of England. At this site an integrated approach of surface and subsurface geophysics, terrestrial and aerial LiDAR, GPS surveys, borehole inclinometers and surface tiltmeters combined with conventional ground investigation methods is being used to monitor the active landslide at Hollin Hill, North Yorkshire. The combination of repeated terrestrial LiDAR surveys and continuous subsurface geophysics allows the monitoring of large scale changes in the morphology of the slope in conjunction with subsurface movements. The Hollin Hill landslide has been surveyed with both aerial and terrestrial LiDAR surveys providing a unique opportunity to appraise the relative merits of the different technologies and their application in monitoring an active natural landslide site under typical UK conditions. High resolution repeat terrestrial LiDAR surveys and field differential GPS measurements are used to provide an accurate baseline geomorphological map data on the rate of movement and relative areas of activity on the landslide. Borehole inclinometers and novel down-hole acoustic emission slope displacement rate sensors attached to active waveguides allow depth of movement to be determined. To understand the subsurface processes time lapse Electrical Resistivity Tomography (ERT) and Self Potential (SP) have been utilised in order to characterise the subsurface structure, monitor hydrogeological changes (i.e. water table, moisture content, seepage pathways) and investigate the link between these changes and the movement of the landslide. These geophysical techniques provide spatial/volumetric information at a site scale, whilst being sensitive to hydraulic changes in the subsurface and augmenting the study of movement of the landslide in three dimensions.

The aim of this work is to characterise the subsurface structure of the landslide and reveal the hydraulic precursors to movement which can eventually be used to develop a true 4-D landslide monitoring system. The landslide is being remotely monitored through the installation of an automated time-lapse electrical resistivity tomography (ALERT) system which is permanently installed on the site. The ALERT system uses wireless telemetry (in this case GPRS) to communicate with a PC. Once installed and configured, the system operates autonomously without manual intervention. Environmental and geotechnical sensors have also been installed to monitor rainfall, ground movement and pore pressure changes within the landslide. Early results from the geophysical monitoring have allowed an accurate subsurface geometry of the landslide to be defined coupled with a highly accurate surface model from the LiDAR data.

The combined systems are now capable of relating ground water conditions and ground deformations, each with at least two independent methods, and relate these to changing environmental factors at Hollin Hill and hence contribute to our knowledge of the changing climate.