

Landslides and USAR



Outline:

- Recent, large, multiple fatality landslides
- Can't happen in NZ right?
- Life safety risks - if engulfment occurs
- USAR considerations
- Exercise: Oso Landslide

Baltimore, USA. Retaining wall failure, April-May 2014. No fatalities <http://www.youtube.com/watch?v=MrNluXrrHKY>



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Baltimore, USA – post failure



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Ab Barak, Afghanistan – Google earth image pre-failure



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Ab Barak, Afghanistan – post-failure with 300-2700 fatalities. Some survivors rescued.



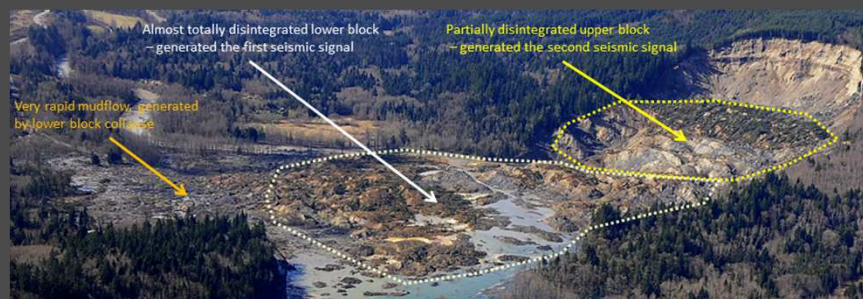
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Unknown location, Afghanistan



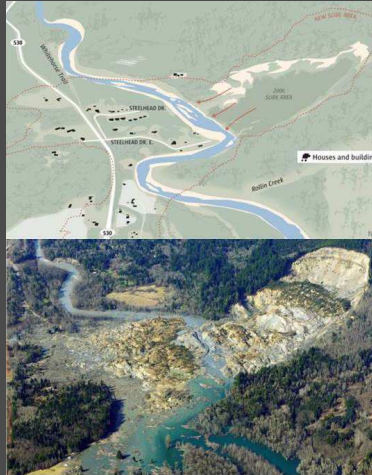
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Hazel/Steelhead Landslide near Oso in Washington State, USA.



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Ohiwa Harbour, New Zealand. July, 2004



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Matata, New Zealand. May, 2005



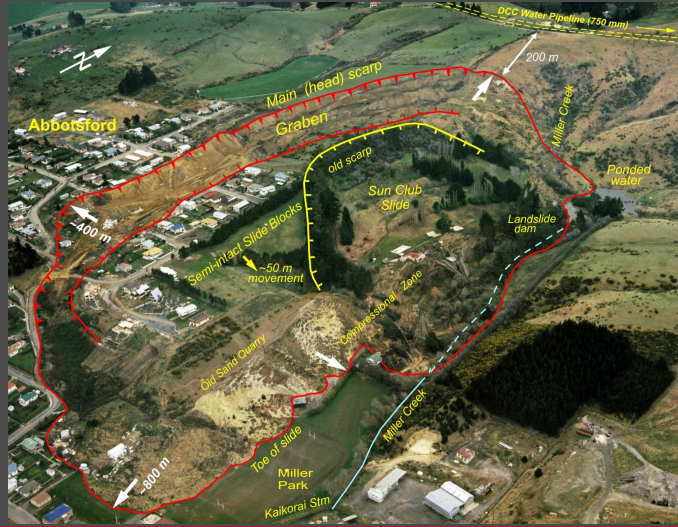
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Morehau, New Zealand. June, 2013



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Abbotsford, Dunedin, New Zealand. August 1978



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Waihi (Lake Taupo), New Zealand. 1780, 1846, 1910



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Tangawai, 1953



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Tangawai, 1953



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Tangawai, 1953



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Tangawai, 1953: 151 dead

- *One carriage was carried more than 2 kilometres downstream. The others were swept across the flooded main road or rammed into the riverbanks. Some people had escaped and swam to the banks, but dozens drowned in the tangles of gorse there.*
- *The work of recovering victims went on for several days along 60 kilometres of the river. Twenty bodies were never found; it was assumed they had washed out to sea, some 120 kilometres away.*

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Debris flows

- <http://www.youtube.com/watch?v=RR4OOjDr0w8>

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Landslide life safety – hazard and risk in relation to landslides

- **461 people killed by earthquake since 1840**
 - Includes earthquake-induced landslides
 - Three earthquakes responsible for most of the deaths (454 of 461)
 - 1929 Murchison – 17 deaths
 - 1931 Hawke's Bay – 256 deaths
 - 2011 Christchurch – 181 deaths
- **This is the total number of deaths.**

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Landslide life safety – hazard and risk in relation to landslides

- **484 people killed by landslides since 1840**
 - Includes earthquake-induced landslides
 - Includes lahars
- **Many are single fatality events**
- **Large scale events do occur**
 - Tangawai 1951 – 151 deaths
 - Waihi (Lake Taupo) 1846 – 50 deaths
 - Serpentine Gully, Otago 1963 – 40 deaths
 - Kopaawahara, Hawke's Bay – 21 deaths

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Landslide life safety – hazard and risk in relation to landslides

- **Landslides are as deadly as earthquakes**
- **Not all landslides are the same**
 - Debris flows (including lahars) responsible for most of the large multiple fatality events
 - Not all debris flows kill (e.g. Matata)
 - Rock-falls are deadly
 - Slumps and creeping landslides generally provide forewarning (e.g. Abbotsford)

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Landslide life safety – hazard and risk in relation to landslides

- **Critical element is the speed of failure**
 - Fast landslides kill
 - Slow landslides provide time for evacuation
- **Emergency management for landslides – evacuate as a precaution**

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Landslide life safety – hazard and risk in relation to landslides

- **Landslide victims – immediate light surface rescue will recover most if not all live victims (i.e. this will occur prior to USAR arrival) – e.g. Matata**
- **Survival from ‘engulfment’ effectively zero**
- **Rescue of the Thredbo survivor after three days the exception**

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Landslide rescue operations

- **Level 0: research of affected area before arrival on site**
- **Level 1: Wide area assessment**
- **Level 2: Sector assessment**
- **Level 3 Rapid search and rescue**
 - USAR arrives
- **Level 4: Full search and rescue**
- **Level 5: Total coverage search and recovery**

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Landslide rescue operations (Command)

- **Where is BOO?**
- **Forward safe area**
- **SAR area**
- **Observations/Observers**

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Landslide rescue operations (Intelligence)

- **Primary hazards – further landslide movement**
- **Secondary hazards – flash flooding/debris flows**
- **Tertiary hazards – electricity, gas, water and wastewater services**

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Landslide rescue operations (Logistics)

- **Do responders have appropriate PPE?**
- **What water craft are readily available? IRB's? Kayaks?**
- **What heavy machinery is available? (Long reach digger with swamp tracks, minimum 12 tonne)**

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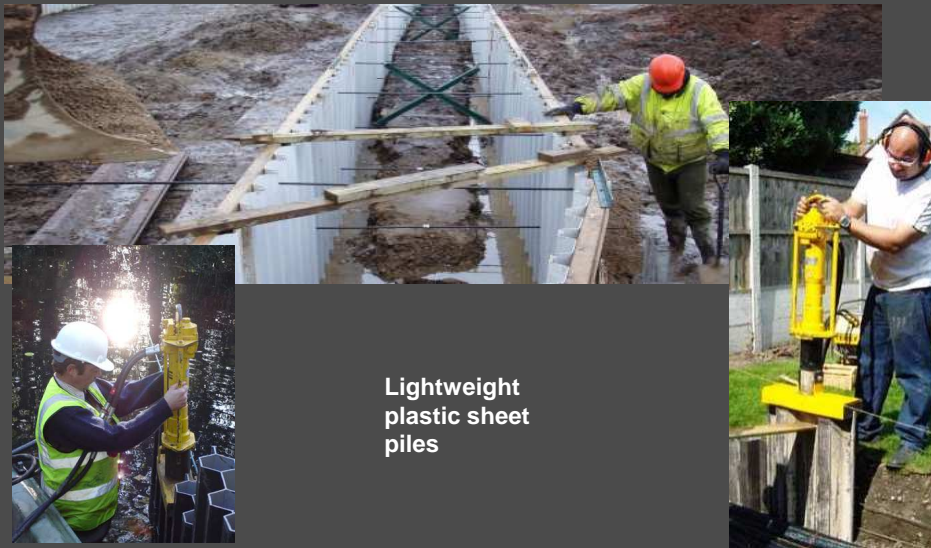
Landslide rescue operations (Logistics)

Lightweight
plastic sheet
piles



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Landslide rescue operations (Logistics)



Lightweight
plastic sheet
piles

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Landslide rescue operations (Logistics)

Mud shoes



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Landslide rescue operations (Logistics)

Swamp mats



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Landslide rescue operations (Logistics)



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Landslide rescue operations (Intelligence)

- **Prioritising the search area:**
 - Where were most of the people?
 - What areas can be readily accessed now?
 - What is the highest risk area? (Avoid?)
 - Where is survival potential greatest?

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Landslide rescue operations (Operations)

- SAR begins
- Communications (minimum two people teams)
- Dogs
- Markings

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Oso/Steelhead/Hazel/SR530 Landslide

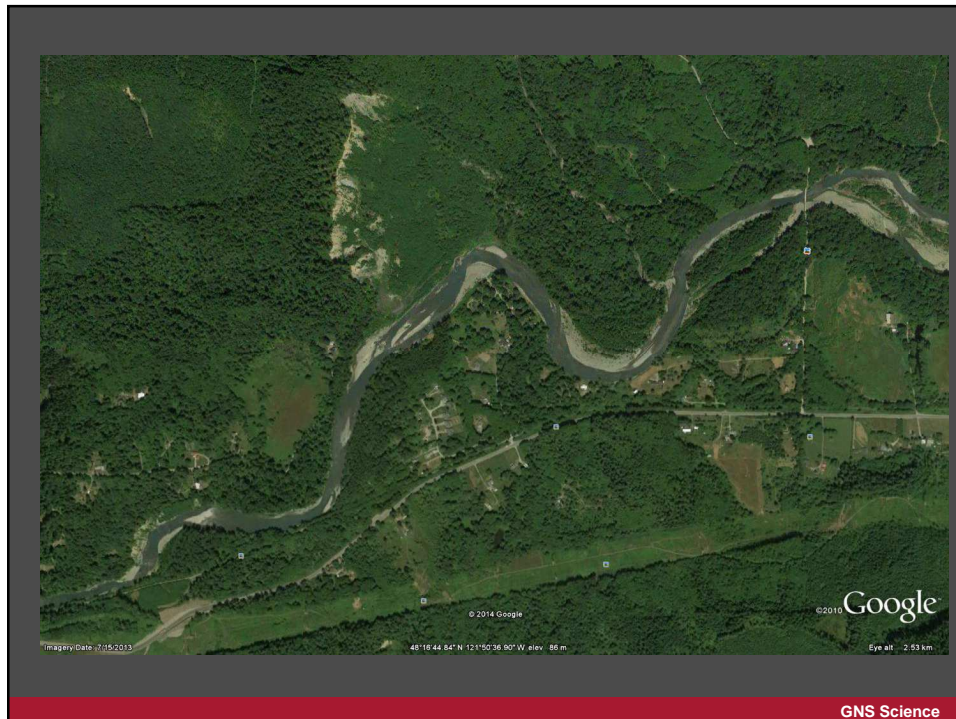
- Landslide date 22 March 2014
- Eight people rescued on the day of the slide
- As of 30 May 2014, 42 confirmed fatalities, 1 person still missing

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Hazel/Steelhead Landslide near Oso in Washington State, USA.

- Pre-existing landslide that had failed in 1937, 1949, 1951, 1967, 1988, 2006
- Landslide dam – very saturated materials and commonly unable to support the weight of a searcher
- Debris field of 120 hectares
- Dogs critical for locating victims
- Weeks of work required

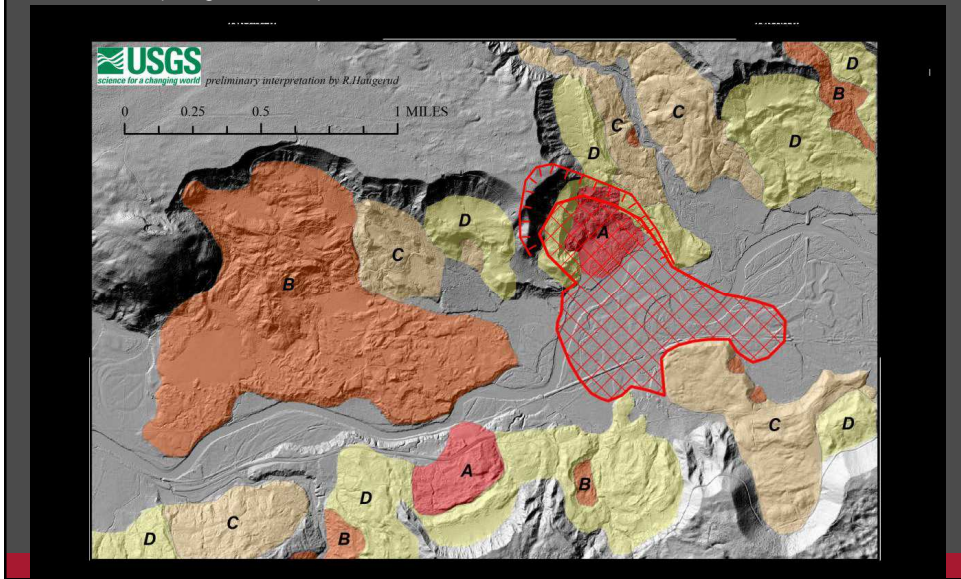
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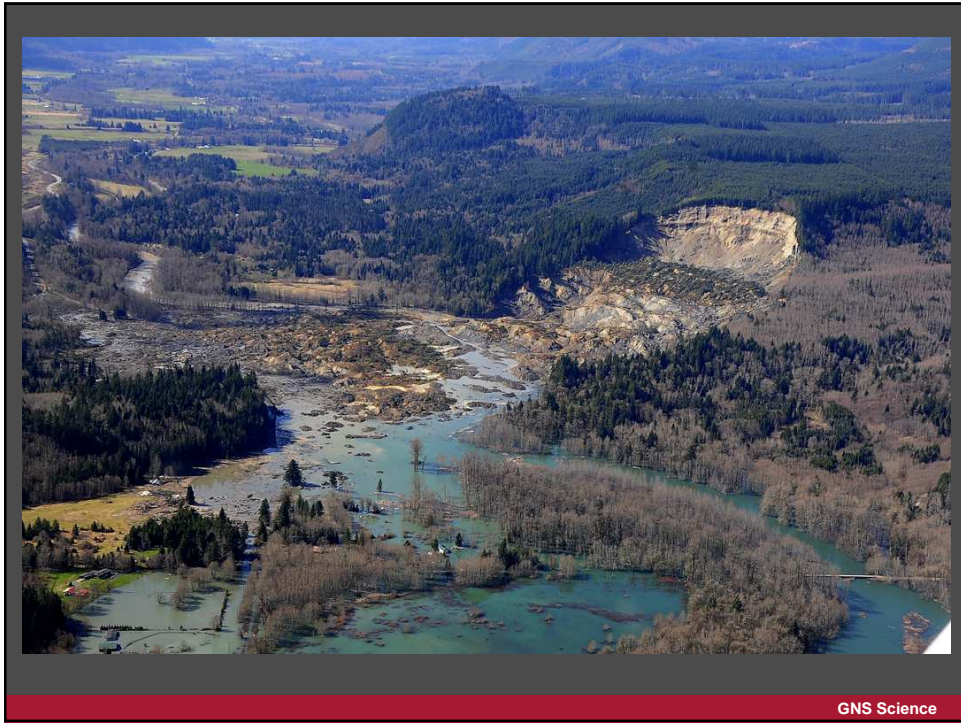


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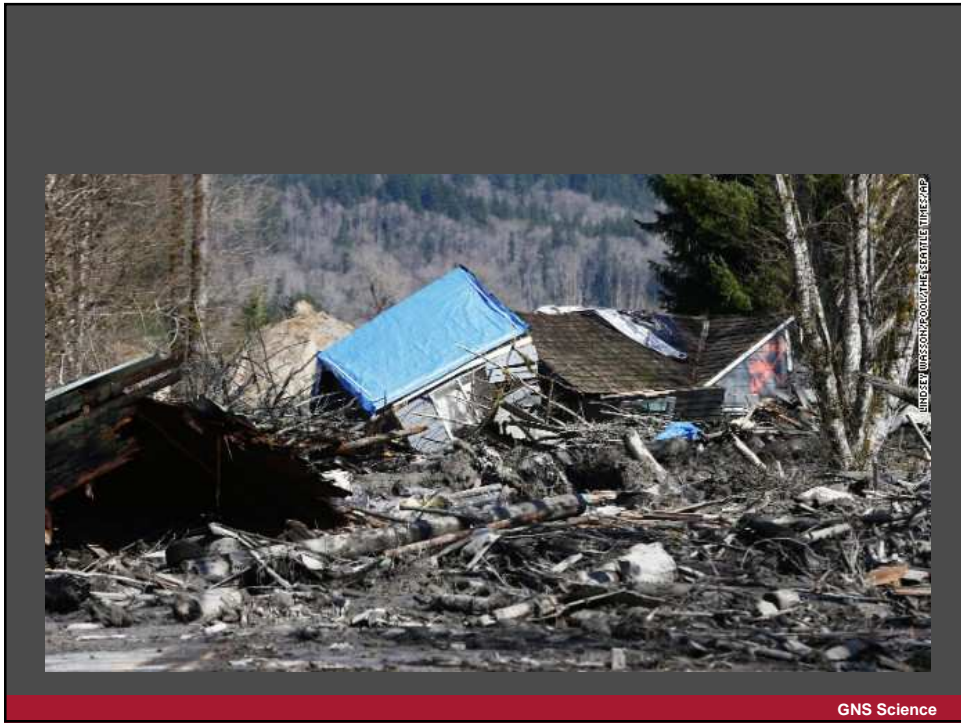


Shaded-relief image calculated from the 2013 lidar survey. Colored areas show older landslide deposits, distinguished by their relative age: A, youngest to D, oldest. The red cross-hatched area marks the approximate extent of deposits from the March 22, 2014, landslide. (Haugerud, 2014)





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A FEMA team of Urban Search and Rescue dogs and their handlers from Virginia Task Force-1, including Elizabeth Chaney (left) and Sally Dickinson, with her dog named Fielder, hold a demonstration for the media near Oso, Washington on April 8, 2014. The dogs work 4-8 hours in the field and are assisted by vets and vet techs. FEMA deployed 20 dog teams from around the country for 14 day shifts. Today, 35 people are confirmed dead in the SR530 slide, according to the Snohomish County Medical Examiner. Thirty-one of those victims have been identified. Up to 11 people are still missing, according to the Snohomish County Sheriff's Office.



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Recovering the victims

- To date 25 victims have been recovered. This might seem low when there may be as many as a further 90 people buried in the debris. However, recovering victims from a mudflow is exceptionally difficult as the remains are likely to be deeply entombed in a material that has very low permeability. For this reason, the authorities may need to decide to preserve the site as a grave. If the search is to be continued, a very detailed mapping exercise will be needed. This will require three key elements:
 - Attempts will be needed to identify where on the ground each victim was located when the landslide struck. Were they in their house, in a car on the road, etc. The better the initial location information the better the chances of finding the final resting place;
 - The landslide mechanisms will need to be identified in great detail. Detailed mapping of the landslide will be needed to do this – the investigators will need to ascertain whether victims were pushed ahead of the slide, were entrained within it or were buried *in situ*. In my experience the latter is the least likely in this type of slide, but the patterns will vary across the landslide;
 - Detailed mapping of the human debris will be needed. The remains of each structure will need to be mapped out. This will give key information about the dynamics of the landslide at each point, and of course it is also likely that many of the victims would have been close to, or within, buildings.
- This is a time-consuming, challenging and sometimes dangerous task, and one that will not necessarily be successful. Generally speaking this level of work has rarely been undertaken, so it would push the boundaries of our knowledge. The authorities will need to balance competing pressures in determining a way to proceed. This may not be an easy, or a popular, choice.

Information from: <http://blogs.agu.org/landslideblog/page/3/>

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Personnel and equipment work in 40x40 foot sections of the SR 530 mudslide area reviewing all material down to native soil, near Oso, Washington on April 8, 2014. Today, 35 people are confirmed dead in the SR530 slide.



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