

FIELDTRIP 3

AN INTRODUCTION TO SUNNY MATATA AND ITS GREAT DEBRIS FLOWS



The 18 May 2005 debris-flow disaster at Matata. *Debris flow* damage at Awatarariki (top) and Waitepuru Streams (base).

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THE 18 MAY 2005 DEBRIS-FLOW DISASTER AT MATATA: CAUSES AND MITIGATION SUGGESTIONS

- On 18 May 2005, a band of very intense rain passed over the catchments behind Matata. It triggered many landslips, and several major debris flows, which, with their associated flooding, caused well in excess of \$10 million damage in Matata, and closed SH2 and the railway for many days. The rainfall appears to be not more than a 500-year recurrence event, and the associated debris flows may be of a similar recurrence interval. There is evidence that equally large, and larger debris flows have occurred since 7000 years ago. Historical records indicate smaller events have occurred since 1860.
- Witness descriptions and the physical evidence indicate that the phenomena that damaged Matata in the vicinity of Awatarariki and Waitepuru Streams were debris flows. Evidence in the upper catchments indicates that the debris flows were direct consequences of landslips triggered by exceptionally heavy rain. These debris flows directly damaged some homes and property. Other homes and property were damaged by debris floods that extended beyond where the debris flows came to rest. A debris flow, beyond its limits of flow, is often accompanied by a debris flood. The associated debris flood is regarded by technical experts as an integral part of the total debris-flow event. Debris flows are dense fluid mixtures of all manner of debris and water. They move very rapidly, and are capable of carrying immense boulders. Boulders up to 7 m in diameter were moved by the debris flow in Awatarariki Stream.
- The phenomenon that damaged property in the vicinity of Waimea Stream was a debris flood. We were not able to determine whether this debris flood had an associated debris flow in the upper stream catchment. A debris flood is less damaging than a debris flow, and it can occur in the absence of a debris flow.
- The phenomenon that damaged property in the vicinity of Ohinekoao Stream was a debris flow that reached to SH2. Its associated debris flood damaged the railway and property beyond.
- The landslide phenomena that came directly from the hillside above Matata, and along SH2 to the west of Matata were debris avalanches. These are very similar to debris flows, but they lack a confining channel. Similar features falling into the catchments south of Matata initiated the debris flows.
- The evidence that still can be seen as debris dams in the catchments, is from landslides that fell after the debris flows had passed. The highly erosive debris flows cleaned out the valley bottoms, and destabilised the slopes along the channel, causing secondary landslides. Many of these have been larger than many of the initial landslips that triggered the debris flows.
- The boulders carried by the debris flows came mostly from debris-flow erosion of pre-existing boulders previously buried in the bed and banks of the stream channels. They got there by falling from the bluffs above the stream at various times in the past. Most of the harder boulders are derived from strongly welded portions of the Matahina ignimbrite formation. The boulders eroded from the channels already are being replaced by collapse of the steep slopes. This process will continue. Although the

supplies of boulders in the channels have been depleted by the event of 18 May, they have not been exhausted. Further debris flows are possible and likely whenever there is rain with high enough intensity to trigger debris avalanches on the steep slopes.

- The geology of the area is a series of mid to late Pleistocene fluvial gravels, marine sediments and tephra capped by the 280-ka Matahina ignimbrite. The marine sediments are hard soils to very weak rock including beds of unconsolidated sands. The materials are easily eroded, and the steep, deeply incised landscape is highly susceptible to debris flows. A high proportion of pumice in the eroded soils likely contributed to the high mobility of the debris flows which were mobile on an extraordinarily low gradient.
- The earthquake swarm that has been shaking Matata for many months did not contribute to the disaster of 18 May. Landslips that occurred in the 1987 Edgecumbe earthquake were the source of some of the boulders that were carried by the 18 May debris flows. Others fell in landslips on 18 May, but many were already in the bed and banks of the channel from earlier events, and were picked up by the immensely erosive debris flows.
- By their nature, debris flows are more dangerous than floods, and they make the flooding associated with them much worse than it otherwise would be without a debris flow. They make the flooding worse for two reasons: (1) they travel faster than the flow of water in the same channel and pick up all of the floodwater in their path, thus delivering water to the catchment outlet faster than would be possible in a simple flood; (2) deposition of sediment from a debris flow can fill the normal stream channel and allow water draining from the debris flow to flood into areas not normally accessible by floodwater.
- Hyperconcentrated flows of sediment-laden water draining from the Matata debris flows caused debris floods. That is, the water was so highly charged with sand and silt that it no longer behaved like normal water; it flowed faster and was denser, and was capable of moving larger boulders that could be moved by a normal flood flow across the lowland fans at Matata.
- The landslips that initiated the debris flows were triggered by very intense rain, probably in excess of 2 mm/minute that fell in the catchments during a severe thunderstorm. This intense rainfall fell in a narrow band only a few kilometres wide that passed across the catchments to the south of Matata from near the mouth of Ohinekoao Stream to the settlement of Awakaponga. Had this band of rain been some 500 m closer to Matata, a different and much more devastating outcome might have occurred. The existing debris flows could have been larger, and other catchments also could have poured debris flows into Matata. In addition, there may have been more debris avalanches from the slopes immediately behind Matata. Such events have happened many times in the prehistoric past, and they created the land on which Matata stands.
- Parts of Matata are naturally protected from flooding and debris flows. This is because the ancient debris flows fans were trimmed by Tarawera River, until the late 1920s, and the streams draining from the catchments to the south of Matata now are cut deeply to toes of the fans, leaving much of the land free from flood risk. The low railway

embankment gives some other parts of Matata varying degrees of protection from water and debris floods, by diverting shallow flows. But the railway also increases the danger to some areas, because it diverts flows to areas not otherwise at risk.

- There are areas around Matata that are unsafe for human habitation. Significant areas of present-day Matata have always been at risk from debris flows, debris floods and debris avalanches. These are wider than the currently affected areas. With engineering works, it is possible to reduce the danger to some areas to commonly accepted levels, but there are other areas where such mitigation is not feasible. Here it will be necessary either to accept the risk, or remove dwellings from these areas. Of course, any area designated as a floodway or debris-flow route will be uninhabitable, but could be used for recreation.
- Because of the location of the railway and SH2, it is not possible to provide effective engineering mitigation of the hazards to Matata without integrating this protection with engineering works associated with the railway and SH2. Of critical concern are the effects of bridge and culvert sizes. Where these are too small or misaligned to safely pass debris flows or debris floods, the resulting obstruction to the flows causes deposition and a somewhat random choice of path for the immediately following debris. If the path of the debris cannot be predicted or controlled, then mitigation works can not be effective, and restricting building becomes the only safe option.

Extracted from:

McSaveney, M.J., R.D.Beetham, G.S. Leonard 2005. The 18 May 2005 debris-flow disaster at Matata: causes and mitigation suggestions. Institute of Geological & Nuclear Sciences client report 2005/71 (publicly available at [www.geonet.co.nz/Landslides/ILandslide resources/Landslide reports](http://www.geonet.co.nz/Landslides/ILandslide%20resources/Landslide%20reports))

Costello, D.A. 2007. Slope failures and debris flow assessment at Matata, Bay of Plenty, New Zealand. MSc thesis. University of Auckland.



Debris avalanches from the old sea cliffs just north of Matata.



Numerous *debris avalanches* in the upper Awatarariki Stream coalesced to form the *debris flow*.



Examples of *debris avalanches* into the Awatarariki Stream behind Matata.



The largest boulder seen that was carried by the *debris flow* in the Awatarariki Stream is about 7m across.



The main stream and a tributary of the Awatarariki, both cleaned out by the erosive power of the *debris flows* that passed down them.



A debris-flow detention structure protecting a suburb of Vancouver, Canada, that may be a suitable model to trap debris-flow boulders in the former quarry area of Awatarariki Stream.

