Shotover River Landslide Response

Introduction

On the 8th July 2008, a large landslide reactivated near Arthur's Point, on the Shotover River, Queenstown. Maximum rates of movement at the headscarp were of the order of 1700 mm/day, according to Otago Regional Council engineers. Once the initial failure had developed, movement rates were estimated to have dropped to 100-200 mm/day. The decision was taken to close the river to commercial jet boat and rafting operations because of the risk of sudden failure of the landslide into the Shotover River. In addition, the Moonlight Track was also closed, which runs along the headscarp of the failure (visible in the photos below).

On the 21st July 2008, with movement still occurring, it was decided by GNS Science to initiate a landslide response. Simon Nelis and Neville Palmer from GNS Science travelled to Queenstown and undertook monitoring of the landslide using the Riegl 420i Terrestrial Laser Scanner. Between the 23rd and 24th July, five laser scans were taken during daylight hours of the Shotover River landslide. The surveys were taken to gather information on whether movement was still occurring and if so where it was occurring, and what was the rate and magnitude of the movement.

Landslide Details

The landslide has developed within schist rock in the Shotover River Gorge. Foliation in the schist dips into the slope. The landslide failure mechanism is a combination of block sliding and rock-fall. The block slide is a wedge-type failure, with the failure surface developed at the intersection of three persistent rock mass defects (probably joints within the rock mass). The sliding of the rock mass has disturbed and disrupted the sliding block. This in turn has led to a number of rock-falls occurring from the top of the sliding block.

The rock-fall debris has been contained within the main gully system below the sliding block, with very little debris reaching the fan at the river (Figure 1A). The debris fan is relict, being partially vegetated and represents the accumulation of material from previous failures and slope ravelling over many years.

From the digital model produced by the laser scan survey, the estimated volume of the Shotover River Landslide is 30,000 – 40,000 m^3, although this is likely to bulk to 45,000 – 60,000 m^3 upon failure. The volume of material is great enough to temporarily block the Shotover River should catastrophic failure occur.

Movement monitoring

In order to monitor the movement of the Shotover River Landslide, the point cloud images from successive laser scans were compared and the differences in position computed. Figure 1B shows the deformation of the landslide over a 30 hour monitoring period. The first scan was taken at 11.00hrs on 23rd July and the last scan at 15.30hrs on 24th July All values are in meters with blue representing movement towards the observer (downslope movement or debris accumulation) and reds movement away from the observer (erosion or rock-fall). Grey colours represent less than 5 cm of movement (survey accuracy). The monitoring has indicated the following:

- Deformation of the head-scarp or the area above the head-scarp has not occurred during the survey period;
- Up to 300 mm of movement within the sliding block was recorded over the 30 hour monitoring period;

- Debris from small rock-falls that occurred during survey period were contained within the main gully system, with very little material reaching the debris fan at the slope-river interface.

The current survey has indicated that movement is on-going and because of this repeat surveys will be conducted to monitor the rates and magnitude of movement of the landslide.

Figure 1A: Photograph of the Shotover River Landslide taken from the true left-hand bank. Red indicates the source area and yellow the deposition zone.

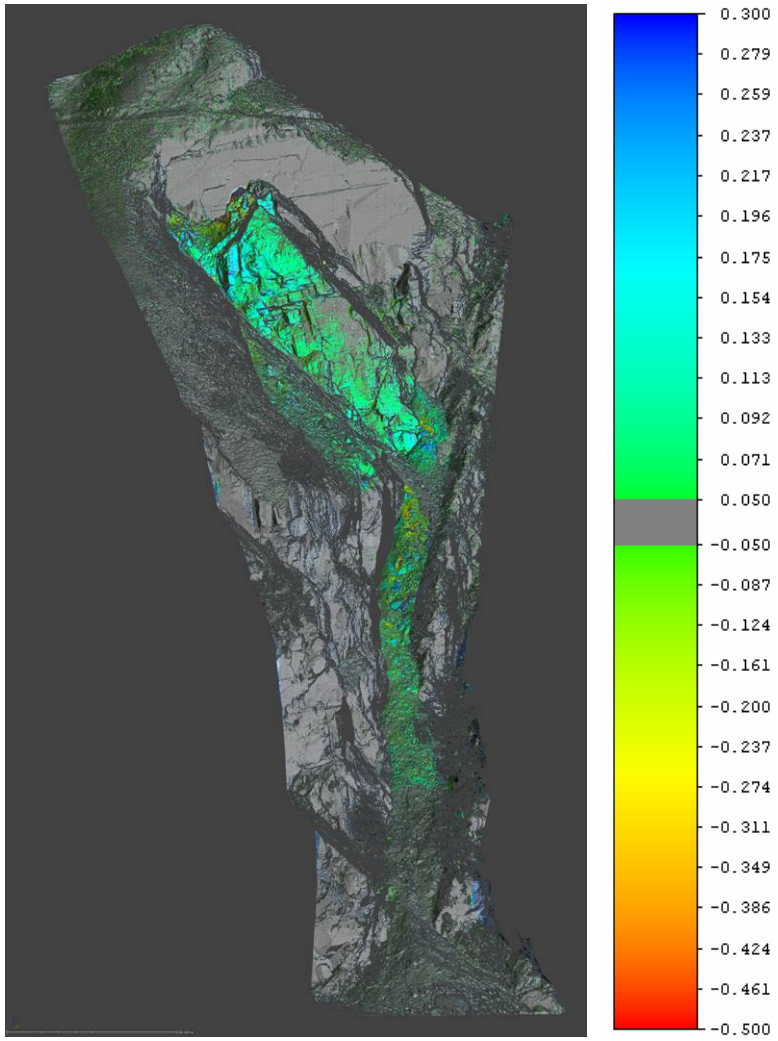

Figure 1B: A processed laser scan image of the Shotover River Landslide showing movement for the 24hr period between the 23 and 24th July 2008. The scale bar to the left represents meters of movement. Red indicates movement away from the observer, i.e. erosion and blues movement towards the observer, i.e. downslope movement of the slide mass. Grey indicates areas with less than 5 cm of movement, i.e. survey error. Maximum downslope movement over the 24hr monitoring period was 300 mm.