The Use of Terrestrial Laser Scanning for the Characterization of Debris Accumulation Patterns in the White Canyon, British Columbia

David A. Bonneau[1] (david.bonneau@queensu.ca), D. Jean Hutchinson[1] & Scott McDougall[2]

[1] Department of Geological Sciences and Geological Engineering - Queen's University, Kingston, Ontario, Canada

[2] Department of Earth, Ocean and Atmospheric Sciences – University of British Columbia, Vancouver, British Columbia, Canada

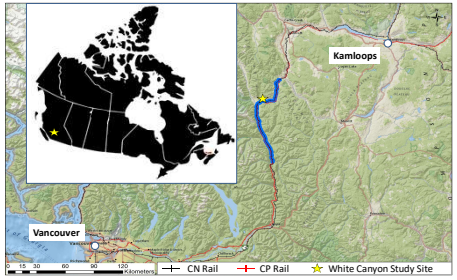
Introduction

The Thompson-Fraser Rail Corridor in Interior British Columbia (BC), Canada is one of the most operationally challenging sections of rail in all of Canada. The movement of accumulated debris from rockfall and rock slides poses a significant geohazard to the safe operation of trains through this corridor. As part of the Canadian Railway Ground Hazard Research Program (RGHRP), terrestrial laser scanning has been ongoing at a number of sites in the corridor since 2012.

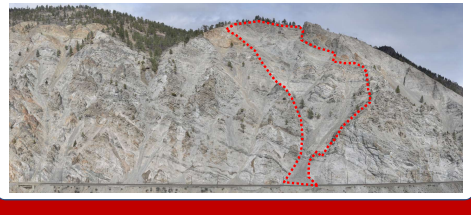
The aim of this study is to present a methodology to monitor the spatial and temporal accumulation of debris on a slope with terrestrial laser scanning. This methodology will help evaluate the recharge threshold for debris flow initiation as suggested by the supply-limited theory as proposed by Jakob (1996).

Study Site

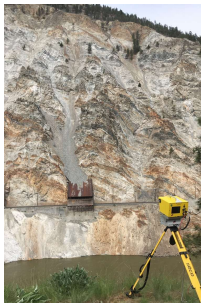
The White Canyon, located 250 km northeast of Vancouver, BC near the confluence of the Thompson and Fraser Rivers is an active slope which has been monitored as part of the RGHRP program. The Canadian National (CN) rail line crosses the base of this slope. Rockfalls are common due to the highly weathered and fractured bedrock. The rockmass is very complex, with the primary unit being a foliated quartzofeldspathic gneiss with amphibolite bands, containing amphibolite and gabbroic intrusions (Monger, 1984).



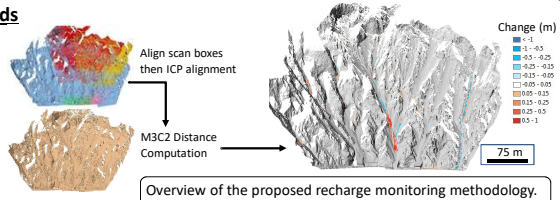
For this study, the focus will be on a specific channel in the East section of the Canyon. The select channel is highlighted in red in the image below. The channel is approximately 450 m in length and has an average slope angle of 35 degrees.

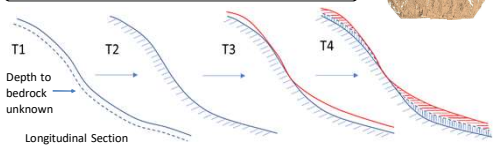


Methods



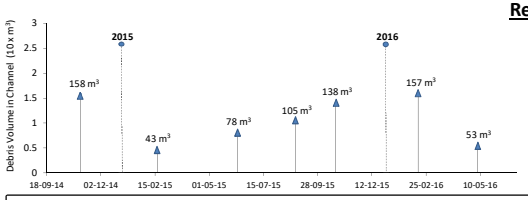
- Terrestrial laser scans are collected approximately every 2-3 months, and have been since 2012.
- The scans are processed and aligned to a reference scan.
- M3C2 change detection (Lague et al., 2013) was conducted between scans.
- High resolution panoramic images were also taken.

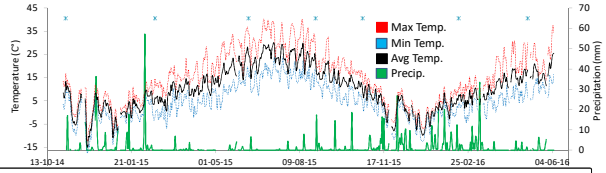




Overview of the proposed recharge monitoring methodology.
T1 – Initial scan of channel.
T2 – Debris movement has occurred and scoured channel to bedrock.
T3 – Channel begins to recharge from rockfall and rockslides.
T4 – Debris movement occurs. Using baseline in T2, the degree of debris and bedrock incision can be calculated.

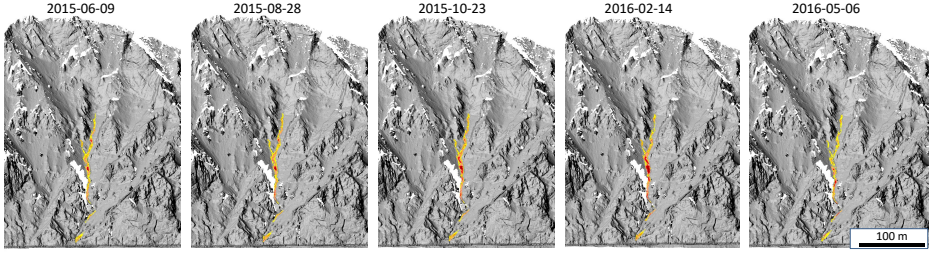
Results



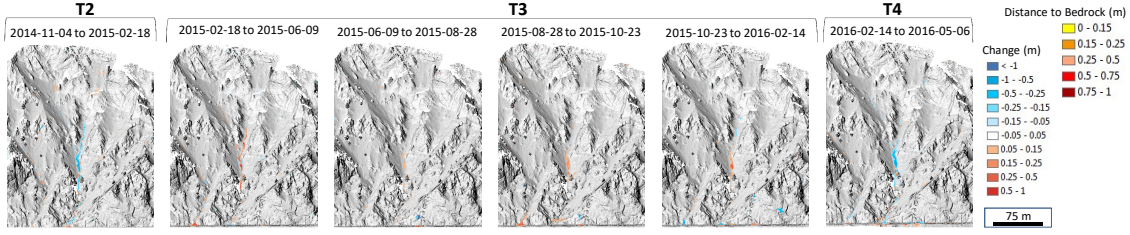


Debris Volumes

- In T2: a channel bedrock baseline was established.
- T2 baseline was compared to subsequent scans to estimate the amount of debris in the channel at the time of each scan.
- In T4, the profile was variable, with some sections of the channel being scoured and others showing accumulation of debris.

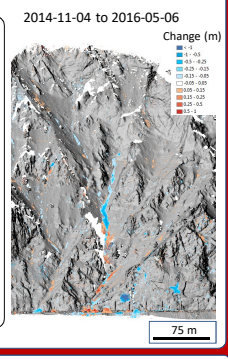


M3C2 Change Detection



Temporal Censoring

In this plot, the change detection is made between the first and last data sets from this study, showing the overall movement of debris over 16 months. This masks the details shown in the change detection plots to the left, and misses the evidence of two debris flow events. Higher frequency scanning permits the detection of individual talus movement events, and the loss and recharge of material in the channel.



Conclusions and Future Work

This study has shown that terrestrial laser scanning can be implemented to successfully monitor the spatial and temporal accumulation of debris on a complex slope. As data is collected, the behaviour of this channel and the others in the White Canyon, will be analyzed. Cycles of accumulation and flow will be assessed over time to ascertain the effect of weather related events and debris movement. In addition, the size of the debris will be analyzed to determine if there is any relation between the movements of the debris and the material grain size and shape.

References

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