SUSTAINABLE FUTURES 30|50
WHANGAREI DISTRICT

Whangarei District Natural Hazard Constraints Report

Prepared by: David Coleman

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1.0 Introduction

The purpose of this report is to provide an overview of the risks posed by natural hazards within the Whangarei District, and their implications for development. It includes a brief description of various natural hazards, summarises the legislative environment, and qualitatively assesses their influence or impact in terms of the three futures scenarios used in Sustainable Futures 30/50. The geographical features of Whangarei District such as the extensive coastline, variable geology and topography, and climatic variability mean that natural hazard events are a regular occurrence. This report is based upon presently available material from documents prepared by Northland Regional Council (NRC), the Institute for Geological and Nuclear Sciences (IGNS), the Ministry of Civil Defence and Emergency Management (MCDEM), and National Institute of Water and Atmospheric Research (NIWA) and others.

It should be noted that this report excludes the most recent available material on climate change, and instead focuses on the present hazardscape[1] of Whangarei District. However, some sections on flooding, landslides, and coastal hazards include some allowance for climate change, when this is explicitly provided for within the source material. This approach is not for the purposes of downplaying the significance of climate change and its potential impacts on Whangarei District. Instead it is felt that a separate report may be the most appropriate way of examining climate change impacts especially as they are not solely contained within the realm of natural hazards, but can affect economic output and other facets of community life.

Taken as a whole, the following information and accompanying maps will be used to understand, and plan for, the constraints to development posed by natural hazards. It is recognised that much of Whangarei District, and the main settlements, are in areas of known risk and there will be some difficulties in alleviating that risk. But in terms of future development, it may be prudent to avoid some of the more serious natural hazards, which also reflects the trend in natural hazard management globally.

1.1 Natural Hazards: A Briefing

The term "natural hazard" has been defined in various pieces of New Zealand's legislation and includes the following:

Resource Management Act (1991): *Natural hazard means any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, and flooding) the action of*

[1] Term used to define the "*knowledge we have of the intensity, duration and frequency of hazardous events*" (Gray 2003).

which adversely affects or may adversely affect human, life, property, or other aspects of the environment:

Civil Defence and Emergency Management Act (2002): *Hazard means something that may cause, or contribute substantially to the cause of, an emergency.*

Building Act (2004) Definition: *Natural hazard has the meaning given to it by section 71*

Section 71

In this section and sections 72 to 74, natural hazard means any of the following:

(a) erosion (including coastal erosion, bank erosion, and sheet erosion):

(b) falling debris (including soil, rock, snow, and ice):

(c) subsidence:

(d) inundation (including flooding, overland flow, storm surge, tidal effects, and ponding):

(e) slippage.

Natural hazards therefore include a wide range of phenomena ranging from widespread hazards such as earthquakes, landslides, flooding, and can also include things such as wildfires, pest invasion and so on. All these definitions have similar components which include a naturally occurring biophysical event, and its impacts on people, communities, and their values. *"A hazard is the potential for an event to interact with individuals and communities, and the social, economic, cultural and environmental resources supporting them" (National Hazardscape Report, 2007:5).*

Local government has had a long involvement in natural hazards management, and roles for the various councils were enhanced by the enactment of the Resource Management Act 1991. However, despite this involvement, exposure to natural hazard events continues to increase.

1.2 Natural Hazard Risk

The actual impact of any natural hazard event is dependent on the level of risk and exposure accepted by the local community in regard to a local hazard, and the way this risk influences development and settlement patterns in a geographical area. The management of natural hazards is primarily about reducing risk from natural hazards, which can range from large scale engineering works (e.g. stop-banks and dams) through to education campaigns such as those used by the Earthquake Commission or www.getthru.govt.nz, and onwards to avoidance-based

programmes, such as managed retreat, in response to coastal hazards, considered by Environment Waikato[2].

When talking about natural hazard risks, two main characteristics are often considered: the frequency of the event and the overall impacts/potential impacts (magnitude). *Risk,.., is the combination of the likelihood and the consequences of a hazard" (National Hazardscape report, 2007:5).* By combining these two characteristics, some level of risk is ascertained for the purposes of decision making. The level of risk is usually communicated to the public as the frequency of a particularly sized event occurring in a given year. For example, media will report on 1/50 year events or more correctly 1/50 Annual Return Interval (ARI)[3] etc. The number 50 refers to a return period of 50 years and this is used to represent an estimate of the magnitude of an event (e.g. how much water in a river bed). What this assessment means is that every year, there is a 2% chance that an event of a given size (intensity) will occur. It does not mean that if a 1/50 year event was to occur, another 50 years will pass before the next event occurs. The larger the return period given by modelling, the more significant the potential impact of the event (e.g. as reflected in stream flow, stormwater capacity and so on). For some events, a range of values may be applicable, ranging from 1/5 ARI events through to 1/1000 ARI vents. Best practice for professionals is to put forward a range of ARI's that are useful for decision-making. In this instance, the 1/5 ARI may be a significant amount of water that overtops banks but doesn't flood much further, whereas the 1/1000 year event would be a massive amount of water that would probably overtop any local floodplain and cause widespread significant damage. As a planning horizon, many councils use planning horizons of 50 or 100 year ARI and being a balance between risk and cost effectiveness. Which planning horizon can be contentious, and has been the source of court proceedings[4].

Much of Whangarei District is subject to various hazards. Established communities and households are already located within areas that experience natural hazard events such as flooding, coastal hazards, and live in locations with areas of moderate or high instability risks. This is generally for historical reasons, such as access to water, transport, and agricultural production, or lack of suitable alternatives in the vicinity of important resources. Recent patterns of development are still occurring in at-risk areas within Whangarei District, due to the quality of local natural features such as coast, views, and running water leading to these being popular residential localities.

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[2] http://www.ew.govt.nz/publications/Technical-Reports/Managed-Retreat-from-Coastal-Hazards-Options-for-Implementation/

[3] The average period of time between events of a particular size happening. Also annual recurrence interval.

[4] E.g. C102/05 Alexandra District Flood Society Incorporated v Otago Regional Council

Whilst on-site solutions are generally used to alleviate the risk here and elsewhere in New Zealand, questions are being asked as to whether further risk should be accepted. This is a query worth asking as insurance costs and claims in regards to natural hazards across New Zealand, and the world, have increased markedly. The National Hazardscape Report (2007:15) notes that Cyclone Bola and the February 2004 storms are the most expensive weather related events in New Zealand. In 2008, natural hazard events across the globe (including the earthquake in China) led to economic losses of US $262 billion. Between 1970 and 2008, 35 of the top 40 costliest natural hazard events were weather related, including storms, hurricanes, and floods[5]. In addition, the number of recorded disasters, according to figures held by United Nations Strategy for Disaster Reduction, has increased markedly for hazards, especially weather and water related events[6].

[5] http://www.swissre.com/resources/dd6346004d4e9669ac76eecedd316cf3-sigma2_2009_e.pdf

[6] http://www.unisdr.org/disaster-statistics/occurrence-trends-century.htm

2.0 Biophysical Profile and Hazardscape of Whangarei

Northland is a long peninsula that is subjected to extreme weather events generated in the North Tasman Sea or in the tropics. Most extreme events within the district are generated from unstable weather patterns that generate heavy rain, thunderstorms and squally conditions. At the extreme end, one ex-tropical cyclone travels within 500 km of Northland every year, whereas the North Tasman Sea generated depressions that can form so-called weather bombs which have impacts across New Zealand, such as the Waikato Weather Bomb in 2002, which also affected Northland.

Whangarei District is approximately 2850 km² in area, including enclosed estuaries, bays and islands. Whangarei District is characterised by a varied environment compromising of steep hills, lowland river valleys and flats, and 270 km of open coastline. It has a mild, humid climate, owing to being almost sub-tropical in setting and attributes. Approximately 58% of the land areas of the district is used for production farming (including dairying, other pastoral, and specialist farming), whilst 20% is used for production forestry. The annual rainfall is variable, which ranges from 1000 mm on parts of the coast through to 2500 mm in the inner hill country where steep terrain can enhance precipitation over ranges. Whangarei contains the only city of the region, which acts as a service centre to other districts, and the city has relatively well developed infrastructure. Of concern to the region is that the major business centre of Whangarei is highly susceptible to flooding, due to a mix of small catchments, the effects of storm tides, and a storm-water system that requires upgrading.

There are many rivers and streams criss-crossing the landscape, many rising in steep hillside catchments (over 600 metres above sea level). NRC classifies most rivers as slow moving, meaning that they recede relatively slowly compared with the rise in the headwaters (NRC, 2002). Their flows change with the rainfall and high intensity rainfall events, and can be filled with silt and debris. Approximately 16% of our district is shrouded in native forests and shrub-lands, which provide vital ecosystem services such as a high quality of water and flood attenuation effects in the upper catchments. Many of these are located in the upper hills with most of the lowland ecosystems having been converted into production farming or residential areas. The coastline ranges from rocky cliffs to sandy embayments, from high slopes to low lying areas. Whangarei Harbour is the largest enclosed seawater area, but other estuaries and harbours occur at Pataua, Whangaruru, Whananaki, and Ngunguru.

Northland-wide, the highest risks are associated with flooding, coastal storm surges, ex-tropical cyclones, land instability, and biological factors such as pest and animal disease and possibility of human epidemics. These are generally regarded as the biggest risk factors for Whangarei District as well. However, with the exception of floods and climatic events, the overall exposure to other hazards such as earthquakes is regarded as low (Beethem et al 2003) although some

level of risk remains. The most regular climatic hazards for Whangarei District are unstable weather patterns which lead to thunderstorms and intense rainfall.

Some natural hazard types have seen increased risk levels due to the increased probability of the event happening or an increased exposure of the local community due to population growth/preference for settlement in these areas. The most prominent examples of these are flooding, coastal storm surges, ex-tropical cyclones, biological hazards, and rural wildfire (NRCEMGP, 2004:42). This increase in exposure is not unique to Northland or Whangarei, but is a consistent pattern across New Zealand, whether Otago[7] or Waikato[8]. Like those places, Northland and Whangarei must consider its options on how to best manage natural hazards in the face of continuing development pressure. Figure 1 illustrates the main focus area of this report.

[7] http://www.orc.govt.nz/Documents/ContentDocuments/env_management/flood_mgt/Final%20Joint%20Flood%20Mitigation%20Strategy.pdf

[8] http://www.ew.govt.nz/naturalhazardsreport

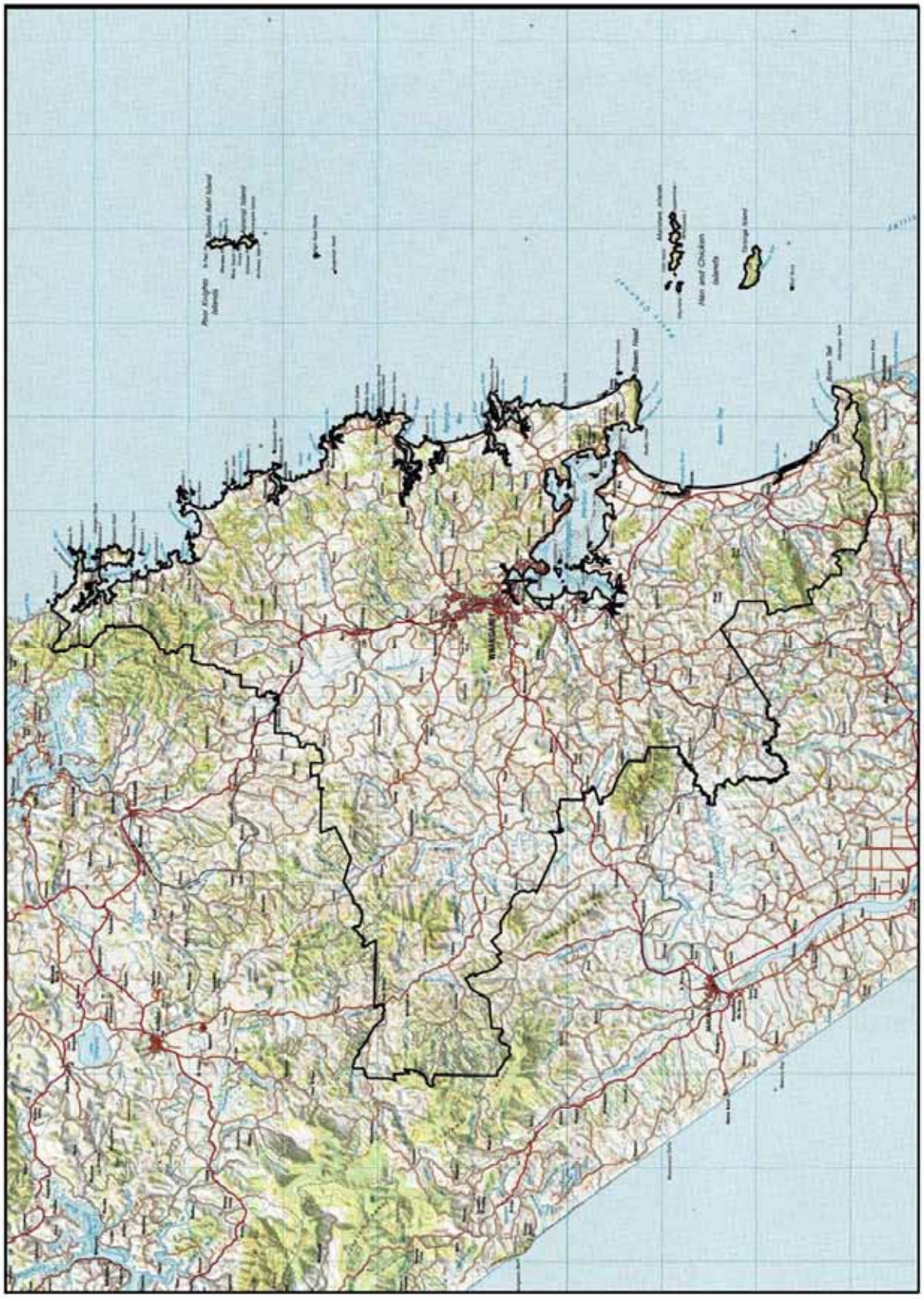


Figure 1: Topographical Map of Whangare

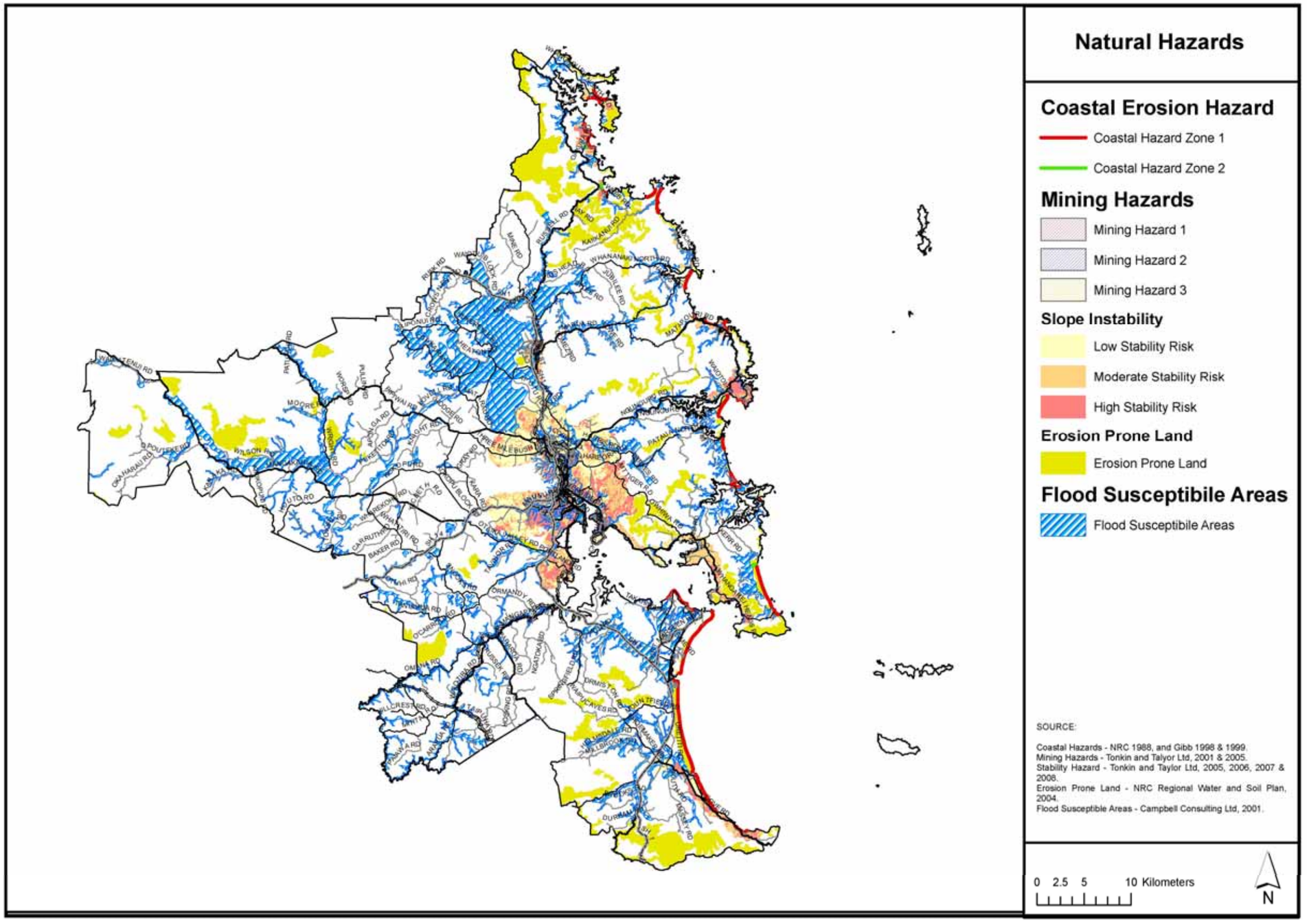


Figure 2: **Broad Hazardscape Map for Whangarei**
Based upon Whangarei District Plan and Northland Land and Soil Plan.

3.0 Individual Hazard Types

The following sections provide brief descriptions of the natural hazard events experienced within the Whangarei District. Please note that they are not in alphabetical order, but have been listed according to their priority risk level noted in the Northland Regional Civil Defence Emergency document, (NRCEMGP, 2004, p42). In addition, the list includes several hazards that are human in origin, and have not been considered in this report.

HAZARD	Seriousness	Manageability	Growth	Total Score
Flooding	4.0	3.0	2.0	**9.0**
Coastal – storm surge	3.6	3.0	2.0	**8.6**
Ex-tropical cyclone	3.6	3.0	2.0	**8.6**
Biological – human epidemic	2.6	4.0	2.0	**8.6**
Biological – pests and animal diseases	2.4	4.0	2.0	**8.4**
Coastal – tsunami – distantly generated	2.7	4.0	1.0	**7.7**
Coastal – tsunami – locally generated	2.7	4.0	1.0	**7.7**
Volcanic – local volcanic field	2.7	4.0	1.0	**7.7**
Volcanic – distant eruption	2.2	4.0	1.0	**7.2**
Earthquake	2.4	2.5	1.0	**5.9**
Drought - agricultural	1.6	2.0	1.0	**4.6**
Hazardous substances	2.0	1.5	1.0	**4.5**
Infrastructural failure - electricity	2.5	1.0	1.0	**4.5**
Criminal act/terrorism	1.8	1.5	1.0	**4.3**
Infrastructural failure – water (urban)	2.1	1.0	1.0	**4.1**
Infrastructure failure – information technology	2.0	0.0	2.0	**4.0**
Major transportation crash – aircraft	1.7	1.0	1.0	**3.7**
Major transportation crash – marine	1.6	1.0	1.0	**3.6**
Land instability	2.0	0.0	1.0	**3.0**
Infrastructural failure – roads and bridges	1.7	0.0	1.0	**2.7**
Fire – rural (wildfire)	2.0	-1.5	2.0	**2.5**
Drought – water supply	1.2	0.0	1.0	**2.2**
Mine subsidence	1.2	-2.0	1.0	**0.2**

Table 1: Hazard Priority Listing (sourced from Northland Civil Defence Emergency Management Group Plan, 2004:42)

3.1 Flood Hazards

Flooding is generally accepted as having the highest risk potential within both Whangarei District and Northland as a whole. The bulk of Whangarei District's population has historically been developed within or close to areas with hazard risk because of other factors, such at water transport, key agricultural and horticultural areas, and difficulties in settling on steep hills.

A flood event occurs when enough rainfall occurs in a given time period that cannot be dealt with by natural or artificial drainage systems. The large amount of silt and debris captured off the land adds to river flooding hazards, with much silt emanating from the steep topography and soils prone to slipping in the upper catchments. As mentioned above, most tend to be small scale intense rainfalls affecting parts of the district, but larger systems can have a more regional effect. In the annual Climate Summary Reports (2000-2008) produced by NIWA, Whangarei or wider Northland had significant rainfall events that generated flooding on 25 separate occasions[9].

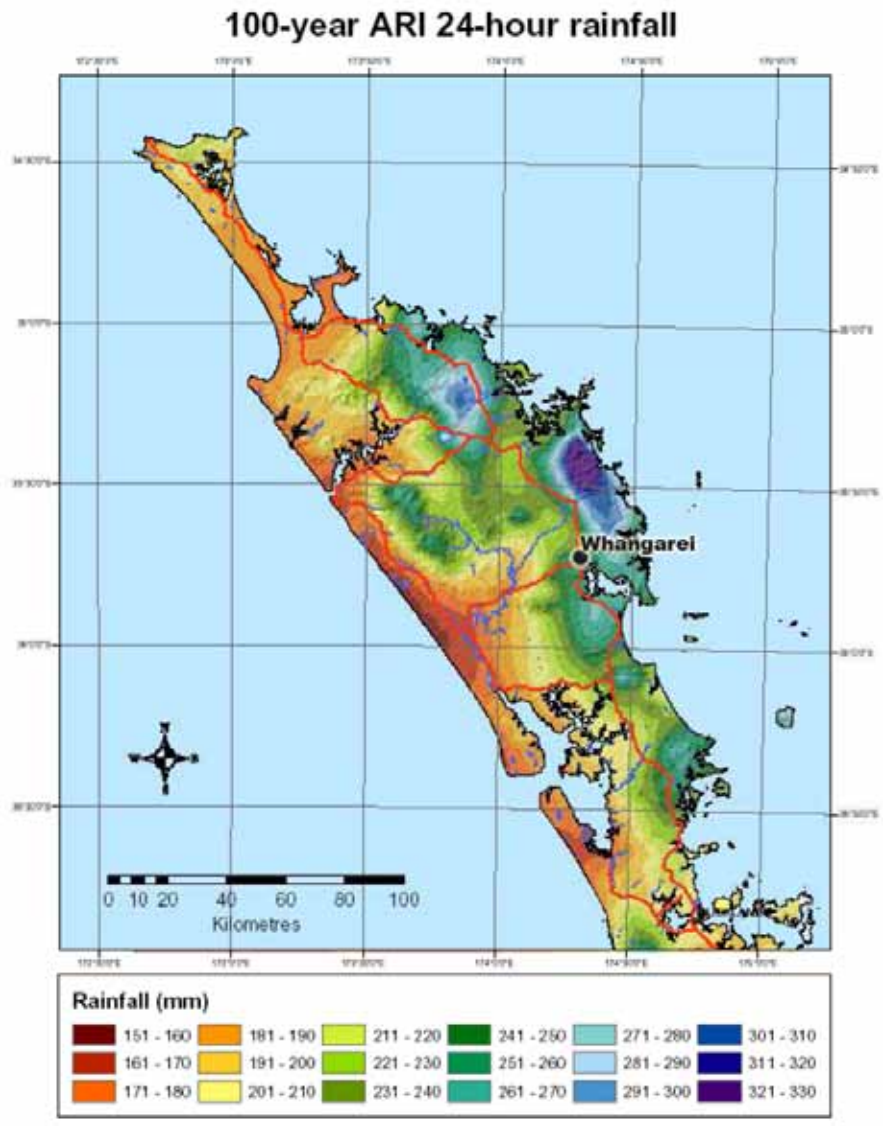


Figure 3: Total Rainfall (mm) Expected to Fall in a 24 Hour Period with a Re-occurrence Interval of 100 years. Sourced from Gray (2003)

[9] The full list of climate summaries can be sourced from: http://www.niwa.co.nz/news-and-publications/publications/all/cs/annual

Whangarei District often experiences high and intense rainfall events, with a modelled 1/50 return period of a 24 hour rainfall of 200-250 mm occurring within the Whangarei District (NHR 2007:61). In the 2007 March event, some 300 mm of rain occurred in Whangarei, which was the highest since records began in 1943. A local hotspot is the Eastern Hills north of Whangarei, such as on the Puhipuhi plateau, which can experience even higher intensities of rainfall.

Based on presently available information, 31,773 ha of land (equal to 12% of the district) is designated under the Flood Susceptible Resource Areas mapped in the Whangarei District Plan (or as part of later flood susceptibility reviews; available on the WDC GIS system). These are the areas that may be expected to be flooded as a 1 in 50 return period. This means that every year, there is a 2% chance of a major flooding event occurring within a given catchment, and the volume of water would inundate the land.

The greater part of the flood susceptible area is within the Hikurangi Swamp Basin and within the catchment of the Mangakahia River, as figure 4 illustrates. Flooding in the Hikurangi Swamp Basin has been regular and the subject of many media images such as in 2007. The Mangakahia River floods regularly, with a recorded peak in 1936, when it rose 19 metres at Titoki (Brenstrum, 2003:8). Both areas drain through important agricultural regions and in areas where important transportation links occur. Substantial flood susceptible areas can be found in the catchments above around Marsden Point/Ruakaka, including Waipapa Stream and Ruakaka River. Finally, there are also considerable flood susceptible areas near the main urban areas as well, including the central business district (CBD) as illustrated in figure 5.

At present, 13,523 parcels of land are located fully or partially within flood susceptible areas across the whole district. This exposure continued to increase with development patterns in the last decade. Of the 11,833 new parcels of land created since 1996, 24% (2,867) are located in flood susceptible areas. However, it should be noted that since 2003, the rate of lot creation in flood susceptible areas has slowed, from 296 per annum through to 90 per annum. Since 1995, 1,259 building consents have been processed for flood susceptible lots, across all Environments. This represents an increasing level of risk exposure for flooding hazards across the district.

In total, 2,500 flood susceptible parcels of land are noted as Living 1, 2, or 3 Environments, which are the main residential zones. A total of 1,275 parcels of Business Environment land are also located in flood susceptible areas, which represents 58% of the total number of Business lots across the whole district. The major hotspots are Business 1 Environment lots located in the CBD, which number 392, or 93% of the total Business 1 Environment lots in the whole district. This represents a significant risk, which is why work has been ongoing to address the CBD flooding risk since 2006. The URS New Zealand report notes that four major storm events have occurred in the CBD in the last 50 years (May 1956, March 1988, March 1995, April 1999;

URS, 2006). In 1936, 300mm of rain was recorded in Whangarei (Brenstrum, 2003:18). The economic cost of flooding in the CBD has been assessed at 5.6 million per annum (averaged out), but could rise as a consequence of climate change (URS, 2006: 6-4).

It should also be noted that substantial areas normally used for light and heavy industrial uses in the vicinity of the old port are also under the flood susceptible designation, as are substantial areas in the Marsden Point/Ruakaka area.

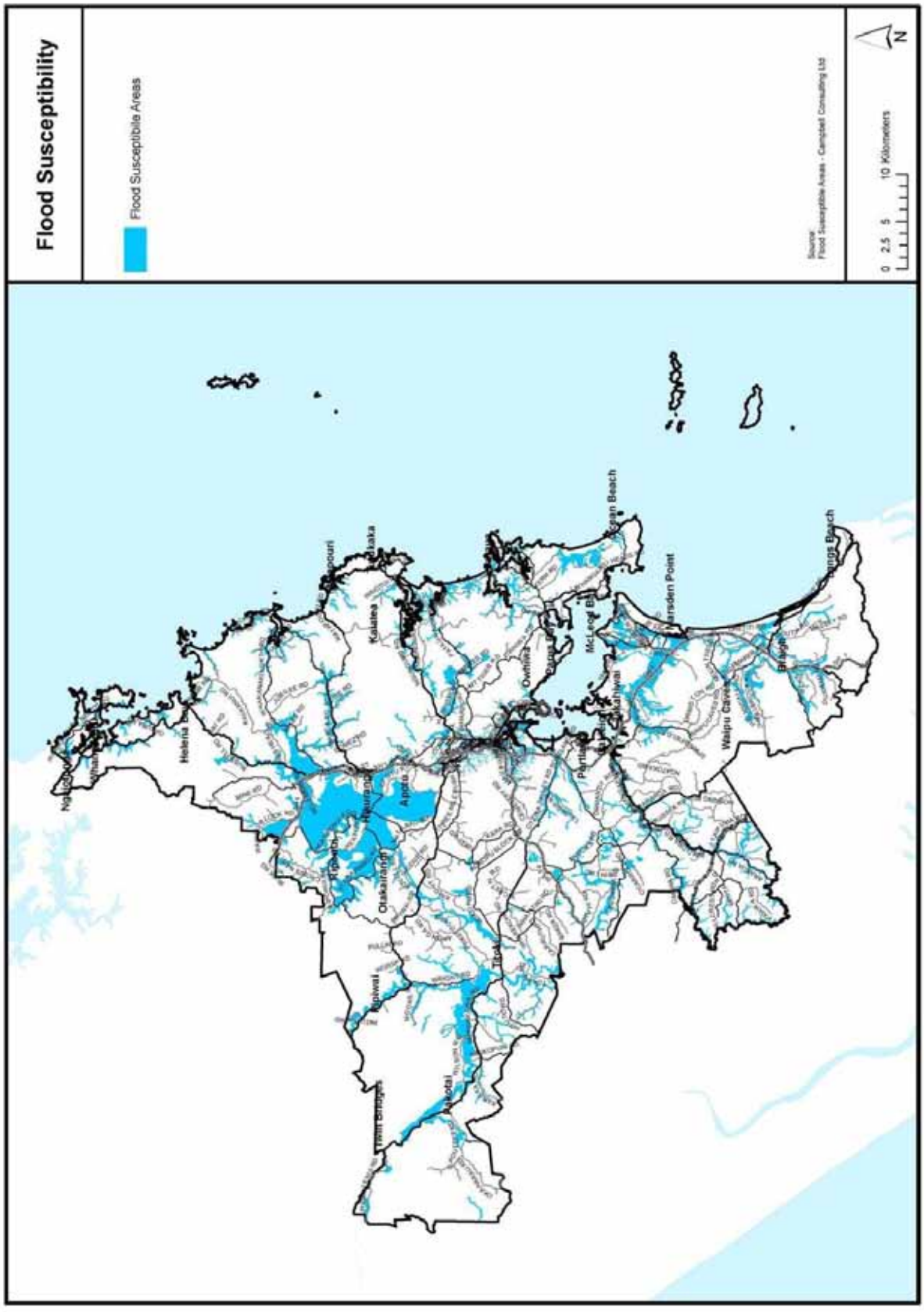


Figure 4: **Map of Flood Susceptible Areas**
Based on the Whangarei District Plan and later Flood Susceptibility Updates.

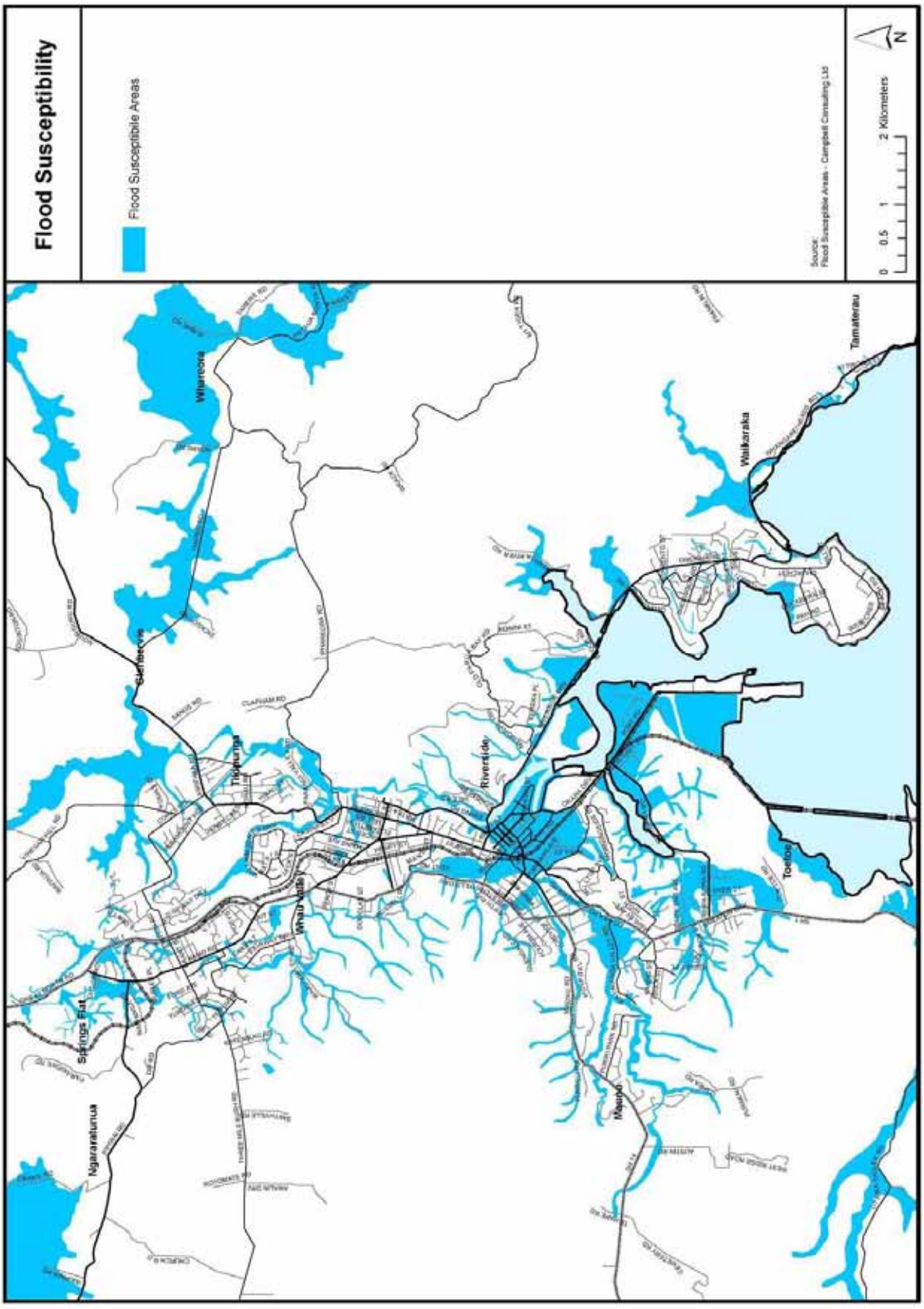


Figure 5: Map of Urban Flood Susceptible Areas in Whangarei District Plan

A variety of tools and methods have been used to avoid or mitigate this flooding risk, ranging from "hard" mitigation measures such as stop-banks construction and management, the use of minimum floor levels, through to vegetation planting for stability and hazard attenuation. NRC has a wide variety of programmes to manage flooding, including the use of drainage districts, warning systems, engineering works and so on. An important recent tool is the use of flood mitigation plans to better integrate flood management planning.

At present flood mitigation plans for rivers in Northland are limited, with only the Awanui River Management Plan and the Interim Kaihu River Management Plans completed by NRC. NRC is in the process of developing further planning documents, and has carried out an initial prioritisation. This study has come up with a list of 27 rivers Northland wide, with 7 being noted in the Whangarei District. In alphabetical order these include: Hatea River, Helena Bay River, Ngunguru River, Otaika River, Ruakaka River, Waiorohia/Raumunga Streams, and Whangarei Heads Streams. Apart from the Helena Bay River, the other six are all located in areas that are either historically/presently urban in character or are the focus for future urban development. This suggests continuing growth in the level of community exposure to flooding risks. The Ruakaka River plan is of particular interest because of the rapid and large scale potential development in this area.

3.2 Extreme Weather Events

Many of the high priority natural hazards found in Northland and Whangarei are driven by extreme weather events such as storms, ex-tropical cyclones and other factors that influence rainfall and wind patterns.

3.2.1 Ex-tropical Cyclone

These events are reasonably regular, and consist of high pressure revolving storms that carry a lot of energy and moisture. Because of Northland's proximity to the tropics where these cyclones are generated, it is considered high risk in the Northland Civil Defence Emergency Management Group Plan (NCDEMGP 2004). Storms generated from this source tend to broaden and have more widespread effect as these systems enter our area, thus they tend to have a regional effect. Wind and heavy rain are the most damaging hazard associated with ex-tropical cyclones, although they can generate storm surges and coastal erosion. Winds of up to 130 km per hour were recorded during Cyclone Bola.

3.2.2 North Tasman Lows

These are wider weather systems that develop in the North Tasman Sea, in the warm waters off Queensland, and carry a lot of moisture. They are very deep depressions, and when they are hemmed in by high pressure systems, they release this moisture onto Northland

(Mckerchar, 2007). These have been called 'eggbeater' storms in the context of Northland, when a low pressure system rotates clockwise against a high pressure system rotating anti-clockwise, and the middle ground between the two gets 'beaten"[10]

3.2.3 Intense Convection

These are the most common sources of stormy weather, and tend to be smaller in area of impact. They are difficult to forecast and measure, but occur on a regular basis. These are the thunderstorms, heavy showers and so on that result from triggers such as rising air releasing moisture, or when different weather systems meet.

3.2.4 Extreme Weather Events (ENSO Cycle)

The El Nino Southern Oscillation (ENSO) is an important climate event that has a strong impact on climate in New Zealand. It is included here as it is a macro-scale driver of weather patterns. The ENSO cycle changes things such as prevailing wind pattern, moisture patterns and so on. In general terms, El Nino brings more westerlies that can dry out the land, whilst La Nina conditions bring more moist humid air from the tropics, predominantly North-easterlies. In an El Nino year, trade winds that normally flow westward across the Pacific weaken, which leads to increased sea surface temperatures in the eastern Pacific, and reduces upwelling in the currents flowing off South America. Cyclone activity in the Pacific also shifts eastwards, leading to more impacts in French Polynesia and the Cook Islands. In La Nina years, the westerly trade winds strengthen, and the western Pacific gets more moisture in the air, whilst the eastern areas become drier. Figure 6 illustrates how significant ENSO can be in regard to drought risk.

[10] Macdavitt, B. (2007) Weather 'eggbeater' whips country's north. New Zealand Herald Story. March 30th, 2007.

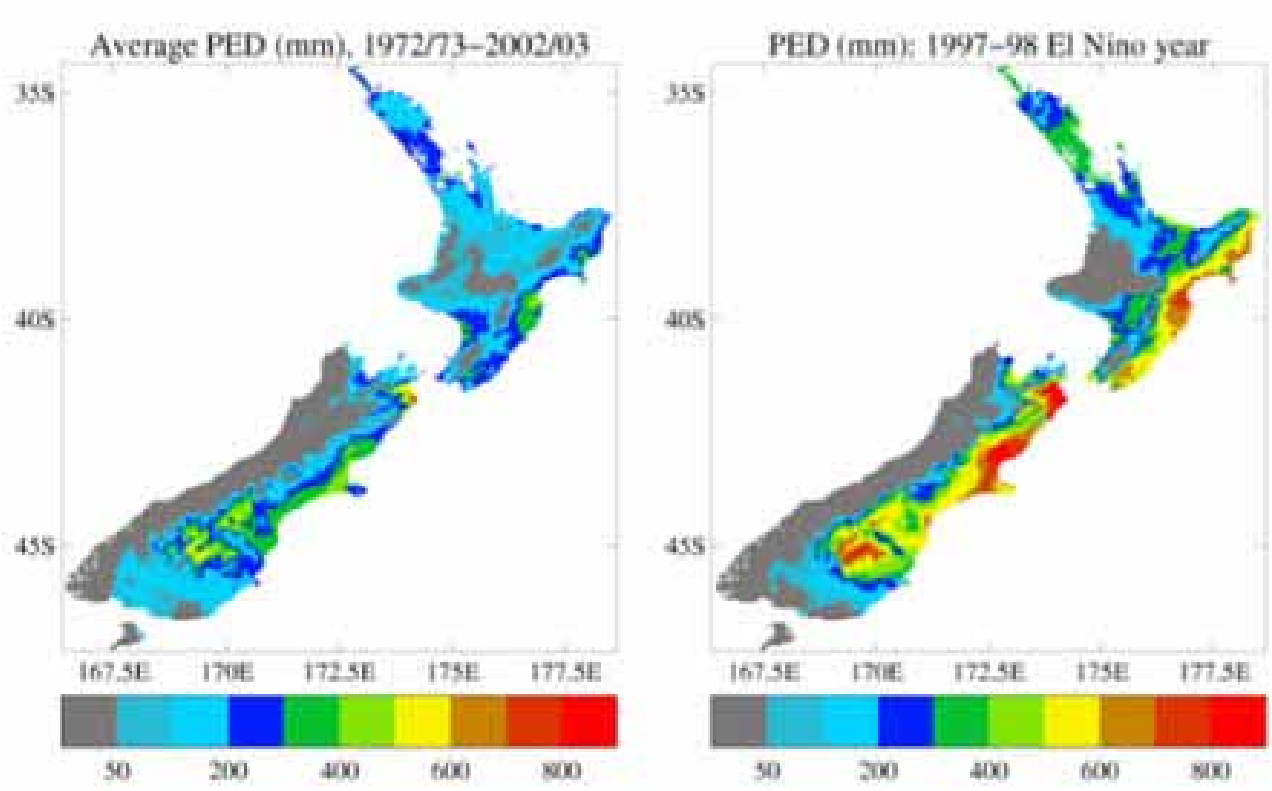


Figure 6: Average Annual PED. Comparison Between Average Years and El Nino Years11. Sourced from Mullan et al (2005)

Regional climate phenomena such as the Interdecadal Pacific Oscillation (IPO) and El Nino Southern Oscillation (ENSO) have an impact on drought frequency and magnitude. As the ENSO cycle is a significant driver of New Zealand climate, it will have an impact on the structure and resilience of local ecosystems through drying or flooding, although not as serious as many parts of Australia. New Zealand research on tree-rings has shown ENSO cycles through the growth patterns of the vegetation[12], and climate fluctuations have been shown to influence activities such as fruiting. Both El Nino and La Nina events can vary in their intensity, from weak to strong. This is based on the impacts of a 1997/98 El Nino event when the approximate cost to the country was 1 billion dollars (MFE, 2007:186).

3.3 Coastal Hazards

Given the maritime nature of Whangarei District, and the wide variety and landscape of the marine environment, it is not surprising that coastal hazards are a major risk. Coastal erosion is probably the most common issue, but some low-lying areas of the district also face some

[11] An explanation about the PED system can be found in Section 3.6.

[12] Fowler, A., Palmer, J., Salinger, J., Ogden, J. (2000). Dendroclimatic interpretation of tree-rings in Agathis australis (kauri): 2. Evidence of a significant relationship with ENSO. Journal of the Royal Society of New Zealand, 30(3): 277-292.

coastal inundation from various sources. Given the number of extreme climatic events in the past, and the increased numbers of people in the coastal environment, this issue ranks high in the assessment of priorities listed in the NCDEMGP (2004:42), as represented by the ranking of coastal – storm surges.

The Whangarei District Plan contains provisions relating to coastal hazards, which include objectives, policies and rules regarding development in Coastal Hazard Zones (**see Appendix 2**). Coastal hazard setbacks are depicted on the maps as hazard setback lines, Coastal Hazard 1 and Coastal Hazard 2. These lines incorporate the wide range of coastal hazards such as erosion, inundation, and storm surges. Coastal Hazard 1 setbacks are areas of high risk. To mitigate this risk, all construction or alterations of buildings (or structures) require resource consent. Coastal Hazard 2 setbacks are deemed to be for areas of lesser risk, but here a minimum sea floor level is required for any building construction to be permitted under the District Plan. Approximately 60 kilometres of the coastline (22%) is subject to coastal hazard lines. When NRC published a State of the Environment Report in 2007, the chapter on coastal hazards made the point that projected sea-level changes associated with climate change by 2100 was likely to substantially increase areas subject to coastal erosion. However, it was not clear from this statement whether the current hazard lines would still represent the critical areas (but with increased landward impact), or whether the area of impact expands (e.g. are new parts of the coast impacted – more than 22% of coast?)

At present, 731 parcels of land are located within coastal hazard areas, of which 528 are located within Living 1, 2, and 3 Environments. Of the 11,833 new parcels of land created since 1996, only 54 (0.4%) are noted were created within a coastal hazard setback, whether 1 or 2. However, it should be noted that since 2003, the rate of lot creation in coastal hazard areas has been increasing from 1 per annum through to 9 per annum.

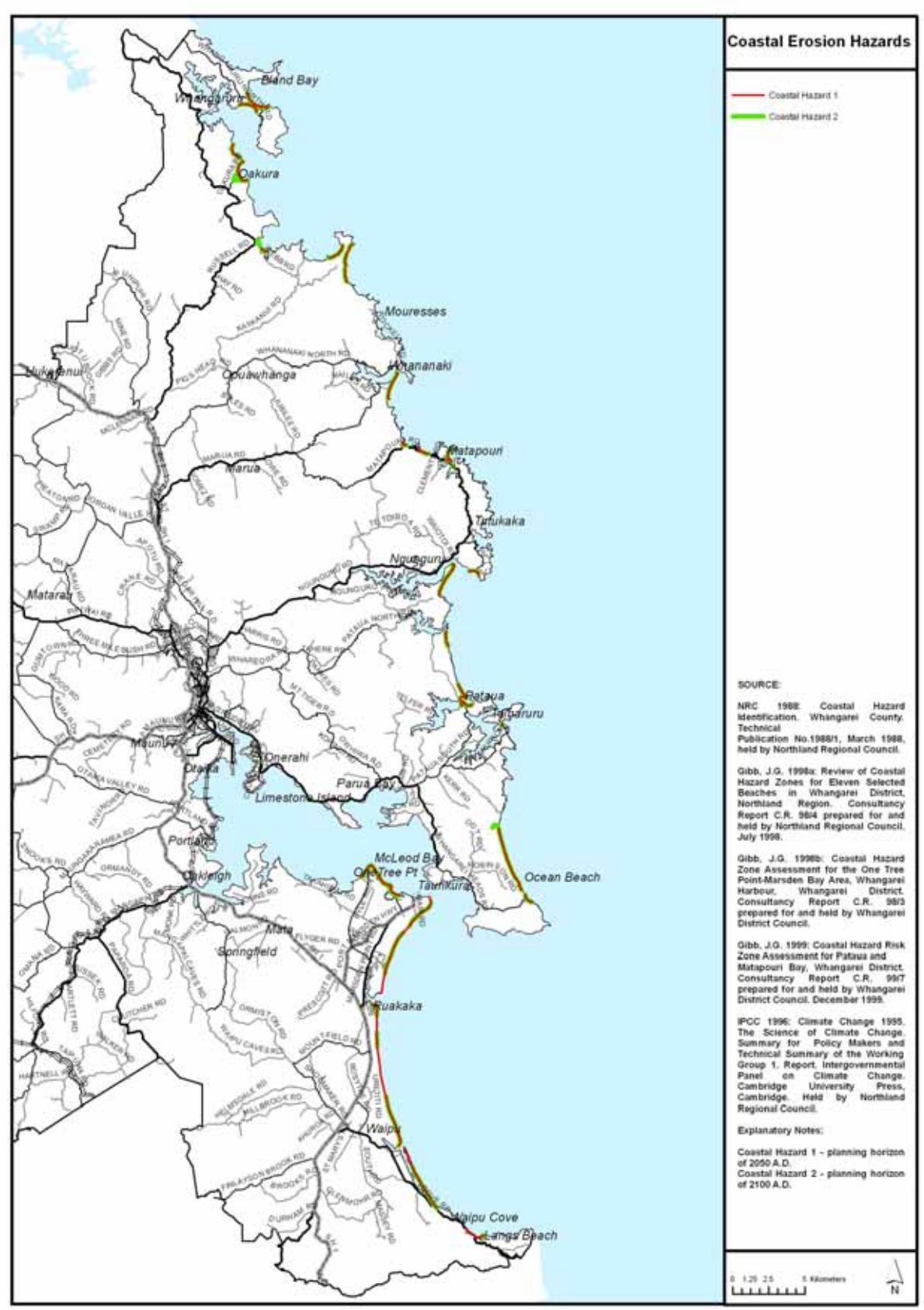


Figure 7: Coastal Hazard Lines Recorded in District Plan

Since 1995, 90 building consents have been processed for lots located in coastal hazards. Some areas in Whangarei District have been identified for high exposure to potential coastal risks, including Matapouri and One Tree Point.

3.3.1 Coastal Erosion

Coastal erosion refers to the wearing away of land (including sandy beaches and dunes) by water (waves generated by various sources or drainage) and, in some cases, wind. Coastal erosion may be mitigated or exacerbated by sediment supply to beaches, artificial and natural structures (although the presence of artificial structures can magnify the impact of erosion elsewhere), and sea and wave conditions (and the energy contained within them). Notably, this particular hazard was given little prioritisation in the NCDEMGP, because the natural hazard events are relatively predictable and any responses to these hazards are more appropriately managed through regional and district plans.

The NRC State of the Environment Report published monitoring information for 24 beaches across Northland, with nine of these being located within the Whangarei District. This report noted that five monitored sites in Whangarei District are at equilibrium, one is accreting (at Bream Bay) and three were eroding: Pataua South, Wellingtons Bay (Whangaumu), and Matapouri[13]. In general, since damaging storms occurred in 2000, in association with a La Nina event that brought in much rain, most eastern beaches have been accreting. However, those areas where the foredune complex and native vegetation have been extensively modified continue to erode.

3.3.2 Coastal Inundation

This is the second significant form of coastal hazard. Coastal inundation normally occurs during large storms, and may be a combination of factors including high water tables, overflow paths from the land, storm surges, high tides and tsunami. To mitigate the impacts of coastal inundation on property, the Whangarei District Plan contains provisions on Minimum Coastal Floor level, which is a threshold based on a mix of known flooding and potential sea level changes.

3.3.3 Coastal Hazard Driver: Storm Surges

Storm surges occur when there is an increase in the local sea level caused by a mixture of wind action and low barometric pressure zones that cause storm conditions. These drivers, especially

[13] The terminology used by the NRC is eroding (shoreline is retreating landward), equilibrium (shoreline is generally stable) and accreting (shoreline is extending seaward). We use the same terminology to avoid confusion.

wind action, cause water levels to rise up above the normal sea level (see Figure 8 for an example). Under this scenario, water is driven onto the coast, which can lead to the flooding of low-lying land and increase coastal erosion. Storm surges are generally the prime contributor to coastal flooding and coastal inundation, although other factors may be at play. The relative frequency of this event is given in the NCDEMGP as a 1/20 year return period for a storm surge that would require emergency services. The NCDEMGP (2004:53) indicated that the coastal margins within 1 km of the coast, and less than 3.5 metres above mean sea level would expect to be inundated by sea water at a 1 in a 100 year return period frequency. However, these have not been mapped.

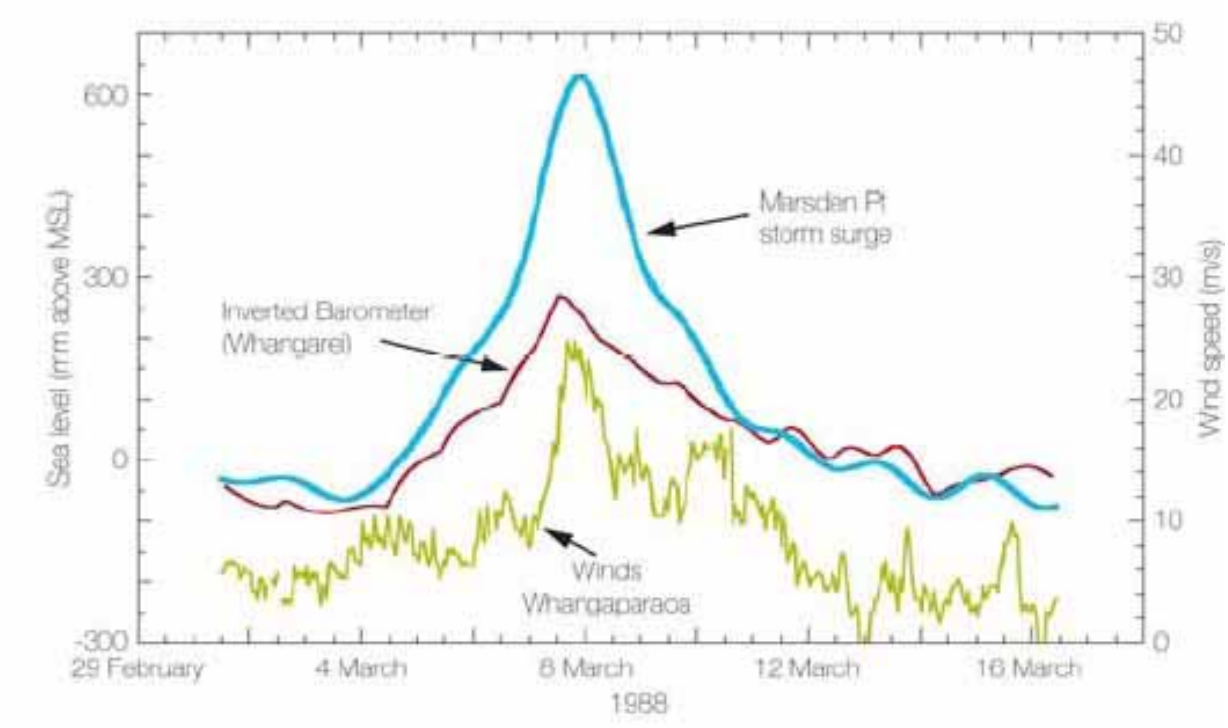


Figure 8: Storm Surge Example
Cyclone Bola, one of the most damaging cyclones to hit New Zealand in recent years, tracked southwards over New Zealand in early March 1988. At Marsden Point, the storm surge measured over 600 mm (blue line). At the peak of the storm surge, approximately 50 per cent was due to the inverted barometer effect (red line), with the remainder due to the influence of the strong winds (green line). Sourced from Ministry for the Environment website. [14]

3.3.4 Coastal Hazard Driver: Tide and Flooding

Bell & Gorman(2003) note that tides are important in the context of coastal hazard as they govern the likelihood of coastal inundation for storm surges or river flooding, and impact on sediment supply to beaches. Should major tides and storms coincide, there is a strong risk of

[14] http://www.mfe.govt.nz/publications/climate/preparing-for-coastal-change-guide-for-local-govt/html/page8.html

inundation within the Whangarei CBD. The CBD of Whangarei is situated on the floodplain of several streams (including Waiorohia, Hatea, and Raumanga) which are also the subject of river management research by NRC. Some parts of these floodplains are less than the highest recorded tide levels (2.02 metres – Lands and Survey Datum). During high tide and rain events, once storage in infrastructure systems reaches capacity, then surface flooding can occur. Some Whangarei storms with only modest high intensity rainfall have been known to produce tides of this level (URS, 2006). Figure 9 sourced from Bell & Gorman (2003), illustrate the difference between the MHWS and the highest astronomical tide.

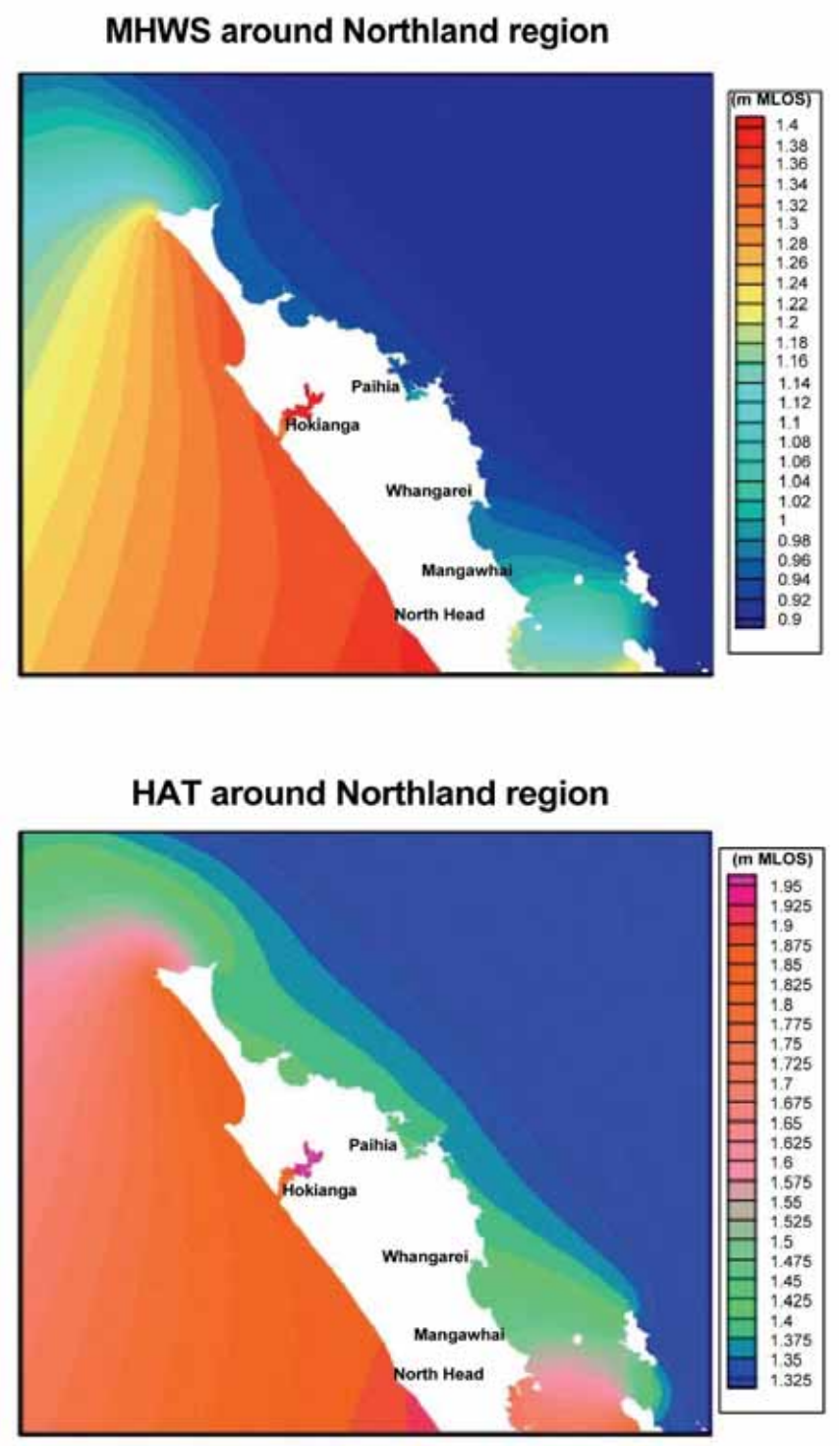


Figure 9: MHWS and Highest Astronomical Tide Above Mean Sea Level. Sourced from Bell & Gorman 2003[15]

[15] MLOS refers to the Mean Level of the Sea – which is the actual level of the sea measured over a defined period of time. This is different from Mean Se Level (MSL)which measures sea level from the land, and is often lower.

3.3.5 Coastal Hazard Driver: Wave Action

Waves and swell can have a significant effect on coastal hazards, as they can exacerbate or impede the flow of sediment along the coast, leading to accretion and erosion, dependant on the local conditions. Waves are created by winds over oceans and sea, and can travel hundred of kilometres. Waves in Northland are developed by a mix of local and distant sources, as Whangarei District faces the Pacific Ocean. In May 2000, continuous easterly winds that created significant wind and wave set-up, which then combined with high tides led to significant erosion in Bream Bay and Matapouri as the waves swept up the beach face (Bell & Gorman, 2003).

3.3.6 Coastal Hazard Driver: Tsunami

A tsunami is an abnormal wave (or series of waves) generated by an unusual event. A tsunami is created when a large volume of a body of water, such as an ocean, is rapidly displaced, whether by underwater landslide, earthquakes, volcanic eruption and so on. When tsunamis reach coastal areas, they can travel quickly, picking up debris, and even travelling up streams. They can also have impacts within harbours, and modelling has indicated that Whangarei Harbour itself would be affected, but at a lesser intensity that on the coast (Berryman, 2005). Northland, as a whole, can be impacted by tsunamis generated from a wide variety of source locations, both local and very distant on the Pacific Rim (over 10000 km). Historically, most tsunami events occur on the eastern coasts facing major generation sources, especially when the ocean floor topography funnels events (Berryman, 2005).

Until recently, tsunamis were generally regarded as a low hazard risk, but this view has changed in recent years. Following the Boxing Day Tsunami that affected communities across the Indian Ocean, many coastal areas began researching their local tsunami risk. Work undertaken since 2005 has suggested that the risk level is higher than previously thought (Goff et al, 2006). Over the last 150 years, there has been four moderately sized tsunami (1.0 -5.0 metres) recorded on the Whangarei coast. Three were sourced from South America (Peru/Chile) and one resulted from the eruption at Krakatau (in 1883). The last one was in 1960, where 1.0 metre waves were recorded in Whangarei following a very large earthquake in Chile (Goff & Goff 2006). In addition, investigations into the paleotsunami record (since the 14th century) have revealed twelve possible tsunami, most of which were less than 1.0 metre in height.

In 2006, several regional councils engaged the Institute of Geological and Nuclear Sciences to review the various risks associated with tsunami (Goff et al 2006). The results of this research have, in turn, led to more research being carried out to identify and map the range and extent of areas most at risk from a tsunami. This research is currently in process, building on the works undertaken by Berryman (2005), and the results are not yet completed.

The first main source, local tsunamis, can be generated by nearshore earthquakes, coastal and submarine landslides, and local volcanic activities. Local tsunamis are those events which can arrive at the coast within one hour or less. Because these types of faults are not as active near Whangarei (as compared with other parts of New Zealand), this aspect of the natural hazard risk has been regarded as quite low. The second main source of local tsunami would be mid-range generators such as volcanic eruptions along the Tonga-Kermadec Trench. They would take between one and three hours to arrive. The last generation sources are those very distant, such as the northern Chilean-southern Peruvian coast, or western North America. These take between twelve and fourteen hours to arrive. Much of the Whangarei coastline would be affected, and figures 10 and 11 indicate potential wave sizes.

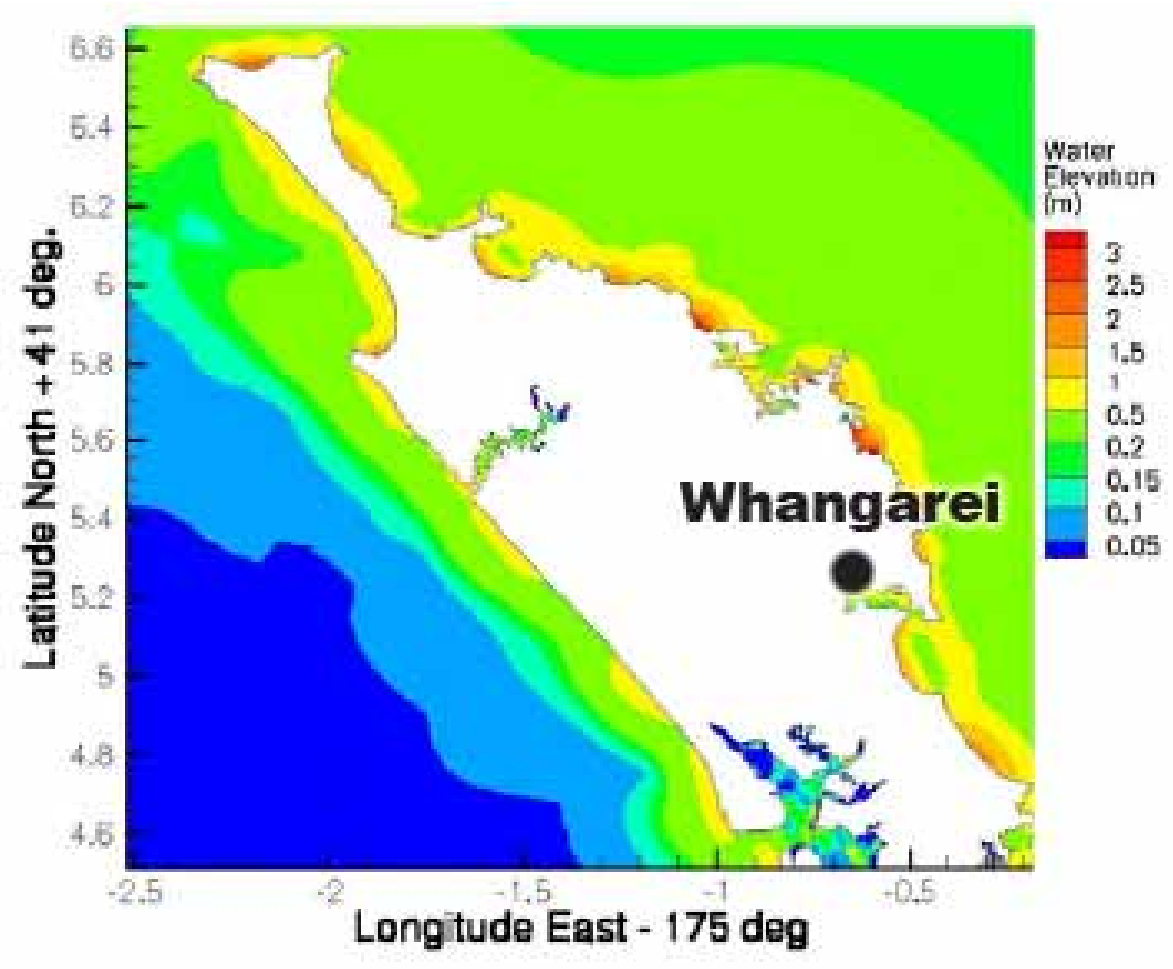


Figure 10: Maximum Water Surface Elevations For An Eastern Distant Source (e.g. Peru-Chile). Sourced from Chague-Goff & Goff (2006:22)

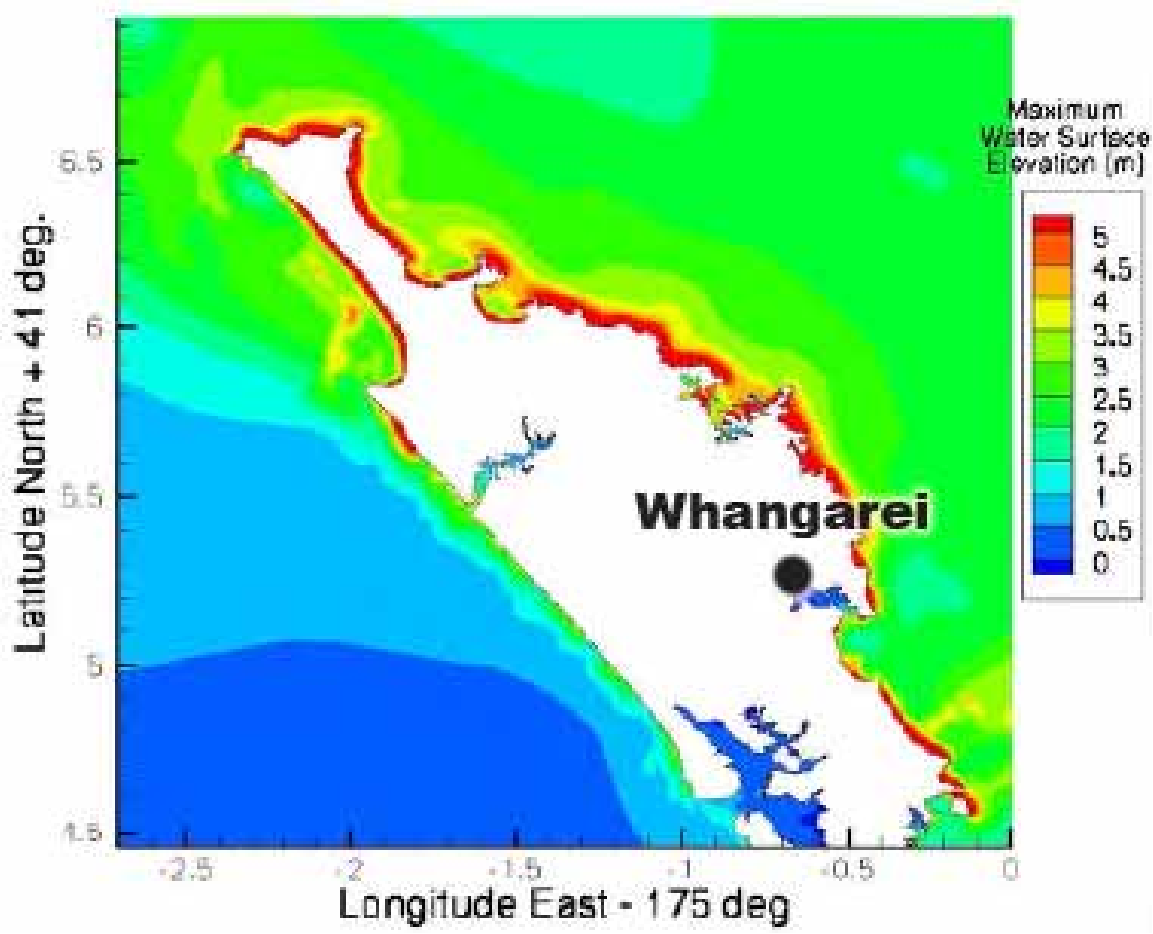


Figure 11: Maximum Water Surface Elevations for the Tonga-Kermadec source Central Location with MW 9.0H. Sourced from Chague-Goff & Goff (2006:22)

The report produced for the northern regional councils indicates that the Tonga-Kermadec source is a relatively high risk, given that the area is regarded as being active (Goff et al, 2006). This modelled risk suggests that the locally most damaging tsunami would be the Kermadec –Tonga Trench.

3.4 Extreme Weather Events: Droughts

Droughts are among the most common hazards faced in New Zealand, and these happen regularly in Northland as well. Droughts are caused by a mix of factors including high temperatures, wind, and lack of rainfall. Whilst droughts are natural phenomena, they become hazards when dry periods are greater in time and intensity than people are able to manage according to their resources. They can be very costly through impacts on local agricultural

production. Parts of Whangarei District may have 51-75 annual days of soil moisture deficit[16] (NHR: 81), with dry periods usually lasting about 3-4 months in duration.

Various definitions of drought exist, but in the NRC Land and Soil Plan, they are grouped around agricultural and hydrological droughts. An "agricultural drought" is a period when the soil is estimated to have a "moisture deficit" as determined by a balance of daily pasture evapotranspiration and rainfall[17]. This can result in significant impacts on the agricultural/horticultural industries. A "water supply" or "hydrological drought" can result in a water supply shortage, although storage capacity (dams and reservoirs) and demand are also important factors.

Quantifying drought risk is difficult, but in recent years various forms of measurement have been developed. Potential Evapotranspiration Deficit (PED) is the unit being increasingly used, and includes the climatic factors of temperature, wind, and rainfall in calculations. This unit measures the amount of water (in millilitres) needed to be added to a crop or pasture over a year in order to prevent loss of production. For example, if a drought has a PED of 200 mm, then 200 mm of water (irrigation or rainfall) would be needed to be added during a growing season. Figure 12 contains maps of different intensities of PED in New Zealand and their likelihood. It should also be noted that local environmental factors will impact on the intensity of the effect of this PED. For example, in areas that are historically dry, 200 mm may be relatively minor in impact as local farming methods make allowances for regular water shortage (e.g. Marlborough), whereas in a historically wet area (e.g. Manawatu), a PED of 200 mm will have more impact as the vegetation types and soil structure is more adapted to wetter conditions. To quantify risk, various ranges of PED are used; these being 200mm, 400mm, and 600 mm. Parts of Northland are already susceptible to some drought risk. The following figure sourced from Mullan et al (2005:9) gives probabilities in terms of 1 in 20 year return period (or 5% per annum), based on historical records. A PED range of 300-500 would be across most of the district, and would have a significant impact.

[16] Soil moisture deficit differs slightly from PED, and records the number of days that plant growth is restricted due to insufficient moisture in the soil.

[17] The use of PED rather than daily soil moisture deficit is a more recent unit of measurement than the Land and Soil Plan.

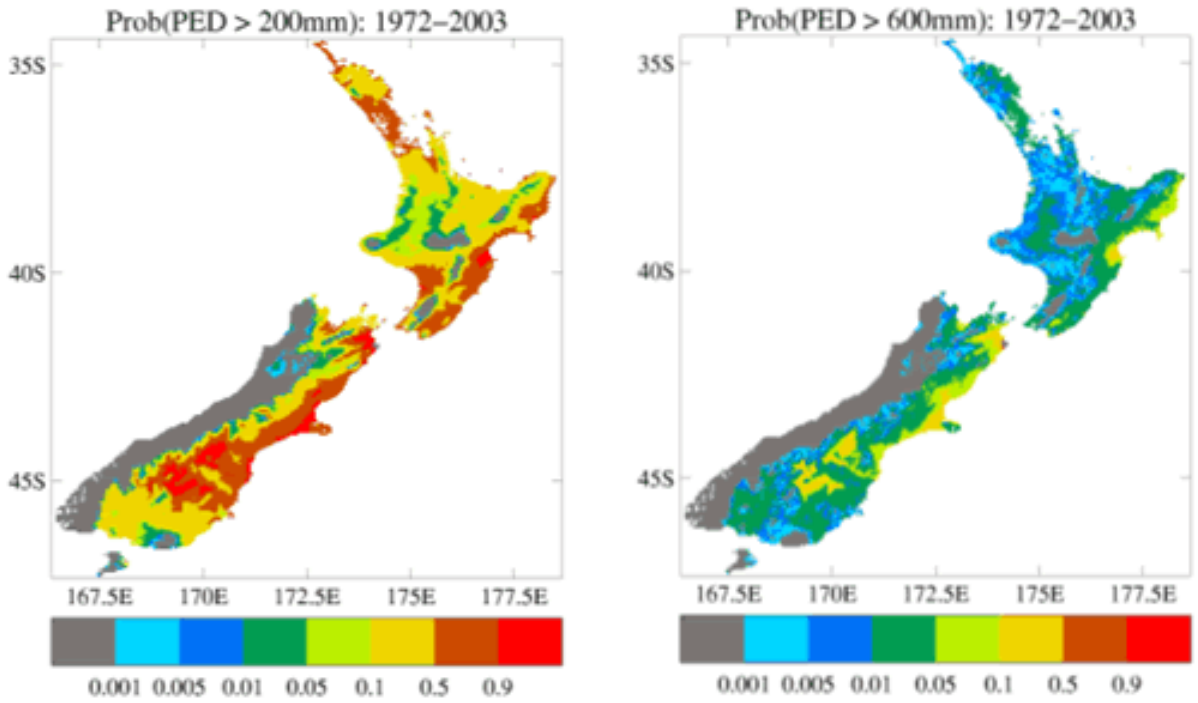


Figure 12: Probability Maps of Potential Evapotranspiration Deficit. Sourced from Mullan et al 2005

Drought is expected to be one of the natural hazards exacerbated by climate change, and further details on this will be available in the climate change report.

3.5 Biological Hazards

When addressing natural hazards, people are often primarily concerned with physical or climatic aspects of risk. Biological natural hazards, such as human epidemics or pest species, can have an impact on the social, environmental, cultural and economic resources of Whangarei District. Due to its historical dependence on agriculture, horticulture, and forestry, Whangarei District, as a part of Northland is at risk from a large variety of biological invaders, especially given its favourable climate. It is generally rated as having one of the highest invasion and naturalization rates of any region in New Zealand, both on land and in water (Sullivan et al, 2005). For example, the Northland Regional Pest Strategy notes 21 terrestrial and 17 aquatic species of concern (NRC, 2007). But in an assessment prepared by Williams (2008), another 34 at-risk plant species were assessed for their "weediness" and invasibility. These reports also state generally the type of impact in a general sense. Northland has many different vertebrate pests, including pigs, goats, possum, magpies, mynas, mustelids, rats, and feral cats. Whilst there is some deer, their populations have not yet established to a significant size.

Arguably, the risk posed by invading invertebrates could be the higher risk. Invertebrate such as oriental fruitfly[18], new mosquito species, varroa mite, and ants are of considerable concern. For example, Wardle (2005) notes 19 introduced ant species established in Northland (compared with 10 native ant species in New Zealand), including Argentine and Darwin's ant which are regarded as problems across the world. Ward (2009) notes the potential of Northland and Auckland for the invasibility of fire ants, another major ant pest, given the climatic factors.

In general terms, the local management of weed species is undertaken and led by the NRC through their pest management strategies. Some of these species have direct and quantifiable economic impacts, whereas others have more indirect impacts. Some species pose a threat to native ecosystems, particularly aquatic, and their overall resilience in the face of land use changes and resource use. This, in turn, means that these systems have less ability to provide a range of ecosystem services. Examples of this would be aquatic weeds impacting on water quality, or perhaps issues with invaders such as willows that may exacerbate flooding. Examples of these types of links will be included in the Ecosystem Services Report.

In recent years, Avian and Swine Influenza have received a great deal of publicity, but other types of disease, such as the Ross River Virus, could also become established in Northland, given the benign climate and potential vector species. The outbreak of new diseases is expected to be another area exacerbated by climate change. Infectious diseases of note that are vector-borne (e.g. mosquitoes, mites/ticks etc) include the salt-marsh mosquito (Aedes camptorhynchus) capable of transmitting Ross River Virus, and Barmah Forest Virus. Other intercepted threats include mosquito species capable of transmitting dengue fever, Japanese encephalitis, and other viral fevers. It should be noted that yellow fever, malaria, and filariasis are not regarded as high risk (MOH, 2001). Northland is mentioned frequently in regard to potential for the establishment of vector borne diseases (Mackerath et al, 2007).

3.6 Volcanic Hazards

Volcanoes can create a wide range of hazards including ash fall, lava flows, pyroclastic flows, lahars, and debris avalanches. A pyroclastic flow is a "rapid, ground-hugging surge of gases, ash, and rock" (NHR, 2004:29), whereas a lahar is a mixture of water, ash, and rock. Despite the presence of a young volcanic landscape, dotted with small young basalt peaks, rich volcanic soils, and ancient lava flows, Whangarei is not associated with high volcanic risk. In their report in 2003, the Institute for Geological and Nuclear Sciences note two main volcanic fields within Northland, with one being located within Whangarei District – this being the Puhipuhi-

[18] Kriticos, D.J., Stephens, A.E.A., Leriche, A. (2007). Effect of climate change on oriental fruitfly in New Zealand and the Pacific.. *New Zealand Plant Protection 60:271-278*

Whangarei volcanic field in Figure 13. Volcanoes have been active in the past, with the youngest eruptions in our district being found within the Puhipuhi-Whangarei fields over 250,000 years ago. There is some doubt as to whether this field is still active or not (Beethem, 2003).

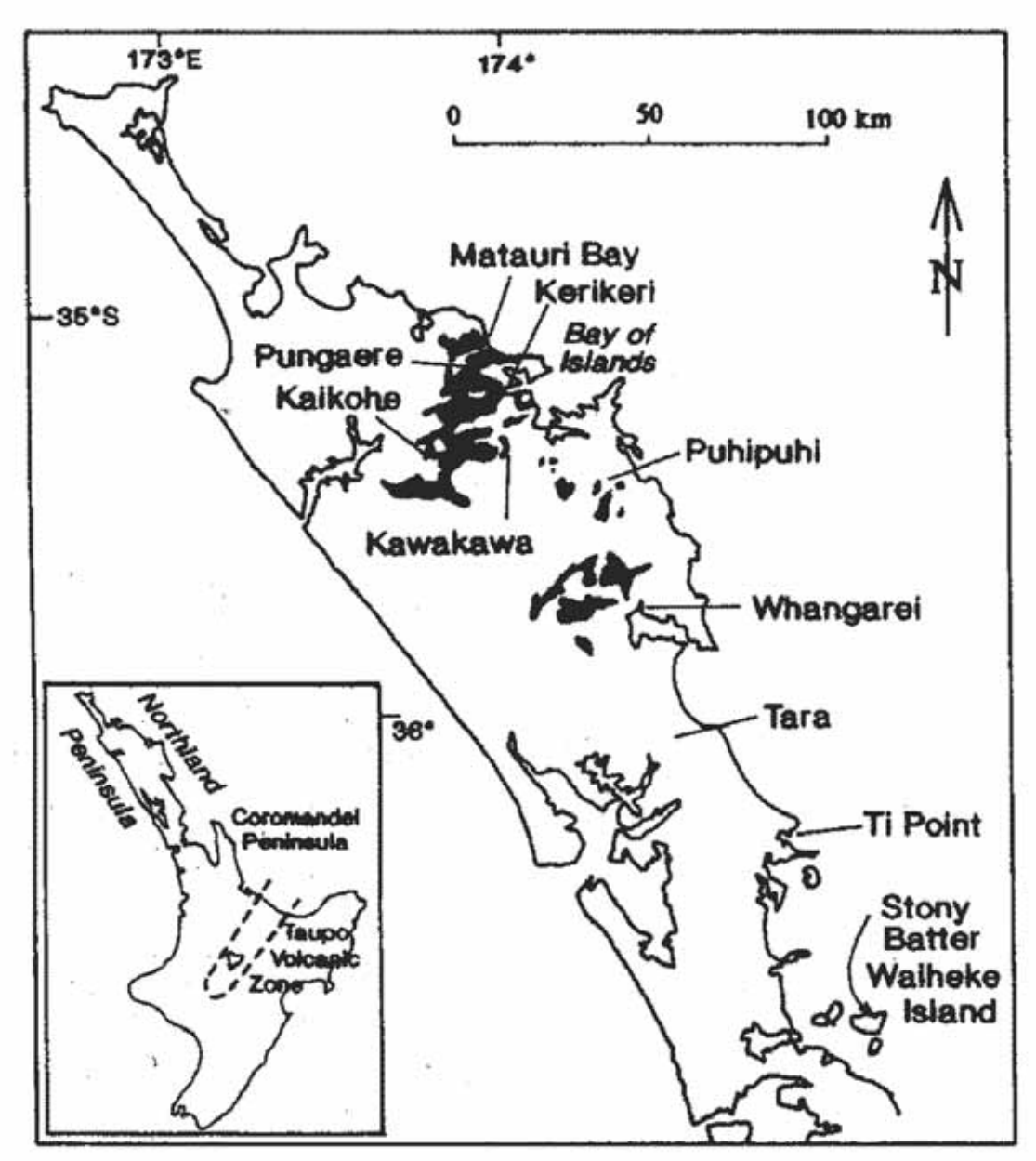


Figure 13: Location of Late Cenozoic Basalts and Associated Volcanics in Northland Sourced from Beethem et al (2003) (after Smith *et al.* 1993).

When considering volcanic hazards, local and distant sources must be considered with the risk of ashfall remaining a possibility within the district. Past evidence notes that Taupo and Taranaki ash has fallen within the district, but overall, this ashfall is not expected to pose a large risk. Potential Auckland ashfall is also not expected to affect Whangarei District significantly. Overall, the hazard appears to be very low. (Beethem, 2003).

3.7 Earthquake Hazard

In general, the Whangarei District is less likely to be hit by a major earthquake than most other areas of New Zealand. Earthquake risk is low (Beethem et al, 2003), with no active faults, and the whole Northland peninsular is regarded as tectonically stable. The National Hazardscape Report (2007) indicates no notable shallow earthquakes in Northland (p19), and the same report notes that the intensity of the largest earthquake to potentially hit Northland would be between 5-6 on the Modified Mercalli (MM[19]) scale, amongst the lowest in New Zealand (NHR, 2007:21), at a 1/50 year annual return period event. Figure 15 suggest that MM5 is likely to be even rarer, with an annual return period of 475 years being assessed for this report. Beethem et al (2003) also state that the return period is estimate to be relatively infrequent, with a risk estimate of MM 6 being 1/1000 annual year return period and MM7 being a 1/7000 return period. Whilst there is a proven risk, with small earthquakes having been felt, including one in Peria in 1963, overall, the risk is less than other areas in New Zealand.

[19] MM refers to Modified Mercalli which is a scale used to measure earthquakes by the way it is felt by people. MM5 is a earthquake which could be felt by most, but would be similar in effect to the vibration off a train passing. MM6 refers to an earthquake which could be felt by all in the area, books would fall off shelves, but overall damage would be slight. MM7 would be an earthquake where it is difficult to stand, some furniture broken, and there would some damage to poorly design buildings.

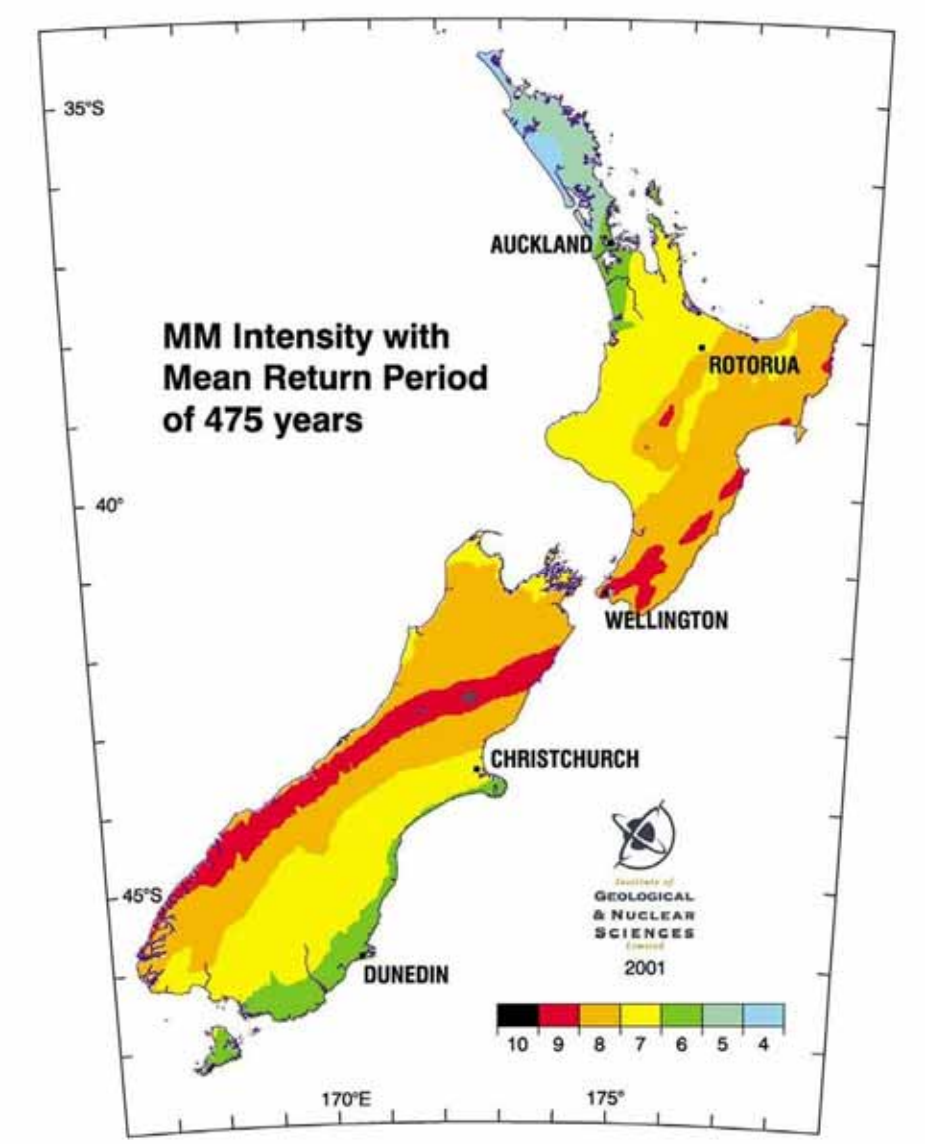


Figure 14: Earthquake Scale with a Return period of 475 Years. Sourced from Beethem et al (2004)

3.8 Land Instability

Landslides are a geological hazard in Northland and Whangarei, and present an ongoing risk to life and property. The NCDEMGP (2004) report notes that Northland has a complex geology with a wide variety of soft rocks susceptible to movement, including those on gentle slopes. Whangarei District is well known for its geological instability, with landslide being a relatively common event in the past, and continuing through the present. The main trigger is intense or prolonged rainfall. The National Hazardscape Report (2007:43) notes that Whangarei District has experienced several episodes of rainfall-induced landslide hazards, although not as significant as Cyclone Bola's impact on the East Coast or the 2004 storms impact in the lower North Island. Recent examples of landslides having a lasting impact on the district include those

on Helena Bay Hill Road which impacted strongly on communities dependant on this road. Beethem et al (2003) noted that areas of Whangarei over 'formation mudstone' and some sandstone can be susceptible, even on slopes less than 10º, and that this impact can range from 5-20 metres deep. Any slope over 15° and underlain with Northland allocthon is considered to have high risk failure (Beethem 2003) with parts of Raumanga, Kioreroa, Morningside and Riverside having some risk within city boundaries. The exception to this is the Mahurangi Limestone which is regarded as very strong.

In addition there are some ancient large landslides such as in Onerahi, north of Sherwood rise. Large ancient slides between SH1 and Vinegar Hill road which may be partially active are also specifically noted in this report. Beethem et al (2003) notes that vegetation stabilises over mudstone and sandstone, and that removal on some sites can create problems. Tonkin and Taylor was commissioned to provide a series of land stability reports for the main residential and business areas within the District, including Whangarei city and the main coastal settlement areas but did not include rural areas and coastal areas of the district beyond the fringes. According to findings in this series of reports[20], 13663 ha are noted as high or medium risk (illustrated in figure 15). This translates into 15,880 parcels of land within urban, urban fringe, and coastal residential lands are located on land that is either high or medium risk in terms of slope instability. However, given that these reports concentrated on urbanised area, this represents a large number. Of the total number of parcels, 7,942 lots susceptible to land instability are noted as Living 1, 2, or 3.

Of the 11,833 new parcels of land created since 1996, 27% are designated as being at risk from instability. It should also be noted that since 2003, the rate of lot creation in high or medium risk stability hazard areas have increased from 237 per annum to 261 per annum. Since 1995, 1922 building consents have been processed for lots susceptible to instability. It should be noted that this number does include lots in which only a part of the lot is assessed as being under a moderate or high slope instability risk. Figure 15 presents a broad overview of the extent of moderate to high risk areas within the urban areas

[20] Translating this area into percentages of the district is not possible as it is known that many parts of the district have not been assessed.

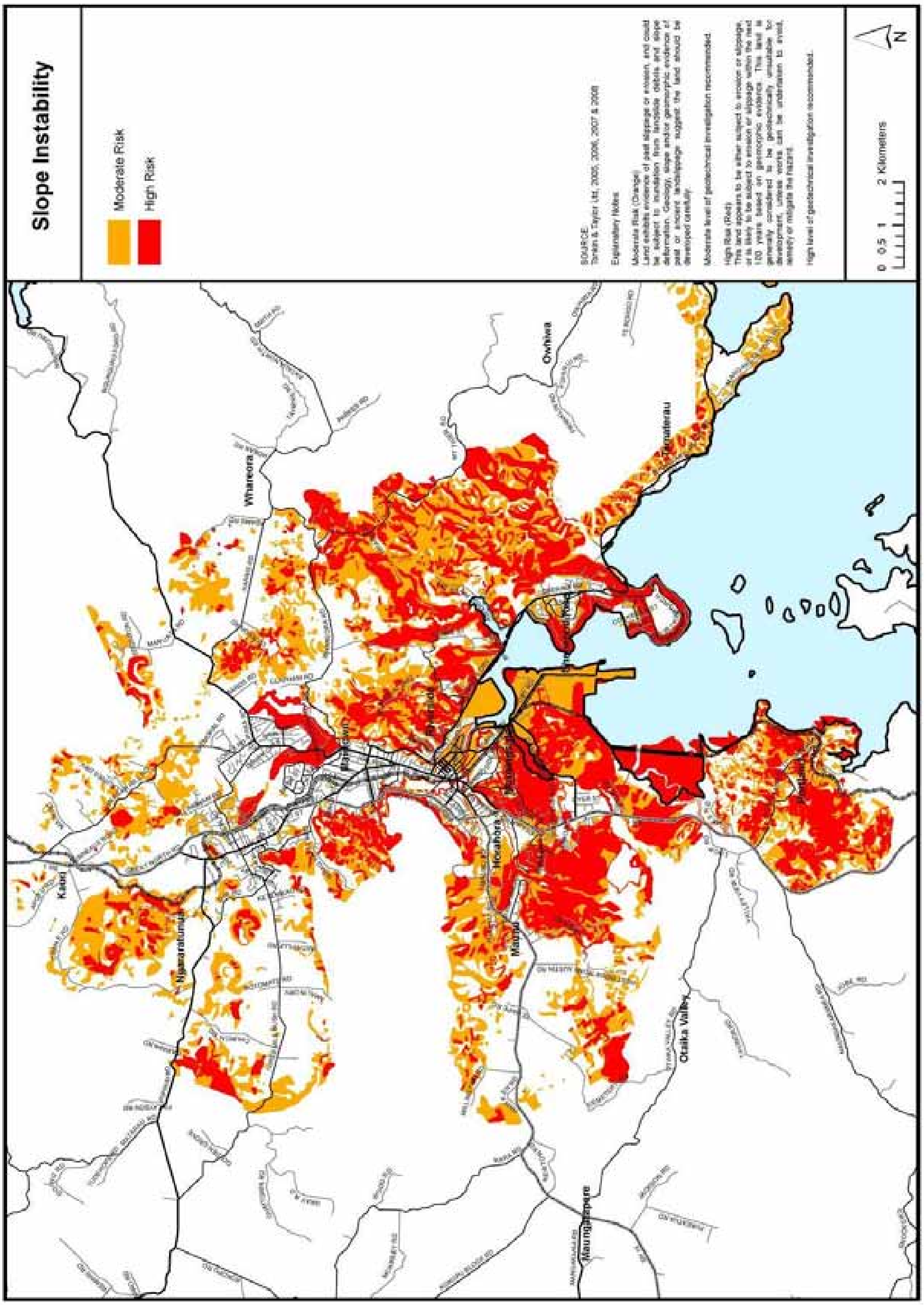
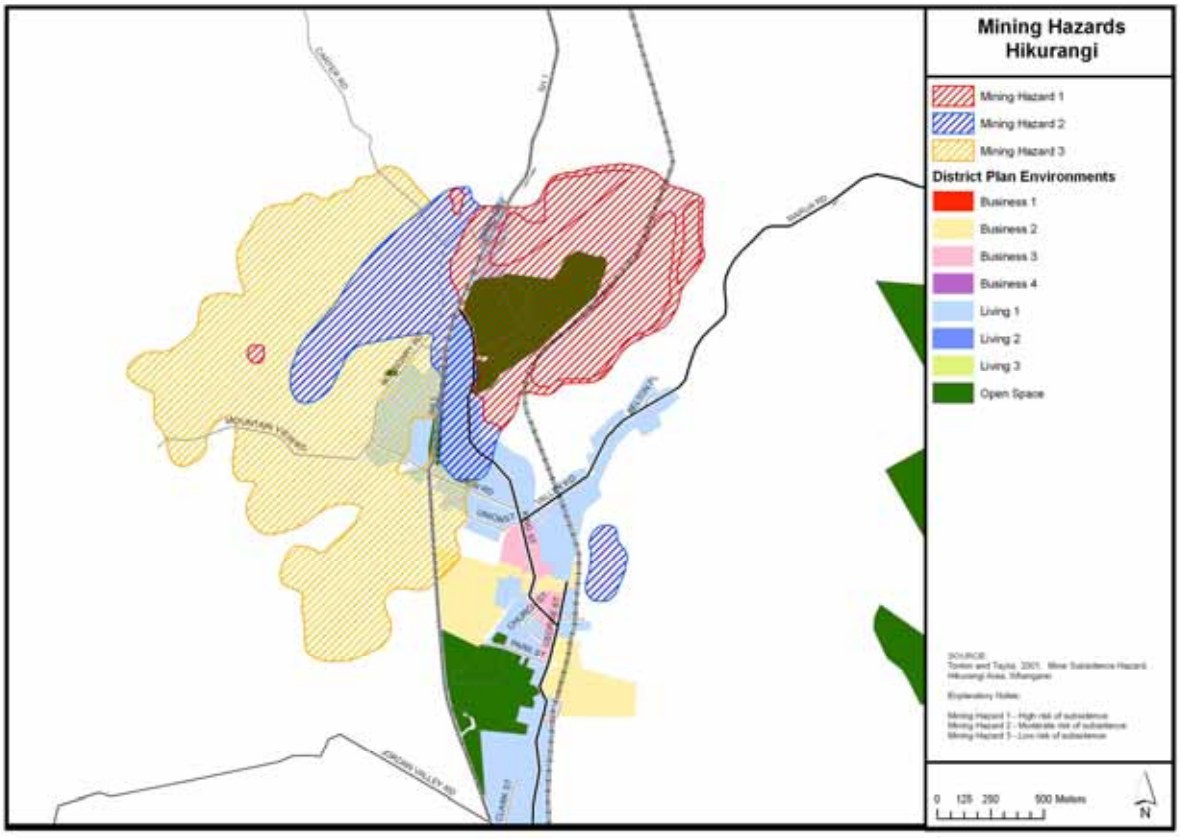


Figure 15: **Map of Stability Around the Whangarei Urban Area based upon Reports commissioned by Whangarei District Council from Tonkin and Taylor (2003).**

3.9 Mine Subsidence:

Whilst mine subsidence is an issue that was primarily created through human activity, it has been included here as natural conditions may exacerbate the hazard. Key areas are in Figure 16. This information is primarily about impacts of former coal mining rather than limestone mining.



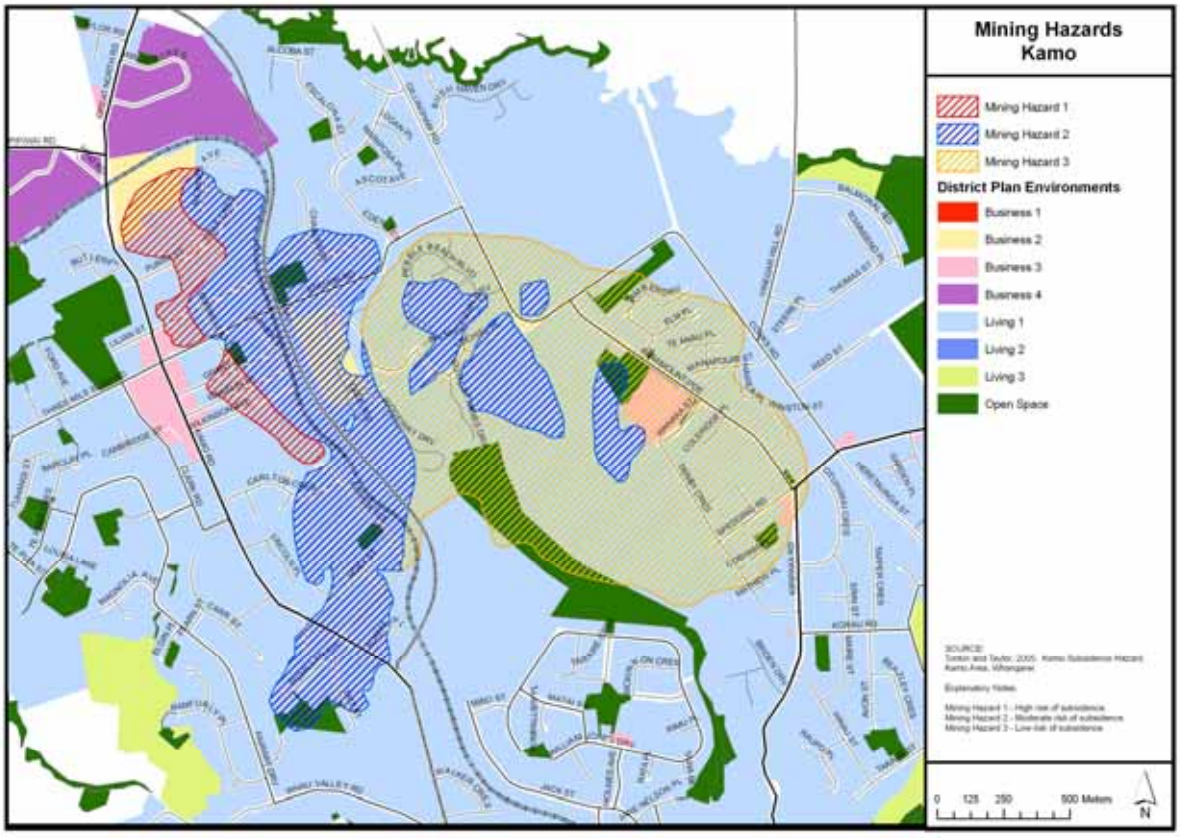


Figure 16: Mining Hazard Maps from Whangarei District Plan: Hazard Areas

Coal was mined at various locations throughout the district, including Hikurangi, Kamo, and Ruatangata, with 1.6 million tonnes produced, and the last coal mine ceasing in 1955. Subsidence has occurred in some places like Kamo (mainly between Kamo Road and the railway line), which led to further assessment of the hazard, and, in turn, led to provisions being included in the District Plan (see **Appendix 2** for copy of rules). All investigations to date acknowledge that there may be additional areas of workings that are unrecorded, but overall Figure 17 indicates the main areas.

3.10 Erosion Prone Land

Erosion prone land is land whose characteristics make them susceptible to the movement of rock, soil and sand via wind, water and gravity. NRC has mapped them in their Land and soil Plan and has defined them as being*: Class VIIe, VIIIe and VIIIs1 land use capability units generally depicted on the 1:50,000 New Zealand Resource Inventory, Northland Region, Second*

Edition."(NRC, 2004). Approximately 12 % of Whangarei District has this designation[21]. Figure 17 illustrates these areas.

At present, 2,350 parcels of land in Whangarei District are located on erosion prone land, either fully or partially. Of the 11,833 new parcels of land created since 1996, 4.3% are designated as being erosion prone (511 lots). However, it should be noted that since 2003, the rate of lot creation in erosion prone areas has declined from 50 per annum to 20 per annum. Since 1995, 284 building consents have been processed for erosion prone land. Some erosion prone land is located in urban areas as Living 1, 2, or 3, with about 515 parcels being mapped. Most of these have been created since 1995, but overall development in these areas is relatively small.

3.11 Wildfire Hazard

Whilst the NRCDEMGP does not rate wildfire as being a high risk or hazard, it does note that scrub along the coast is highly flammable in summer, and that some of the more isolated communities can be vulnerable to fire, especially in the case of wildfire impacting upon local infrastructure. It also noted that recent residential development into fire prone areas has increased risk. In the Northland Regional Policy Statement: Efficiency and Effectiveness Report in 2005, concerns were raised over subdivision in bush areas due to fire concerns (NRC 2005:45). In a report last year, Doherty et al (2008) analysed the numbers, area, and generation source of wildfire across regions in New Zealand. In Northland, an average of 197 wildfires would occur annually, ranging from 62 (1992/93) to 385 (2006/07). In terms of area impacted by wildfires, 440 ha per annum was affected during that time, ranging from 161 ha in 1994/95 to 1072 ha in 1996/97. As part of the report, it was stated that, on average, 53.4 ha of grass, 339.5 ha of scrub, and 46.6 ha of forest would be affected in the Northland Region. It should be noted that the distribution of impacts can differ between regions, e.g. in Nelson/Marlborough, it is wildfires on grasslands that tends to be the main types of source affected.

[21] The land use background report has more detail on overall landuse.

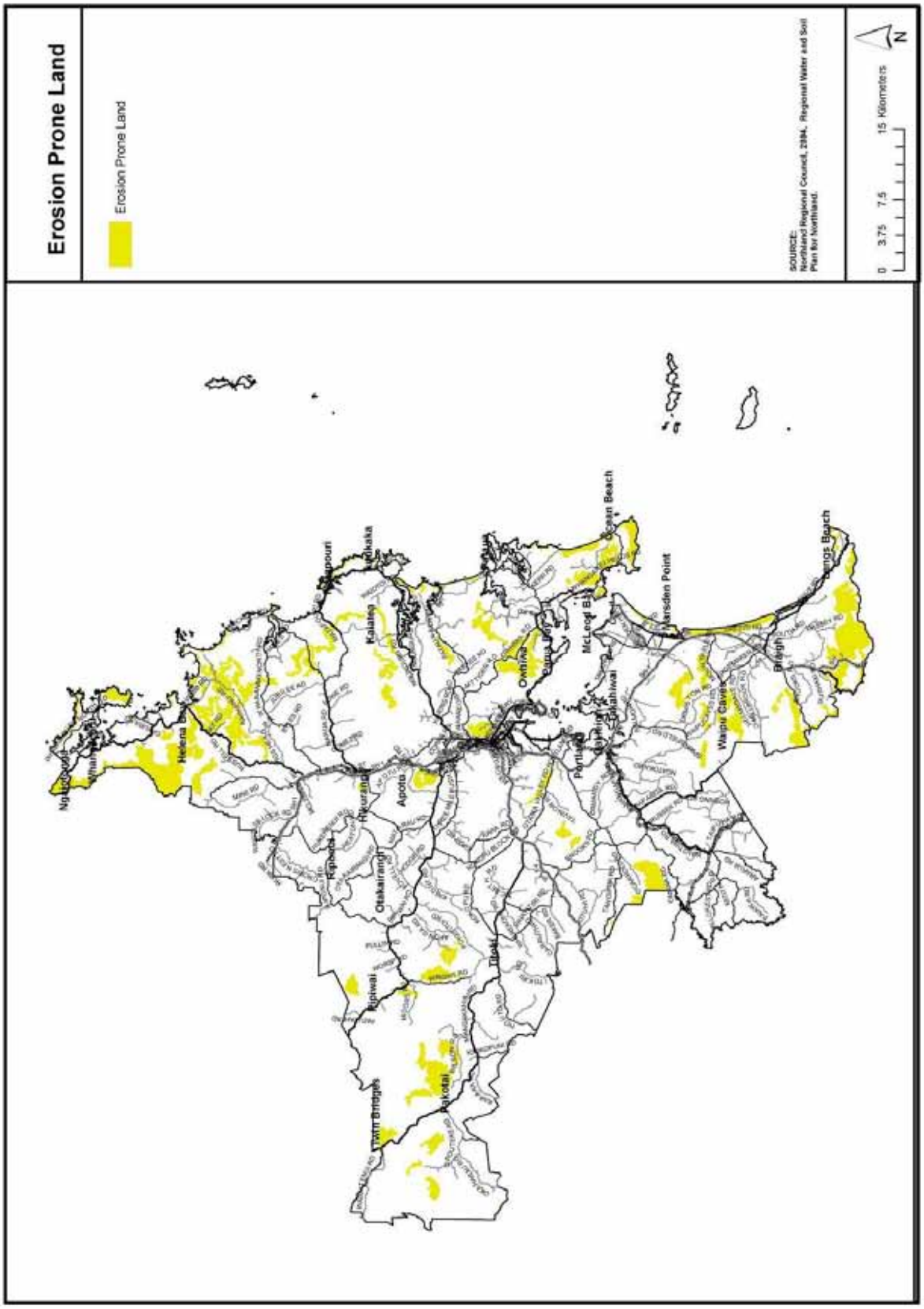


Figure 17: Map of Erosion Prone Land
As identified in Northland Regional Land and Soil Plan

4.0 Managing Risks[22]

4.1 Civil Defence and Emergency Management Act 2002

The purpose of the CDEM Act is to provide for emergency management preparation, the development of policies, and event planning. The Act provides an overall framework that includes regulations, national strategies, and CDEM plans for each tier of governance (including requirements for CDEM plans, duties and powers during a state of emergency). The Act is administered by the Ministry of Civil Defence and Emergency Management. It sets out duties and functions for different tiers of government, emergency services, and lifeline utilities (key infrastructure providers that include private industry). The CDEM Act reflected a change in the focus of civil defence away from solely responding to actual events, to one which used multiple methods to reduce overall risks and ensure preparation for future recovery. One major purpose was to develop the resilience of communities or their ability to handle shocks from hazardous events.

Civil defence and emergency management planning is grouped around 4R's or reduction, readiness, response and recovery. Reduction refers to actions or planning that reduces the hazard risk, whether through land-use planning, building up community resilience, or undertaking engineering works. Readiness refers to natural hazard event planning itself, including the various functions and roles of different sectors of society. Response refers to powers and duties during a civil defence event itself. Finally, recovery points to pre-event planning and actions which help communities recover from events. Figure 18 illustrates the various components.

4.2 Building Act 2004

This is the primary statute regulating building work, performance standards for buildings, and the registration/licensing regime for building inspection practitioners. In terms of natural hazards, it is primarily geared towards the management of risk in regard to construction and modification of buildings. The key sections of the Building Act in relation to natural hazards include: ss.35, 37 and 71–75.

The Whangarei District Plan rules in regards to natural hazards are primarily geared towards the construction or modification of buildings or structures (see Appendix 2). Therefore when

[22] A good reference for the full list of natural hazard provisions in various pieces of legislation can be found in Tonkin and Taylor, (2006). Natural Hazard Management: Research Report. Found on http://www.qualityplanning.org.nz/qp-research/natural-hazards-aug06/natural-hazards-aug06.pdf. This document also has a comprehensive section on risk management.

the rule is triggered, it is likely that the Building Act 2002 will also be brought into play as well. Also relevant are the Building Regulations 1992 (including the Building Code) and Building (Specified Systems, Change the Use, Earthquake-prone Buildings) Regulations 2005. These can be found on the following website:

www.legislation.govt.nz

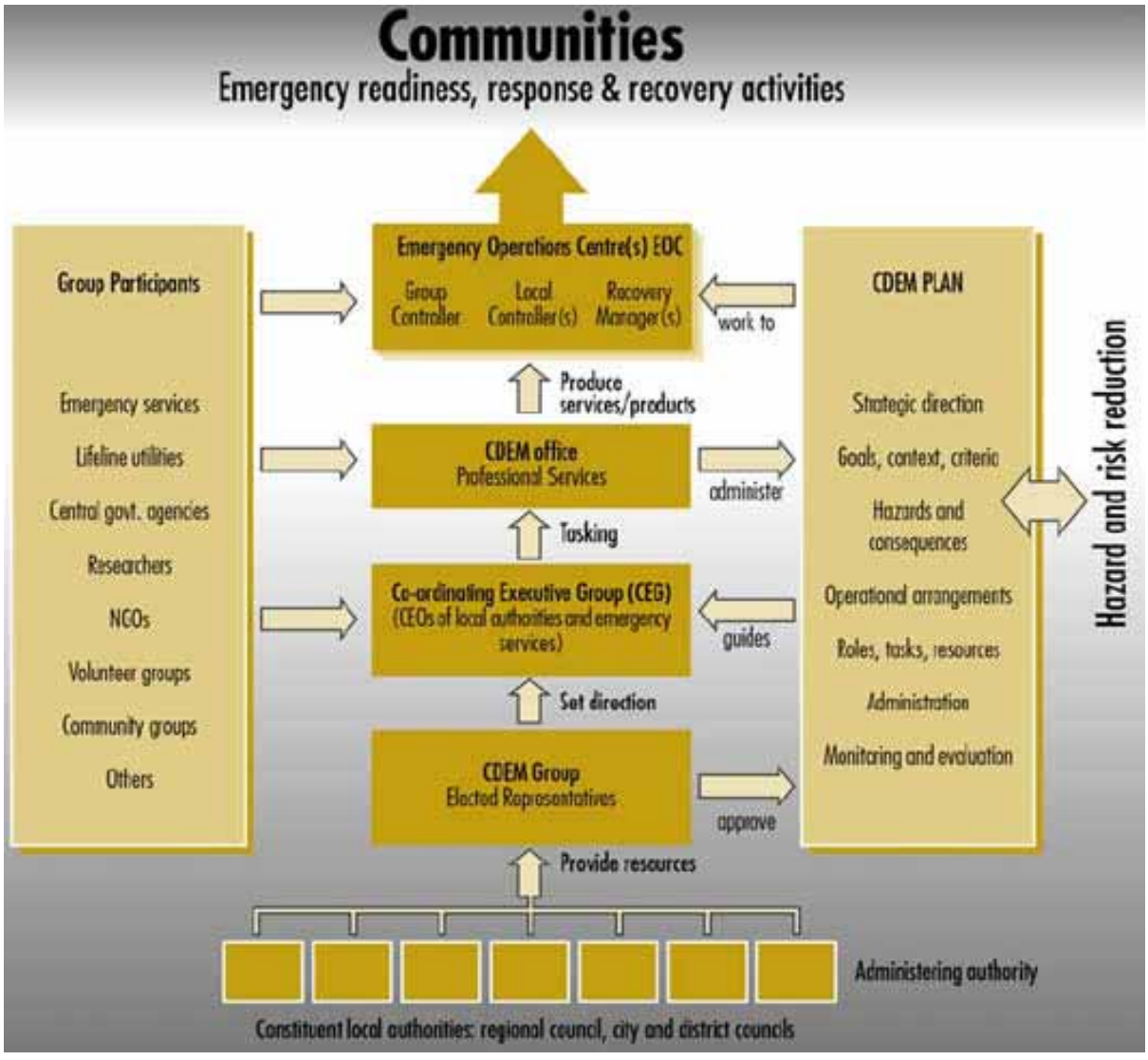


Figure 18: Roles of Agencies in Civil Defence Planning Sourced From the MCDEM Website

4.3 Local Government Act 2002

The purpose of the local government act is to provide the general framework, powers, obligations and powers to which local authorities must fulfil.

10 Purpose of local government

The purpose of local government is—

(a) to enable democratic local decision-making and action by, and on behalf of, communities; and

(b) to promote the social, economic, environmental, and cultural well-being of communities, in the present and for the future.

There are some specific sections of the Act that enable Council action on natural hazards. These include: Section 14 Principles Relating to Local Authorities, Section 93-96 relating to the preparation of the Long Term Council Community Plan, and Section 163 Removal of Works in Breach of Bylaws.

4.4 Resource Management Act 1991

This Act is the primary tool for managing the environment and natural hazards.

5 Purpose (1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while—

(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

Several key documents and policies prepared under the Resource Management Act include: National Policy Statements (NPS): These are documents prepared by central government for providing clear guidance to regional and territorial authorities on various environmental matters. Both regional and territorial authorities need to 'give effect' to the provisions in these documents. The first NPS prepared was the New Zealand Coastal Policy Statement (NZCPS). The NZCPS was the subject of a review in 2006, and the new document is currently being prepared. The draft version has strong provisions in regard to natural hazard management.

Central government has also indicated that a National Policy Statement on Flood Risk Management is a distinct possibility[23]. Whilst draft proposals have been put forward by various organisations, as yetnothing substantial has been put into the public arena.

[23] http://www.mfe.govt.nz/issues/land/natural-hazard-mgmt/manage-flood-risk.html

The Resource Management Act sets out explicit functions for regional councils and district councils in the management of natural hazards:

Section 30 Functions of regional councils under this Act (1) Every regional council shall have the following functions for the purpose of giving effect to this Act in its region:

(c) the control of the use of land for the purpose of—

(iv) the avoidance or mitigation of natural hazards:

Section 31 Functions of territorial authorities under this Act

(1) Every territorial authority shall have the following functions for the purpose of giving effect to this Act in its district:

(b) the control of any actual or potential effects of the use, development, or protection of land, including for the purpose of—

(i) the avoidance or mitigation of natural hazards; and

Regional policy statements, regional plans, and district plans are prepared under this legislation and these sections, and the local policy and plan provisions are covered within Appendices 1 & 2.

4.5 Northland Regional Council

NRC is the main authority addressing natural hazards in the region and coordinates Northland's CDEM Group under the Civil Defence and Emergency Management Act. It has the function of integrating regional infrastructure as well as erosion control, sedimentation reduction, and the management of water quantity and quality. Managing natural hazards features heavily in the Draft Community Plan 2009-2019, Northland Regional Policy Statement, and various Regional Plans prepared by NRC. These provisions emphasis the importance of gathering and disseminating information on natural hazard risk; the importance of monitoring; the need for territorial authorities to provide appropriate natural hazard provisions in their respective district plans; the promotion of natural flood control mechanisms such as wetlands; and outlines Northland Regional Council's responsibilities. It also produces a State of the Environment Report which contains sections on natural hazards and coastal hazards.

4.5.1 Regional Emergency Management Group Plan

This is the overriding document that details the emergency response and management procedures in Northland, and can be found on the Northland Regional Council website at the following location:

http://www.nrc.govt.nz/upload/1443/Civil_Defence_Plan.pdf.

The Northland Civil Defence Emergency Management Group Plan identifies and assesses the various risks for Northland as a whole. This document includes sections providing the risk profile, and categorises particular hazards as extreme through to low risk. These assessments are combined with other factors including seriousness (relative impact in terms of people or dollar), manageability (what natural hazards can be managed), and growth (in which communities exposure increases, or the risk probability of occurrence is increased) to develop priorities for action. It also contains a list of all the legislation critical to the management of natural hazards, and the overall operational structure for Northland civil defence activities. The CDEM group has formulated a public education strategy as well as a risk management strategy around natural hazards

4.6 Whangarei District Council

Whangarei District Council has four main responsibilities in regard to natural hazards: District Plan provisions and resource consents, building consents, infrastructure provision, and civil defence responsibilities. The District Plan contains provisions relating to natural hazards, and has objectives, policies, and rules relating to flooding in areas zoned as flood susceptible in the District Plan maps. See Appendix 3 for the chapters relating to District Plans. Infrastructure ranges from the maintenance of the stormwater system, coastal protection activities, through to the management of the Hikurangi Swamp Flood Control Scheme.

Whangarei District Council has also been concerned with mitigating the effects of flooding in the CBD[24], and facilitating the preparation of community response plans in fast developing coastal communities[25]. The Draft Community Plan also recognizes the risks associated with flooding, but has opted to transfer management of flooding to Northland Regional Council. The rural areas have seen less effort from Whangarei District Council, apart from ongoing debate over the Hikurangi Swamp scheme.

4.6.1 Whangarei District Plan

In line with the functions held under the RMA, the Whangarei District Plan contains provision on natural hazards, with flooding and coastal hazards being the main issues. Whangarei District Council has assessed and updated its flood susceptible areas and coastal hazard areas on a regular basis over the last few years to ensure that the material is accurate. The District Plan

[24] Links to the CBD flooding documents can be found here:
http://www.wdc.govt.nz/customerservice/?lc=reader&m=ts&i=1626

[25] E.g. Marsden Bay Community Response Plan, Whananaki Community Response plan etc. Per comm. Mitchell, A. Emergency Management Officer WDC.

has policies and objectives relating to natural hazards, and contains mapping of some of the major hazards within the district.

However, other types of hazard risk are more difficult to provide for within district or regional plans. These include risk such as wildfire, drought, volcanic risk, and risk from earthquakes and so on. This is because the impacts are likely to be widespread across the district, or the best means of response is technical (in the case of earthquakes), or their frequency of impact is quite low. In these cases, it is often the response that matters, rather than any land-use planning.

4.6.2 Whangarei District Emergency Management Plan[26]

This document provides an overview of the Whangarei District readiness, response, and recovery phases of civil defence emergency management but should be read in conjunction with the Northland Regional Council Group Plan and the National Strategy. Whangarei District Council Civil Defence Emergency Plan gives strong detail on operational procedures in the event of an emergency, emergency powers, and potential response options.

4.7 Iwi Management Plans

In general terms, natural hazards are not noted explicitly within any of the iwi management plans lodged with Council (from Ngatiwai, Ngati Hine, and Patuharakeke). However, many of the issues, objectives and policies recorded within these documents make mention of various natural features that will influence the potential management of natural hazards such as flooding. Significantly, each IMP has significant sections on water quality and much of this is centred around rehabilitation as well as integrated approaches to catchment management.

4.8 Community Response Plans

These are community based and community owned plans that ensure emergency preparedness for some areas either regarded as isolated (physically) or at risk from a potential hazard. At present, the natural hazard that has provided a catalyst for such plans has been tsunami. Whananaki, Ruakaka, Whangaruru, and Hikurangi are underway, or are in the process of being completed. Other areas expected to be covered/prepared include most of the larger settlements around the district. A key aspect behind the community response plan is that it is developed by the local community itself. It contains information about local facilities, can be operated without outside assistance, and is maintained by the community itself.

[26] Whangarei Civil Defence Website: http://www.wdc.govt.nz/CivilDefence/CDindex.aspx

5.0 Best Practice

Several trends are evident in international natural hazard and flooding research and should be incorporated into the preferred planning policy:

5.1 Hard to Soft Mitigation Measures

Many countries and their respective local authorities are changing the way that they address flooding issues by complementing the structural forms of mitigation (e.g. stop-banks, dams) with mitigation methods of a non-structural manner[27] such as land-use planning and community education. There has also been a parallel shift from using built solutions to natural structural solutions, e.g. from built infrastructure like dams, through to the use of vegetation/washlands[28] and retention basins which can decrease the intensity of the flooding event. In addition, there has been a shift in the way that rivers and stream are viewed as 'resource pools' to multifunctional landscapes[29].

5.2 Recognising Vulnerable Populations

Natural hazards literature treats populations exposed to natural hazards differently, in that planning needs to recognise the inequalities that exist across society[30]. In terms of natural hazards planning, such inequalities manifest as vulnerability, in the widest sense of the word. Vulnerability is not just the physical proximity to a natural hazard, but is also related to the active and less visible resources that a population has to recover or mitigate the effect of a natural hazard. Thus a vulnerable population is a function of factors such as access to resources or power, health status, minority status, gender and so on[31]. Therefore, hazard management planning needs to also consider ways of identifying more vulnerable communities as well as reduce the impact of natural hazards. Any constraints mapping for the district should be overlaid with socio-economic indicators to better assess risk.

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[27] Petrow, T., Thieken, A.H., Kreidrich, H., Bahlburg, C.H., Merz, B. (2006). Improvements on flood alleviation in Germany: Lessons learned from the Elbe flood in August 2002. *Environmental Management*, 38: 717-732.

[28] Morris, J., Hess, T.M., Gowing, D.J., Leeds-Harrison, P.B., Bannister, M., Wade, M., Vivash, R.M. (2004). *Integrated Washland Management for Flood Defence and Biodiversity.* Report 598 for English Nature

[29] Pahl-Wostl, C. (2006). The importance of social learning in restoring the multifunctionality of rivers and floodplains. *Ecology and Society*, 11(1): Art 10.

[30] Tapsell S, Penning-Rowsell E C, Tunstall S M and Wilson T L (2002) Vulnerability to flooding: health and social dimensions, *Philosophical Transactions of the Royal Society of London Series A-Mathematical Physical and Engineering Sciences* 360, 1511-1525; Werrity, A., Houston, D., Ball, T., Tavendale, A., Black, A. (2007). *Exploring the social impacts of flood risk and flooding in Scotland*. Report commissioned by Scottish Executive Social Research.

[31] Adger, W.N. (2006). Vulnerability. *Global Environmental Change*, 16:268-281.

Best practice literature notes that a variety of techniques may be used to assess vulnerability. Techniques are divided into expert analysis of the issues versus inclusive tools that include participatory rural appraisal, sustainable livelihoods and so on. Established expert tools used explicitly in the natural hazard literature includes the use of social impact assessment[32] and GIS methods[33]. The use of census data to assess vulnerability based on socio-economic factors is another common approach[34]. The inclusion of social capital into flood research and natural hazard planning is a relatively recent phenomenon[35], and one that is expected to be further detailed in future research.

5.3 Risk Management

The management and mitigation of risk is seeing an increased use across the globe[36], and the advice from central government is following this pattern[37]. Risk management approaches are more evident at local government in New Zealand[38]. Whilst this has some uses, it still relies heavily on expert led approaches. Therefore whilst the information may be accurate, flood risk management will not be embedded into local communities unless there is full understanding of the consequences by the local communities. The development of community response plans will help embed natural hazards knowledge and actions.

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[32] Allan, C., Curtis, A., Mazur, N. (2006). Understanding the social impacts of floods in Southeastern Australia. Advances in Ecological Research, 39: 159-174.

[33] Kleinosky, L.R. Yarnal, B., Fisher, A. (2007). Vulnerability of Hampton Roads, Virginia to storm surge flooding and sea-level rise. Natural Hazards, 40:43-70.

[34] Cutter, S.L. Mitchell, J.T. Scott, M.S. (2000) Revealing the vulnerability of people and places: A case study of Georgetown County, South Carolina. Annals of the Association of American Geographers, 90(4) 713-737; Paton, D., Johnston, D., Saunders, W. (2003). Mapping social vulnerability to natural hazards using GIS. Planning Quarterly, March, 6-8.

[35] Murphy, B.L. (2007). Locating social capital in resilient community-level emergency management. Natural Hazards, 41: 297-315; Burby, R.J., Deyle, R.E., Godschalk, D.R., Olshansky, R.B. (2000) Creating hazard resilient communities through land-use planning. Natural Hazards Review, 2: 99-106.

[36] Petrow, T., Thieken, A.H., Kreibich, H., Bahlburg, C.H., Merz, B. (2006). Improvements on flood alleviation in Germany: lessons learned from the Elbe flood in August 2002. Environmental Management, 38:717-732; Wynn, P. (2005). Development control and flood risk: Analysis of local planning authority and developer approaches to PPG25. Planning, Practice and Research, 20(3): 241-261; Howe, J, White, I (2004). Like a fish out of water: The relationship between planning and flood risk management in the UK. Planning, Practice and Research, 19(4): 415-425.

[37] Centre for Advanced Engineering (2005). Managing flood Risk: Draft New Zealand Protocol. Report to the Flood Risk Management Governance Group, Christchurch, New Zealand.

[38] Local Government New Zealand, Unpublished material. National Policy Statement: Flood and Stormwater Risk Management: A Position Statement from Local Government. Draft only. Queenstown Lakes District Council & Otago Regional Council. (2006). Learning to Live with flooding: A flood risk management strategy for the communities of Lakes Wakatipu and Wanaka.

5.4 Incorporation of Local Knowledge

There has been increasing effort across the globe to include community knowledge into natural hazards planning in general[39], which has also occurred in flood management planning. In New Zealand, focus has been on the incorporation of traditional indigenous (Maori) knowledge[40], but other types of participatory research are emerging. Perhaps the most meaningful arena for incorporating this knowledge is in the rural regions where land-tenure is longer, thus observation of river trends may be more accurate.

[39] Burby, R.J. (2001). Involving citizens in hazard mitigation planning: making the right choices. Australian Journal of Emergency Management, 21(3): 45-51.

[40] King, D.N.T., Goff, J., Skipper, A. (2007). Maori Environmental Knowledge and natural hazards in Aotearoa-New Zealand. Journal of the Royal Society of New Zealand, 37(2): 59-73.

6.0 Comparison of the Three Futures

The Growth Strategy outlines three alternative futures for the district over the next 30/50 years. The Three futures are presented to stimulate debate as to the preferred future settlement pattern for the district over the next 50 years. The following is a brief analysis of the most plausible impacts of natural hazards, dependant on the likely spatial patterns of development in the Whangarei District. It has been primarily constructed by layering the information on the three futures, and their main settlement areas, against the various hazards. What the three futures do is give a rough estimate of exposure and whether it is likely to increase or decrease in future settlement, dependant on the preferred future strategy. There is some focus on the potential nodes/themes and their exposure to certain hazards. These include Whangarei City and margins, countryside areas including Hikurangi, Marsden Point/Ruakaka, and coastal settlements.

Future One represents a lightly regulated, market led approach to development and, in general, reflects land development in the district over the past 10-20 years. It is presented as a continuation of this lightly regulated, largely market driven approach to land development and can be seen as a baseline against which to evaluate the other two options, in addition to being an alternative development path in its own right.

Futures Two is an intermediate position between Futures One and Three. It represents a moderately controlled, less consolidated development path based upon a three tier settlement pattern. These tiers consist of: twin cities at Whangarei and Marsden Point/Ruakaka competing with each other for higher level service provision; urban and coastal settlements with some associated urban sprawl and ribbon development; and rural urban development largely at village level with some sporadic development throughout the rural area.

Future Three represents a managed, consolidated development path based upon a structured five tier settlement pattern. This hierarchical arrangement is as follows: Whangarei City as the primary district and regional urban centre with a strong, protected and enduring CBD; a satellite town at Marsden Point/Ruakaka which complements (but does not compete with) Whangarei City; five urban villages within greater Whangarei; one rural (Hikurangi) and two coastal growth nodes at Parua Bay and Waipu; and two rural villages along with eight coastal villages located along the coastline from Waipu Cove in the south to Oakura in the north.

The report identifies that many parts of the district are already susceptible to one or more natural hazards, especially in term of the more heavily settled parts of the district. Given the assumption that there will be growth in the district population, irrespective of the "Future", then it is expected that the natural hazard risk will be exacerbated. However, some risk factors may be more readily mitigated or their impacts limited in terms of area, whereas other risks are

less easily avoided or mitigated. The priority listing in the NCDEMGP (2004) priority list gives some guidance as to which hazards should be avoided wherever possible.

In general terms, these are flooding, coastal hazards, land instability, biological, and volcanic hazards. Coastal hazards and flooding can be, and have been, managed by a variety of policy tools including regulation, education and incentives. Whilst volcanic risks and earthquakes were given high and medium priorities respectively, it is unlikely that the settlement pattern will have any mitigation of the threat of these hazards (unlike Wellington with its active fault lines). Tsunami is a further risk, but is still the subject of additional future research and results may be included within the Climate Change Report. Biological hazards are generally managed through the health system, in the case of human epidemic, rather than local government planning. Likewise, the primary responsibility for managing biological invasions is through Biosecurity New Zealand and regional authorities, but territorial authority planning can help alleviate some of these issues through spatial planning. For example, as most new naturalised weed species are sourced from urban gardens, a more distributed population will facilitate quicker colonisation by weed species, but overall biological hazards have little impact on the scenarios.

Of the natural hazards noted in this background report, land instability is the hazard that is expected to see continued exacerbation as most present settlement sites are already subject to this hazard. Irrespective of the preferred future, land instability hazard exposure will grow. However, as it ranks lowly in the NCDEMGP (2004), possibly due to limited spatial impacts of many events, and given that engineering options are available in most cases, it may not pose as strong an obstacle to future population growth.

Wildfire, despite some concerns, is seen as a low priority at present, and may not represent a major obstacle either. Drought is the final hazard which can have a strong impact on the district, but can be difficult to mitigate in terms of settlement patterns. However, should settlement and land-use reduce the availability of water resources then it may be prudent to avoid aquifers and undertake activities to improve catchment storage.

So in terms of the following qualitative analysis, options are assessed against the following:

Higher Risk (Constraints)	**Lower Risk (Constraints)**
Exposure to flood susceptibility	Land Instability
Coastal hazard exposure	Erosion-prone land
	Impact on the provision water resources (for water supply/drought mitigation).

Table 2: Risk Categories for Qualitative Assessment

The way that natural hazards are managed or accommodated will be a distinguishing factor between the three futures, and whether the pattern or intensity of settlement incorporates redundancy. Redundancy in this sense refers to allowances made for setting aside areas to help mitigate or avoid the impacts of natural hazards. In order to produce the three settlement patterns assessment, it is assumed that Future 1 has low management (in terms of policy direction), Future 3 has high management, and Future 2 has medium management. This management criterion relates to the use of regulation, incentives, education and provision of infrastructure to reduce exposure of natural hazards, and whether the exposure level is increase or decreased.

These risks are compared against four general geographical area types and their relative population sizes: Countryside[41], Coastal, Marsden Point/Ruakaka, and City/Urban; and classified as increase/neutral/decrease in exposure, and whether it is expected to be high, medium or low increase.

Geographic Type	**Baseline**	**Future 1 (%)**	**Future 2 (%)**	**Future 3 (%)**
City & Margins	66%	57%	61%	61%
Coastal areas	8%	13%	10%	14%
Marsden/Ruakaka	4%	3%	19%	11%
Countryside	20%	25%	7%	11%
Total	**100%**	**100%**	**100%**	**100%**
Urban (5000+)	70%	60%	80%	84%

Table 3: Relative Percentage of Total Population in Geographical Area Type

In table 3, baseline numbers are based on data from the Census 2006. Following this, Future One is based on recent growth rates that are projected into the future, in an area by area basis. Future Two and Future Three represent a combination of information, in which possible growth nodes (especially at Marsden Point/Ruakaka, Waipu, Parua Bay, Hikurangi) are assigned maximum potential numbers to begin with. Then all other areas are attributed values based on the Growth Model 2.7 (WDC, 2008), with any remainder being found in the wider countryside. This is likely to see an underestimation in the Countryside population for Future Two which records 7% of the total population compared with 20% presently.

Please note that settlement figures for Waipu and Parua Bay are contained within the coastal geographical type rather than within the countryside geographical type. Commentary in this report discussing the relative merits of various settlement nodes are in terms of natural hazards and do not account for other constraints that may be evident.

[41] Countryside in this case means lifestyle settlement in currently popular areas, along with farming activities.

6.1 Future One: Lightly Regulated, Market Led Development (Business as Usual)

In this Future (Figure 19) there is continued market led development resulting in a widely dispersed settlement pattern consisting of two discernable trends:

(1) Urban development dispersed throughout the district with concentrations in Whangarei, Marsden Point/Ruakaka, and other urban, rural and coastal locations and along transport corridors.

(2) Widely dispersed, sporadic rural residential development throughout the district including both countryside and coastal countryside environments.

The countryside area has recently seen significant recent growth, and if projected into the future, there is expected to be a substantial population dispersed in the countryside (from 20% to 25%). Recent population growth at Mardsen Point/Ruakaka has not been very strong, and if projected into the future, this area actually decreases its relative percentage of population (from 4% to 3%). Dispersed settlement in the coastal area is also likely, with 13% of the population living in coastal areas. The relative percentage of population found in Whangarei city decreases in this Future, from 66% to 57%. Of the three futures, this is the least urbanised and most dispersed.

In Future One, future exposure to natural hazards is expected to increase in most geographical settlement types, especially as much of Whangarei District already experiences natural hazard risk (table 4). Business as usual follows past trends, and given that many new lots have been created in places already susceptible to hazard risk, future development is also likely to occur in the same risky areas if these trends continue. Flood hazard susceptibility and coastal hazards are the main natural hazard risks, with slope instability also playing a significant role. Natural hazards not only impact on where people live, but can impact on their places of work, transport corridors, and their accessibility to all types of services.

Hazard risk reduction can be a costly exercise, especially if large scale engineering (soft or hard) is required. Whilst increases in population may allow for an increased resource base to fund natural hazard risk reduction, such an increase may be offset by a dispersed population increasing the area of risk exposure. In addition, if the location of future settlement is unknown settlement, there is less certainty as to whether expenditure in risk reduction is in the right place. Given the sporadic patterns of settlement in Future One, there will be less certainty surrounding infrastructure expenditure used to mitigate natural hazard risks due to fears that any expenditure may not be in the best place for the longer term, and the dispersed nature of settlement may mean higher costs in providing suitable works to reduce risk.

There will be increased exposure inside Whangarei City together with its margins, with land instability and flood susceptibility being key issues. In terms of potential hot spots as indicated on the map as development nodes; north of Onerahi, Otaika, and eastern margins of the city all face a variety of risks, especially slope instability. Areas such as Maunu, Tikipunga, and Kamo are comparatively less risky for continuing development. Parts of Kamo are subject to subsidence risk, but the areas are in the main well document. The key issue is the continued flood susceptibility of the central business areas, and the ongoing need to mitigate flood hazards in this area.

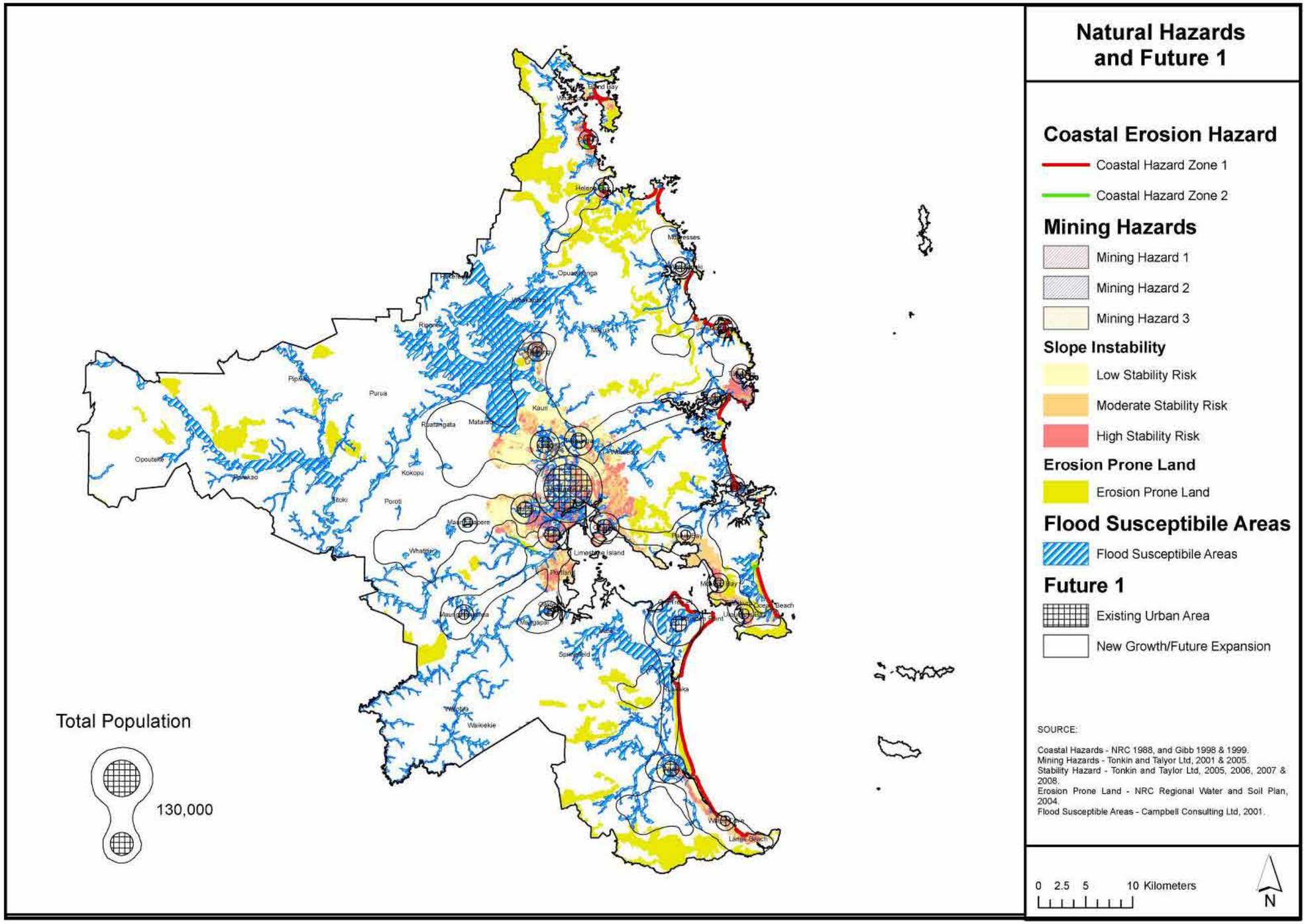

Figure 19: Broad Hazardscape Map overlaid with Future One

	Increase/Decrease in Natural Hazard Event Exposure			
Hazard Type	**City & Margins**	**Marsden/Ruakaka**	**Coastal**	**Countryside**
Flood susceptibility	Medium Increase	Low Increase	Medium Increase	Medium Increase
Coastal Hazard	Low Increase	Low Increase	High Increase	Neutral
Land Instability	Medium Increase	Neutral	Medium Increase	Medium Increase
Erosion Prone	Low Increase	Low Increase	Low Increase	Low Increase
Water Resources	Low increase	Low Increase	Low Increase	High Increase

Table 4: Qualitative Analysis of Key Natural Hazard Exposure in Future One

Continued development in Bream Bay around Marsden Point/Ruakaka does hold some risk, irrespective of the preferred future, but given the projections, any increases in risk exposure are likely to be small compared with other geographical types. Marsden Point/Ruakaka is exposed to the more risky hazards in terms of the coast as the extent of the coastal hazard line maps indicate, and there is ongoing risk from flooding.

In this "Future" the biggest concern is likely to be continued growth in coastal areas, which are exposed to a wide range of hazards, both in existing settlements and dispersed between settlements. Most coastal settlement themselves already have some levels of risk, and the areas between these settlements are also at risk from slope instability, flooding in some places, and coastal hazards. Key areas such as the Ngunguru/Tutukaka/Sandy Bay, Waipu/Langs Beach and along the northern side of Whangarei Harbour are the main hotspots. A further issue for the coast is the isolated nature of some settlements, and their dependence upon infrastructure such as roads, which themselves are at risk from flooding and land instability.

In terms of rural residential areas on the fringes of the City, population expansion in this area is expected to increase the risk exposure, due to the increase in dispersed population. But given the most popular lifestyle areas are not in areas of high risk, with little flood susceptibility or fewer land instability problems, this increase is not as high as would be expected by the population numbers. Areas including Maungatapere, Maungakaramea, northwest of Kamo, and around Glenbervie are of this nature. However, these areas are found on important aquifers and near waterways, and therefore is expected to substantially impact on water resources and have been noted as being 'at-risk' aquifer in the NRC (2004). Given the substantial level of population increase in this Future (close to 21000 people dispersed across the countryside), the impact on water resources is expected to be very high. Of additional concern is how settlement

in some upper catchments might affect downstream flow patterns in settlements that already face some flooding. These areas include countryside area near Ruakaka (west of SH1), Glenbervie, and Springs Flat.

In addition, there are still some concerns over infrastructure provision, namely roads that may be at risk though low-lying topography or unstable land, and methods used to respond to major natural hazard events. A dispersed settlement results in longer times for response, wider search and rescue areas per capita and can stretch emergency services to their limit.

6.2 Future Two: Twin City/Urban and Coastal Spread

Future Two (Figure 20) represents a moderately controlled, partly consolidated development path based upon a three tier settlement pattern. These tiers consist of:

(1) Twin cities at Whangarei and Marsden Point/Ruakaka

(2) Urban and coastal settlements with some associated urban sprawl and ribbon development,

(3) Rural urban development largely at village level with some sporadic development throughout the rural area.

Under this scenario, the countryside area has seen a substantial decline in its relative population size, from 20 % down to 7% (most likely underestimated), both dispersed and within any larger present rural settlements. Population growth at Mardsen Point/Ruakaka has been very high, and the relative population has jumped from 4% to 19% of the population. Settlement in the coastal area has also continued, with an increase in the relative population of 8% to 10% likely. The relative percentage of population found in Whangarei city decreases a little in this Future, at least when compared with the present baseline. However, of the three futures, this is the most concentrated with 80% of the population found in Whangarei and Marsden Point/Ruakaka settlements (See table 3).

Hazard risk reduction can be a costly exercise, especially if large scale engineering (soft or hard) is required. In this scenario, settlement is given some direction towards two main areas, which does increase certainty as to whether expenditure in risk reduction is undertaken the right place. Despite this increase certainty, there are still questions as to whether having competing city centres also results in competing infrastructure expenditure used to mitigate natural hazard risks. Both main localities already experience flood risk, and is likely to see an increased exposure. However, the infrastructure required for newly established Marsden Point/Ruakaka is likely to be cost-effective compared with retrofitting around Whangarei City.

Future Two (outlined in table 5) is likely to increase some exposure to natural hazard risks around Whangarei City and its margins, especially in terms of both flood susceptibility and slope instability, but given the population projected for other parts of Whangarei District (e.g.

Marsden Point/Ruakaka),the increased exposure is comparatively smaller than either of the other two "Futures". In addition, the development of a twin city at Marsden Point/Ruakaka would take some pressure off critical infrastructure services by having a second centre, but conversely, it may mean fewer resources are available to mitigate the existing flood hazards around the city. This is the main reason for the assessment of a medium increase in flood hazard risk exposure change. Whilst there will be increased exposure to land instability around the urban nodes, and some coastal hazards around Whangarei Harbour, this is relatively smaller than other futures.

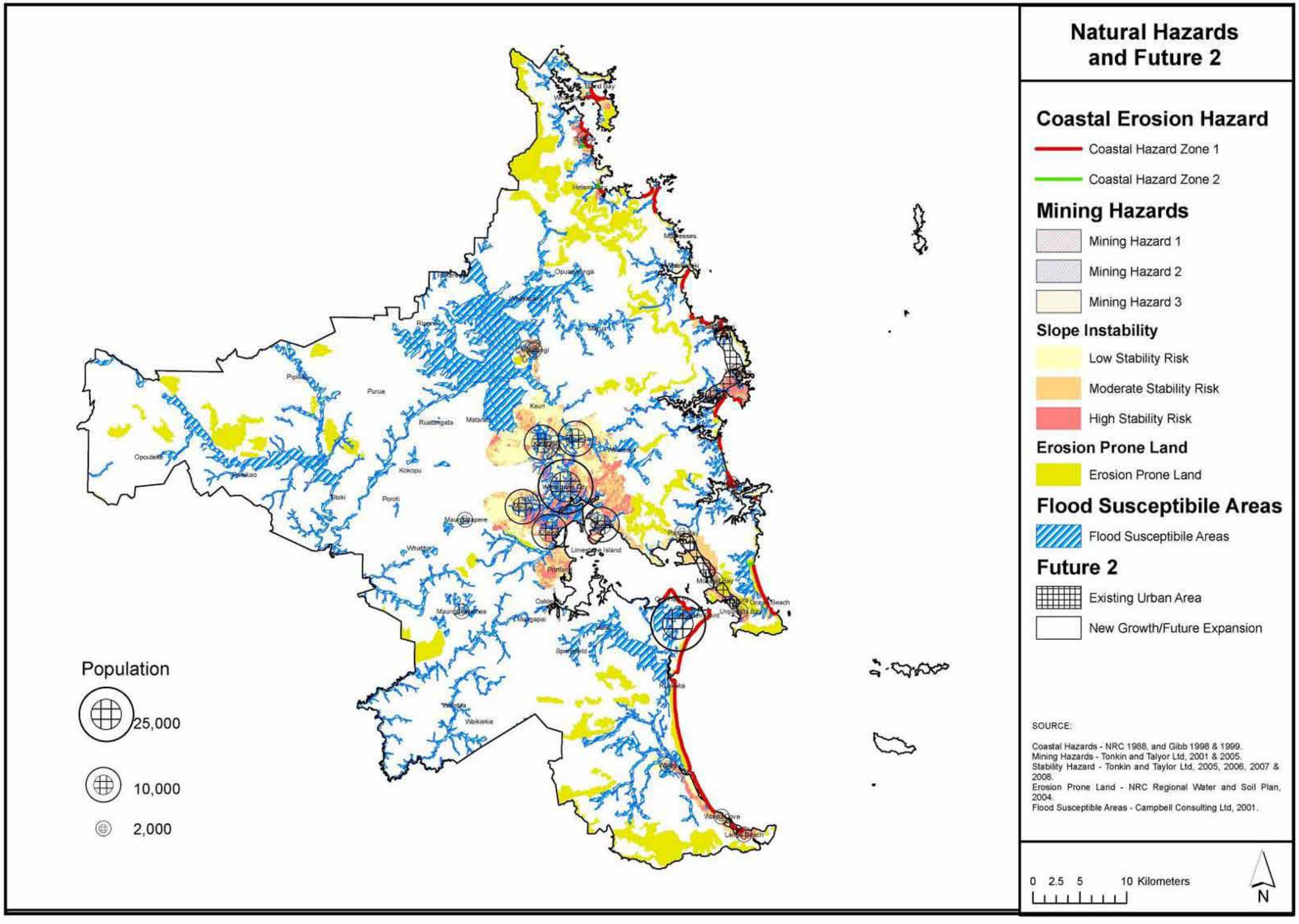

Figure 20: Broad Hazardscape Map overlaid with Future Two

	Increase in Natural Hazard Event Exposure			
Hazard Type	**City & Margins**	**Marsden/Ruakaka**	**Coastal**	**Countryside**
Flood Susceptibility	Medium Increase	High Increase	Low Increase	Low Decrease
Coastal Hazard	Low Increase	Medium Increase	Medium Increase	Neutral
Land Instability	Medium Increase	Medium Increase	Low Increase	Low Decrease
Erosion Prone	Medium Increase	Neutral	Low Increase	Low Decrease
Water Resources	Low Increase	Low Increase	Low Increase	Low Decrease

Table 5: Qualitative Analysis of Key Natural Hazard Exposure in Future Two

The main concern in this future is whether the proposed twin city at Marsden Point/Ruakaka will result in a high level of exposure to various risks, especially around Ruakaka. Flood hazard risk is the highest of the three futures, especially given that a larger population at Ruakaka means that land use is likely to be intensive, with much of the area used for settlement purposes. In addition, continued growth in the usage of the industrial areas in close proximity to the coast will increase the exposure to coastal hazards of employment areas (although this is likely to occur to a certain degree, irrespective of the "Future").

In terms of coastal settlement, coastal hazard risk exposure is expected to increase, especially around some of the popular development areas already experiencing sporadic development such as Whangarei Heads, Waipu/Langs Cove and the Ngunguru/Tutukaka area. These areas still face some risk in terms of slope instability. However, overall less dispersed settlement along other parts of the coast will likely offset this increase, and the exposure increase is less than Future One.

In terms of further countryside settlement, this "future" is not likely to see a large increase in risk exposure as the dispersed population is expected to decrease as a proportion of the overall population growth. In addition, the areas still expected to be popular are those that don't have substantial risks associated with them. These include Maunu-Maungatapere and northwest of Kamo. This poses some risk to water resources, but given the population decline, overall impact on water resources will lead to a decrease in water resources risk.

6.3 Future Three: Satellite Town/Rural and Coastal Villages

Future Three (Figure 21) represents a controlled, consolidated development path based upon a structured five tier settlement pattern. This hierarchical arrangement is as follows:

(1) Whangarei City as the primary district and regional urban centre with a strong, protected and enduring CBD.

(2) A satellite town at Marsden Point/Ruakaka which complements (but does not compete with) Whangarei City.

(3) Five urban villages within greater Whangarei urban area.

(4) One rural and two coastal growth nodes

(5) Two rural villages along with eight coastal villages.

Under this scenario, the countryside area has still seen a large decline in its relative population size, from 20% down to 11% of the total population. However, most of this is contained within rural settlements such as Hikurangi and Maungatapere. Population growth at Mardsen Point/Ruakaka is high, with the population jumping from 4% to 11% of the population. Settlement in the coastal area is also high, with an increase in the relative population percentage of 8% to 14%, which is the highest of the three futures. However, the bulk of this growth is around Parua Bay and Waipu. The relative percentage of population found in Whangarei city decreases somewhat in this Future (from 66% to 61%). Depending on the definition of urban, this is the most urbanised settlement pattern with 84% of the population found in Whangarei, Marsden Point/Ruakaka, Waipu, Hikurangi, and Parua Bay (if we assume that 5,000 and up is an urban population). Otherwise the total for Whangarei City and Marsden Point/Ruakaka is 72% (see table 3)

The increase in population may allow for increased resource base to fund natural hazard risk reduction, and with the population concentrated in particular settlements, expenditure use to decrease risk exposure may be allocated with more certainty. In this future, settlement patterns are given the most direction towards main nodes and there will be more direction away from areas of hazard risk. Despite this increase in certainty, Future 3 still sees the expansion of some development nodes, with an accompanying expansion in risk exposure, and some difficulties should transportation corridors be affected by a natural hazard event.

Overall, this future (outlined in table 6) is likely to increase risk exposure around the City and its margins, especially in the urban nodes. This is because there would be policies in place to promote development within or close to existing urban boundaries. Future 3 will probably exacerbate the exposure to instability hazards, given that consolidation of existing areas is a preferred means of settlement. This consolidation approach would, however, mean that any resources expended on the mitigation of natural hazard risks is more easily carried out with certainty.

Marsden Point/Ruakaka still sees some settlement, but compared with Future 2, this settlement is more constrained and likely to be the most compact of the three futures, and policies would be likely to promote strong mitigation to some hazards. However, there will be an increase in risk exposure, particularly to flooding.

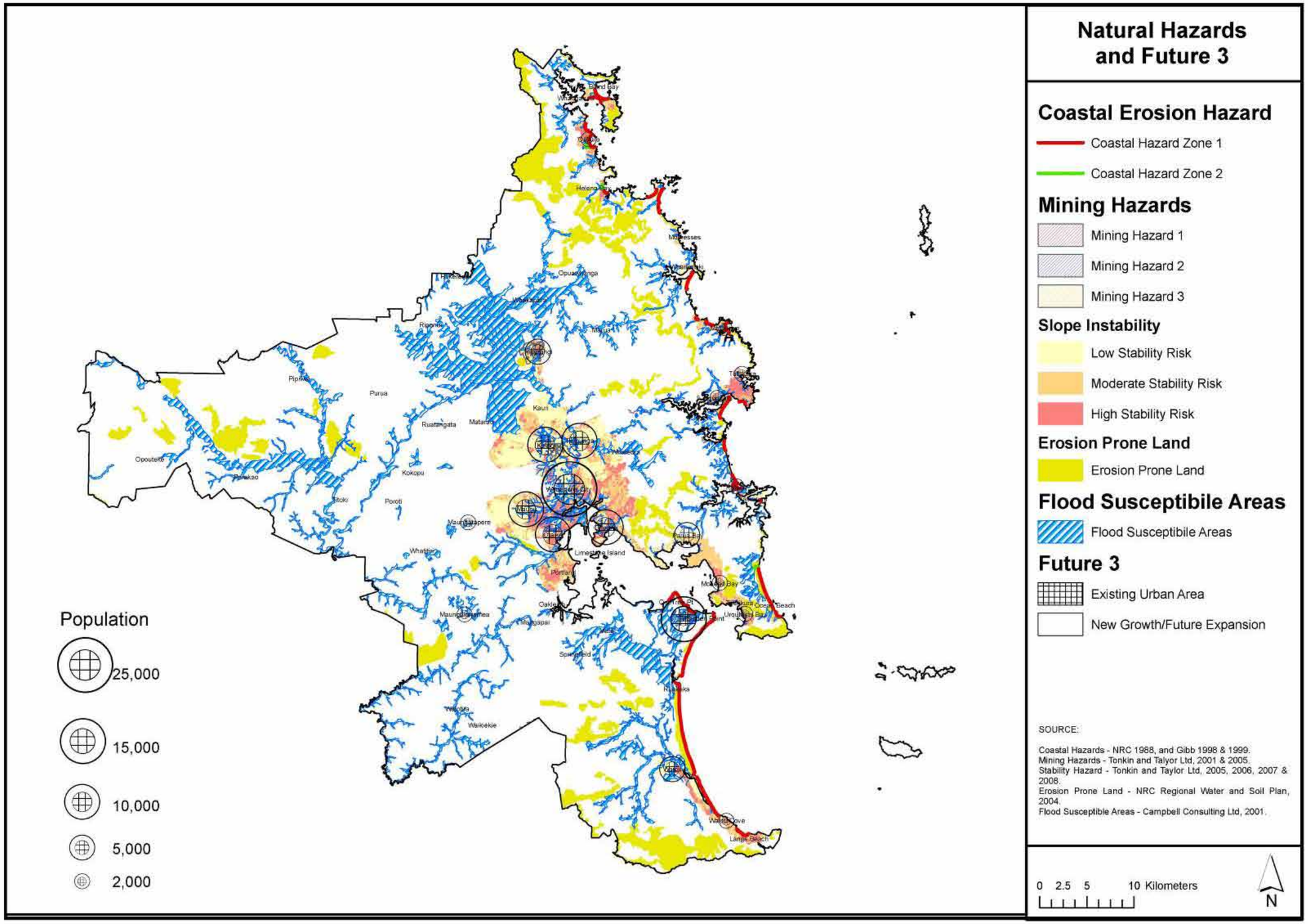

Figure 21: Broad Hazardscape Map overlaid with Future Three

	Increase in Natural Hazard Event Exposure			
Hazard type	**City & Margins**	**Ruakaka/Marsden**	**Coastal**	**Countryside**
Flood susceptibility	Medium Increase	Medium Increase	Medium Increase	Low Decrease
Coastal Hazard	Low Increase	Medium Increase	Medium Increase	Neutral
Land Instability	Medium Increase	Low Increase	Low Increase	Low Decrease
Erosion prone	Medium Increase	Neutral	Neutral	Low Increase
Water resources	Low Increase	Low Increase	Neutral	Low Decrease

Table 6: Qualitative Analysis of Key Natural Hazard Exposure in Future Three

Coastal area settlement in this future will have increased risk exposure of the three Futures, but overall, despite having the highest relative percentage of population, it is expected to be less that Future One as the population is less distributed along the coast and consolidated in present locations. Overall, this scenario is expected to reduce potential exposure to coastal hazards and flood susceptibility, and may allow for more soft engineering solutions to alleviate some risk in concentrated areas. In addition, it will probably reduce impact on water resources (in terms of aquifers and watersheds). The growth of Waipu and Parua Bay as development nodes still holds some risk, with flood hazards around Waipu, and some moderate slope stability in the vicinity of Parua Bay.

Of the three futures, Future 3 is likely to reduce exposure in the countryside the most, as the policies promote consolidation in the present settlement sites. However, of note in terms of Future 3 is the possible expansion of Hikurangi and Waipu as development nodes. Given the substantial flood hazard area located in the vicinity of both, and the strong possibility of isolation in the event of flooding, any development in these areas needs to be carefully managed. In Hikurangi, there is some potential in several areas, including the basin alongside Valley Road, north of the sportsgrounds and to the east of SH1, and perhaps the lower hills/slopes surrounding Mt Hikurangi that face the main settlement. These are also areas that have less risk associated with old mining zones. Based on present information, several areas have potential for future settlement include alongside St Marys Road, South Road, and the area between Cove Road, Nova Scotia Drive and the Waipu River. However, it is noted that further research of the catchment is being undertaken in Waipu, and that further work on the Hikurangi Catchment would be required to ensure these settlement viability as future growth nodes.

7.0 Conclusion

As indicated in this report, Whangarei District has a high exposure to natural hazard risk. Whilst earthquake and volcanic risk are less that other parts of New Zealand, the climatic hazards are high and will be a significant influence on development. Flood hazard, coastal hazards, and land instability are generally high in the district, and will continue to be high irrespective of the preferred Future. Land-use changes have the potential to exacerbate natural hazard exposure, but given that many parts of the district already have some risk, land-use planning will be needed to direct development away from natural hazard with the highest risks, which are generally weather related. Land-use planning needs to incorporate risk management as part of the decision-making process.

Flood hazards, coastal hazards, and land instability are recognised as being the higher risk events for Whangarei District planning. Analysis of climatic extremes, extreme weather events, and regional topographical features continues to be needed in land-use planning especially as hazard events become more costly, and in some cases, more regular. Volcanic risks are still evident, but earthquakes are not seen as being high risk. Both are difficult to incorporate into land-use planning, as are occurrences such as drought and biological threats. Tsunami risk is still under investigation, and results from this research will be incorporated into the Climate Change Report.

Of the three Futures, Future Three is likely to have the smallest increase in risk exposure overall, although it will require some concentration of population settlement in areas susceptible to slope instability and ongoing flood risk. Of note is the potential development around the nodes of Waipu, Parua Bay, and Hikurangi, where each node faces a different set of risks. Future Two appears to have the highest increase in risk exposure, especially around Marsden Point/Ruakaka, and in areas located along the coast between settlements such as Ngunguru/Ruakaka or around Whangarei Heads. Future One represents a middle ground in terms of natural hazard risk, with only small increases in risk in the countryside areas, similar increases as Future Three in terms of Marsden Point/Ruakaka and Whangarei City, but potentially major issues in terms of coastal hazards risk.

As alluded to in the scoping analysis, it is difficult to ascertain the overall impact that increasing the population will have on reducing exposure in some parts of the district. It can be argued that the increased population has higher resources to fund reductions in natural hazard risk, but this may only occur if densification in some areas means higher level of resources per land area. However, if the increased population continues to disperse, the higher population will be offset by a larger area requiring mitigation methods. Investment in mitigation requires certainty

of outcome, and Future Three would create the most certain outcomes as it provides the strongest direction for development which in turn build confidence for decision-making.

Overall, careful land use planning, taking into account natural hazard risk, is required when determining the future spatial arrangement of land uses in the district. There will be areas in the district where development should be avoided and/or restricted to avoid an increase in hazard risk, particularly flooding, coastal erosion, and land instability.

Over and above determining the macro-scale of the most risk-free settlement pattern for the district, careful (and more detailed) local analyses are required during structure planning of identified growth areas within the district. These structure plans should identify and direct development away from high risk areas towards areas of lesser risk. Structure plans direction then needs to be incorporated into District Plan provisions and resource consent processes. In addition, strong leadership in managing risks associated with natural hazards will continue to be necessary at the regional level, especially as many of the local risks results form similar patterns regionally. Whilst there provisions at the regional level, there is still room to strengthen these to direct settlement away from natural hazards.

8.0 Bibliography

Adger, W.N. (2006). Vulnerability. *Global Environmental Change*, 16:268-281.

Allan, C., Curtis, A., Mazur, N. (2006). Understanding the social impacts of floods in Southeastern Australia. *Advances in Ecological Research*, 39: 159-174.

Beca Carter Hollings & Ferner Ltc. (2002*). Whangarei Coastal Management Strategy – Coastal Hazards.*

Beetham, D., Kerr, J., McSaveney, M., Perrin, N., Rosenberg, M., Smith, W. (2003) *A review of natural hazards information for Whangarei District*. Wellington: National Institute of Water & Atmospheric Research Ltd.

Beetham, R.D., McSaveney, M., Dellow, G., Rosenberg, M., Johnston, D., Smith, W. (2004). *A review of Natural Hazards Information for Northland Region.* Wellington: Institute of Geological and Nuclear Sciences.

Bell, R.G., Gorman, R.M. (2003). Overview of Weather and Coastal Hazards in the Northland Region – Part II: Coastal Hazards. Wellington: National Institute of Water & Atmospheric Research Ltd.

Berryman, K. (2005). *Review of Tsunami Hazard and Risk in New Zealand.* Wellington: Institue of Geological and Nuclear Sciences.

http://www.civildefence.govt.nz/memwebsite.nsf/Files/Tsunami_Hazard_report/$file/Final_Hazard_and_Risk_Report-web.pdf

Brenstrum, N. (2003). Storms from the tropics. *Tephra*, 8: 17-20.

Burby, R.J. (2001). Involving citizens in hazard mitigation planning: making the right choices. Australian Journal of Emergency Management, 21(3): 45-51.

Burby, R.J., Deyle, R.E., Godschalk, D.R., Olshansky, R.B. (2000) Creating hazard resilient communities through land-use planning. *Natural Hazards Review*, 2: 99-106.

Centre for Advanced Engineering (2005). Managing flood Risk: Draft New Zealand Protocol. Report to the Flood Risk Management Governance Group, Christchurch, New Zealand.

Chague-Goff, C., Goff, J.R. (2006) *Tsunami hazard assessment for the Northland Region*. NIWA Client Report CHC 2006-069.

Cutter, S.L. Mitchell, J.T. Scott, M.S. (2000) Revealing the vulnerability of people and places: A case study of Georgetown County, South Carolina. *Annals of the Association of American Geographers*, 90(4) 713-737.

Doherty, J.J., Anderson, S.A.J., Pearce, G. (2008) An *analysis of wildfire records in New Zealand: 1991-2007*. SCION Report Number 12789. Christchurch, Scion.

Fowler, A., Palmer, J., Salinger, J., Ogden, J. (2000). Dendroclimatic interpretation of tree-rings in Agathis australis (kauri): 2. Evidence of a significant relationship with ENSO. *Journal of the Royal Society of New Zealand,* 30(3): 277-292.

Goff, J.; Walters, R.A.; Callaghan, F. (2006*). Tsunami Source Study*. NIWA Client Report CHC2006-082. Report for Environment Waikato (on behalf of Environment Waikato, Auckland Regional Council, Environment Bay of Plenty, Northland Regional Council).

Gray, W. (2003) *Overview of Weather and Coastal Hazards in the Northland Region*. 55pp. Wellington: National Institute of Water & Atmospheric Research Ltd.

Howe, J, White, I (2004). Like a fish out of water: The relationship between planning and flood risk management in the UK. *Planning, Practice and Researc*h, 19(4): 415-425.

King, D.N.T., Goff, J., Skipper, A. (2007). Maori Environmental Knowledge and natural hazards in Aotearoa-New Zealand. *Journal of the Royal Society of New Zealand*, 37(2): 59-73.

Kleinosky, L.R. Yarnal, B., Fisher, A. (2007). Vulnerability of Hampton Roads, Virginia to storm surge flooding and sea-level rise. *Natural Hazards*, 40:43-70.

Local Government New Zealand, *Unpublished material. National Policy Statement: Flood and Stormwater Risk Management: A Position Statement from Local Government*. Draft only.

Mackereth,G., Cane, R., Snell-Wakefield,A., Slaney, D. Tompkins,D., Jakob-Hoff, R., Holder,P., Cork,S., Owen,K., Heath,A., Brady,H., Thompson, J. (2007). *Vectors and vector borne diseases: Ecological research and surveillance development in New Zealand Risk Assessment A cross departmental research pool funded project.*

http://www.biosecurity.govt.nz/files/regs/imports/risk/risk-assessment-vector-borne-diseases.pdf

Ministry for the Environment (2007). Environment New Zealand 2007. *State of the Environment Report*. Wellington, Ministry for the Environment.

Ministry of Health (2001). *An Integrated Approach to Infectious Disease: A discussion document. Wellington,* Ministry of Health.

http://www.moh.govt.nz/moh.nsf/ea6005dc347e7bd44c2566a40079ae6f/db605416f9a606aecc256a62000b3703/$FILE/discussiondoc.pdf

Morris, J., Hess, T.M., Gowing, D.J., Leeds-Harrison, P.B., Bannister, M., Wade, M., Vivash, R.M. (2004). *Integrated Washland Management for Flood Defence and Biodiversity*. Report 598 for English Nature.

Mullan, B., Porteous, A., Wratt, D., Hollis, A. (2005). Changes in Drought risk with climate change. A Report prepared for Ministry for the Environment and Ministry of Agriculture and Forestry. Wellington, NIWA.

Murphy, B.L. (2007). Locating social capital in resilient community-level emergency management. *Natural Hazards*, 41: 297-315.

Northland Regional Council (2007) *Northland Pest Management Strategies.*

Northland Regional Council (1999). *Northland Regional Policy Statement*.

Northland Regional Council (2007) State of the Environment Report. Whangarei: NRC. Chapter 7 Coastal Hazards.

Officials Committee for Domestic and External Security Coordination. (2007) National Hazardscape Report. Wellington: Ministry of Civil Defence and Emergency Management.

Pahl-Wostl, C. (2006). The importance of social learning in restoring the multifunctionality of rivers and floodplains. *Ecology and Society*, 11(1): Art 10.

Paton, D., Johnston, D., Saunders, W. (2003). Mapping social vulnerability to natural hazards using GIS. *Planning Quarterly*, March, 6-8.

Petrow, T., Thieken, A.H., Kreidrich, H., Bahlburg, C.H., Merz, B. (2006). Improvements on flood alleviation in Germany: Lessons learned from the Elbe flood in August 2002. *Environmental Management*, 38: 717-732.

Queenstown Lakes District Council & Otago Regional Council. (2006). *Learning to Live with flooding: A flood risk management strategy for the communities of Lakes Wakatipu and Wanaka.*

Sullivan, J.J., Timmins, S.M., Williams, P.A. (2005) Movement of exotic plants into coastal native forests from gardens in northern New Zealand. *New Zealand Journal of Ecology*, 29(1): 1-10.

Tapsell S, Penning-Rowsell E C, Tunstall S M and Wilson T L (2002) Vulnerability to flooding: health and social dimensions. *Philosophical Transactions of the Royal Society of London Series A-Mathematical Physical and Engineering Sciences* 360, 1511-1525.

Tonkin & Taylor Ltd. (2006) *Land Zonation Mapping Stability Hazard Mapping/Geotechnical Assessment Level and Effluent Disposal Potential for Kamo, Maunu, Onerahi, Otaika and Tikipunga.*

URS New Zealand LTD. (2006) Whangarei CBD Flood Management Study: Flood Damage Assessment. Prepared for Whangarei District Council. Wellington: URS New Zealand LTD.

Van Roon, M. (2003). Managed flooding: Integrated Catchment Management needed to avoid flooding and pollution in Coromandel. Planning Quarterly, December, pp 9-12.

Ward, D. (2009). The potential distribution of the red imported fire ant, Solenopsis invicta Buren (Humenoptera: Formicidae), in New Zealand. *New Zealand Entomologist*, 32:67-75.

Williams, P.A. (2008). *Biological Success and Weediness of Existing Plant Species in Northland.* Landcare Research Contract Report: LC0708/080.

Williams, P.A. (2008) *Biological Success and Weediness of Some Terrestrial Weed Species not Presently in the Northland Regional Council's RPMS.* Landcare Research Contract Report: LC0708/079

Werrity, A. (2006). Sustainable flood management: oxymoron or new paradigm. *Area*, 38(1): 16-23.

Werrity, A., Houston, D., Ball, T., Tavendale, A., Black, A. (2007). Exploring the social impacts of flood risk and flooding in Scotland. Report commissioned by Scottish Executive Social Research.

Whangarei District Council (2007). Operative *Whangarei District Plan*. Whangarei: Whangarei District Council.

Whangarei District Council (2008). *Whangarei District Growth Model. Version 2.7.*

Wynn, P. (2005). Development control and flood risk: Analysis of local planning authority and developer approaches to PPG25. *Planning, Practice and Research*, 20(3): 241-261.

Appendix 1: Key Provisions from NRC Regional Policy Statement

21. NATURAL HAZARDS

21.1 Introduction

Northland is subject to a variety of natural hazards which affect people, property and other aspects of the environment. Erosion, land instability and flooding are the most significant with the greatest damage to property often resulting from cyclonic storms which hit the region. High winds associated with the storms also cause damage with coastal areas often being the most severely affected. Human activities such as land clearance can contribute to the problems caused by cyclonic storms and other naturally occurring events.

Climatic droughts occur relatively frequently in the region and are the most common form of natural hazard. Long periods of hot, dry and sometimes windy weather can have a profound effect on the region's agricultural economy. By comparison, volcanic activity and associated earthquakes are a relatively minor hazard threat. Fire also poses a hazard threat during the often extremely dry summer periods. Although the region contains a number of faults, they are not particularly significant from a seismic perspective. Tsunamis arising from disturbances of the seabed in more active parts of the South Pacific are a potential threat. Another potential threat is the trend of rising sea levels associated with global warming or the greenhouse effect. Recent studies indicate that sea levels around New Zealand may increase between two and six times above the present average of 1.7 mm a year. This means that levels could rise by 0.2-0.59 metres by the year 2025, and 0.37-1.1 metres by the year 2100.

Several of the region's major settlements, as well as important farming areas, are located within flood plains. Over the years, extensive stopbank systems and other protection works have been built to limit the risk of flooding to these areas, with the assistance of central government. Subsidy money for such works has, however, been progressively reduced and in the future, greater emphasis is expected to be placed on less capital intensive hazard avoidance and mitigation measures.

Under the Resource Management Act, both the Regional Council and the District Councils have responsibilities to avoid or mitigate the effects of natural hazards. There is no clear statutory distinction between the roles and responsibilities of the two authorities, largely because of the inter-relationship between land and water management and associated hazard threats. This inter-relationship is most obvious when one considers the effects of flooding and erosion in the coastal environment. Furthermore, a range of measures are needed to deal with natural hazards and they can be developed at a regional or district level depending on the frequency

and scale of the particular hazard threat. The Act does, however, require that the Regional Policy Statement determines for each part of the region, whether the Regional Council or the District Council is to be responsible for developing objectives, policies and rules relating to the control of the use of land and the particular hazards concerned.

The Regional Council and the three District Councils have discussed how best they can carry out their hazard avoidance and mitigation responsibilities under the Act. A co-operative approach is proposed, with the Regional Council focusing primarily on hazard threats which are of regional significance, principally coastal erosion, flooding in major catchments, and drought. The District Councils are expected to focus on the more localised erosion, flooding, land instability and subsidence threats. In the latter regard, rules relating to the use of hazard prone land (apart from that in the Coastal Marine Area) are to be incorporated into District Plans. This approach is seen as the most appropriate, as the District Councils have related responsibilities under the Building Act 1991 to control the erection of buildings on hazard prone land (apart from that in the coastal marine area) through the building consent process.

The sharing of hazard mitigation functions between the Regional and District Councils is to be carried out in a manner which fits in with respective civil defence responsibilities. Under the Civil Defence Act 1983, the Councils are required to administer civil defence plans and have in place associated emergency recovery systems. Central government also has responsibilities in this area with the Prime Minister's Department having a Recovery Plan for Natural Disasters and Emergencies, and the Minister of Agriculture having an Adverse Effects Relief Programme. All three levels of government are expected to have a continuing role in assisting communities to recover from natural hazard disasters, many of which cannot be avoided, even with appropriate risk reduction systems in place.

21.2 Issues

The following is a summary of the significant resource management issues of the region related to natural hazards:

1. The threat to existing and future communities from natural hazards, the potential and nature of which may be unknown.

2. Recognition and understanding of the range of existing natural hazard threats and the likely frequency and magnitude of particular events.

3. Identification of areas of high hazard risk, especially those prone to erosion, flooding and land instability, and provision of related information on avoidance measures to people.

4. Incorporation of comprehensive systems of hazard identification and analysis into the resource consent and building consent processes.

5. Damage to natural systems through inappropriate hazard protection measures.

6. The contribution which certain land use activities have in increasing the hazard threat especially in high risk areas. Such activities include:

- *Clearance of vegetation by mechanical or other means in areas exposed to the elements and/or with poor soil structures.*
- *Earthworks, including mineral extraction, in sensitive foreshore and riparian areas.*
- *Erection of structures, especially buildings, in flood plains.*

7. Maintenance of existing protection works, including flood control schemes, and effectiveness of future works.

8. Recognition of global warming and the effects of rising sea levels on future land use and subdivision activities along the coast.

9. Recognition that small communities often cannot bear the costs associated with natural hazard disasters. Local authorities need to co-ordinate disaster recovery operations and where appropriate, seek financial assistance from central government.

21.3 Objective

1. To avoid or mitigate the adverse effects of natural hazards by minimising and where practicable, avoiding the risk to life and damage to property, infrastructural services and other aspects of the environment, from natural hazard events.

Explanation *The Northland region is susceptible to a range of natural hazards, many of which have the potential to cause significant property damage along with social and economic disruption to communities. Minimising the adverse effects of the various hazards, particularly on people, property and associated infrastructure, is an important part of sustainable resource management.*

21.4 Policies and Methods of Implementation

(a) HAZARD IDENTIFICATION AND MONITORING

Policy

1. To identify major hazard threats and ensure that effective monitoring systems are in place.

Methods of Implementation

1. Monitor shoreline movements and undertake coastal hazard surveys in high risk areas. (Regional Council)

2. Monitor rainfall and river levels in major catchments and provide early flood warning systems where practicable. (Regional Council)

3. Carry out flood hazard mapping of high risk areas and investigate options for minimising flood damage. (Regional Council and District Councils)

4. Make available information on areas and sites with known flooding, instability and other natural hazard related problems. (Regional Council and District Councils)

5. Prepare and distribute publicity material related to hazard investigations and related monitoring systems. (Regional Council and District Councils)

6. Monitor scientific research on climate change and sea level rise and publicise associated findings relevant to the region. (Regional Council and District Councils)

7. Investigate and provide for the management of the risks associated with atmospheric natural hazards such as drought, fire, wind, tornadoes, and cyclonic storms and other such natural atmospheric phenomena, in Regional and District Plans. (Regional Council and District Councils)

8. Monitor the effects of land and water use, including land instability, coastal erosion and flooding. (Regional Council)

Explanation *Research into the nature of hazard threats and associated risk factors is the key to lessening their impact on the community. Both the Regional Council and the District Councils have responsibilities in this area with a sharing of information and associated publicity being crucial to increased public awareness of the risks. Liaison with the Auckland Regional Council is also required in cross boundary identification and monitoring matters.*

(b) HAZARD AVOIDANCE AND MITIGATION MEASURES

Policy

1. To ensure that hazard mitigation measures are provided in conjunction with new development, where such measures are required in order to ensure the safety of life and property.

Methods of Implementation

1. Make information on hazard risks and associated mitigation options available on request. (Regional Council)

2. Include appropriate provisions in District Plans on land use activities and subdivision in hazard prone areas including those areas likely to be affected by rising sea levels. This may include the setting aside of margins adjoining the coast and rivers which are hazard prone.(District Councils)

3. Include appropriate provisions in Regional Plans relating to activities in the Coastal Marine Area, rivers and streams, which are likely to exacerbate the effects of natural hazards. (Regional Council)

4. Prepare guidelines relating to the design of structures in the Coastal Marine Area which are likely to be affected by rising sea levels. (Regional Council)

5 Incorporate natural flood control mechanisms such as wetlands and floodplains in the mitigation of flood related natural hazards.

6. Promote hazard mitigation measures such as willow clearance from waterways as part of landcare programmes. (Regional Council)

(c) HAZARD PROTECTION WORKS

Policies

1. Promote cost effective and environmentally sound physical protection works where existing major capital works are at risk in hazard prone areas.

2. To ensure that new protection works have minimal impact on amenity values, heritage features and indigenous habitats and ecosystems, especially in the coastal environment and associated with rivers, lakes, wetlands and their margins.

Methods of Implementation

1. Encourage the review of the effectiveness and environmental effects of existing flood control schemes and where appropriate the maintenance of these and development of new schemes. (Regional and District Councils)

2. Ensure where appropriate, in terms of effectiveness and environmental effects, the maintenance of existing groynes, seawalls and other foreshore protection works and the development of new facilities in appropriate areas. (District Councils)

3. Review major flood control schemes and investigate options for improved flood control. (Regional Council in association with District Councils)

4. Include provisions relating to the design and construction of hazard protection works in the Coastal Marine Area in the Regional Coastal Plan. (Regional Council)

5. Include provisions relating to the design and construction of hazard protection works on land adjacent to the Coastal Marine Area, rivers and lakes in District Plans. (District Councils)

Explanation *The risk to the community from natural hazards can be reduced by a number of avoidance and mitigation measures. Emphasis is to be placed on limiting the likely exposure of people and property to hazard risks through avoidance planning, including rules in district and regional plans relating to high risk areas. Physical protection works have traditionally been an important method of reducing exposure to hazards. Existing works are expected to be maintained and provision made for new ones where they are clearly the most effective option from an economic and environmental*

perspective.

21.5 Environmental Results Anticipated

- *Increased public awareness of the risks of natural hazards and their exposure to them.*
- *A reduction in the damage caused to the environment by significant natural hazards.*
- *A reduction in the damage*

Provisions from Northland Regional Council Land and Soil Plan

11.4 OBJECTIVES

To ensure that the use of river and lake beds is undertaken in a manner that preserves natural character through, and has regard to, maintaining amenity values, minimising erosion and safeguarding the life supporting capacity of associated ecosystems.

Flood control of floodplains that protects individuals, communities and their properties.

The management of land drainage activities so that adverse effects on water and soil resources are avoided, remedied or mitigated.

11.5 POLICIES

Existing Drainage Districts and Flood Control Schemes

To avoid, remedy or mitigate adverse environmental effects resulting from the maintenance of existing land drainage and flood control schemes, and any new works associated with those existing schemes.

Explanation: Land drainage and flood control schemes can occur on an individual property basis or on a catchment scale. The existing schemes, which have already significantly modified the environment, should be managed so that any adverse effects on people and their properties are avoided, remedied or mitigated. Adverse environmental effects from further drainage activities or inadvertent over drainage should also be avoided.

Flooding and Erosion Mitigation

To promote structures and works that are effective in controlling floodwaters and in mitigating the effects of flooding and minimising erosion whilst avoiding, remedying or mitigating adverse environmental effects.

Land Uses on Floodplains

To encourage land uses on floodplains that do not result in adverse environmental effects or increased risks to people, properties or communities arising from the passage of floodwaters across floodplains.

Explanation: Floodplains are created as a result of floodwaters overtopping the banks of the river. Some land uses, such as plantation forests, have the potential to trap flood debris, eventually creating a barrier to the floodwaters. The diverted water may affect some other structure or property which is not usually affected by floodwaters.

To manage areas subject to land drainage and flood control schemes through long duration resource consents that are supported by management plans prepared in accordance with Appendix 17.

Explanation: The Council will grant consent for the taking, diversion and discharge of drainage water within those areas specified in Schedule D, where an application is supported by a comprehensive drainage district management plan. These resource consents will provide for all diversion and discharge of drainage water within the area covered by the drainage district management plan that is existing or anticipated in the long-term.

Appendix 2: Provisions from Whangarei District Plan (2007)

Natural Hazards

Significant Issues

High incidences of flooding and ponding threaten parts of the District.

Areas of coastal development are threatened by a variety of coastal hazards, including uncertainty of sea level rise and the effects of tropical storms.

The risk of fire is an issue in the District, particularly to stands of either native bush and grasslands or forestry, and within areas of residential development that are located in close proximity to stands of forestry and other fire-prone areas.

Inappropriately located activities and development increase the likelihood of significant property damage from natural hazard events.

Areas of land instability can pose a significant threat to development and subdivision.

Overview

Risks from natural hazards include land instability, flooding, coastal hazards and fire. The Plan must have regard to these hazards and the threat to human health and safety, and property. Drought is a natural hazard that is common in the District, but the management of this hazard is not best achieved through the Plan.

Generally, where there are steep slopes, little vegetation and high rainfall, land is likely to be subject to erosion and movement. Some land formations, including caves and sinkholes, are inherently unstable and constitute a major hazard. Land instability issues also arise from inappropriate earthwork activities and the removal of vegetative cover. Control of land use and development, in relation to areas of unstable land, has been left to the statutory controls within the Resource Management Act 1991 and the Building Act 2004.

Coal mining was formerly a major industry in Northland with over five million tonnes extracted. Major coalfields were located at Kamo and Hikurangi which are now urbanised. Hazards such as subsidence and sink hole formation arise from the existence of old mines. Potential development in these areas is constrained by these possible hazards. Areas of cut and fill also present a hazard risk where the fill may be unstable and therefore unsuitable for use and development. Potential erosion and land instability hazards present a number of issues that require attention, as the effects of these processes not only result in property damage and risk to human health and safety, but can also affect water quality, natural functioning of water bodies and sediment control.

The high rainfall intensities and the occurrence of tropical storms in the District expose many areas to flooding hazards. There are obvious floodway areas plus areas that are susceptible to

ponding. Traditional residential development has centred around the alluvial plains and the coastal foreshore, where the probability of flooding or ponding is high.

Coastal hazards pose a significant threat to a high number of communities in the District. Coastal erosion, landslip and flooding from the sea are the dominant natural coastal hazards along both sheltered and open-exposed coasts.

Coastal erosion exists as either a long-term trend or a significant short-term shoreline fluctuation, especially on sand dune-backed coasts. Landslip is directly associated with coastal erosion where the coastal geology is relatively weak and prone to slope failure.

Flooding from the sea occurs from either severe coastal storms or tsunami that result in waves overtopping the coast and temporarily flooding low-lying coastal hinterland. The identified coastal hazards are forecast to be increased by the effects of climate change from an enhanced greenhouse effect, including rising sea levels at rates generally exceeding those of the last 6,500 years.

Coastal land that is, or is likely to be, subject to the effects of the identified coastal hazards over planning horizons of 50 to 100 years, (adopted widely for hazard assessment) is identified on the Planning Maps by Coastal Hazard Areas 1 and 2 lines, respectively. The Coastal Hazard Areas were first identified in 1988 by the Northland Regional Council but the area of these zones has been reviewed and updated in 1998 and 1999.

Traditional methods of foreshore stabilisation may, in fact, exacerbate, not mitigate, the impact of these coastal hazards. Policy 3.4.5 of the New Zealand Coastal Policy Statement 1994 (NZCPS) requires that new subdivision, use and development near the coast should be so located and designed that the need for hazard protection is avoided. The intent of this policy is to avoid having to implement hazard protection, and should guide where subdivision use and development is appropriate.

Policy 3.3.1 of the New Zealand Coastal Policy Statement requires that a precautionary approach is adopted towards activities involving the subdivision, use or development of areas of the coastal environment. The Objectives and Policies of this part of the District Plan reflect this requirement.

The warming of the earth's surface and atmosphere, caused by increases in greenhouse gases is predicted to result in a rise in sea level, higher local temperatures and changes in rainfall patterns and 'storminess'. The New Zealand Coastal Policy Statement Policies 3.4.2 and 3.4.4 state that plans must recognise the effects of possible sea level rise and that there are natural defence systems within the coastal environment that will mitigate the associated environmental effects. Subdivision, use and development will be discouraged from locating in areas that form

natural defence systems. A copy of the NZCPS is available at Whangarei District Council's offices for perusal by the public.

Scrub and bush fires are a potential hazard. Grassland, dune lands, stands of native bush and exotic forestry blocks are included in the areas considered to be at risk, as is residential development where it is in close proximity to such areas.

There is a risk of volcanic activity in Northland, but because of the difficulty of defining exactly where and when an eruption will occur, it is not practicable to provide for hazard avoidance in the District Plan. A risk of damage from earthquakes also exists but is provided for by the building standards required by the Building Act 2004.

Objectives

The adverse effects of natural hazards on people, property and the environment are avoided, as far as practicable, or otherwise remedied or mitigated.

Existing natural buffers against natural hazard effects are protected, maintained and enhanced.

> *Explanation and Reasons: Natural hazards can rarely be fully understood or controlled by humans. The avoidance and mitigation of the effects of natural hazards are the better management approaches, with avoidance being preferred to reduce the risk to property and the health and safety of people. Natural buffers against natural hazards, such as coastal dunes, need to be protected so as to maintain their ability to protect people and property from natural hazards.*
>
> *Note that coastal hazards exist only when activities occur too close to the active coastal zone, remove natural defence systems (such as the dunes) and interfere with natural and physical processes.*
>
> *The commentary to Policy 3.4.3 of the New Zealand Coastal Policy Statement states that "the obligation to 'enhance' is directed at developers not at local authorities in their regulatory capacity. Local authorities can ensure such enhancement through conditions attached to resource consents".*

Policies

Natural Hazard Effects

To ensure that subdivision, use and development do not increase the risk from, occurrence of, or the adverse effects of natural hazards.

> *Explanation and Reasons: Certain uses and development may initiate or intensify the adverse effects of natural hazards on the site and beyond. The activity will be restricted*

if the effects cannot be mitigated to an acceptable level. This will be assessed on a case-by-case basis.

Location of Activities

To avoid subdivision, use and development in identified natural hazard areas where the natural hazard is likely to impact adversely upon human health and safety, property and infrastructure.

Explanation and Reasons: The difficulty of managing the adverse effects of natural hazards highlights the need to avoid development in identified-hazard prone areas where substantial potential risk to human life exists. If mitigation of the natural hazard can be proved to reduce the potential risk to human health and safety to an acceptable level, activities will be considered. Natural hazards have the potential to cause damage, by a range of degrees, to property and infrastructure. Activities may be acceptable if mitigation of the natural hazard reduces risk to human life and property to an acceptable level. This will be assessed on a case-by-case basis.

Natural Protection

To ensure that existing natural processes and features, such as sea cliffs, beaches, coastal dune systems and vegetation, which provide a buffer against natural hazards, are recognised, protected and enhanced in order to maintain their functioning and integrity.

Explanation and Reasons: Natural processes, such as coastal erosion, can involve such powerful forces that human intervention is futile. There should be protection of existing natural processes and features that have the potential to minimise the effects of natural hazards.

Sea Level Rise

To ensure that all buildings or structures in the coastal environment should be located so as to avoid the effects of a forecast 50 centimetre rise in global sea level this century.

Explanations and Reasons: A rise in global sea level of about 50 centimetres by the year 2100, as forecast by the Intergovernmental Panel on Climate Change (1996) , will exacerbate both erosion and flooding from the sea, providing a cumulative threat to buildings or structures situated within close proximity to the sea. The policy adopts a precautionary approach to this hazard by ensuring that sea level rise is considered for all development in close proximity to the sea.

Coastal Hazards

To avoid the need to implement hazard protection works when locating new subdivision, use and development in the coastal environment.

Explanation and Reasons: In many instances, the use of coastal hazard protection works is futile and does not achieve acceptable environmental outcomes. Effective hazard management would be to avoid the hazard. In the coastal environment this can usually be achieved easily by setting back subdivision and development from the beach, thus allowing natural processes to continue without endangering people and property.

Mitigation measures

To ensure that mitigation measures in response to natural hazards do not, themselve,s produce adverse effects on the environment and are designed and located to achieve their purpose.

Explanation and Reasons: Engineering measures used to limit the effects of natural hazards might themselves cause adverse effects. An example within the District includes the filling of low-lying land to lessen the risk of flooding. This can change water flow patterns and simply transfer the hazard elsewhere. Due to these factors, any mitigation measures will be assessed for their impacts on the overall environment, rather than merely on a site-specific basis.

Flood Flow Paths

To ensure that subdivision, use and development does not obstruct the flood flow paths of rivers and the efficient functioning of natural drainage systems.

Explanation and Reasons: Activities located in the flood paths of rivers and streams have the potential to interfere with the flow of floodwater. This may increase the adverse effects of the flooding upon human health and safety, property and infrastructure.

Fire Threat

To ensure that subdivision, use and development in areas where there is a high actual or potential risk of fire, incorporate measures to avoid or mitigate such risk.

Explanation and Reasons: Fire is a significant natural hazard. In some areas, such as forests and coastal grasslands and shrub lands, the risk of fire is higher than in other areas. In high-risk areas the avoidance or mitigation of risk can be achieved through measures such as the creation of firebreaks, provision of adequate on-site water supply or careful choice of building materials.

Methods

Regulatory Methods

Identification of Natural Hazard Areas on the Planning Maps. These include:

- *Flood Susceptible Areas (Policy 19.4.7).*

- *Mining Hazard Areas (Policy 19.4.1).*
- *Coastal Hazard Area 1 (Policy 19.4.5).*
- *Coastal Hazard Area 2 (Policy 19.4.5).*
- *Subdivision rules relating to ability to subdivide in natural hazard areas (Policy 19.4.1).*
- *Resource Area rules relating to activities in natural hazard areas (Policy 19.4.1).*
- *Resource consent conditions (Policies 19.4.1 to 19.4.8).*
- *Investigate options for minimising flood damage (Policy 19.4.7).*
- *Prepare and distribute publicity material related to hazard investigations and related monitoring systems (Policies 19.4.1 to 19.4.8).*
- *In association with the Northland Regional Council, review flood control schemes and investigate options for improved flood control (Policies 19.4.6 and 19.4.7).*

Other Plans and Legislation

- *The Northland Regional Water and Soil Plan (Policies 19.4.1 to 19.4.8).*
- *The Building Act 2004 (Policy 19.4.1).*
- *The New Zealand Coastal Policy Statement (Policies 19.4.1 to 19.4.8).*
- *The Regional Policy Statement for Northland (Policies 19.4.1 to 19.4.8).*
- *The Northland Regional Coastal Plan (Policies 19.4.1 to 19.4.8).*

Information, Education and Advocacy

- *Liaison with the Northland Regional Council (Policies 19.4.1 to 19.4.8).*
- *Develop a natural hazard events' register (Policy 19.4.2).*
- *Educate and inform resource users about areas with known flooding, instability and other natural hazard-related problems, and the systems in place to monitor these natural hazards (Policies 19.4.2 and 19.4.6).*
- *Educate and inform resource users about climate change and sea level rise as new information is made available (Policy 19.4.4).*
- *Provide guidelines on structural and non-structural mitigation measures (Policy 19.4.6).*
- *Investigate options for minimising flood damage (Policy 19.4.7).*
- *Prepare and distribute publicity material related to hazard investigations and related monitoring systems (Policies 19.4.1 to 19.4.8).*

- *Develop maps showing areas of elevated rural fire risk resulting from factors other than weather (Policy 19.4.8).*
- *Maintain maps identifying natural hazard risk areas on Council's Geographic Information System (Policy 19.4.1).*

Council Works and Services

- *Works and services relating to maintaining existing Council-owned protection works (Policy 19.4.6).*
- *Catchment Drainage Plans (Policy 19.4.7).*

Anticipated Environmental Results

The following results are expected to be achieved by the foregoing Objectives, Policies and Methods. The means of monitoring whether the Plan achieves the expected outcomes are set out in the Whangarei District Council Monitoring Strategy.

- *Natural hazard areas are identified, assessed, classified and shown on the planning maps in the District Plan.*
- *Subdivision, use and development is avoided in identified natural hazard areas and/or the adverse effects from natural hazards are adequately avoided, remedied or mitigated.*
- *The adverse effects from natural hazards on the environment, people's health and safety and property are avoided, as far as practicable, or otherwise remedied or mitigated.*
- *Natural buffers relating to natural hazards are protected, maintained or enhanced.*

56 Natural Hazards

56.1 Introduction

This Chapter contains rules relating to land uses in areas mapped as hazard areas. These areas are shown on the Planning Maps by shading on the Resource Area Maps. These rules apply in addition to any other rules in this Plan applicable to the same areas or sites. In addition, Council's "Policy for Application of Section 36(2) of the Building Act 1991[42]" will apply to all areas mapped as hazard areas, particularly to Coastal Hazard Areas.

Chapters 1 and 2 describe activities and rules and how to read the rule table. See Chapter 2.3.3 for a list of matters to which discretion is restricted. These apply to every restricted

42 Now superseded by Section 72 of the Building Act 2004

discretionary activity mentioned in the rule table, in addition to those matters given in the table.

The Planning Maps identify land which, on the information currently available, is susceptible to flooding; either due to rivers or streams overflowing their banks, inundation from the sea during high tides or storm surges, or to water ponding during extended periods of wet weather. Due to the scale of the mapping, there will be some areas within the identified land that are less prone, or not prone, to flooding, just as outside the identified flood-prone land there will be land which is subject to flooding.

Coastal hazard reports prepared for Northland Regional Council and Whangarei District Council from 1988 onwards have been used as information sources to assess Coastal Hazard Areas. A list of these information sources is contained in Schedule 56.1 of the Plan. Copies of these references are available from the Council.

The Council is conscious of the need to improve the quality of the natural hazards information and will be carrying out the appropriate research and analysis as resources permit. For example there is a programme to prepare Catchment Drainage Plans for all significant areas of development in the District. People who wish to carry out development in an area identified on the Resource Maps as being subject to natural hazards, should check with the Council to see whether there is any more detailed or up-to-date information relating to the property in question.

Schedule 56.1

The coastal hazard information included on the Resource Maps of this Plan is derived from the following Coastal hazard information sources:

NRC 1988: Coastal Hazard Identification. Whangarei County. Technical Publication No.1988/1, March 1988, held by Northland Regional Council.

Gibb, J.G. 1998a: Review of Coastal Hazard Zones for Eleven Selected Beaches in Whangarei District, Northland Region. Consultancy Report C.R. 98/4 prepared for and held by Northland Regional Council. July 1998.

Gibb, J.G. 1998b: Coastal Hazard Zone Assessment for the One Tree Point-Marsden Bay Area, Whangarei Harbour, Whangarei District. Consultancy Report C.R. 98/3 prepared for and held by Whangarei District Council.

Gibb, J.G. 1999: Coastal Hazard Risk Zone Assessment for Pataua and Matapouri Bay, Whangarei District. Consultancy Report C.R. 99/7 prepared for and held by Whangarei District Council. December 1999.

IPCC 1996: Climate Change 1995. The Science of Climate Change. Summary for Policy Makers and Technical Summary of the Working Group 1. Report. Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge. Held by Northland Regional Council.

56.2 Natural Hazards Rule Table

56.2.1 Coastal Hazards

*Construction or alteration of a building or structure in a Coastal Hazard Area is **permitted** if:* a) *It does not occur in Coastal Hazard Area 1; and* b) *All buildings within Coastal Hazard Areas have a minimum floor level of 2.5m above One Tree Point Datum Mean Sea Level 1964.*	*The construction or alteration of a building or structure that does not comply with a condition for a permitted activity is a **discretionary** activity.*

56.2.2 Earthworks

*Earthworks upon sand dune complexes are a **permitted** activity if:* a) *Such earthworks do not occur in Coastal Hazard Area 1; and* b) *In Coastal Hazard Area 2, the earthworks do not exceed a volume of 25.0m^3 or an area of 150.0m^2, and all sand displaced by such works is returned to the dune complex immediately; and* c) *The site of the earthworks which will not be covered by buildings or structures is immediately stabilised by appropriate dune binding vegetation within 10 working days of such earthworks being completed.*	*Any earthworks upon dunes that does not comply with a condition for a permitted activity is a **discretionary** activity.*

56.2.3 Flooding

*Construction or alteration (excluding internal modifications) of a building or earthworks in a Flood Susceptible Area, is a **permitted** activity if:*	*Construction or alteration of a building or earthworks that does not comply with a condition for a permitted activity is a **restricted discretionary** activity.*

a) *A report or certificate from a suitably qualified and experienced professional is provided to the Whangarei District Council which indicates that the activity is designed to accommodate the flood hazard and will not create any adverse effects upstream or downstream; or* b) *The work involved is maintenance of an existing building.* ***Note:*** *Reference may be made to previous reports relating to the flood susceptibility of the area.*	***Discretion is restricted to:*** i. *Construction or alteration of a building in relation to its location;* ii. *The avoidance, remediation or mitigation of coastal hazards;* iii. *The additional matters listed in Chapter 2.3.3.*

56.2.4 Mining Subsidence

Construction or alteration (excluding internal modifications) of a building or earthworks within a Mining Hazard Area is a ***permitted*** *activity if:* a) *A geotechnical survey of the ground under, and in the immediate vicinity of the site, is undertaken, and* b) *A report or certificate, which has been prepared by a suitable qualified and experienced professional, is provided to the Council which indicates that:* i) *Where the site is to accommodate a residential unit, there is an identified building area of at least 100m2 where a residential unit can be built so that there is compliance as a permitted activity with the rules in this plan; and* ii) *The site is suitable for the activity or structure, and*	*Construction or alteration of a building or earthworks that does not comply with a condition for a permitted activity is a* ***restricted discretionary*** *activity.* ***Discretion is restricted to:*** i. *Construction standards;* ii. *Effects on health and safety;* iii. *The additional matters listed in Section 2.3.3.*

iii) *The structure is of an appropriate design and the building materials are appropriate in the circumstances; and* c) *The risk of subsidence is not increased by the construction, alteration or excavation.*	

Coastal Hazards

Short-term coastal erosion occurs because of storm events such as high winds, waves and increased water levels along the coastal foreshore. Coastal flooding is an associated natural hazard. Coastal Hazard Areas prone to coastal erosion and flooding are shown on the Planning Maps. These coastal hazards can present a serious risk to human life and physical structures. A potential rise in sea level will exacerbate these hazards. By ensuring that the floor levels of structures and buildings are at least 2.5m above One Tree Point Datum Mean Sea Level 1964, this risk will be significantly reduced. Natural processes and features such as coastal dunes and mangroves can provide some defence against coastal hazard,s and this protection should be maintained and enhanced where possible.

Earthworks

Earthworks in coastal dunes can reduce the protection these natural systems provide against coastal hazards. Earthworks also make the dunes very unstable, thus causing a new hazard to emerge. Re-vegetation will help protect the dunes and thus protect the properties behind them.

Flooding

The Flood Susceptible Areas identified on the Planning Maps identify flooding from river systems, potential overland flow and low-lying areas which have experienced, or could be subject to, flooding under conditions such as poor drainage. The controls in the Plan are intended to reduce the risk from flooding by requiring the flood risk to be assessed when undertaking any activity such as building.

The assessment of flood susceptibility in plantation forestry areas may be included as part of the Annual Harvesting Plans, prepared as a requirement of resource consents granted by the Northland Regional Council.

Mining Subsidence

The areas subject to possible mining subsidence are identified on the Planning Maps. A network of tunnels exists in the residential areas of Kamo and Hikurangi. The risk to properties

situated above these old coal mining tunnels, and to human life, can be minimised by ensuring that any earthworks or structure is suitable and does not increase the likelihood of subsidence. This can be achieved by controlling the design and building materials of structures that are built in these areas.