Rock Slope Asset Assessment and Management – RS contributions

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In Memory of Dr. A. Keith Turner

Professor Emeritus, Colorado School of Mines
Visiting Research Associate, British Geological Survey
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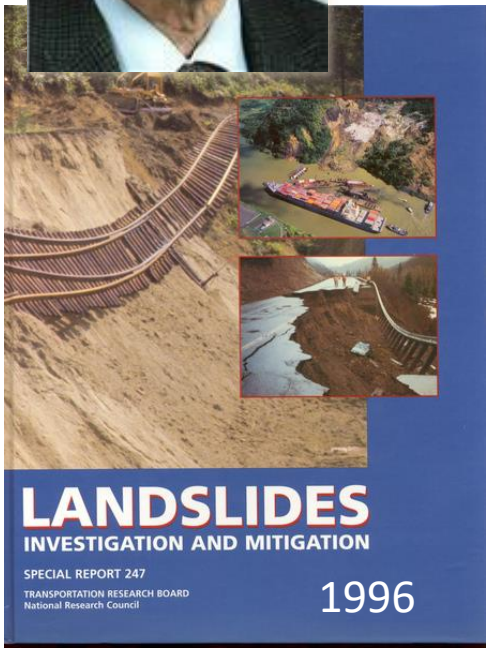
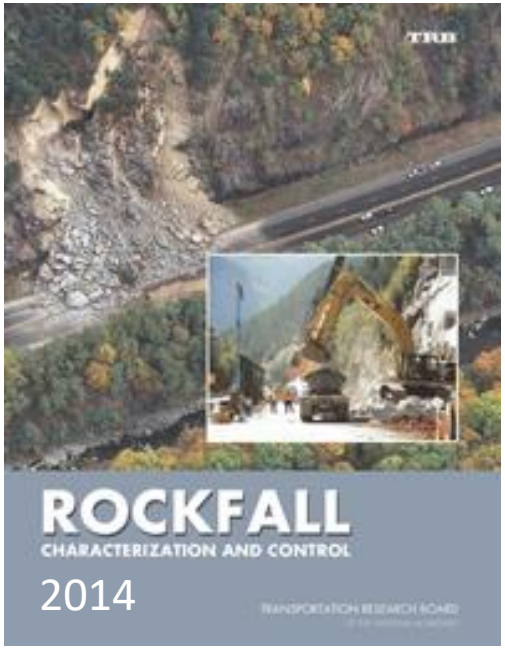
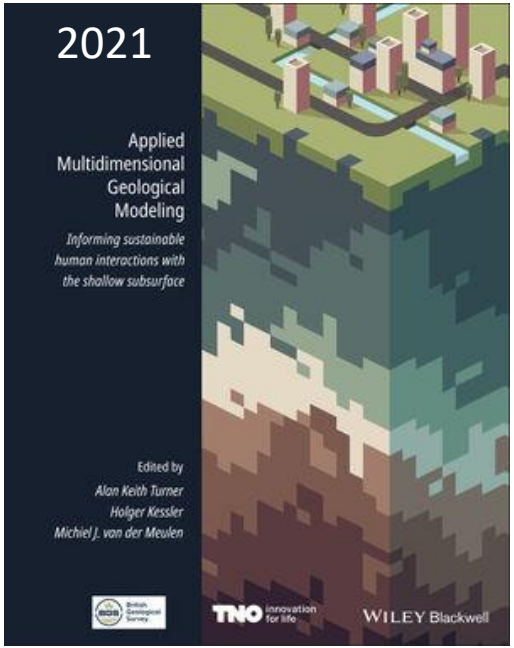






The challenge:

How do we:

assess the current condition,

collect sufficient data and

develop knowledge to

predict future conditions and

move to pro-active natural rock slope asset management?

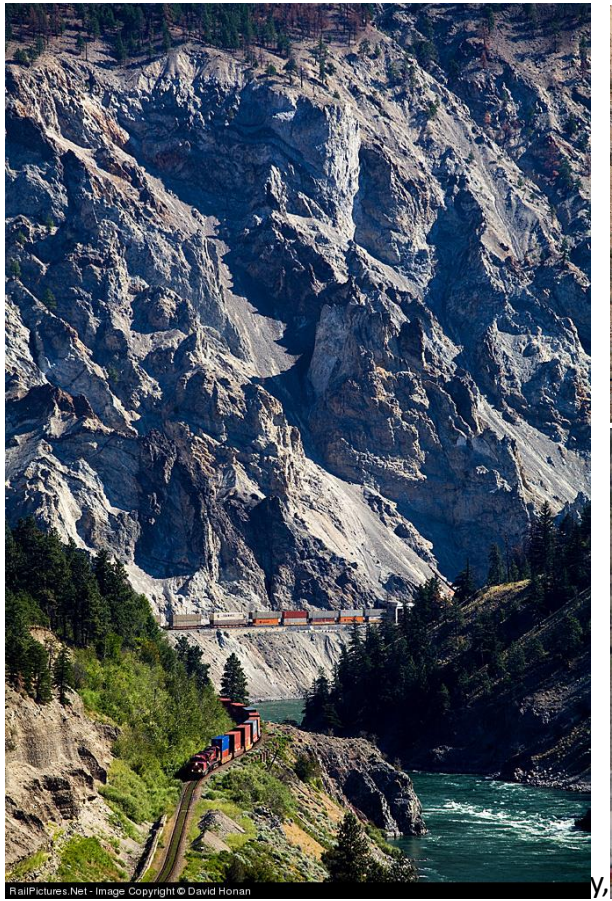
When the slopes are adjacent to railway infrastructure – which occupies a fixed position?

The Problem –

Rock slope failure events are complex and can involve several stages of activity. Warning signs are often not detected in advance.

Video, courtesy of Trevor Evans

Slope Hazards



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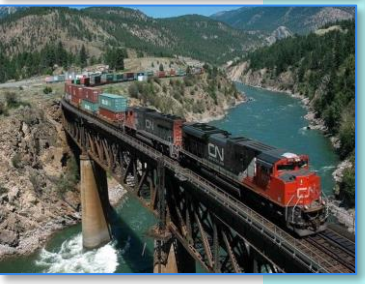
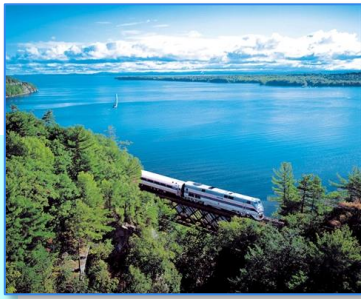
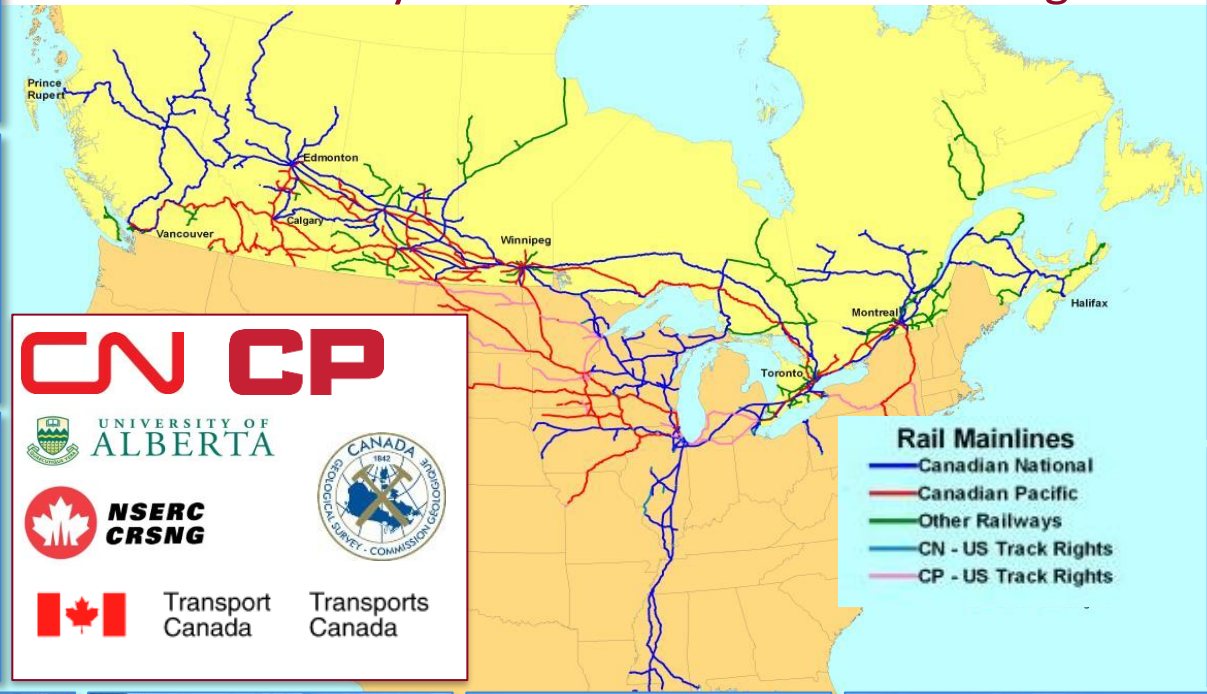
Acknowledgements:
Canadian Railway Ground Hazard Research Program







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Transport Canada

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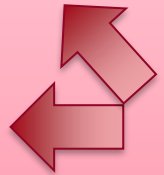
Innovations – Remote sensing of rock slopes

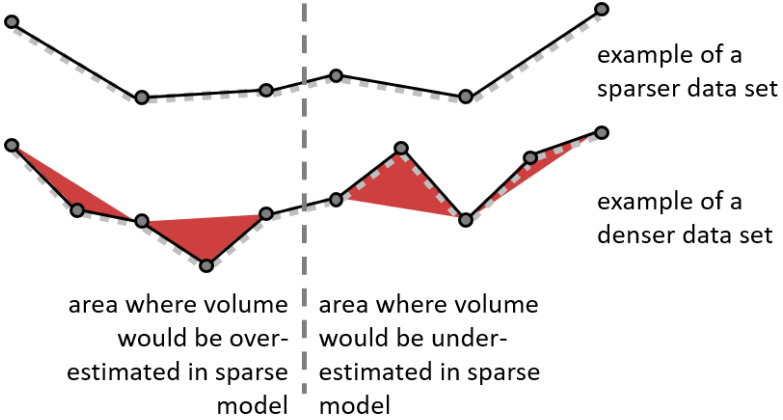
Equipment

Gigapan

LiDAR

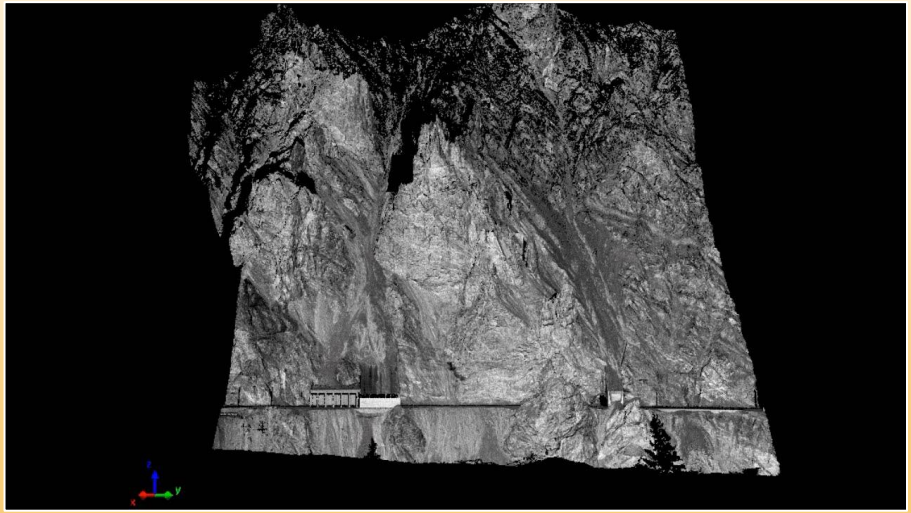
Vantage points



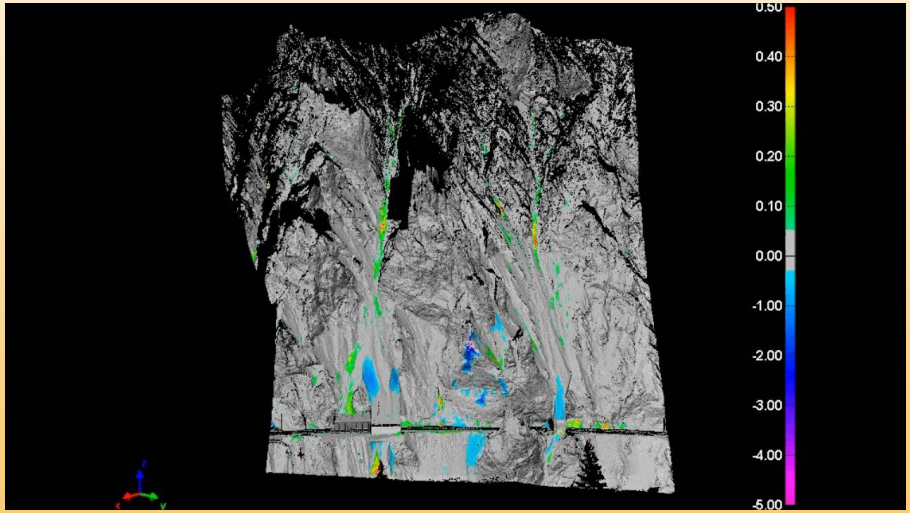


Innovations – Usage of RS data

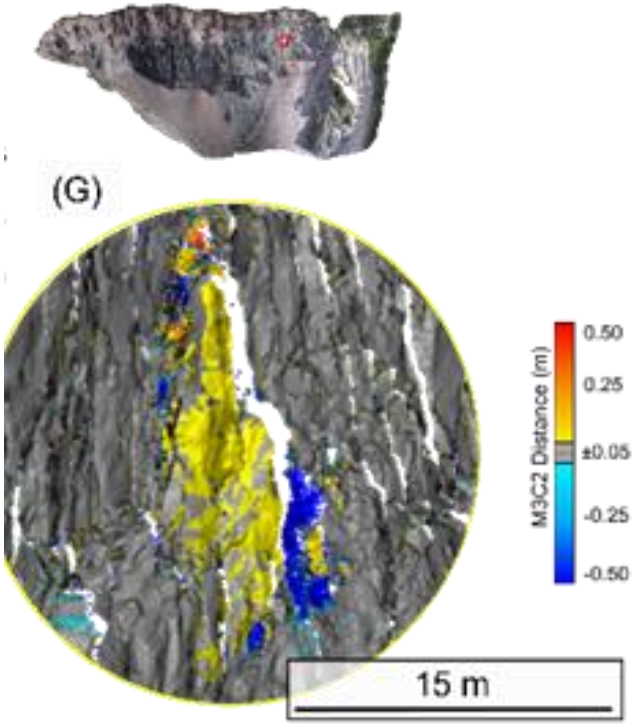
Geometry

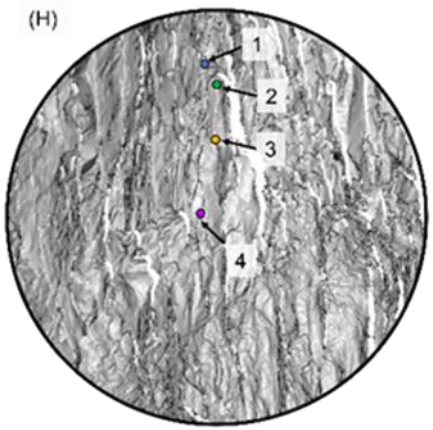


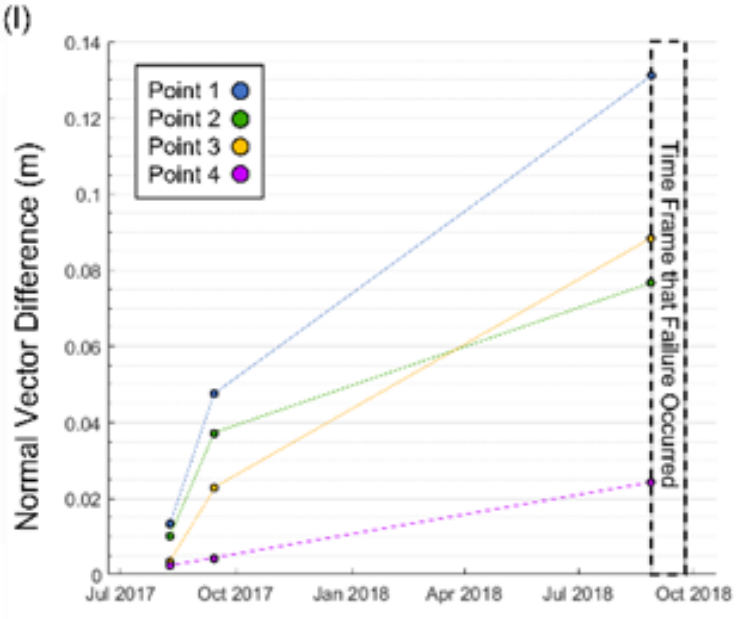
Change



Innovations – Usage of RS data







Innovations – Remote sensing of rock slopes

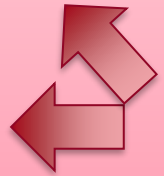
Bonneau, DiFrancesco, Kromer

Equipment

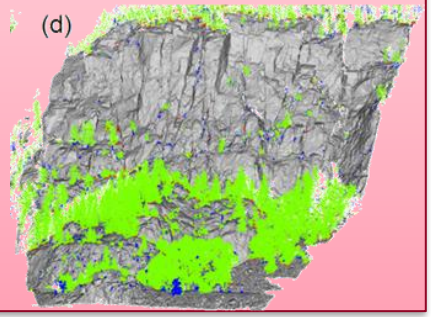
Gigapan

LiDAR

Vantage points

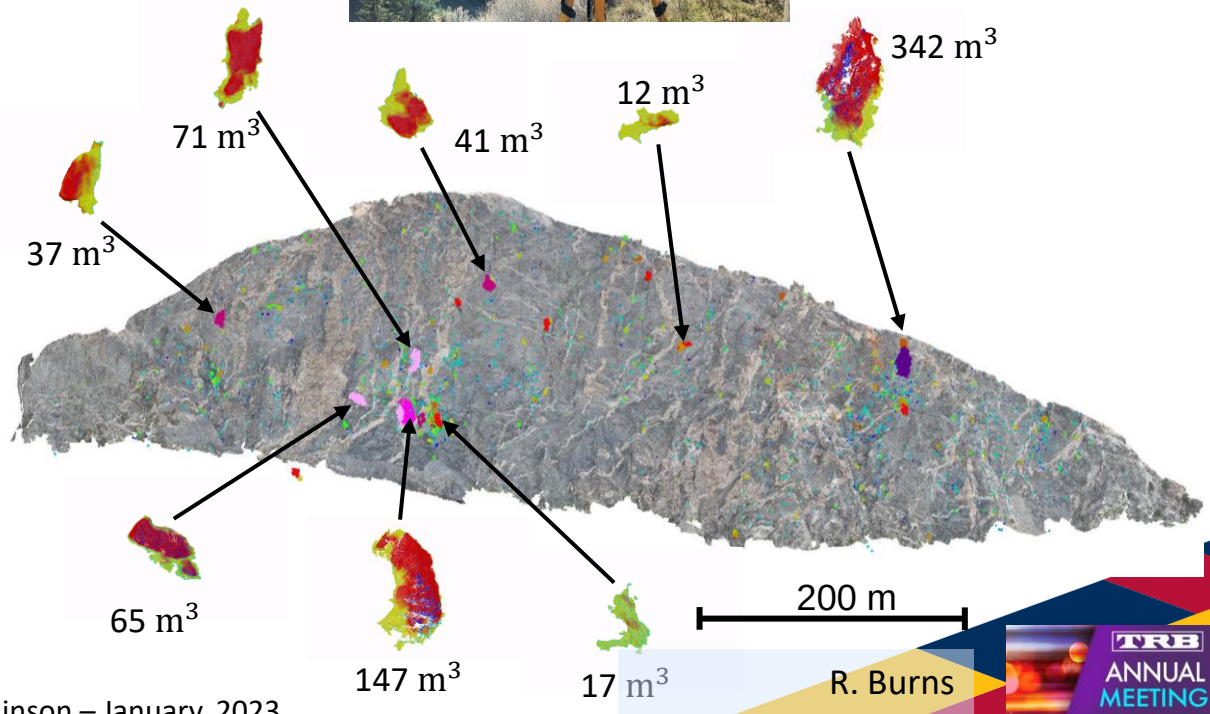


Automated processing



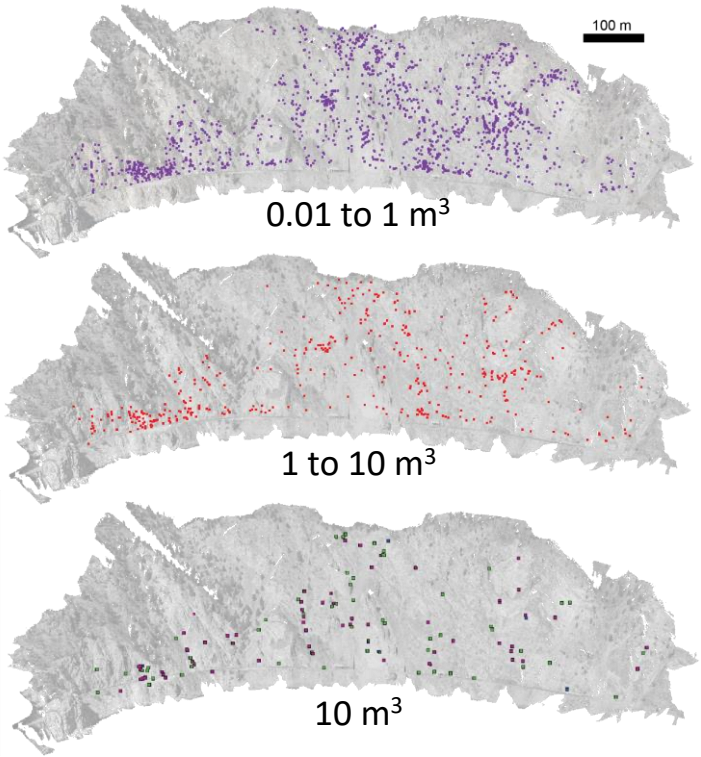
Digital Rockfall Inventory

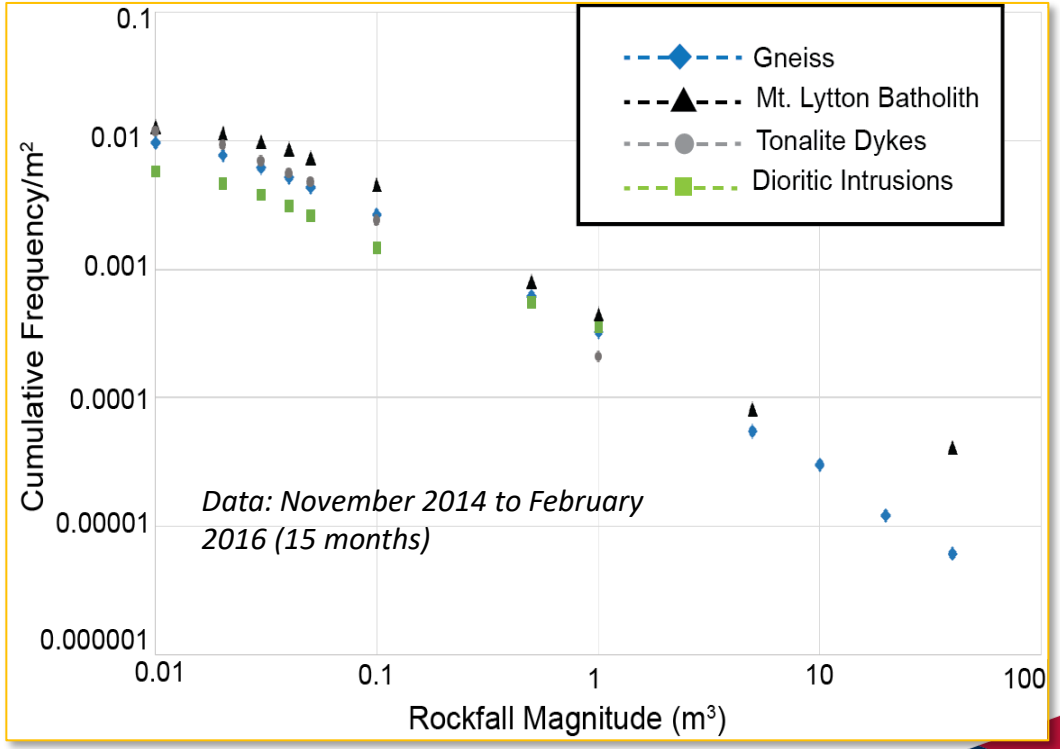
- Accurate identification of rockfall source zone location
- Shape, volume, lithology, source zone characteristics
- Rockmass structure, block fragmentation, impact positions
- Velocity, critical displacement, conditioning and triggering events
- Learn about and understand rock slope processes, as we monitor them.



R. Burns

Rockfall events – Frequency Magnitude

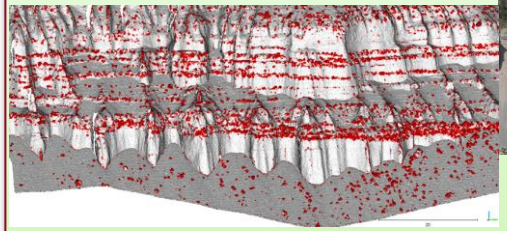


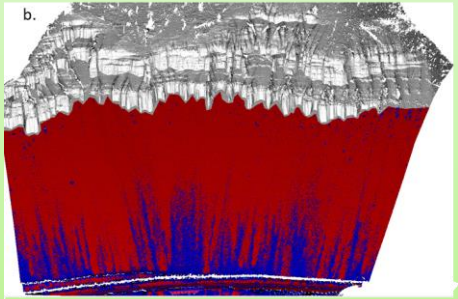


van Veen et al, 2017

Innovations – Automated analysis of remotely sensed data

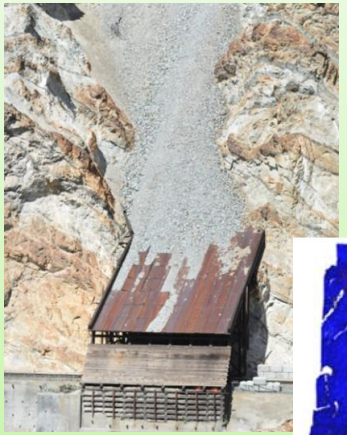
Feature identification

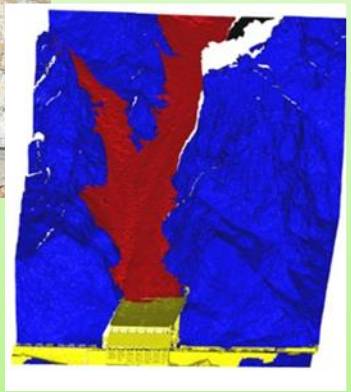




D. Bonneau

Image segmentation



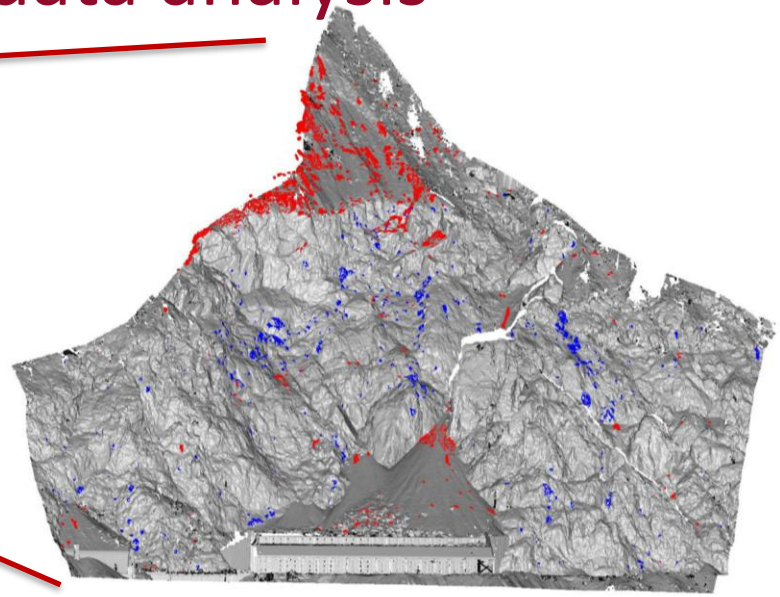


Classes

- Debris Channel
- Rock Slope
- Built Infrastructure

I. Farmakis

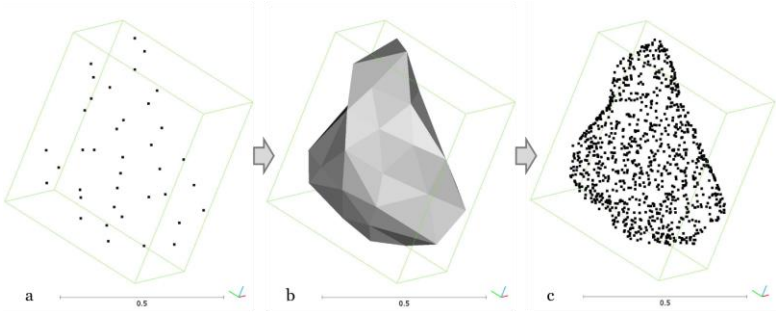
Development of AI based data analysis

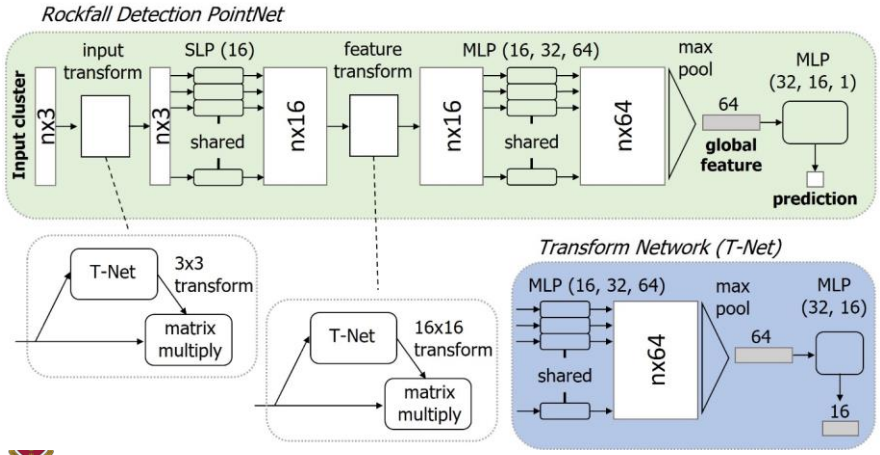


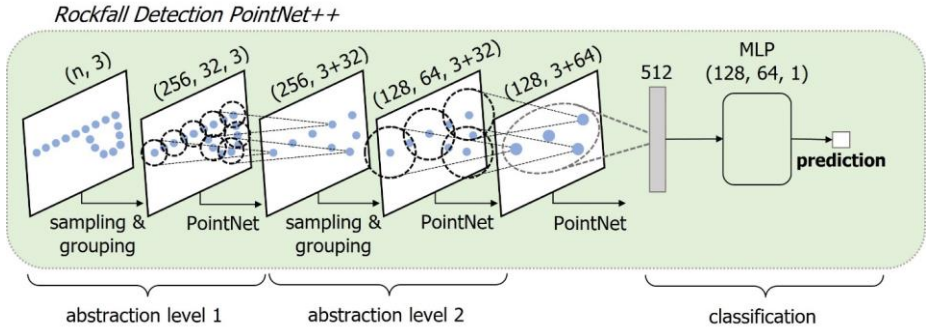
Deformation clusters: Rockfall Non-rockfall

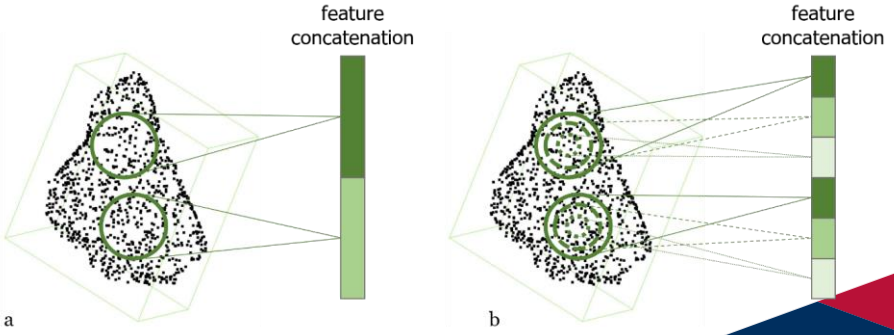
- 5-year long LiDAR-based change detection database
- Total of 8,966 deformation clusters (38.7% rockfalls)
- All clusters are manually labeled as **rockfall** and **non-rockfall** instances

Neural Network Architectures





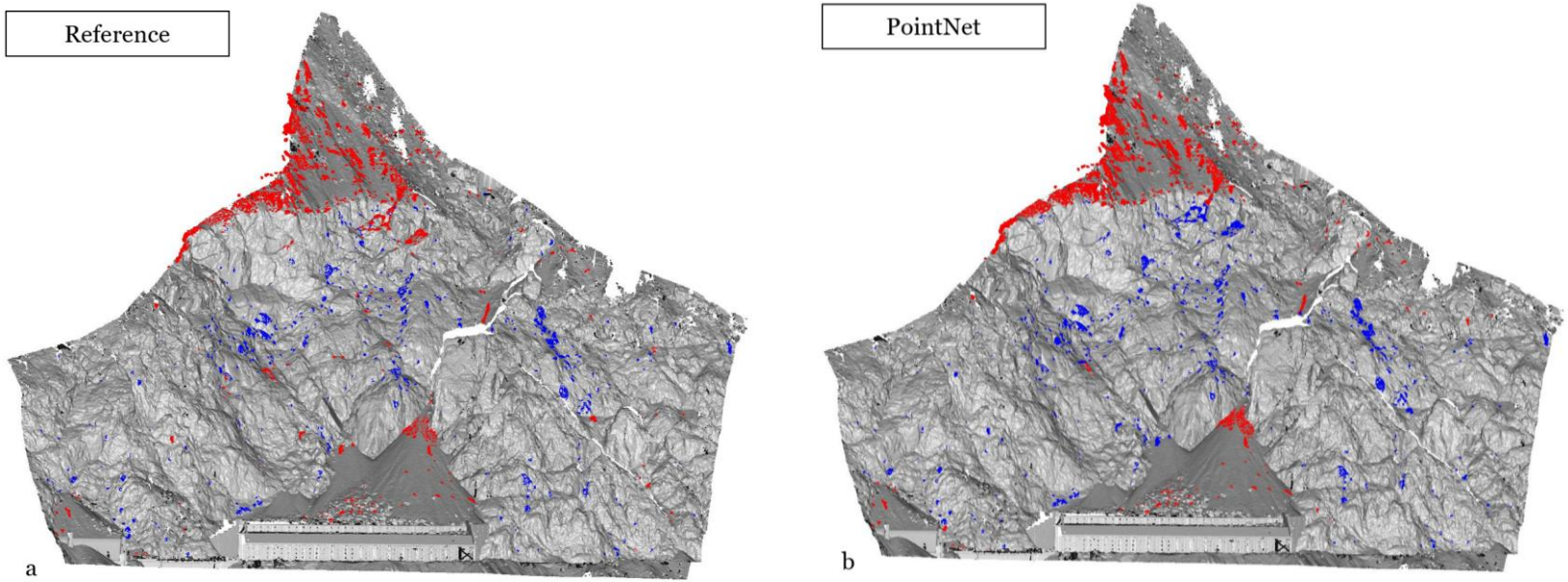




D. J. Hutchinson – January, 2023

I. Farmakis (2022)

Results



Dataset #1						
	PointNet		PointNet++ SSG		PointNet++ MSG	
	Loss	Acc	Loss	Acc	Loss	Acc
Train	0.4252	0.8636	0.3716	0.8155	0.2871	0.875
Dev	0.4355	0.8504	0.3854	0.8265	0.3203	0.861
Test	0.4105	0.8872	0.3895	0.8482	0.3466	0.8527

I. Farmakis (2022)

Comments

- Increasing volumes of RS data are becoming available, and automated processing methods are being developed.
- ML and AI will play a large role in processing vast amounts of data to provide us with actionable data.
- Geological complexity poses a challenge to full automation, until the methods have been tested on a wide variety of natural slopes with differing failure mechanisms and behaviour.
- Eventual goal is input to asset condition assessment and mitigation efforts.

Thank you very much for your attention

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