

Engineering Heritage and Nature, Finding a Balance: An Auckland Perspective on the Effects of Natural Hazards on Coastal and Marine Heritage

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Abstract

Auckland's engineering heritage, while perhaps perceived as mainly European/colonial, embraces evidence of several hundred years of Māori occupation of Tāmaki Makarau, principally in the form of terraced volcanic cones and agricultural areas. Overall the wider Auckland coastal vulnerability includes lower level Māori sites, together with foreshore protection works and heritage buildings, not least their contents.

The engineering heritage is vulnerable to a number of natural hazards. Earthquake risk may be somewhat less than further south, but the city lies on a narrow isthmus between two large harbours and on a volcanic field which last erupted a mere six to seven hundred years ago. Tsunami risk is significant for the eastern coasts, whether from far-field trans-Pacific events or more seriously from near field movements on the Hikurangi subduction zone or the Kermadec trench running into the Bay of Plenty.

This paper highlights specific examples of impacts of volcanic eruption and then discusses heritage vulnerability to earthquake, tsunami and extreme climate-related events. Reference is made to much ongoing work by Auckland Council and supporting agencies, not only in seismic strengthening of heritage buildings as covered by other papers, but updating of potential coastal hazards from tsunami and increasing high sea levels and appropriate responses.

1. Introduction

Engineering heritage, commonly perceived as coming initially from the colonial era, had a late start in Auckland compared with main cities further south. It was the capital city shortly after the Treaty of Waitangi signing in 1840 until that moved to Wellington in 1865. Early developments centred around the port and preoccupation with the land wars and subsequent expansion southward into the Waikato. City development only really started from the 1870s.

But Auckland's engineering heritage in broad terms goes back long before European arrivals in the 19th century. This paper's scope starts 700 years ago, discussing remnant evidence of Māori occupation to give an overview, in coastal terms, of the balance or lack of it between engineering, heritage and nature.

Heritage features along Auckland's coasts are especially vulnerable to natural hazards. The city sits on a narrow isthmus between two large harbours, itself studded with volcanic cones. While earthquake hazard is relatively low, tsunami risk is becoming more clearly defined. Oceanic storms are frequent, particularly with relevance to the more populated and historically developed eastern coasts

The city was one of the last developed in the former British Empire but became the key port in

New Zealand's colonial era and several heritage features may be at risk. In some cases it may not be the structure itself as much as the treasures it contains.

In heritage terms little remains of the early waterfront work (in contrast with the 1837 stone wharf at Whitianga). However sufficient port buildings from the turn of the 20th century remain to demonstrate the port development and substantial 'reclamation' (i.e. filling in the harbour).

2. Māori Heritage in Tāmaki

Sometime in the 13th century a group of East Polynesian explorers and colonists arrived in Aotearoa/New Zealand. On their double hulled sailing waka they transported their families, tools, animals and plants. They found the largest landmass to be settled by Polynesians, a land teeming with birds and seafood, but unlike their tropical homelands it was a temperate place. Skills developed for life in the tropics needed to be modified and to assist this process anywhere that was warmer, or could be made warmer, was particularly favoured and valuable.

Auckland, or Tāmaki Makaurau, was one of those places. With two large harbours, more than forty pocket sized volcanic cones and thousands of hectares of volcanic soil, it was an ideal place to live.

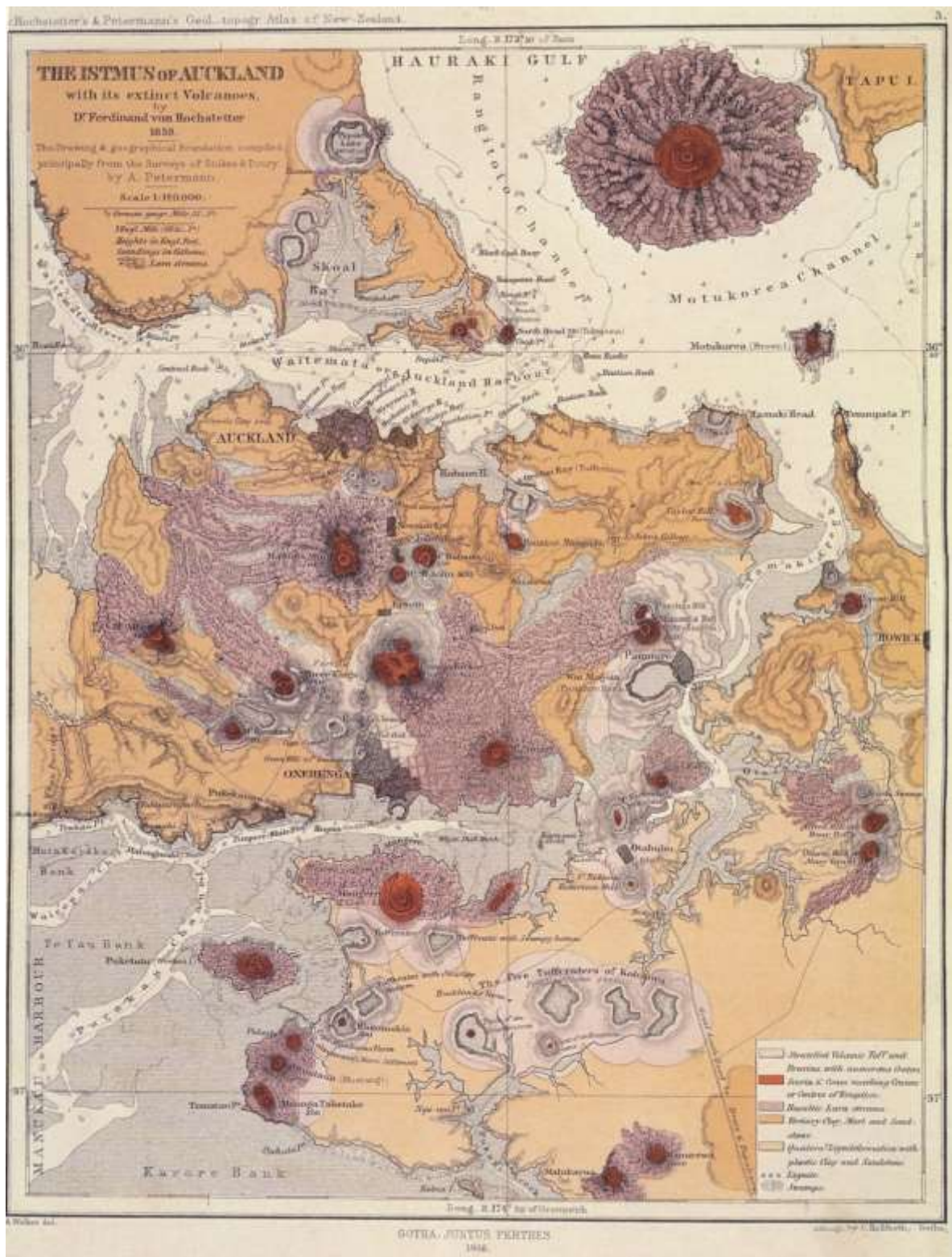


Figure 1: The Isthmus of Auckland by Dr Ferdinand Hochstetter 1859 (Sir George Grey Special Collections Auckland Libraries NZ Map 5694b).

The free draining volcanic soil was much warmer than the neighbouring clay soils and more suitable for the crops brought from the tropics. By using the rubble found in the volcanic areas to build solar heated garden nursery beds and with the development of new storage methods, the rua or kumara pit, the Māori population expanded rapidly covering most of the volcanic parts of Tāmaki.

With population growth came competition for garden land. By the 16th century Māori started to fortify settlements to defend both households and food storage areas. Headlands were defended by deep ditch and banks and the volcanic cones terraced and palisaded to create secure places to live. The evidence of these substantial earthworks is still clearly visible on the larger volcanic cones.



Figure 2: Mangere Mountain Pā, a painting by Chris Gaskin (Courtesy Department of Conservation).

In Tāmaki this lifestyle continued until the late 18th century when warfare and the arrival of muskets led to depopulation and the abandoning of many of these old pā and gardens. When Pākehā (non-Māori immigrants) arrived increasingly from 1840, they found an area described as ‘a sea of fern.’ Under the fern were the remains of hundreds of kāinga (villages), pā and gardens. This huge archaeological landscape was gradually eroded by the new city. Roads, houses and other services were built across the old field systems and the volcanic pā, and a rich rock resource started to be quarried. Until recently there has been little balance between development and heritage protection. Of the thousands of hectares of volcanic fields with their Māori garden walls and stone structures less than 200 hectares remain. Many of the cone pā have been quarried away, Mt Cambria (Takaroro) in Devonport, and Otuataua, Mt Smart (Rarotonga) and Elletts Mountain (Maungataketake) south of the city, have completely disappeared and many others so damaged as to be unrecognisable. Several of the larger cones have been flattened to accommodate water reservoirs and the access to them.

Today the remaining volcanic cones and two major remaining areas of volcanic fields have been protected and while damage from human activity still occurs, it usually by accident rather than design. Some sort of balance has been reached but for most of these extraordinary features it is too little too late. From this year, katiakitanga (guardianship) of several major cones is being vested in local hapū or iwi (descendent groups and tribes).

As well as the settlement in volcanic areas, the other main concentration of Māori settlement in Tāmaki was coastal. Kāinga and pā were often built on headlands or beach-fronts. These sites are facing another threat; often this is due to cliff regression of erodible Waitemata series

sandstone, or beach erosion, sometimes by sand or gravel extraction.

3. A Unique Volcanic Memory

One of New Zealand’s most important archaeological sites is on Motutapu Island in Auckland’s Hauraki Gulf. Around six hundred years ago the last phase of Auckland’s largest volcano, Rangitoto, erupting a few kilometres away, progressively covered a village. After the initial eruption, a group accompanied by dogs left clear footprints in wet volcanic material which over time solidified.



Figure 3: Rangitoto Eruption (Courtesy Department of Conservation).

Since the 1960s pieces of these footprints have been eroding out of the beachfront, and since 1980 numerous attempts have been made to protect the ancient buried village, initially using timber and rubble sea walls, both of which did little to protect the site and may have exacerbated the problem.



Figure 4: Sunde Site Motutapu Island (Courtesy Department of Conservation).

It was initially unclear why this particular beach was eroding until some historical research indicated that scows, the flat bottomed early colonial sailing barges had collected gravel and sand for Auckland building projects. The solution to the exposure of this important site was ‘beach replenishment’. The profile in front of the old village

has remained at a higher level and while not giving 100% protection is working better than engineered solutions like breakwaters or walls.

4. Earthquakes and Volcanic Eruptions

Auckland is generally perceived as having relatively low seismic risk compared with other parts of New Zealand. The last significant earthquake was in 1891 on the Waikato fault some 50 kilometres south of Auckland. Occasional minor tremors remind us we live on a volcanic field, at least two noticeable within the last few years and some 80 tremors since 1996 [1]

A recent overview of large scale faulting in the Auckland region [1] highlights the Wairoa fault as the most potentially active, but concludes that a greater risk may be from unknown faults buried under volcanic or other more recent material



Figure 5: Faults previously recognised in the Auckland Region (Reference 1 Fig. 20b Page 40).

Extensive seismic strengthening has been applied to numbers of large heritage buildings in the city as described in other papers. Coastal structures vulnerable to seismic damage would include historic defensive forts dating from the late 19th century (the era of Russian invasion fears), mainly on the crest of North Shore cliffs and volcanic cones.

The Māori prehistory and its vulnerability has already been discussed, the major losses being occasioned by colonial settlement rather than nature. It has been noted that early Māori witnessed the last volcanic eruption – it was that recent! However there can be no prediction of future frequency, only to assume the volcanic field is not dead. The Auckland War Memorial Museum currently has a display which graphically demonstrates the effects of a new volcano erupting in the Rangitoto channel, coincidentally near the inferred site of the 2011 tremor.

In the event of an eruption, the effects on heritage items would be the least of Auckland's concerns.

5. Tsunami

Recent and ongoing research by crown research institutes, NIWA (National Institute of Water and Atmospheric Research Ltd) and GNS Science (Institute of Geological and Nuclear Sciences Limited), is defining in broad terms the risk to lower lying areas of the North Island's east coast. The East Cape and Bay of Plenty coasts are most vulnerable to near and far source tsunami, with greatest risks from undersea earthquakes on the tectonic boundary between Pacific and Australasian plates, as manifested by the Hikurangi and Kermadec subduction zones

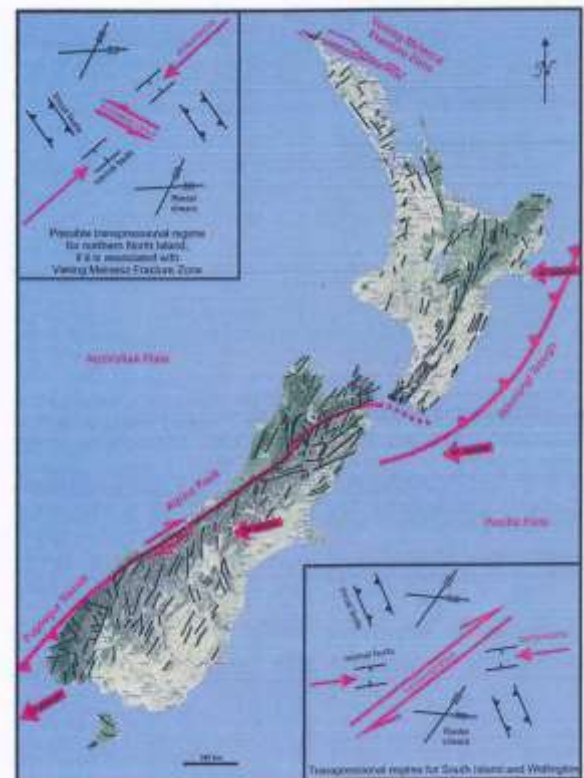


Figure 6: Hikurangi Trench and main fault lines (Reference 1 Fig32 Page 62).

There will be less than one hour's warning for Bay of Plenty communities from the latter and evacuation procedures are receiving priority from Civil Defence Emergency Management.

In Auckland, heritage items at risk would include the several kilometres of basalt rock sea walls along Tamaki Drive and shorter lengths in Devonport. As with the Lyttelton graving dock in 1960, there could be over-topping and damage to the historic Calliope dock in the Devonport Naval Base.

With regard to the historic stone house at Mission Bay, the new Naval Museum in Torpedo Bay under Devonport's North Head, Mansion House at Kawau Island and even earlier historical buildings in the Bay of Islands, (Paihia, Russell and Kerikeri) the heritage items most at risk could be the taonga (treasures), art works and artefacts in the buildings. Consideration should be given to their

security or removal in the event of ground floor flooding, if not structural damage.

The range of physical tsunami hazard is becoming more evident. Smaller harbours like Whitianga and Tutukaka have experienced severe and repeated tidal flows and surges in sympathy with tsunami wave periods, usually over more than the twelve hour tidal period and hence coincident with at least one high tide. Larger harbours like the Waitemata did not respond to events like the Samoan earthquake tsunami other than with small fluctuations (*pers. com*).

The following comments are summarised from the Executive Summary of the Ministry of Civil Defence and Emergency Management's 2013 Review of Tsunami Hazard in New Zealand [2]

- New research and improved modelling shows hazards on the North Island east coasts are higher than previously estimated.
- New Zealand has experienced about ten tsunami of five metres or more since 1840.
- The report draws on lessons from the 2011 Tohoku tsunami in Japan which indicated non uniformity in ruptures between tectonic plates.

The possible effects from near field events on Auckland's east coast have been modelled and likely areas of inundation shown on publically available maps.



Figure 7: Tsunami Evacuation Zones for Devonport. Shore exclusion zone in red, evacuation zone in orange and yellow (Ministry of Civil Defence Reference 2).

Warning signs are displayed on popular beaches, and evacuation warning are being set up by telephone and siren. Tsunami responses are part of training of local emergency response groups. Auckland Council is developing data portfolios to enable local board and community response groups to inform property owners, including those

of heritage items, about managing their individual risk.

As regards the Ports of Auckland, the principle heritage features at risk could be the National Maritime Museum at Hobson Wharf and its associated vessels. Experience from smaller harbours shows that very high ebb velocities can cause instability to moored displacement vessels followed by elevated water levels breaking moorings. Clearly the results and effects would be greatly magnified in the commercial port, and in Auckland's numerous yacht marinas. Of note is only a very few vessels of all sizes put out into the harbour when advised of the Samoan earthquake (*pers. com*). In that event there were no noticeable tidal movements compared with excessive and repeated variations in Tutukaka, Whitianga and other smaller harbours.

It can be noted that the 1960 Chilean earthquake tsunami exposed the bones of the 1840 wreck of the *HMS Buffalo* at Whitianga. Given the relevance of the ship to the citizens of Glenelg, South Australia, there have been short-lived suggestions of salvage of at least some parts of the wreck.

6. Coastal Inundation by Storm Tides and Waves in the Auckland Region

The above is the title of a NIWA report prepared in 2013 for Auckland Council [3]. The study calculated extreme sea level elevations for a range of annual exceedance probabilities. The three main harbours considered were Waitemata, Manukau and Kaipara. The Waitemata and its adjacent coast have the most heritage significance. The effects at high tide could be similar to those from tsunami. This has been experienced in recent months and is likely to become even more frequent with rising sea levels and climate change. Sea level rise at Auckland has been measured at 150 millimetres (mm) over the past 100 years, with variations mainly in sync with El Niño Southern Oscillation shifts.

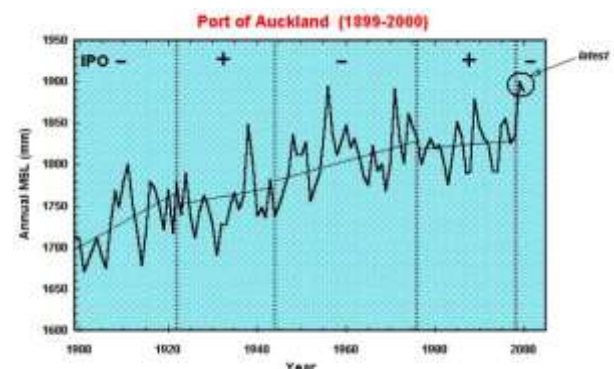


Figure 8: Annual mean sea level at Port of Auckland since 1899. The overall trend has been 1.4 mm rise per year, (<http://www.niwa.co.nz/publications/wa/vol9-no4-december-2001/sea-level-on-the-move>).

The heritage wall along Tamaki Drive was unexpectedly over-topped with some damage by a

short lived storm surge at high spring tide in June 2014, with water flowing towards both Mission Bay and Kohimarama. Mission Bay beach head was over-topped too. However no adverse effects were reported at the Mission House.



Figure 9: Flooding of the North western motorway during the 23 January 2011 storm-tide
(<http://blog.metservice.com/tag/wind/page/2/>).

The NIWA study produced inundation maps rationalising results of earlier studies, together with allowance for sea level rise scenarios of +1 and +2 metres above present day mean sea levels.

Less evident, but still historically significant, are the World War II pill boxes around the entrances to the Waitemata Harbour. Some of these low profile structures are vulnerable to the regression of sandstone cliffs from wind and wave erosion, possibly exacerbated by sea level rise.

Oldest of all examples of natural and human impacts on geological heritage are the threats to the so-called buried forest north of Takapuna on the North Shore. Basalt flows from the Pupuke explosion crater enveloped a standing forest leaving casts of the fallen trees. The largest of a standing kauri is threatened by removal of erodible tuff from under the basalt due to earlier quarrying and resultant exposure to wave action. Concrete underpinning has afforded at least short term support to a unique tree cast in which the bark plates are clearly visible (Brett Avenue, Takapuna).

7. Conclusion

Auckland's heritage at risk from natural hazards may not be extensive geographically, but the time spans involved, covering geological history, Māori occupation and European colonisation, merit detailed knowledge of such treasures and allowance for their protection or at least full documentation. Most at risk in some historical buildings may be the taonga and artefacts on display if not properly secured or elevated in the event of buildings being flooded.

8. Acknowledgements

The authors would like to acknowledge the assistance of Richard Woods of Auckland Council and John and Sue La Roche for the editing of this paper.

9. References

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- [2] Ministry of Civil Defence and Emergency Management "Review of Tsunami Hazard in New Zealand" 2013
- [3] Stevens Scott et al. "Coastal inundation by storm-tides and waves in Auckland Region", Prepared by NIWA for Auckland Council September 2013