Wainui Beach Management Strategy (WBMS) – Summary of Existing Documents

GNS Tsunami Reports

a) Review of Tsunami Hazard and Risk in New Zealand ('National Risk Report')

b) Review of New Zealand's Preparedness for Tsunami Hazard ('National Preparedness Report')

c) Gisborne District Council Tsunami Inundation Study ('Poverty Bay and Wainui Tsunami Modelling Report')

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Date –

a) September 2005

b) December 2005

c) September 2009

Scope –

a) National Risk Report

In 2005 the Government commissioned two reports from the Institute of Geological and Nuclear Sciences (GNS) on tsunami in New Zealand. At that time awareness and concern about tsunami had increased as a result of the devastating tsunami in the Indian Ocean on Boxing Day, 2004; and the government had resolved to consider the risk of such events in New Zealand.

The first report analysed the risk of tsunami on the coastline of New Zealand, focusing on the principal urban centres. It provides estimates of the probability that various localities will experience tsunami. However, the authors stress that there are significant uncertainties involved in understanding the source of tsunami and the probability that they will occur in the future. Their methodology also focuses on earthquake-generated tsunami and does not incorporate tsunami generated from other sources such as landslides or volcanoes without earthquakes.

The report also estimates potential losses, in terms of cost of damage, lives lost and injuries, in major urban centres. There are substantial uncertainties and assumptions involved in the loss estimates. Importantly, the study assumes there is no effective warning before the arrival of a tsunami and that the tsunami occurs at night.

b) National Preparedness Report

The second tsunami report produced by GNS for the government in 2005 reviews New Zealand's level of preparedness at the national and regional level for the tsunami hazards identified in the first report (the 'National Risk Report'). The report focuses on tsunami warning arrangements and the roles and responsibilities of various agencies in relation to tsunami warnings. There is only brief discussion of wider risk mitigation options aside from warning arrangements (e.g. physical protection works, engineering design for buildings, landuse planning).

Recommendations are given on measures to improve tsunami warning and evacuation arrangements.

The report also adds further to the first report's discussion of the seriousness of tsunami hazard compared to other types of hazards.

c) Poverty Bay and Wainui Tsunami Modelling Report

In 2009 Gisborne District Council contracted GNS to model tsunami inundation in Poverty Bay and Wainui Beach under a set of tsunami scenarios. The main purpose of this work was to inform evacuation planning for civil defence.

GNS used a model developed by Cornell University (USA) to simulate the propagation of waves and their change in behaviour as they approach shallower water and flood the coast. It takes into account topographical features and the friction as water flows across the land. The results of the model are maps of areas inundated, inundation depths and wave heights at the coast for various scenarios.

GNS modelled eleven scenarios, three of which were modelled at both mean tide and high tide. The scenarios included tsunami caused by a number of local earthquakes generated off the coast of New Zealand, as well as distant earthquake sources off the coast of Peru.

The likelihood of the scenarios was also assessed to some extent. However, the study is not a true 'probabilistic' model and does not try to provide detailed information on the frequency of events of different magnitude.

Note - the government recently commissioned a probabilistic study of tsunami from GNS. The results are due to be released at the end of this year and should provide better information on the likelihood of tsunami of various magnitudes around the New Zealand coastline.

Key Coastal Hazard Components –

a) Risk Report

GNS found that the entire NZ coastline is at risk of tsunami, but the hazard is variable; and the hazard is greatest in the Gisborne District because of our proximity to the Hikurangi subduction margin east of the North Island and the orientation of the coastline with respect to tsunamis generated near South America.

They provide the following generalised estimates of mean tsunami wave heights for the Gisborne District coastline:

- 100-year return period : 4-6m
- 500-year return period : 8-10m
- 2,500-year return period : 10-12m

However, GNS stress that their estimates are indicative only due to limitations in their methodology and large uncertainties in the data on which their model was based. Significantly higher or lower waves can occur locally and the results should not be used for site-specific assessments. Limitations aside, the work does provide a starting point for understanding the hazard in the Gisborne District.

Approximately 50% of the events are estimated to come from local sources with delays of less than one hour before reaching the coast and 50% from distant sources with delays of more than three hours.

While acknowledging the assumptions and significant uncertainties upon which their loss estimates are based, GNS suggest potential losses from tsunami in New Zealand are significant and possibly 'rather higher than many people may realise'. For example, they estimate that damage to property from tsunami is about twice what is expected from earthquakes with the similar return period.

GNS found Gisborne city to have the highest risk of mortality for a 500-year return period tsunami of all 19 urban areas modelled, with a median estimated number of deaths of 440. However, the model assumes the event occurs at night with no warning (i.e. a worse case scenario). The median estimated cost of a 500-year event in Gisborne city was $1,400,000,000.

b) National Preparedness Report

GNS explain that the principal tsunami warning system in New Zealand is that from the Pacific Tsunami Warning Centre in Hawaii. Seismic and sea level data collected from around the pacific is sent to the centre and used to issue warnings to countries about a potential tsunami. New Zealand then has its own national and regional arrangements to disseminate the warnings to local communities. GNS analyses these arrangements and made a range of recommendations for improvement.

The warning system based on the Pacific Tsunami Warning Centre can only be effective for distant tsunami with sufficient lead times for the various communication processes to take place. New Zealand has not yet developed a warning system for local source tsunami, like those that could affect Wainui/Okitu. Therefore, educating the public to recognise and respond to natural tsunami warning signs is the principal preparedness measure for local-source tsunami. Indeed, Gisborne city is one area GNS noted where public education and self evacuation are particularly important because of vulnerability to local source tsunami. GNS also found that the individual risk for people living at low elevations (<4m) in Gisborne would be 'intolerable' if they were not informed of the risk.

Natural warning signs of tsunami broadly include:

- earthquake shaking
- sea level fluctuations
- various sounds that have been described as thunder, locomotives and helicopters.

GNS note that, while advanced local-source early warning systems have been developed in Japan (that can deliver warnings within 3 minutes of an earthquake); they consider it unlikely they will be developed in New Zealand. This is because the cost would be difficult to justify given New Zealand's lower population density and there would remain issues ensuring effective evacuation even with an advanced warning system. In time, New Zealand may be able to develop a warning system for local sourced tsunami. But in the meantime, public education and self evacuation are the main focus for local-source tsunami.

GNS's comparison of tsunami hazard with other hazards indicates that, in terms of potential fatalities, tsunami risk is of a similar order to earthquakes, volcanoes, and (possibly) sudden-onset floods (debris flows). Therefore, GNS argue that, the government should be investing a similar amount in tsunami as it does for these other hazards. They recommend government, amongst other things,

- invest in improving the warning systems
- commission more national research on the tsunami hazard
- develop national guidelines on education, evacuation and signage

GNS's discussion of wider mitigation options, beyond warning systems and evacuation is limited, but includes the following observations:

Protection

- Japan is the leading user of engineered protection works but they are controversial.
- Designing physical works to withstand tsunami is difficult and conventional sea wall designs have performed badly in other areas.
- Protection works may give a false sense of security and encourage development that is vulnerable to events beyond the design threshold.
- Coastal dunes and greenbelts such as mangroves and coastal vegetation can significantly reduce the momentum of tsunami water where inundation depths do not exceed a few metres but may also give a false sense of security.

Adaptation

- While earlier studies have concluded changes to the New Zealand building code are not relevant for mitigating vulnerability to tsunami, GNS thought some building design changes could be investigated
- Some areas are subject to ongoing coastal erosion and coastal flooding risk, as well as at risk of tsunami. Against the backdrop of sea level rise and climate change, managed retreat may have to be considered as the only sustainable long-term solution

Landuse planning

- landuse planning tools can help reduce vulnerability to tsunami but is most easily implemented in undeveloped areas.
- Developers could be required to assess tsunami risk and mitigation measures.
- Key infrastructure and critical facilities should be discouraged in areas at risk of tsunami
- Councils could look at redevelopment of infrastructure away from areas at risk of tsunami when it is due for renewal or replacement.
- Tsunami risk can be available to landowners through Land Information Memorandums and Project Information memorandums.

c) Poverty Bay and Wainui Tsunami Modelling Report

The results of the tsunami scenarios show the impact on Wainui/Okitu varies widely, depending not only on the strength of the tsunami, but also the source of the tsunami.

Inundation in Wainui/Okitu from the distant event scenario chosen to represent a '100-year event' (an earthquake generated near Peru) is minor; the water only reaches to the maximum tide level along the beach front and does not penetrate inland. The effects would be minor even if the tsunami occurred at high tide.

The model shows a greater impact on the Wainui coast for the distant event chosen to represent the '500-year event' (another earthquake near Peru). Inundation reaches the top of the beach face and will affect the properties closest to the beach. If this event occurred at high tide the effects would be somewhat worse and strong upstream surges would affect both sides of the streams.

For the local sources modelled the severity of the inundation varies widely according to the specific location and nature of the source earthquake. Development in Wainui/Okitu tends to be protected by the steep beach and large dunes, so is barely affected in the smaller local scenarios. However, for larger local events chosen to represent 'worse case' scenarios there are significant effects. Because the beach faces are steep inundation primarily occurs through the streams and then into residential areas. In the worst event most residential areas along the coast are flooded. Inundation depths in many residential areas reach to 2-3m and inundation depths in some areas alongside the stream and along the beachfront are even higher.

For the distant events, there is about a 14 hour delay after the earthquake in Peru until the waves reach the coast. However, for the local events, the first waves can reach the coast as little as 10 minutes after the source earthquake. For the most devastating local scenarios the first waves reached the coast after 25 minutes.

Specific Coastal Hazard Action Points –

The National Hazard Risk report and the Preparedness Report illustrate that tsunami are a significant hazard in New Zealand when compared to other hazards and, of all regions, the potential wave heights are greatest in the Gisborne District. Therefore tsunami options to address the risk should be considered.

GNS's tsunami modelling shows that, while many of the smaller tsunami may only have minor effects in Wainui/Okitu, there could be significant and devastating effects from some larger tsunami. However, as the report does not provide a real sense of the probability of such events, it is difficult for to determine what options are appropriate to address the risk.

The modelling of tsunami scenarios also illustrates that there is little time for any formal warning system from tsunami generated locally; so self-evacuation is important. For some of the modelled events the first waves reach the coastline in as little as ten minutes. Given the high risk of local source events in the Gisborne area, GNS have

specifically identified Gisborne as an area where public education and self evacuation are very important.

The National Preparedness Report identifies other methods, aside from warnings and evacuation, can have a role in reducing tsunami risk. This includes landuse planning, protection of coastal dunes and physical works. However, discussion of these methods is limited.

Potential Implications for the Wainui Beach Management Strategies –

Current measures to address the tsunami risk focus on evacuation. However, given the relatively high risk of tsunami in the Gisborne area, and that tsunami may come from local sources without time for formal evacuation, consideration should be given to whether there is also a need to look at other ways to address the risk to life and property.