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Kaikoura earthquake landslide

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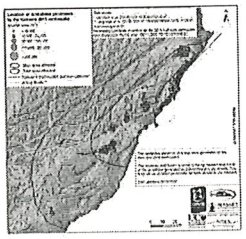
Landslide mapping

Our GeoNet landslide scientists have so far mapped nearly 5,000 landslides from the M7.8 Kaikoura earthquake from North Canterbury through to Marlborough. Because of the huge area involved, most of the mapping has been done in the office using aerial photos, satellite imagery, and pre- and post-earthquake lidar (high quality topography), but our scientists have also been out walking over landslide areas around the Stanton and Leader rivers, and the near the Clarence River mouth, to check that what they have mapped is actually what has happened on the ground. Armed with this information they will be able to provide advice to councils and infrastructure providers on how to manage the landslide and flood risk.

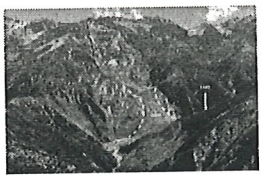
As well as blocking the main roads and rail north and south of Kaikoura, and many smaller roads, landslides have caused widespread damage to farm fences, tracks and water supplies which will take years to repair. We were extremely lucky that no one was killed by landslides, but some properties are still evacuated in Goose Bay and Kaikoura because of the landslide or rockfall risk.

The landslides have happened in two distinct rock types – relatively young soft sandstones and mudstones, and older hard sandstones and mudstones (greywacke) – which behave quite differently. Understanding where the landslides are, and their behaviour, will help with the earthquake recovery as the medium to long term effects show themselves. The huge amount of landslide material coming down rivers over the coming decades will affect bridges and flood protection and may alter river courses. Increased turbidity (muddiness) of streams and rivers will also have an effect on freshwater and marine ecology.

A preliminary observation from the mapping is that the landslides are clustered around the areas of fault rupture, not around the earthquake epicentre (which is what we would normally expect to see). In fact, many of the largest landslides occurred right at the places where faults ruptured to the ground surface. This landslide/fault interaction will be an interesting area for research and we could use this new understanding to revisit historical earthquakes like the 1929 Murchison earthquake to see if large landslides can point to fault ruptures that weren't noticed before. For those wanting more information on how the landslides are being mapped, this document outlines our mapping process.



Mapped landslides as of 23 March 2017 (click for larger image)



Hapuku landslide dam - 10-14 million cubic metres of rock travelled 2.7 km to the valley floor (photo: GNS Science)

Seaview Landslide, on the Papatea Fault near the Clarence River mouth (photo: GNS Science)

Landslide dams

The GeoNet landslide team is working with Environment Canterbury, Hurunui, Kaikoura and Marlborough district councils, and NZTA to assess and manage the risk from landslide dams to downstream communities and infrastructure.

Environment Canterbury and Marlborough District Council staff continue to monitor landslide dams that pose a risk to people or infrastructure downstream – this includes helicopter flyovers every few weeks and after heavy rainfall or strong aftershocks. At present monitoring is focussed on six dams that remain high risk – the Waima (Ure), Hapuku, Linton, Ote Makura, Conway and Stanton river dams. Other dams are also being monitored, but they are of lower risk: Two dams,

the Towy and Leader river dams, have breached or partially breached and are now of less concern. And other dams, including the Medway, Gelt, Bourne and smaller Leader river dams, pose a smaller risk as the potential downstream impacts are relatively minor.

The priorities for landslide dam monitoring change with the landscape; future heavy rain, aftershocks or a dam breach change the risk and will likely see some landslide dams upgraded or downgraded for monitoring.

You can check out the locations of landslide dams in Canterbury, as well as photos and videos, on Environment Canterbury's landslide dam webmap.

GeoNet's landslide team plans to install monitoring equipment, such as GPS stations, extensometers (movement recorders), water level recorders and webcams on some of the dams. NZTA and Kaikoura District Council are already monitoring the Hapuku, Ote Makura (Goose Bay), and Linton landslide dams and warning lights are now installed on the Hapuku, Ote Makura and Linton bridges to warn of a potential landslide dam breach upstream.

Conway landslide dam (photo: GNS Science)

Hapuku landslide dam

Leader River dam partial breach

One of the largest monitored landslide dams, on the Leader River between Waiau and Parnassus in Hurunui District, partially breached on 13/14 February. This dam is one of the 'soft rock' dams, and it appears that the main crest of the dam was overtopped and eroded when the lake level reached the top of the dam. The lake level dropped by around 3-4 metres, and evidence of moderate flood flows was observed in the river bed downstream but there was no known flooding of land next to the river bed. The dam now appears to be stable and the river is flowing over a new, lower crest and along a new course downstream – slightly to the south of the pre-14 November course, which is covered by landslide debris.

Environment Canterbury has two great videos flying upstream and downstream showing the dam and lake on 22 February, a week after the breach. You can see where the lake level has dropped, leaving white algae-covered banks and trees.

Given the size of the dam and the volume of water that was released in the breach, GeoNet sent down a survey crew at the start of March to measure the changes to the dam. Collecting information on landslide dams and how and when they fail is really useful. It gives us a better idea of how the other landslide dams in this event are likely to behave, and it also gives the international science community more data to help say what is likely to happen in future events overseas.

While the flood wave from the Leader dam breach remained in the river channel downstream of the dam and didn't do any damage, it is a good reminder to stay out of all river beds from the Waiau River to the Awatere River as these dams can suddenly release millions of litres of water – you don't want to be in the way of that.

Before: Leader dam 12 December 2016 (looking upstream) (photo: GNS Science)

After: Leader dam 3 March 2017 (looking upstream) (photo: GNS Science)

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The GeoNet landslide team includes scientists and engineers from GNS Science, Massey University, and the University of Canterbury. Our colleagues from the US Geological Survey landslide team and the international Geotechnical Extreme Event Response (GEER) landslide team also helped out in the initial landslide response.

GeoNet is a collaboration between the Earthquake Commission and GNS Science.