The Matata debris flows, 18 May 2005

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Abstract

In May 2005 the eastern Bay of Plenty, North Island, New Zealand community of Matata was hit by intense heavy rain that caused debris flows that cut major transport links, destroyed homes and caused over $ 20 m (€ 11.3 m) of damage. In close consultation with the local community the local Whakatane District Council organised the disaster recovery process and co-ordinated various investigations necessary to determine appropriate future hazard management and risk mitigation strategies to protect lives and property. Three months after the storm the Council adopted a strategy that included for various structural and non-structural risk mitigation measures, with a total cost of $ 19.8 m (€ 11.2 m).

Keywords: extreme rainfall, debris flows, New Zealand, hazard management, risk mitigation.

1 Introduction

On 18 May 2005 a band of intense rain passed over the hills behind Matata, a residential town in the Bay of Plenty, on the east coast of the North Island of New Zealand. The storm triggered debris avalanches on the steep catchment slopes, which in turn set in motion debris flows along the stream valleys.

The debris flows and floods were delivered on to the fanhead on which the town has been developed, flowing across a railway line and a state highway into residential properties.

The railway and highway links were severed, with restricted heavy vehicle use of the highway allowed after a week. Numerous dwellings were destroyed and a large amount of debris spread though parts of the town and into lagoons downstream on the coastal fringe. Remarkably there were no fatalities, nor even serious injuries.

In the town and its near vicinity it is estimated that the total value of damage in terms of immediate disaster recovery activities, insurance claims, lost

WIT Transactions on Ecology and the Environment, Vol 90, © 2006 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)
doi:10.2495/DEB060351

production for rural land, and transport infrastructure was in excess of $ 20 m (€ 11.3 m).

The local Whakatane District Council coordinated the immediate disaster recovery process and instigated investigations to determine the most appropriate strategy for measures to manage long-term risks to the community from the debris flow hazard in the catchments, now better understood.

2 Matata and catchments

Matata is small coastal community in the Whakatane District, located between Tauranga and Whakatane, figure 1. In the near vicinity there are several small cluster settlements, a camping ground, and a number of pastoral and horticultural farming properties on the adjacent river flood plain. State highway and railway transport corridors run through the town, as the principal links from the eastern Bay of Plenty to Tauranga and points further west and north.

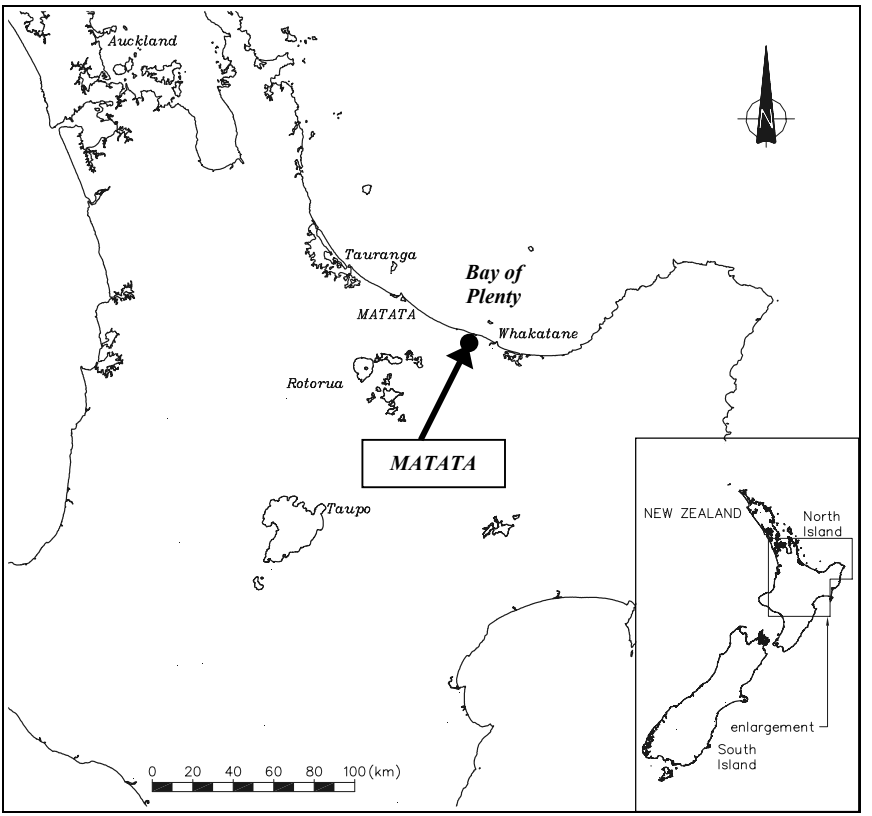

Figure 1: Matata, Eastern Bay of Plenty, North Island, New Zealand.

There are 380 properties in the town, and 240 dwellings. These comprise residential and holiday homes, with a total resident population of approximately 670 people.

Three main catchments drain to and through Matata: the Awatarariki Stream (catchment area 4.5 km^2), the Waimea Stream (0.3 km^2), and the Waitepuru Stream (1.3 km^2). These streams rise from near sea level to 370 m elevation, with a maximum stream length of approximately 3 km, figure 2. These flow into lagoons between the town and the coastal dunes, in which is a wildlife refuge of regional and national significance managed by the New Zealand government Department of Conservation.

At the time of the May 2005 storm the catchments above the town were largely vegetated in secondary and regenerating native forest, with some pastoral land on the crests of the southern ridges.

The surficial ground layers of the catchments are comprised largely of volcanic deposits from the central North Island eruptions, dating back 62,000 years. Underlying these airfall tephra deposits are firm to very hard (welded) ignimbrite formations, on soft weak sedimentary sandstone and siltstone rocks laid down 300,000 years to 700,000 years ago (McSaveney et al. [1]).

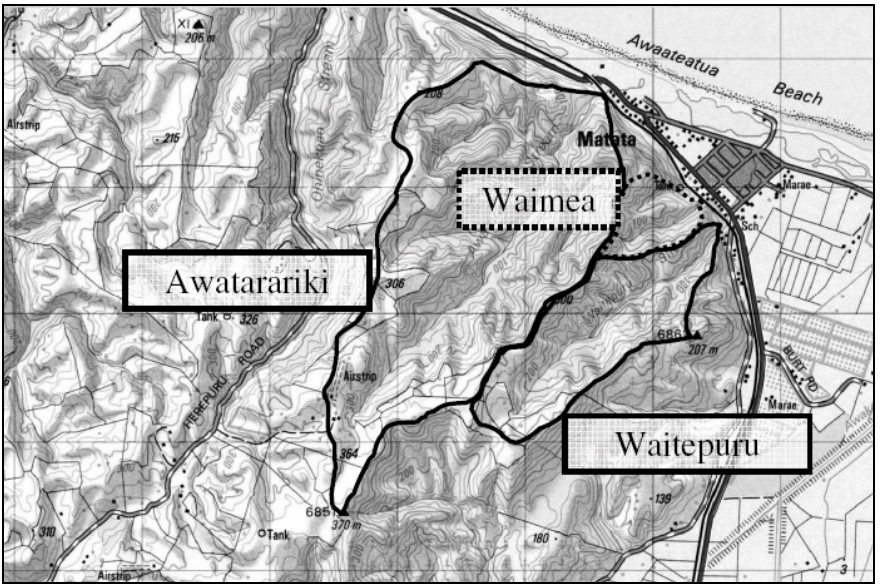

Figure 2: The Matata stream catchments.

3 The storm

In the 20 hours from 10 pm on 17 May until 6 pm on 18 May, 285 mm of rain was recorded at the nearby Awakaponga gauging station, on the river flood plain some 6 km to the south of Matata. It is estimated that, due to the effects of

topography, the rainfall on the Matata catchments may have been up to 30 % greater. The 24 hour rainfall at the Awakaponga station (308 mm) was approximately 25 % average annual rainfall total (Environment Bay of Plenty [2]).

The storm was characterised by 128 mm in the first 11 hours, with relatively minor rain (25 mm) for the next seven hours. Between 4 pm and 5:30 pm, just before nightfall, 126 mm of rain was recorded with a peak 15-minute intensity greater than 2 mm/minute, figure 3.

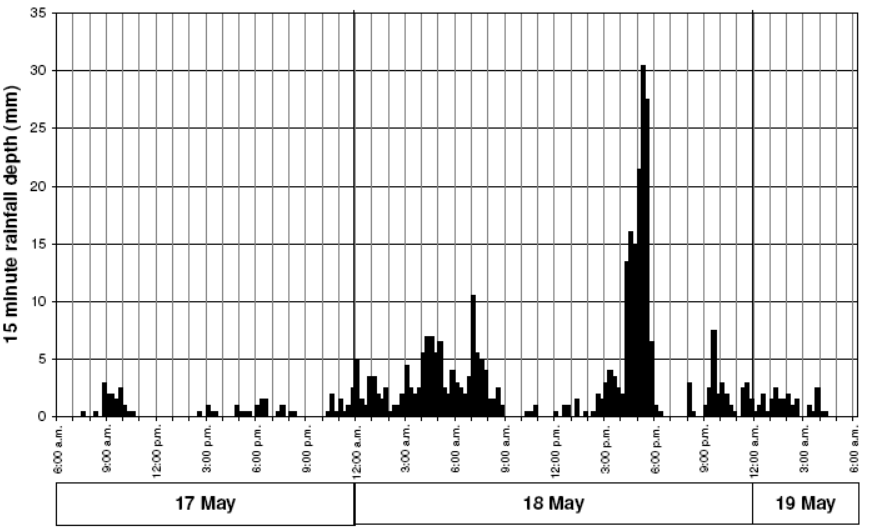

Figure 3: Recorded rainfall, Awakaponga station near Matata, 17 to 19 May 2005.

The storm included rainfall depths at various durations that are significant in New Zealand records, with the maximum 90 minute depth close to the maximum recorded rainfall in the country, figure 4.

Because of the relatively short length of the Awakaponga gauge record (16 years), it has not been possible to estimate the Average Return Interval (ARI) of the storm confidently. The peak 24 hour and 1 hour rainfall depths were both approximately 2.5 times the previous recoded maxima. With reference to other regional data, it is estimated that the event rainfall was approximately 20 % greater than the expected 100 year ARI values, with an ARI of between 200 years and 500 years (Environment Bay of Plenty [2]).

The intense rain in the late afternoon on the already saturated catchment soils set in motion debris avalanches on the steep catchment slopes. Upon entering the stream channels the material from these landslips became debris flows travelling fast downstream as highly saturated masses of rock, rubble, soil tress and other vegetation. These scoured out the stream channels carrying with them material that had accumulated over a period of time. In the debris on the fanhead

after the storm boulders greater than 7 m, and trees over 15 m length were observed. On the Awatarariki Stream a three span 20 m railway bridge was blocked by debris for period. Debris flood waters flowed over the railway and through many properties downstream over a wide extent. Eventually the bridge structure failed and the large mass of debris material was jettisoned through the residential properties downstream.

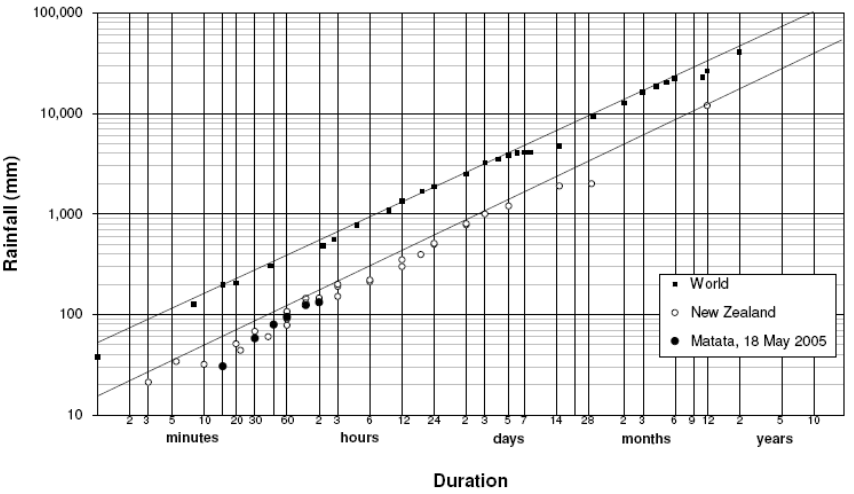

Figure 4: Extreme New Zealand and World rainfall.

From the observation of flood levels in the streams following the event, it has been estimated that the debris flows from the catchment were up to twenty times the theoretical 100 year ARI floods. However, following the recent event and because of the geological nature of the catchments, it is evident that the hazard to the downstream community is not solely from catchment runoff, but from more destructive debris flow events that are likely to be set in motion from the rainfall that in other catchments would otherwise cause conventional flooding of watercourses only.

4 Historical flooding and debris flows

In terms of an historical context, research has shown that Matata has been affected by floods of various impact since first European settlement in the mid nineteenth century (Shearer [3]). Floods have been reported on at least eight occasions since 1891, with 29 references in historical archives to floods in the eastern Bay of Plenty since 1868. Reporting in the local newspaper, the Whakatane Beacon [4], since the May 2005 event included reference to a flood in 1950 and photographs of debris and damage to roading infrastructure. Moreover, McSaveney et al. [1] state that "there is irrefutable evidence for

previous debris flows at Matata" and that the land beneath Matata has been built by large prehistoric debris flows over the last 7,000 years.

5 Effects of the storm

Numerous dwellings were destroyed and a large amount of debris (boulders, rocks, trees and silt) was deposited though the town and into the lagoons downstream. After the event, nearly 150 properties had been significantly affected by the debris flows. Local road, state highway and railway links were severed by the washout of bridges and culverts, and undermining of the road and railway embankment formations. A State of Civil Defence Emergency was declared by the Whakatane District Council, which led the disaster recovery process.

In all, 45 properties were determined to be unsafe for re-occupation with five houses completely destroyed and/or washed away - one house was carried 300 m from its foundations with three occupants inside. A further 16 houses were subject to restricted access dependant on forecast weather, and 85 properties were significantly affected either with some superficial damage to houses (interior flooding) and/or significant silt deposition on the land itself (thus compromising septic tank sewage systems). A debris flood flowed through part of the camping ground to the west of the town, carrying caravans out to sea. A large volume of silt together with trees, cars and garden sheds were carried into the lagoons, substantially filling the previous available water depth. It was remarkable that there were no casualties, fortuitously maybe and probably in part due to the time of day (late afternoon) with enough daylight initially to enable orderly evacuation of affected properties.

Highway use was permitted for heavy goods transport vehicles after a week, with traffic limited to overnight use and subject to speed restrictions. The State of Civil Defence Emergency was lifted 12 days after the storm, with the state highway opened for all traffic on the same date. The railway was reopened for use with completion of temporary culvert structures and reconstruction of track over 3 weeks after the storm.

Rural properties in the Matata vicinity were significantly affected by floodwaters and silt. Many of the properties are located within the Rangitaiki Tarawera Drainage Scheme, dependant for flood protection on stopbanks along the main river courses, and for drainage on pumping when drain outlets are submerged either by floodwaters or high tides.

The District Council coordinated a disaster recovery programme, working with other local and central government agencies and transport operators. The immediate focus was to clear the worst effects of the flows, to enable residents to return to their properties where possible and to re-establish transport links.

The cost of the emergency clean-up activities during the State of Civil Defence Emergency was $ 2 m (€ 1.1 m). Costs to rural land were $ 3 m (€ 1.7 m). The value of houses damaged or destroyed and damage to the town was over $ 7 m (€ 4 m), with damage to district roads, state highway and the railway estimated to be greater than $ 8 m (€ 4.5 m).

6 Future hazard management measures

Following the storm, Whakatane District Council immediately commissioned various studies to determine the actual nature of the hazards to the town, and to identify what risk management measures may be appropriate to provide greater protection to the community in the future. The purpose of these investigations was to develop a robust strategy of land use controls and debris control works for hazard management to enable quick decisions about long-term property re-occupation.

It has been stated that the destruction of the community of Matata in the May 2005 "… floods… was inevitable in that particular geomorphic setting…" (Davies [5]). Furthermore, in the context of Matata and other communities in New Zealand that face similar risks, Davies concludes that "unless adequate provision is made for the identification and mitigation of these situations, more such events will destroy dwellings and more people will die".

In the Whakatane District, the risks to communities represented by debris flows had not previously been well understood. Following the event, the District Council commissioned various studies to gather background information and data, with investigations and analyses to clarify the risks to Matata. These included collection and collation of topographical data, interviews with residents for flood experiences and research of historical archives to identify past flooding and debris flow events, hydrological analysis to determine design rainfall and flood flows, computational modelling of stream channels through the town, a review of the regulatory framework controlling land use and development, and assessment and analysis of the local geology and the catchment processes that led to the May debris flows and damage. The Department of Conservation completed an assessment of options for rehabilitation of the lagoons and long-term management of the wildlife refuge.

The information gathered during the various studies was used to identify and assess various land use planning and structural mitigation works options in the area affected by the event. Throughout the process there was co-ordination between the various local and central government agencies and the land transport corridor operators. There was also close consultation with private property owners and various groups representing the community. There was a strong desire within the community for early decisions regarding future risk management, so enabling resolution of access issues with many property owners unable to return after the event.

Within eight weeks of the event, a preliminary report on infrastructure and planning options was submitted to the Council. This was presented to the community at a public meeting, with private interviews and group consultation following in the next fortnight.

Just over a month later, some 12 weeks after the storm, the Council adopted a risk mitigation plan with various structural and non-structural measures for implementation. These included a 12 m high debris dam in the Awatarariki catchment, debris control bunds on the Waitepuru Stream, highway and railway culvert upgrading works, and restriction of land use on some properties. The

estimated total cost of the measures, including for land compensation and whole life management and maintenance costs, was $ 19.6 m (€ 11.2 m).

Whakatane District Council has commissioned various design and other technical studies to plan for and implement the selected options. The Council has sought funding support from central government. Without central government support, all funding for works not directly related to the state highway and railway would need to be met by the District Council. Over a 30 year financing period, district-wide rates would need to increase by nearly 5 %.

7 Summary

In May 2005 the eastern Bay of Plenty, North Island, New Zealand community of Matata was hit by intense heavy rain that caused debris flows that cut major transport links, destroyed homes and caused over $ 20 m (€ 11.3 m) of damage. After the event the local Whakatane District Council declared a State of Civil Defence Emergency and organised the disaster recovery process.

The Council also co-ordinated various local and central government agencies to collate and gather information necessary to determine appropriate future hazard management and risk mitigation strategies to protect lives and property. The studies proceeded in close consultation with the local community and property owners, who were seeking early resolution of land use restrictions on affected properties. Three months after the storm the Council adopted a strategy that included for various structural and non-structural risk mitigation measures. The total cost of the plan is estimated to be $ 19.8 m (€ 11.2 m).

The Council is now commissioning the various design and technical studies necessary to implement the strategy, including seeking funding support from central government.

References

[1] McSaveney, M.J., Beetham, R.D. and Leonard, G.S., The 18 May 2005 debris flow disaster at Matata: Causes and mitigation suggestions; Institute of Geological and Nuclear Sciences for Whakatane District Council, Client report 2005/71, 2005.
[2] Environment Bay of Plenty, Matata Flooding 18 May 2005: Meteorology; Report D for Whakatane District Council, 2005.
[3] Shearer, I., Historical Research; Administrative and Organisational Services, Project Report D for Whakatane District Council, 2005.
[4] Whakatane Beacon, Bulldozer the star of Matata's 1950 flood, 1 June 2005
[5] Davies, T., The Matata debris flows of 2005 – Inevitable events, predictable disaster; Natural Hazards Research Centre, Department of Geological Sciences, University of Canterbury, 2005.