



Low-cost optical and seismic monitoring of debris-flow hazards on the Rest and Be Thankful, Scotland

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Debris-flows from intense rainfall and storm activity pose a significant hazard to infrastructure and road users in the mountainous regions of Scotland. Over the last ten years the A83 Rest and Be Thankful (RaBT) has had multiple road-impeding debris-flow events and many smaller slope confined flows. This stretch of the A83 is a major route through the west of Scotland and when closed by debris-flow activity it causes major travel disruption and is expensive to maintain. This project aims to develop a network of optical and seismic sensors to monitor slope deformation on this site in order to be able to detect the occurrence of debris-flows, narrow the time window of their occurrence and be able to advise road management agencies (BEAR Scotland, Transport Scotland) of impending debris-flow hazards.

Near-infrared (NIR) trail cameras and Raspberry Shake seismometers are in place on the slope and are continuously running. Laser scanning of the RaBT slope is conducted every two months. The NIR images can be collected and differenced from each other, producing a binary image which highlights any large scale change on the slope, such as debris flow activity. Data from the on-slope seismometers can be processed to extract waveform signals which correspond to debris-flow or slope movement activity; once completed this could narrow the time window for identifying debris-flow to a matter of seconds. Laser scanning every two months allows us to monitor any minor slope movements that may develop into future hazards by comparing successive scans.

Results to date have allowed us to detect five debris-flow events using NIR images and narrow their occurrence to 12 hour time windows. These events all show close links with antecedent intense rainfall events. Laser scanning has identified small tension cracks and slope movements which are now being monitored by BEAR Scotland for future movement. Currently the seismometers have not been shown to identify any events, however full data processing has not yet been completed. The sensor network has the potential to be upgraded to deliver data in real-time in order to facilitate the detection of debris-flows on the RaBT and for relevant agencies to be informed.