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Long-term monitoring of hydrogeological activation behaviour of an active landslide system using time-lapse temperature-corrected electrical resistance geophysical measurements

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If the effects of landslides are to be mitigated and avoided then the causes of landslide activations – and re-activations – must be better understood. The most common subsurface property change in the lead up to rainfall-triggered landslide activation is the moisture content of slope material and associated pore water pressure rises and/or consistency changes. If these characteristic subsurface physical properties can be observed in advance of activation then early warning of imminent slope activation may be possible.

Recent advances in geoelectrical monitoring techniques reveal that time-lapse electrical resistivity tomography (ERT) is a useful tool, capable of observing hillslope hydrogeological processes. However, most previous studies lasted a short time-frame and compared few tomograms. Therefore, a geophysical imaging system through which the progressive wetting of the ground in response to rainfall leading to saturation and then sliding can be observed would seem to be a sensible approach to explore the forecasting of imminent landslide movement.

Presented here is the analysis and interpretation of the results of a four and a half year, long-term and high temporal resolution monitoring campaign of a periodically active inland landslide, located in the UK, by a geoelectrical monitoring system called Automated time-Lapse Electrical Resistivity Tomography (ALERT).

Time-lapse temperature-corrected transfer resistances reveal that the system responds very well to rises and falls in piezometric level and seasonal trends of soil desiccation during warmer, drier months and crack annealing and soil moisture accumulation in response to wetter periods. The existence of threshold slope moisture contents, and hence electrical resistances, above which the slope activates are not observed in resistance/resistivity results most probably due to the complex nature of the landslide system, the monitoring system resolution and a number of physical slope processes taking place.

An exciting development is our improved understanding of shallow earthflow pre-activation hydrogeological behaviour. When interpreted alongside piezometry, an apparent increase in resistance in the months preceding earthflow activation reveals subtle geomechanical processes occurring, including slip surface drainage, due to soil dilation, as strain develops. Correlation between piezometric level fall and associated temperature-corrected resistance rise highlight the sensitivity of the geophysical monitoring system to landslide hydrogeological processes.