

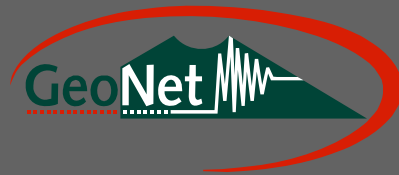
Landslide response and monitoring – the New Zealand GeoNet experience



C.I. Massey, M, McSaveney & G. Dellow GNS Science
with contributions from the GeoNet landslide team and others



The New Zealand GeoNet Project



An **integrated** geological hazards monitoring and data collection system, funded over 10 years by the New Zealand Earthquake Commission (EQC) and designed, built and operated by GNS Science

GeoNet Purpose

- Collect data for the advancement of geological hazards research with the long term aim of improving New Zealand's resilience to hazards events
 - Immediate response to geological hazards events
- “Goal is to ensure that as the New Zealand economy and population grow, a wide range of agencies can adapt to or avoid geological hazards, minimising damage, loss of life and the cost of recovery”**



What does GeoNet do?

GeoNet includes near real-time monitoring of:

- ❑ *Earthquakes*
- ❑ *Volcanic unrest*
- ❑ *Tsunami*
- ❑ *Land stability*
- ❑ *Land deformation*





Map Layers

- Operational sites**
 - CGPS sites
 - Seismograph sites
 - Strong motion seismograph sites
 - Tsunami network sites
- Completed sites
- Under construction
- Permitted sites
- Suitable sites
- Under test
- Temporary
- Planned 2007/2008
- Planned 2008/2009
- Planned 2009/2010
- Planned 2010/2011



GeoNet Sensor Networks

Over 500 sites including telemetry hubs

NZMG coordinates: 3245677 5985493

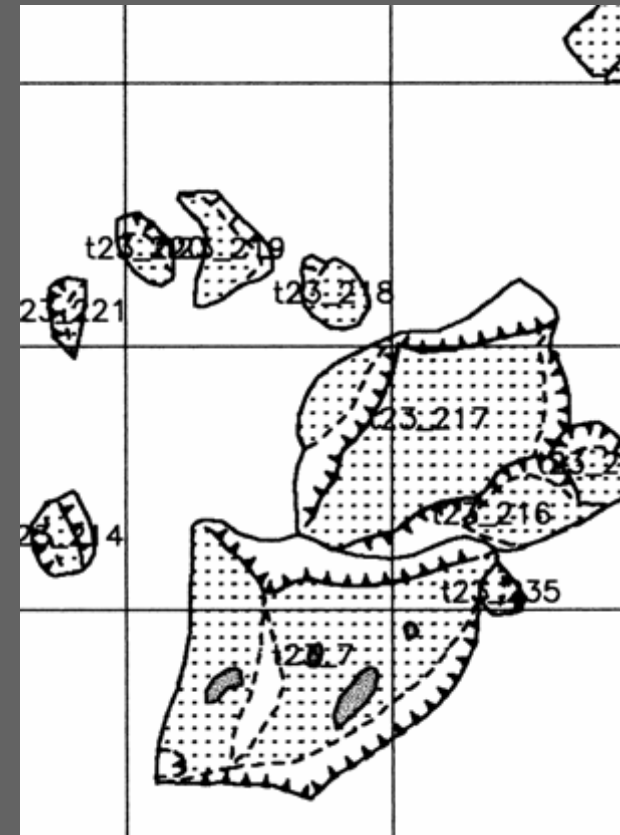
GeoNet landslide activities

- **Landslide distributions**
 - National inventory of historical/pre-historical landslides
 - Catalogue of recent landslide events
- **Landslide monitoring**
 - Development of monitoring techniques
 - Surface and subsurface movement,
 - Movement triggers (rainfall, groundwater and ground shaking)
- **Rapid response (24/7) to landslide events**
 - Facilitate collection of research quality data, of transient phenomena
 - Maintain national register of responders

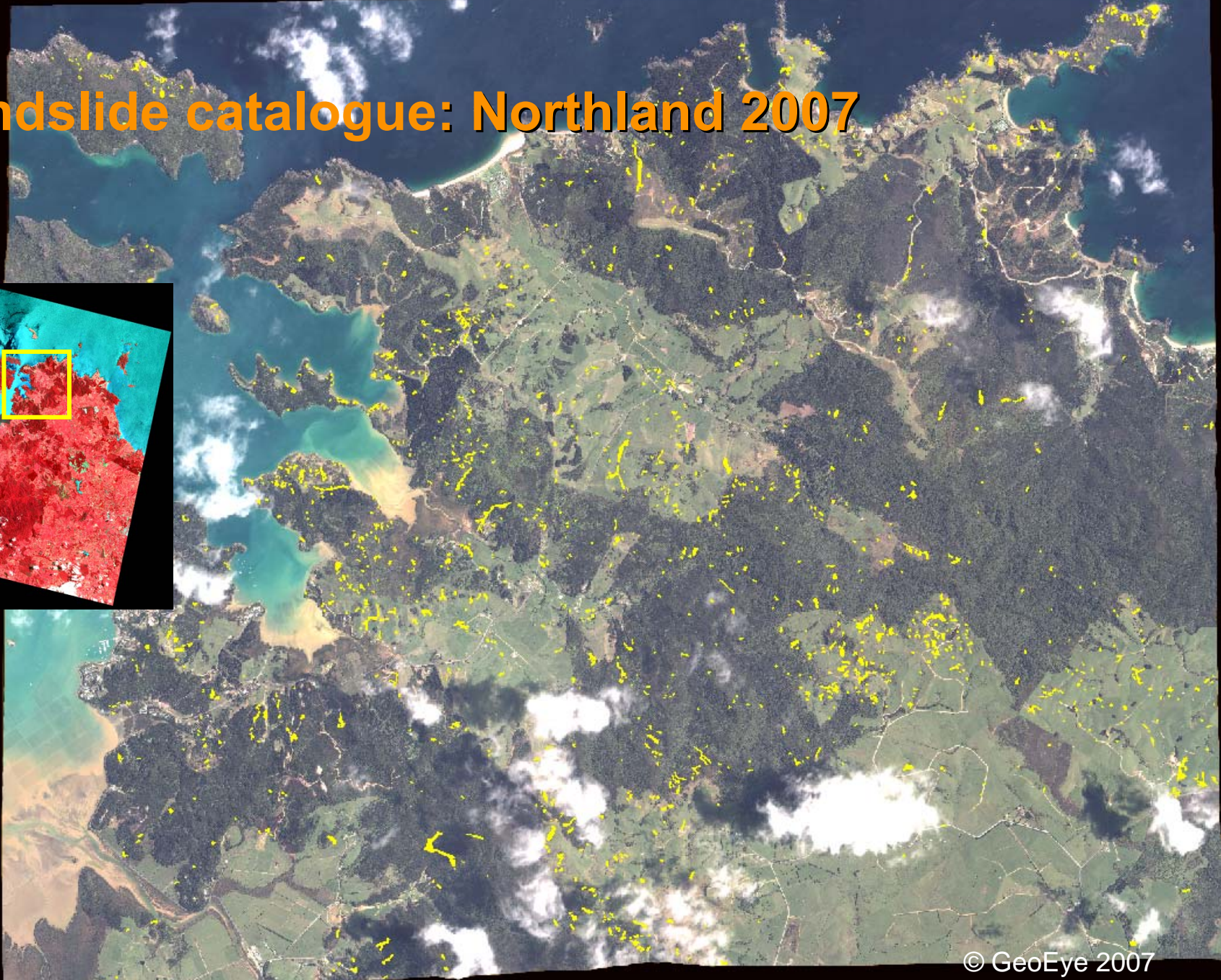
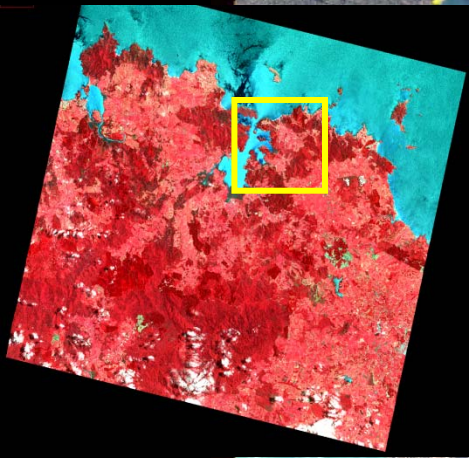
Landslide distributions

- Inventory: mapped locations of landslides from aerial photographs, satellite images and field work
- Catalogue: reported locations and time of occurrence (from 1996)

Landslide distributions



Landslide catalogue: Northland 2007



1km

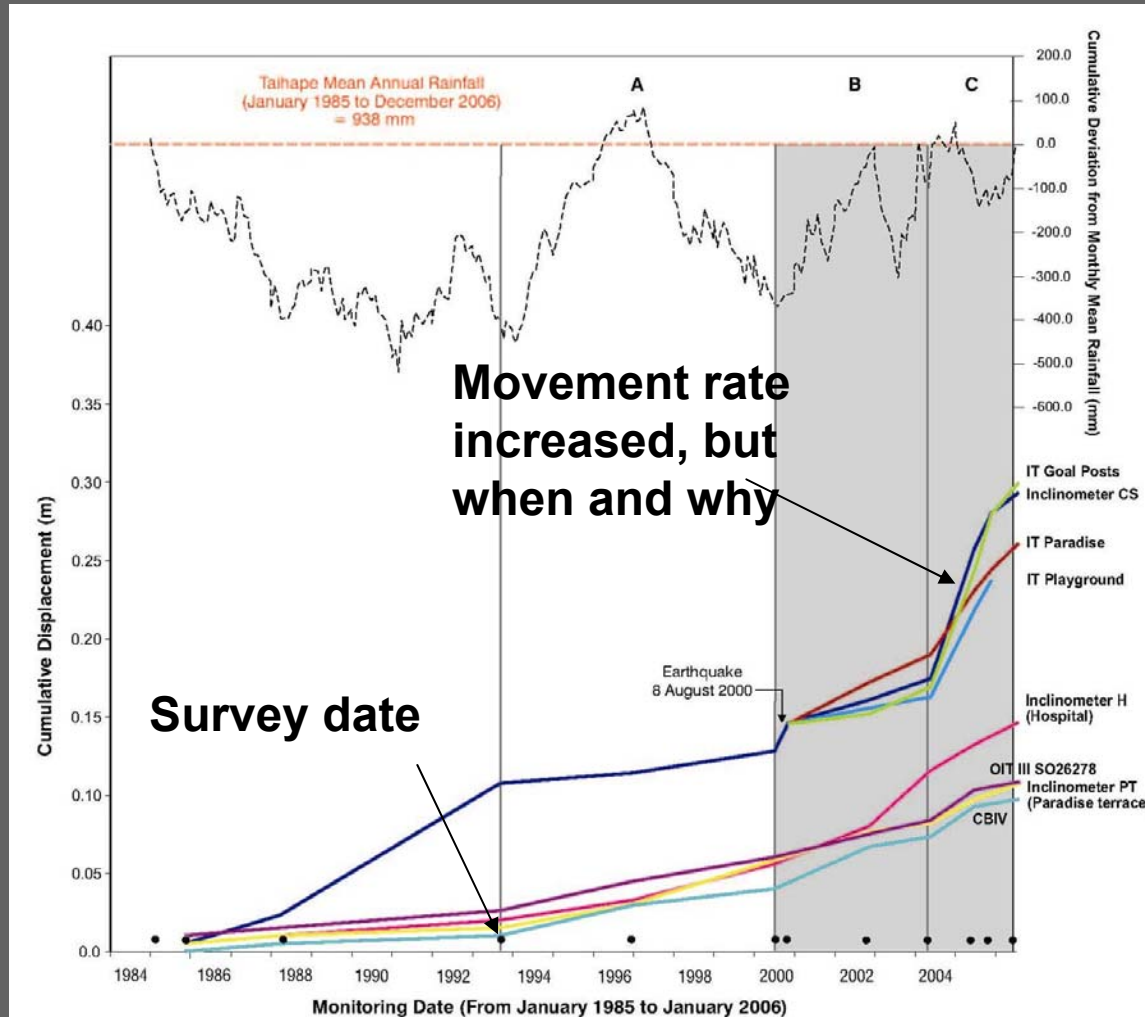
© GeoEye 2007

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Landslide monitoring – the problems

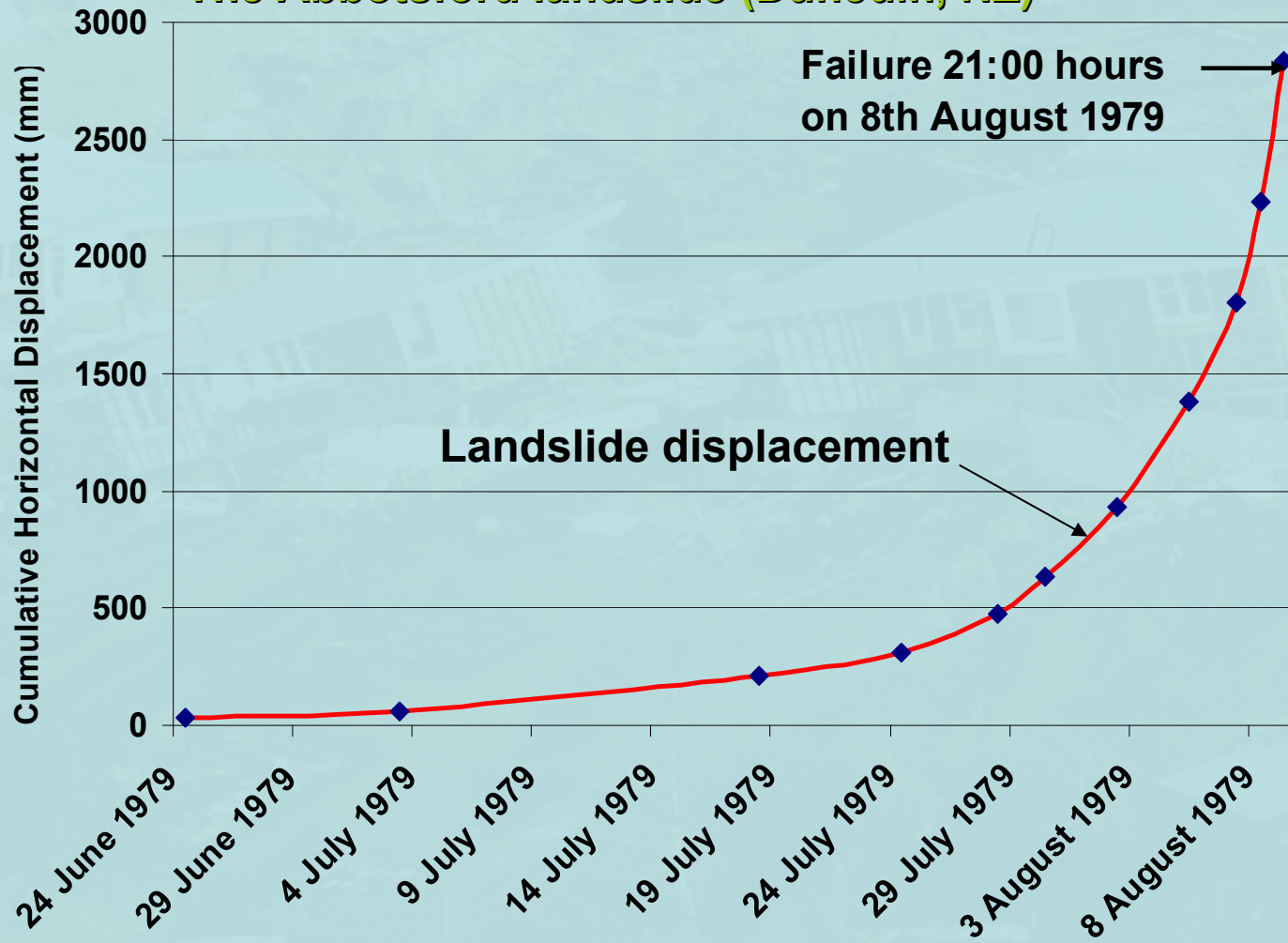
- **Techniques for improved temporal resolution**
- **Transfer, processing and display of data**
- **Landslide-specific data for NZ-wide models**

Temporal resolution – existing



Transfer, processing and availability

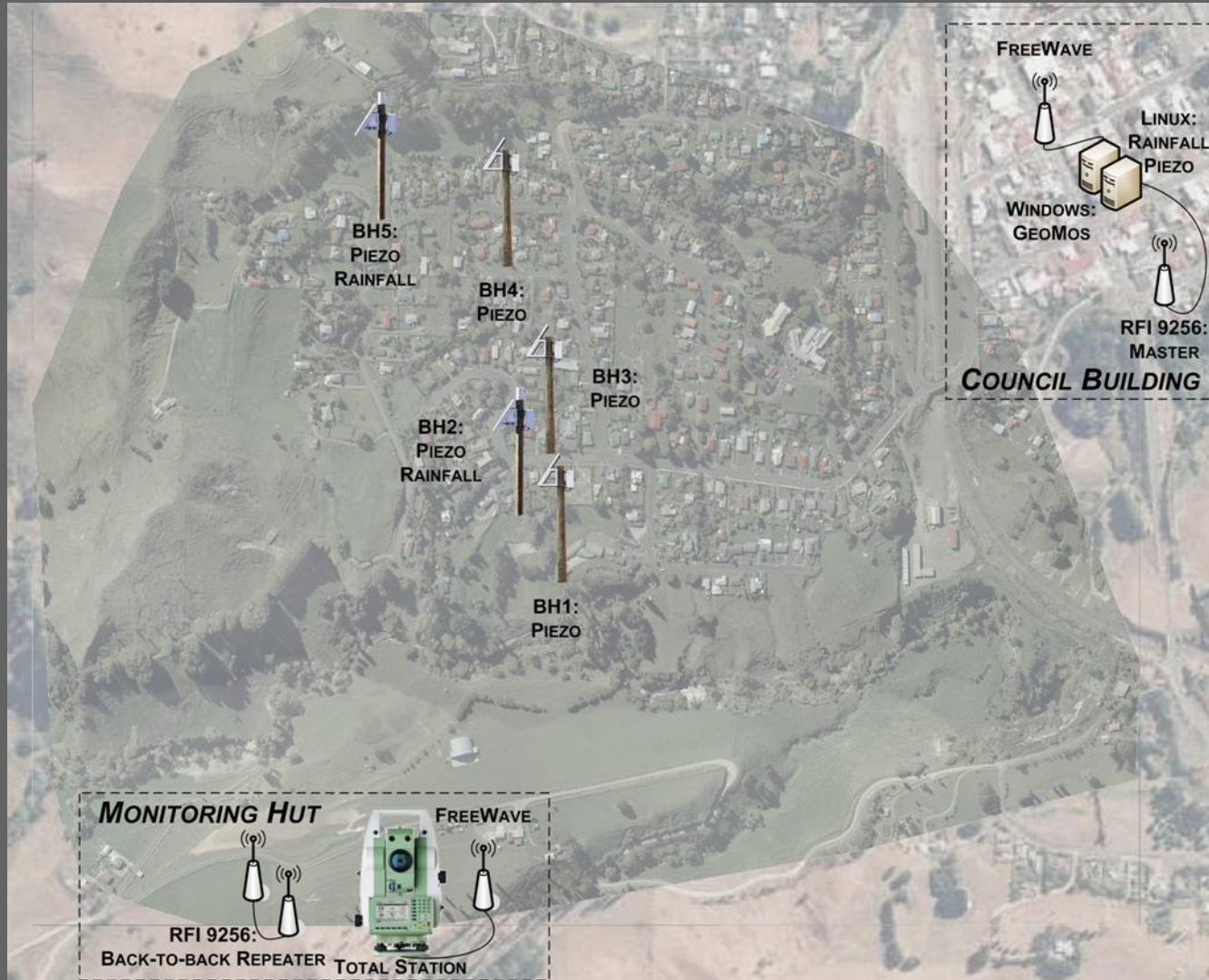
The Abbotsford landslide (Dunedin, NZ)



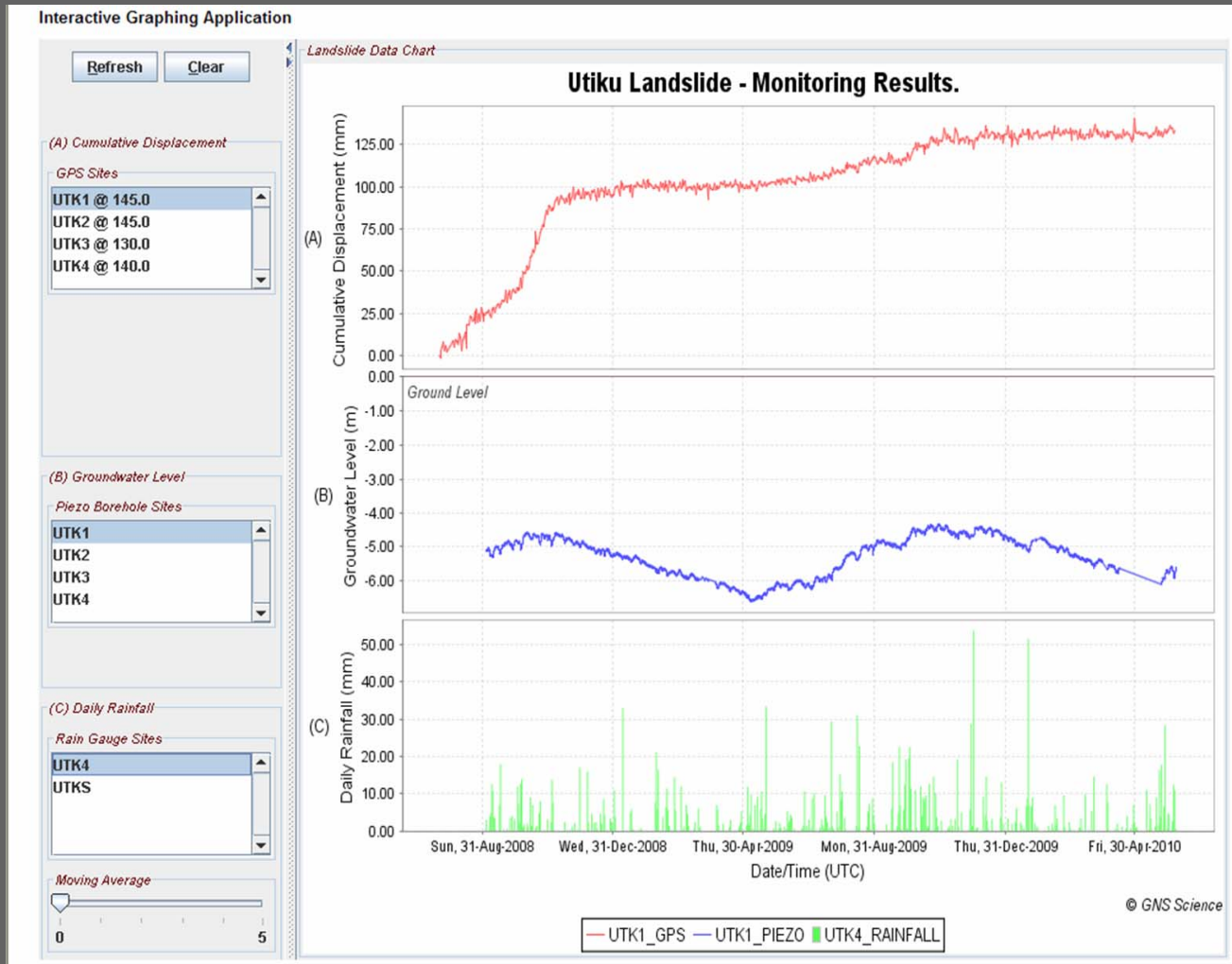
Current techniques



Current network:

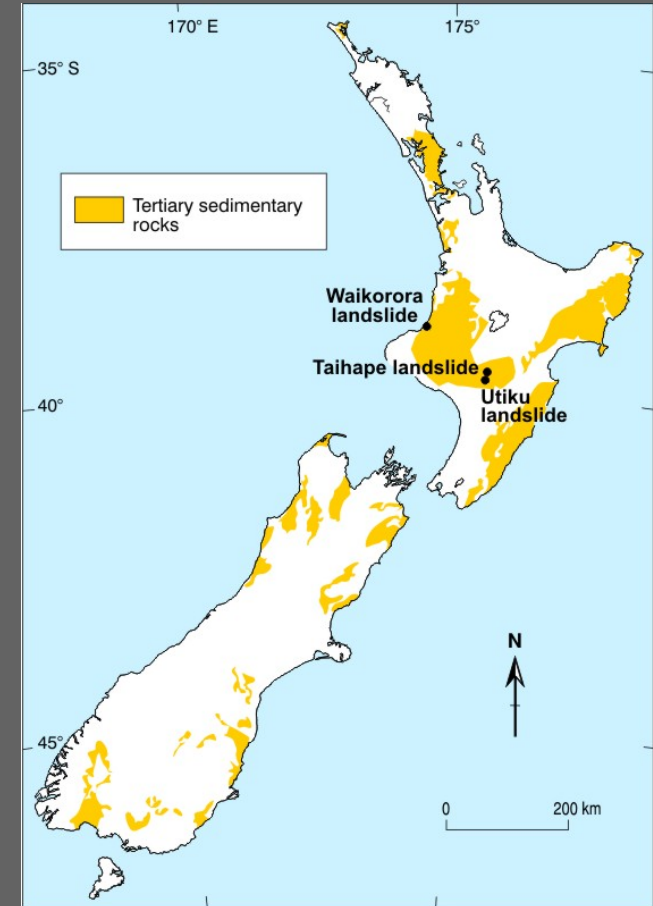


Near-real time display



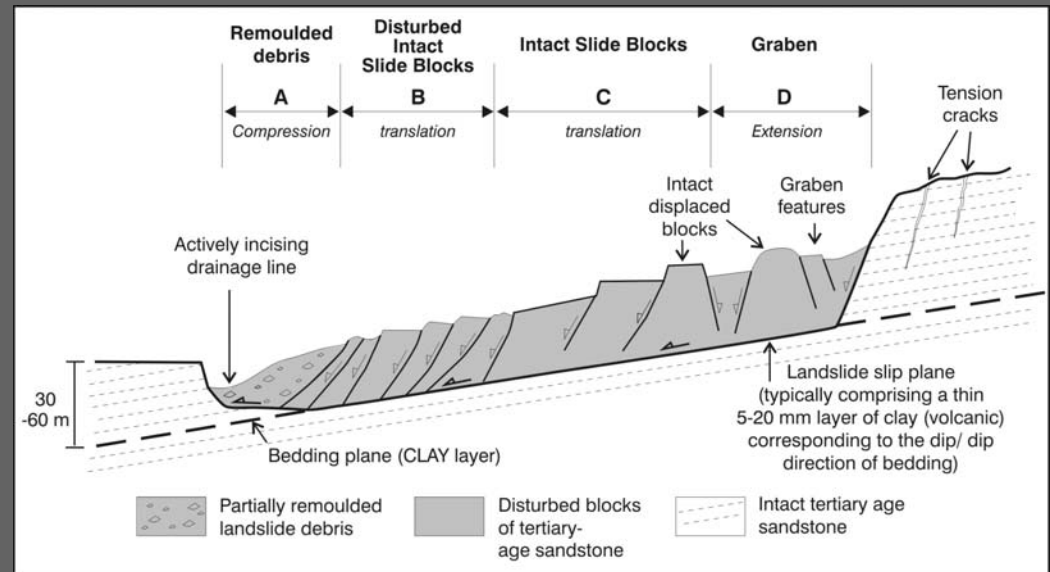
Landslide-specific data for NZ-wide models

- Tertiary-age sedimentary rocks cover about 17% of New Zealand
- They host over 7000 large landslides ($> 10,000 \text{ m}^2$)
- Majority are slow-moving, deep-seated, translational slides
- Taihape and Utiku landslides are two examples

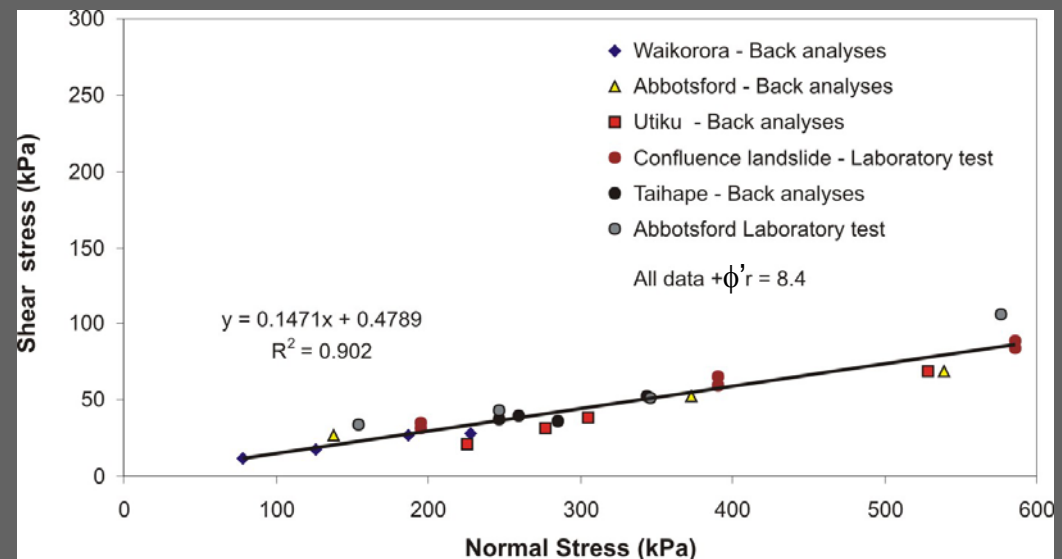


Landslide-specific data for NZ-wide models

- Movement along thin clay seams, parallel or sub-parallel to bedding



- Friction angle of clay seams $< 10^\circ$

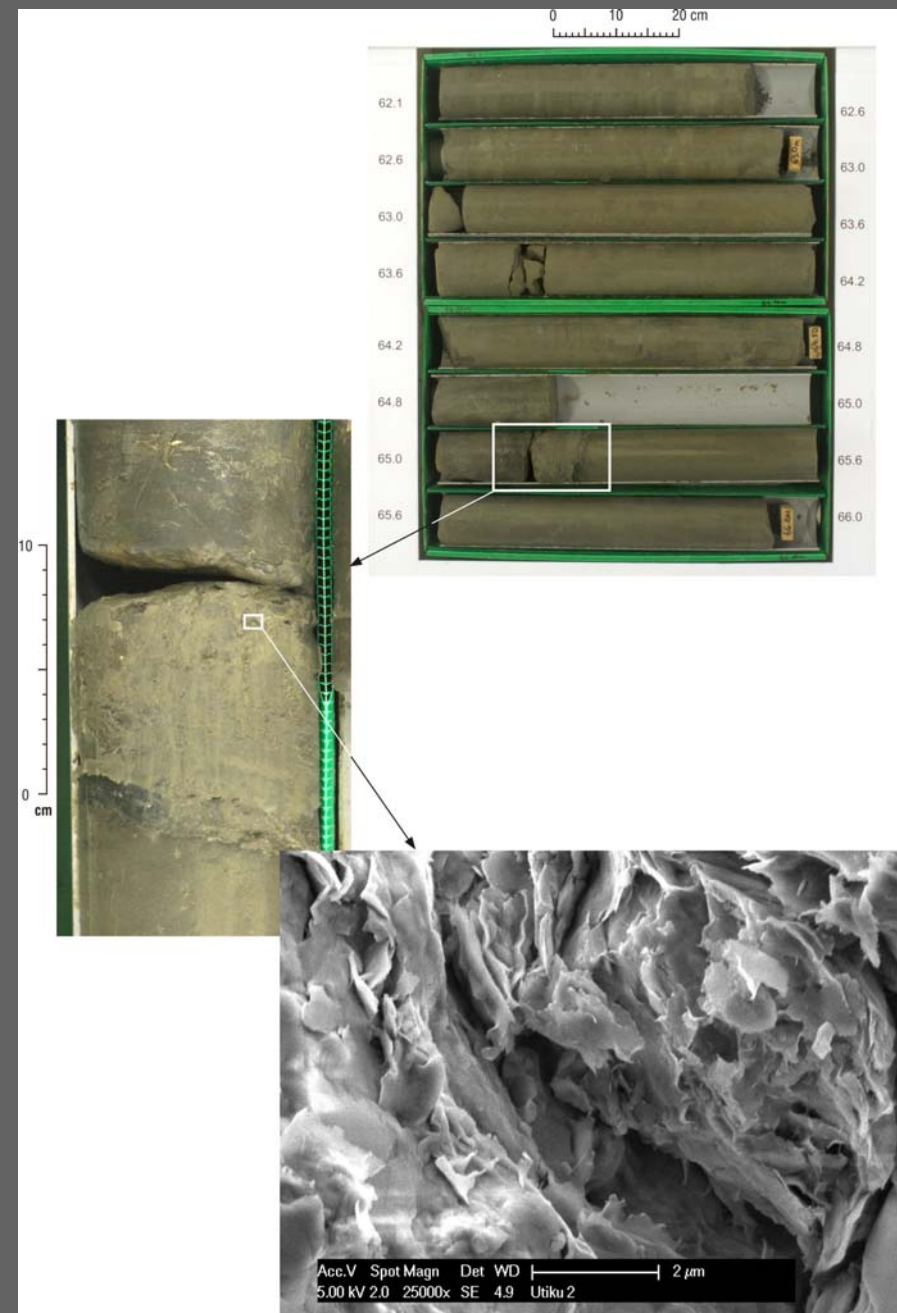


Landslide-specific data for NZ-wide models



Landslide-specific data for NZ-wide models

- Clays are smectites of the montmorillonite group
- Believed to originate from volcanic ash



Landslide slip surfaces



Abbotsford



Utiku



Taihape

GeoNet Landslide Response

- **Criteria for activating a rapid response are:**
 - 1. Death or serious injury**
 - 2. Subsequent catastrophic event (such as landslide dam breach)**
 - 3. Direct damage > NZ\$1 million (5 million Yuan)**

GeoNet Landslide Response

4. **Economic losses > NZ\$10 million (50 million Yuan)**
5. **Threats to public health (such as contaminated water supplies)**
6. **Significant research interests**

Death or Serious Injury

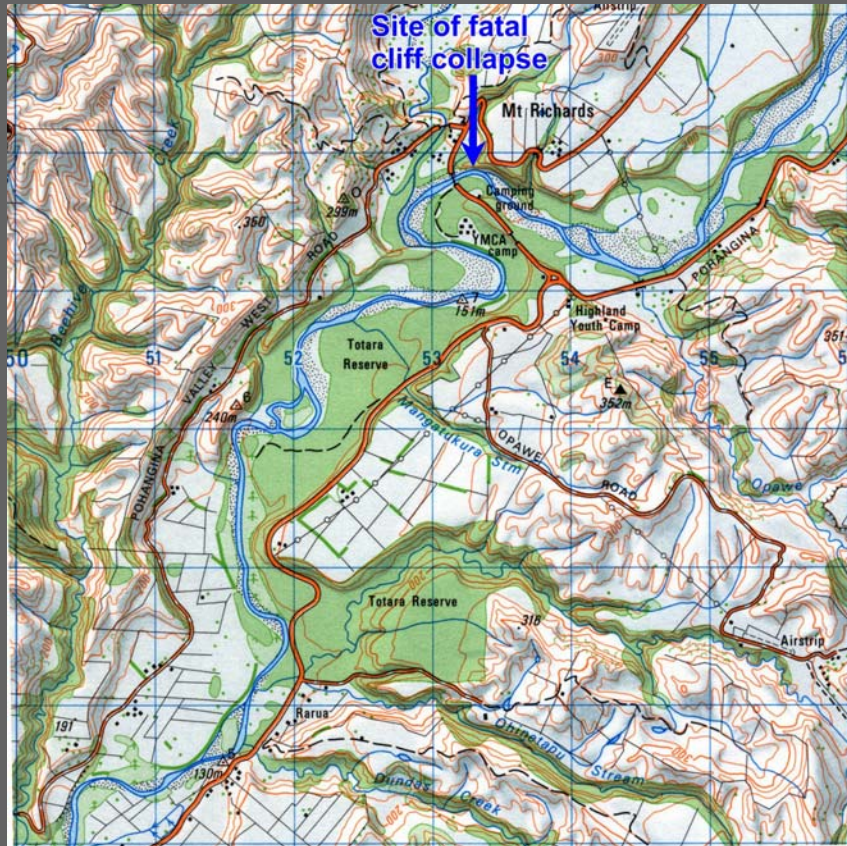
- **Fatality rate from landslides in New Zealand is > 2 per year (since 1840)**
- **Landslide fatalities exceed those for earthquakes or volcanoes**

Death or serious injury

2006 Totara Reserve rock fall, Pahongana River

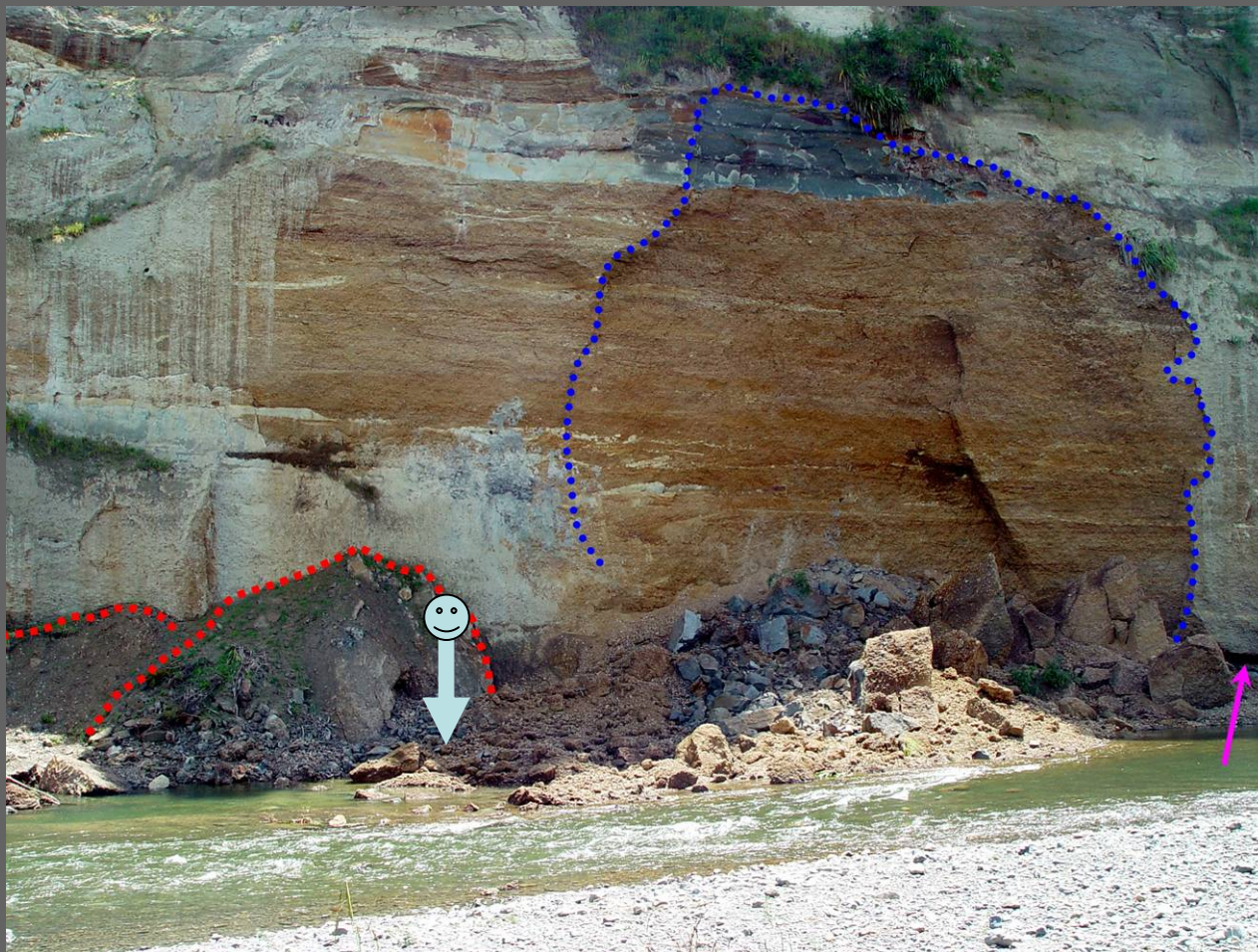
- **River scour at foot of cliff on outside meander bend**
- **Site is popular for camping, picnics and swimming**
- **Cliff collapse is recognised but rare**
- **Eventually, collapse and swimmers will coincide**

Death or serious injury – Totara Reserve



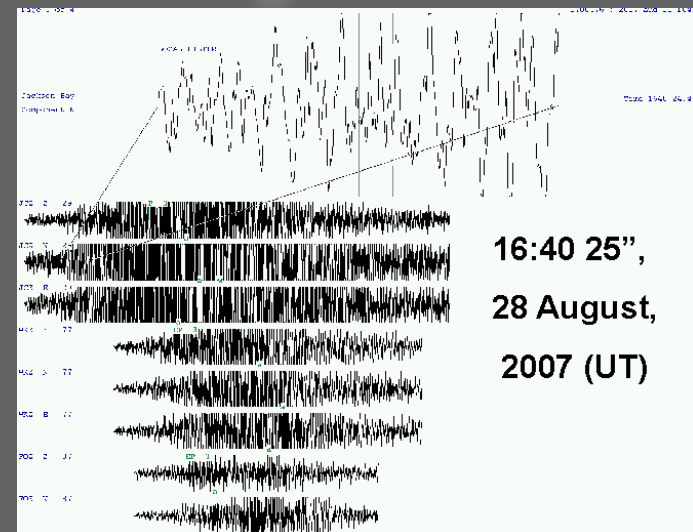
Thin 500 m³ slab peeled off

Death or serious injury – Totara Reserve



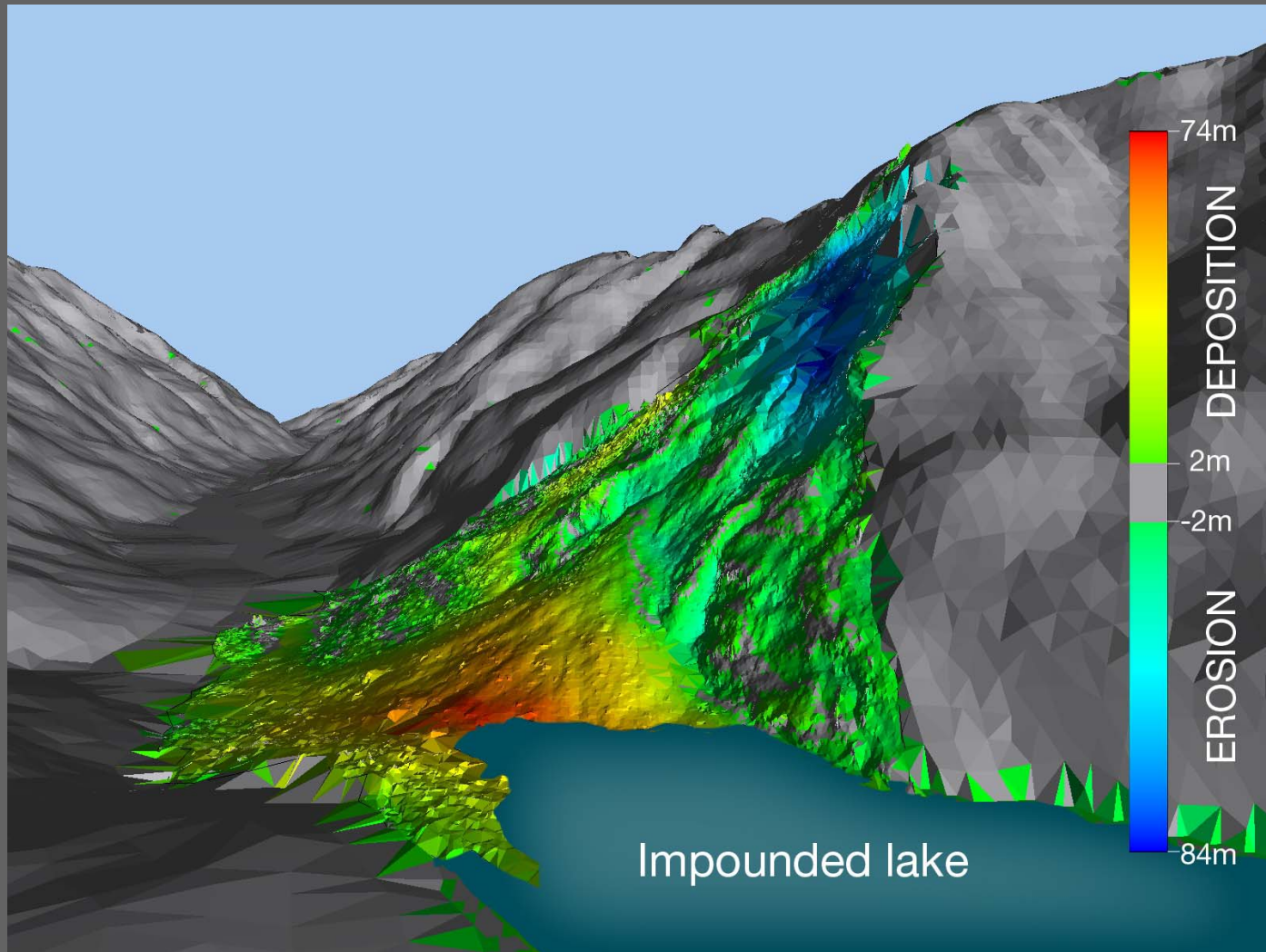
- 3 children killed while swimming
- 1 survivor
- 24-hrs earlier 70 people were here

Subsequent catastrophic events – Young River landslide dam



16:40 25",
28 August,
2007 (UT)

Young River landslide dam

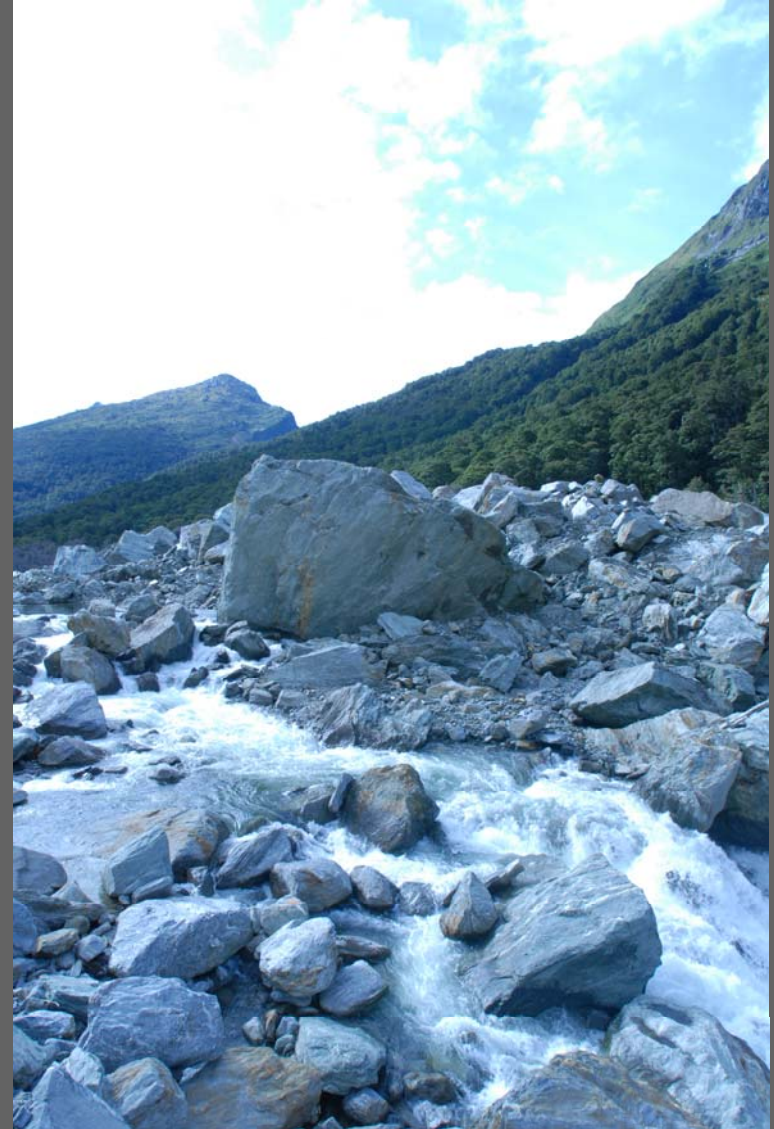


Change model derived from TLS survey

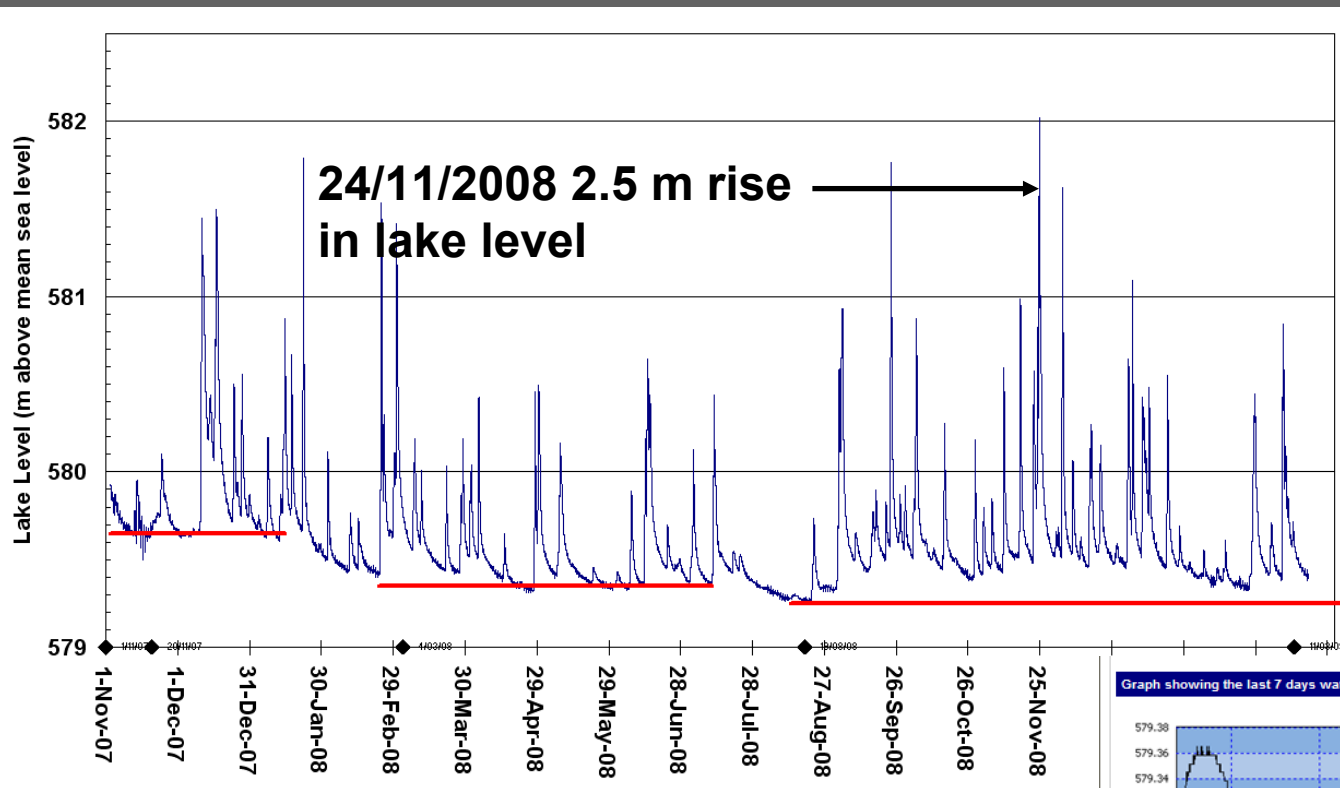
Young River landslide – key facts

Location	Young River Landslide, North Branch Young River (Mount Aspiring National Park), New Zealand, which is a tributary of the Makarora River.
Initiation Date/time	04:40 on 29 August 2007
Trigger	No obvious trigger (no rainfall three weeks prior to initiation and no earthquakes recorded)
Landslide Volume	11 Million m ³
Velocity	100 km/hour (minimum)
Runout distance	1.8 km
Impounded Lake Volume	23 Million m ³
Dam height (at outflow channel)	70 m

Young River – monitoring outlet change

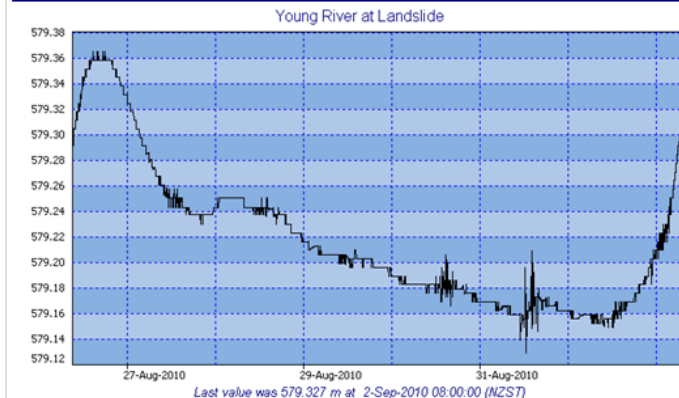


Young River – lake level



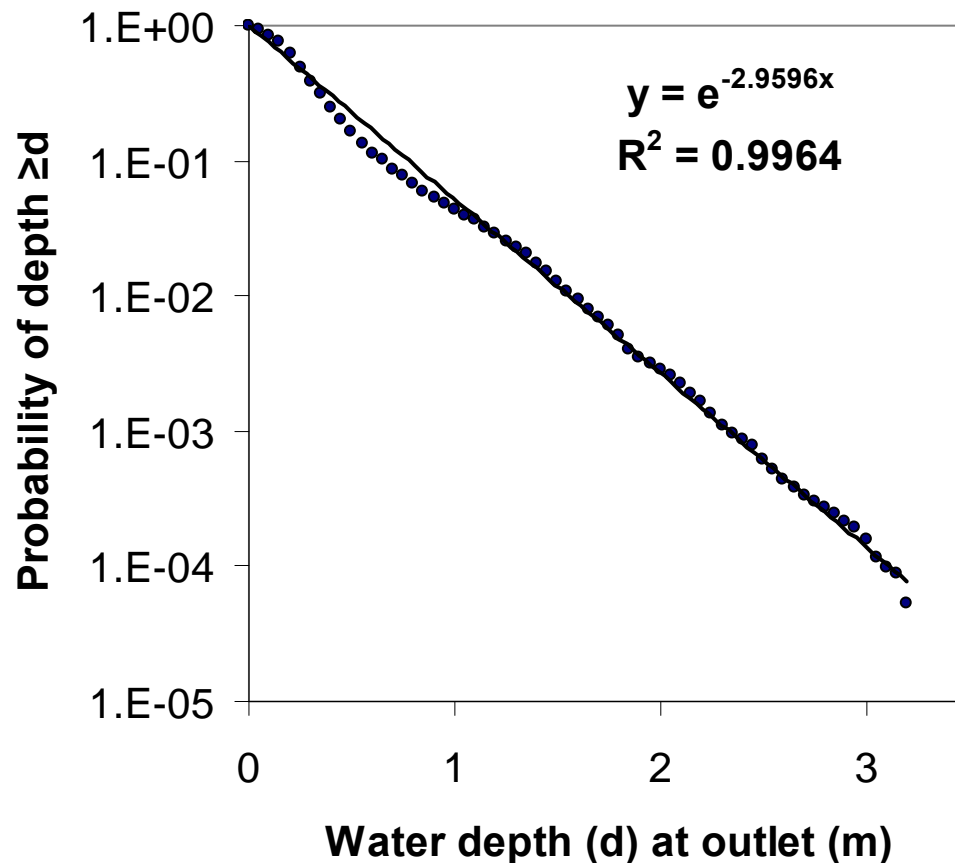
On the web
(updated hourly)

Graph showing the last 7 days water level in metres



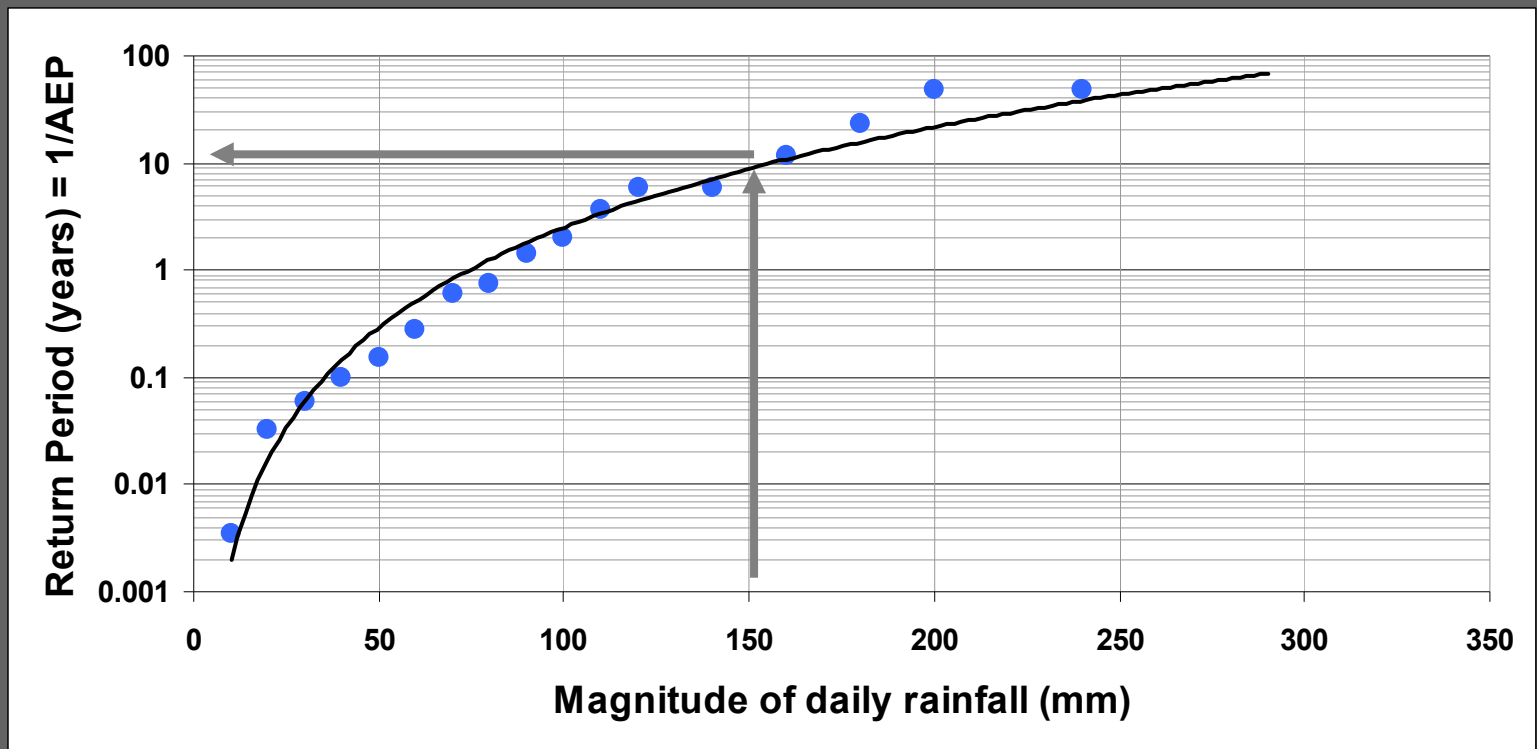
Young River – outlet level

- 3 years of monitoring
- 3 down cutting events recorded
- Total lowering ~ 0.7 m
- Lowering occurs at water depths > 2.1 m (max. depth recorded 3.4 m)



Young River – How has the dam been tested??

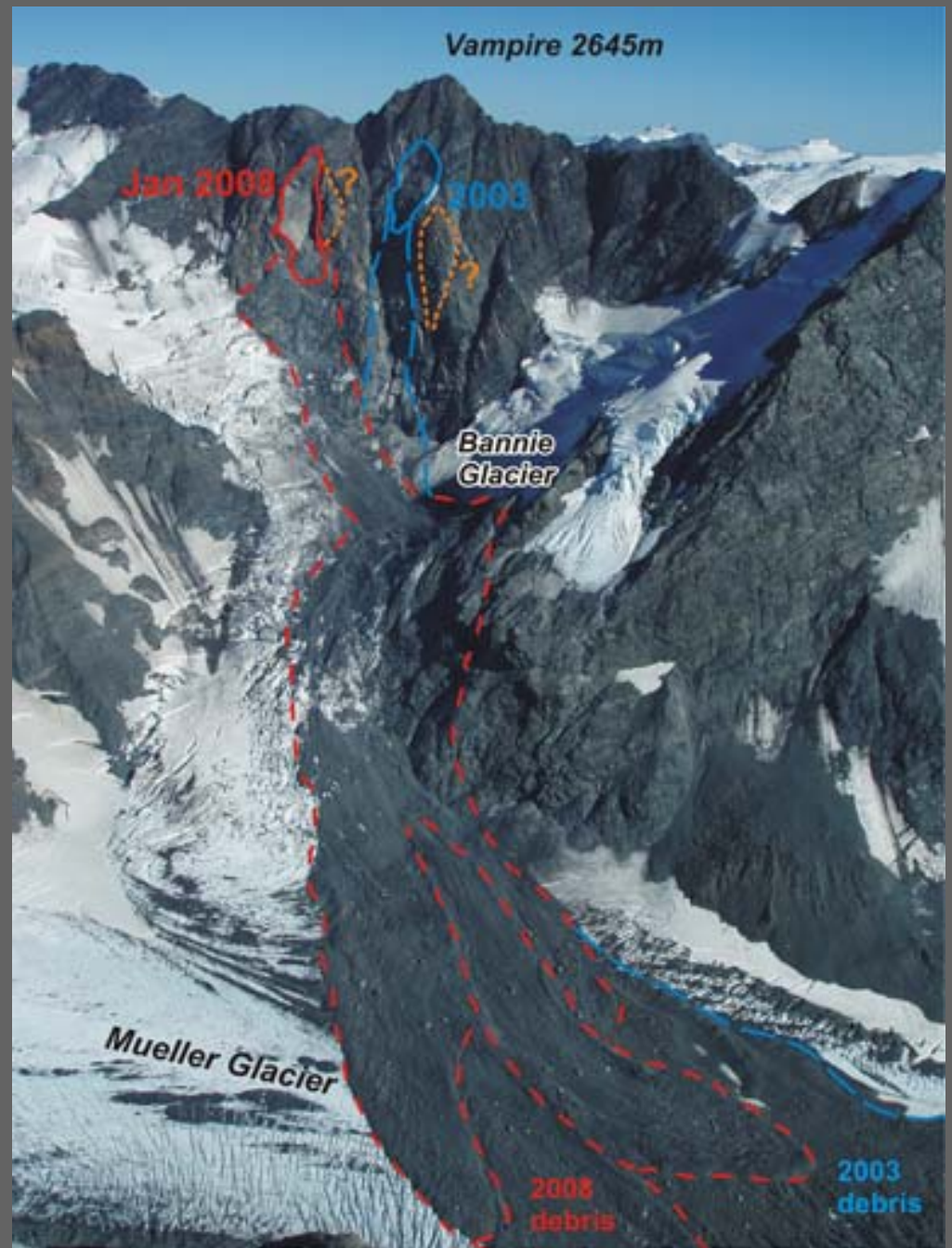
- Rainfall - Max. at dam equivalent to 1:10 year event

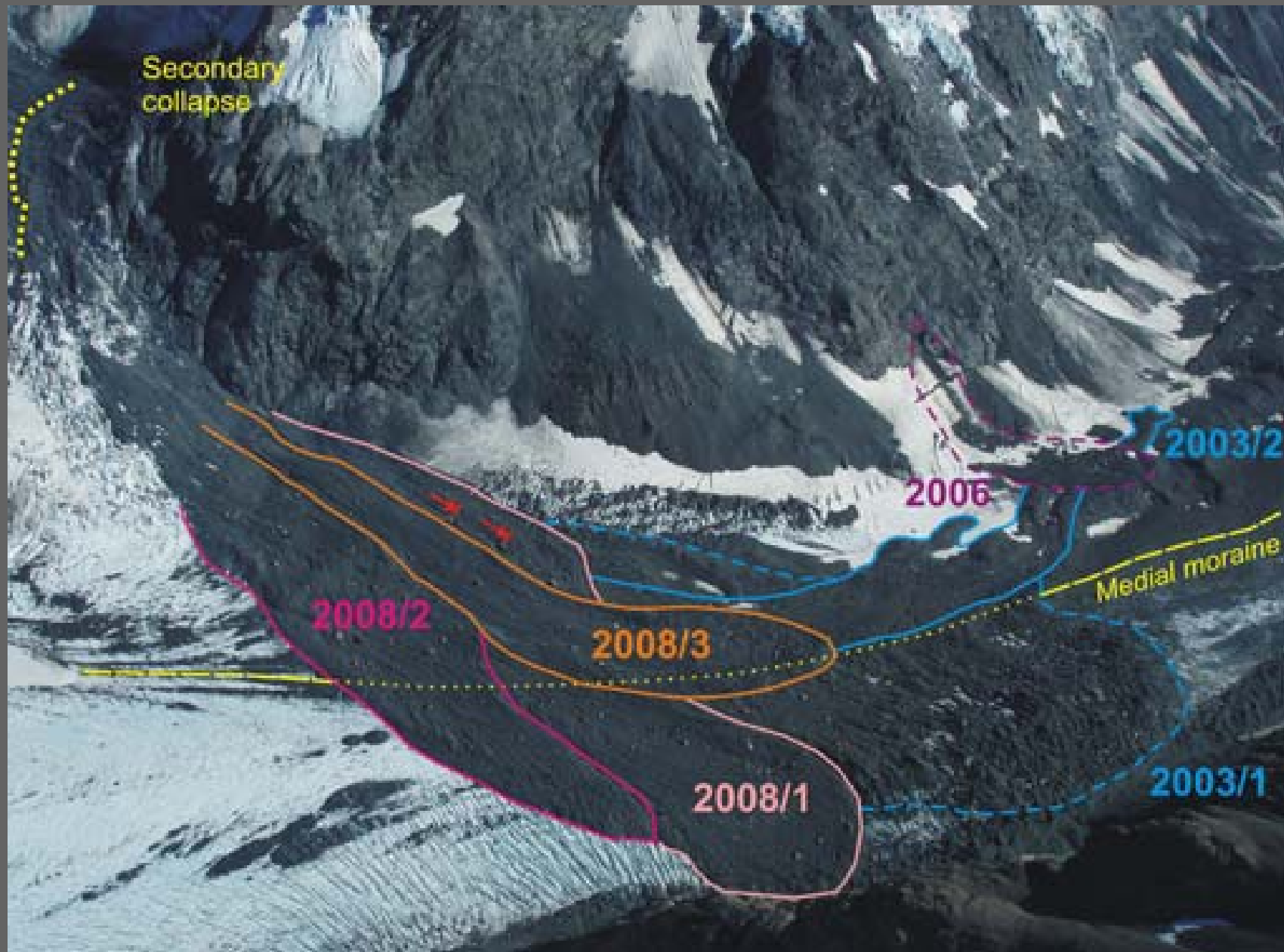


- Earthquakes – shaking intensity \leq MMI 5

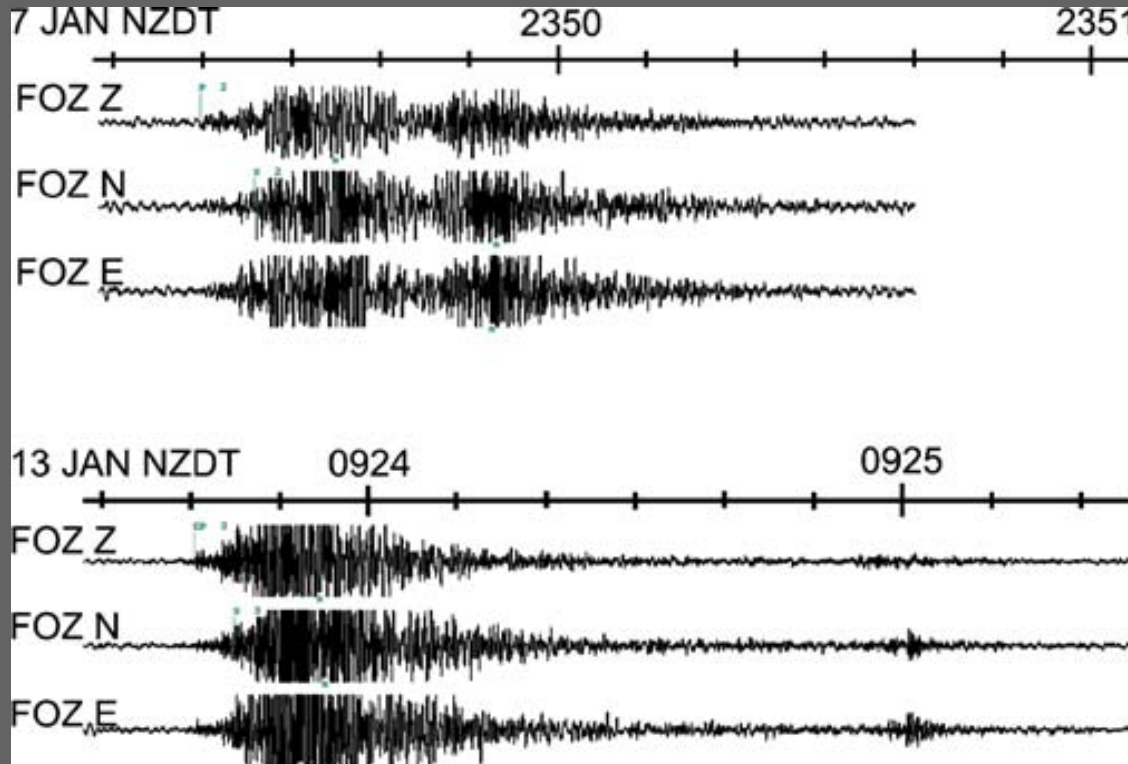
Significant research interests

- Vampire Peak (Mt Cook Nat. Park)
- Two landslides in January 2008





Recorded on seismic network in January 2008



Looks to be defect-controlled, but it isn't



Thanks



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