5.0

Hazards and heritage

Part 5 discusses the types of natural hazards that threaten the Auckland region, our current knowledge about these and the impact of recent natural hazard events on communities and councils, and what we are doing to plan for and lessen the impact of such events.

It also discusses the state of our heritage and our knowledge about historically significant buildings, places and landscapes, including those of special cultural significance to Māori. It outlines the threats that could endanger different aspects of our heritage and the measures that we are taking to preserve it.

5.1

Hazards and heritage – Natural hazards

Contents 5.1

Photo: Browns Island, Auckland. (Source: ARC).

Natural hazards

Introduction

A natural hazard event is any physical environmental process that adversely affects people and/or property. Natural hazards can have severe direct (e.g. death, injury, property damage) and indirect (e.g. loss of income, economic disruption) impacts on people within the Auckland region.

The Auckland region is exposed to a wide range of natural hazards. These can be broadly categorised as:

- Geological. Including earthquakes and volcanic eruptions. These are created by the earth's massive internal pressures releasing energy at the surface. These events occur only occasionally but can impact large areas of the region (landslides can be triggered by earthquakes but occur more frequently in response to climatic processes).
- Climatic. Including landslides (triggered by rainfall), cyclones, floods, droughts and tornados. These hazards occur frequently in the region although their impact is often localised. On occasions a number of these hazards can occur simultaneously. For instance, a cyclone event can cause flooding, landslides, coastal erosion and coastal flooding throughout the region.
- Coastal. Including beach and cliff erosion, coastal flooding and tsunami. Coastal erosion is an ongoing issue for the Auckland region. It is a natural process but becomes a hazard when it threatens or damages development near the coastline.

Each type of natural hazard has distinct characteristics that influence the location, frequency and magnitude of an event. The severity of hazard events varies across the region over time due to factors that include the local environmental (natural and human) conditions and external influences such as climate change (see Climate change in Part 1).

Natural hazards are difficult, or sometimes impossible to control but land use activities that alter the existing environmental conditions can sometimes exacerbate the impact of events. For example, landscape modifications of a steep hill can increase the likelihood of a landslide. Exposure to natural hazards in the Auckland region is consequently determined by a complex interaction between natural processes and human activities.

The risks to communities can be reduced by an improved understanding of each type of natural hazard and its impacts, coupled with effective planning to avoid or mitigate their adverse effects.

Natural hazards monitoring programmes

Various monitoring and research networks within the Auckland region provide data on the frequency and magnitude of natural hazards. Some natural hazards result from natural physical processes that are difficult to research directly (such as cyclones) but we are able to monitor the probability and likely impact of the hazards (such as floods and landslides) associated with that process. More details are provided in the appropriate sections.

Geological hazards

Earthquakes

The Auckland region is located close to the boundary of the Australian and Pacific tectonic plates. As these two plates move over each other, strain builds up in the earth's crust and is released along fault lines, causing a tectonic earthquake. Earthquakes can also be caused, although less frequently, by magma rising toward the earth's surface before a volcanic eruption. In comparison to the rest of New Zealand, the magnitude of earthquakes in the Auckland region is generally small and most are undetected by the public.

There are two active fault lines in the Auckland region: the Wairoa North Fault (in Manukau City/Franklin District) and the Drury Fault (in the Papakura/Franklin districts). Movement along these fault lines occurs about every 13,000 to 43,000 years. Immediately outside the Auckland region, the Kerepehi Fault in the Waikato region experiences movement about once every 2500 years. If movement along this fault line caused an earthquake within the Hauraki Gulf area, it could potentially generate a small tsunami and produce significant ground shaking in the southern part of the Auckland region. Areas of land with deep alluvial sediments close to this fault line, such as the Manukau Lowlands, would experience significant ground shaking as the loosely compacted sediments would amplify the earthquake energy moving through the earth.

The probability of the Auckland region experiencing an earthquake with a ground shaking intensity exceeding the Mercalli Scale (MM) rating of VI is once every 90 years, while an earthquake of VIII (or greater) is expected once every 5400 years. The MM scale grades the impact of an earthquake on people and the community. An earthquake of MM VIII is expected to cause panic amongst people and extensive damage to buildings, especially when these are located on alluvial sediments.

Earthquake monitoring programme

In 1995 a network of seismometers was set up to monitor earthquake within the Auckland region (see volcanic seismic monitoring program).

Indicator 1: Number and impact of earthquakes

Earthquakes in the Auckland region are measured using the Richter Scale (M) which determines the energy that is released. From 2004 to 2008, 27 earthquakes exceeding M2 were detected in the Auckland region. Most earthquakes were less than M 3 and did not release enough energy to be felt, but one M 4.5 earthquake on 21 February 2007 was felt widely through the Auckland region, particularly in Rodney District and North Shore City. It was located 6km east of Orewa, at a shallow depth of 5km below the earth's surface (Figure 1). This earthquake was part of a swarm of ten separate earthquakes that occurred within a 24 hour period. It did not cause any injuries to people but did cause many cases of minor damage to houses (particularly brick chimneys and walls) and their contents. A total insurance payout of $1.5 million was made, with 495 damage claims reported. The majority of insurance claims were from residential properties in Rodney District and North Shore City.

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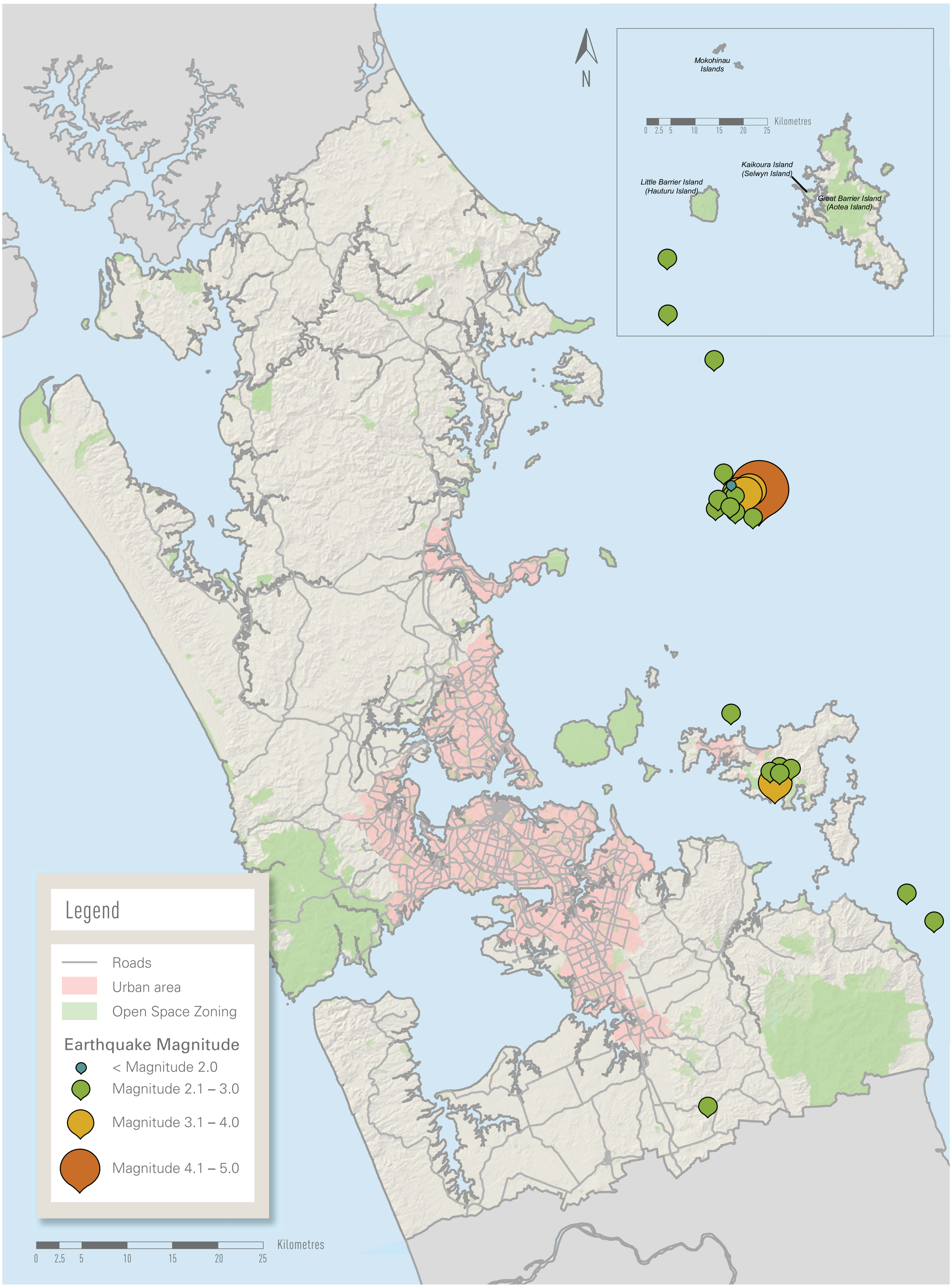

FIGURE 1 Locations and magnitudes of the earthquake swarm in February 2007. (Source: GIS Information Services ARC).

Natural hazards

Volcanic eruptions

The Auckland region is vulnerable to hazards associated with volcanic eruptions in the Auckland Volcanic Field (AVF), the Taupo Volcanic Zone (TVZ) and Mt Taranaki. Most of the Auckland urban area is located on the potentially active AVF. Rangitoto Island was the largest and most recent eruption in the AVF, having formed during two separate eruption events approximately 600 years ago. Eruptions in the AVF are unpredictable with each new event most likely to occur at a new location at any time.

During the last 200,000 years 49 volcanic eruptions have occurred in the AVF. This means that an eruption has occurred, on average, once every 5000 years. The AVF has however experienced periods of increased activity, with up to five eruptions occurring within 100 years (an average return period of once every 20 years) about 30,000 years ago.

Volcanic activity in other parts of the North Island can also affect the Auckland region. Past eruptions from the TVZ and from Mt Taranaki have deposited layers of volcanic ash ranging in thickness from 1mm to 63mm. Over the last 80,000 years, ashfall from these volcanoes has been deposited in the Auckland region once every 750 years, on average. This figure excludes potentially more frequent, smaller ashfall events that can be hazardous to people and infrastructure but are not preserved in the region's geological record. For example in 1996 a small eruption from Mt Ruapehu in the central North Island dispersed sufficient volcanic ash to close Auckland International Airport for three nights.

Recent studies have highlighted the impacts of a volcanic eruption on the people, buildings and infrastructure of the Auckland region (Table 1). The potential level of injuries and deaths from an eruption in the AVF is difficult to determine, as these depend on the ability to predict the eruption site and the time available for the emergency services to undertake large scale evacuations. Injuries and deaths during an eruption would be restricted to people who are unable to be evacuated (e.g. the critically ill or infirmed), refused to leave or have returned to their home and those involved in emergency management.

TABLE 1 Possible level of disruption to people, businesses and employment from a Rangitoto-sized eruption superimposed on volcanic cones in urban areas of the Auckland region. (Source: ARC).

Location	3km radius from vent			5km radius from vent		
	Population	Businesses	Employees	Population	Businesses	Employees
Mt Wellington – Maungarei	61,119	5,606	31,117	151,824	16,759	88,152
North Head – Maungauika	16,206	1,884	7,600	67,338	15,138	81,820
Mangere Mountain – Te Pane O Mataoho	32,103	2,556	19,103	101,121	8,367	66,380
Mt Eden – Maungawhau	99,912	19804	113549	222,579	38,462	203,845

The amount of damage to buildings and infrastructure would depend upon their proximity to an eruption. Most buildings and infrastructure within 3km of an AVF eruption vent would suffer complete or extensive damage with costs exceeding billions of dollars.

A local or distant eruption event that dispersed a thin layer of volcanic ash across the whole of the Auckland region could affect about 240,000 residential buildings and cause about $140 million of non-structural damage. These costs will substantially increase when further considering damage to infrastructure (e.g. water supply, electricity, gas, transport systems), as well as commercial and industrial buildings.

Modelling the economic impact of an AVF eruption suggests that the Auckland region would suffer a 47 per cent reduction in GDP (reducing to 40 per cent if business mitigation responses are implemented) and result in a 14 per cent decline in the national GDP (reducing to 12 per cent with business mitigation response). Overall, the economic impact could be more severe than the Great Depression in the early 1930s, when national economic growth rates declined by 7 per cent. Employment in the Auckland region may be expected to reduce by 268,000 jobs (48 per cent) although this could be reduced if business mitigation responses are applied.

Volcanic seismic monitoring programme

Volcanic seismic monitoring is carried out by GNS Science, a New Zealand government-owned research organisation specialising in geological and nuclear science. The regional volcanic seismic monitoring network contains seven seismometers located around the AVF, recording seismic activity as an indicator for an imminent volcanic eruption.

Indicator 2: Number and impact of volcanic eruptions

Since 2004, the AVF has not experienced any volcanic activity near to the earth's surface (i.e. no earthquakes detected due to the movement of magma). In addition, no eruptions in the central North Island have created sufficient ashfall to affect the Auckland. Therefore, no human harm or damage occurred as a result of volcanic eruptions from 2004 to 2008.

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Climatic hazards

Cyclones

Cyclones are extreme, low pressure weather systems that can inflict a range of natural hazards including high winds, flooding, landslides triggered by heavy rainfall, and storm surges that cause coastal flooding and erosion.

The Auckland region's cyclone season tends to occur between December and April when cyclones move towards the area from equatorial latitudes. There is an 80 per cent chance of a cyclone passing within 500km of the Auckland coast each year. Research suggests that the probability of the Auckland region experiencing a cyclone increases during La Niña weather conditions when north-easterly storms are more frequent (see Weather and climate in Introduction, pg 10).

Indicator 3: Number and impact of cyclones

Since 2004, no cyclone events have impacted the Auckland region.

Floods

Floods occur when heavy rainfall fills waterways beyond their normal capacity or saturates soil to a point where it cannot hold any more water, forcing the water to flow over the surface. In the Auckland region, flood events are recorded from river flow (mean annual flood discharge in m^3) or rainfall intensities (e.g. the annual 1 hour and 24 hour duration rainfall volumes) that exceed an annual event threshold. Rainfall intensities are used as a proxy indicator for flood events because it is not possible to monitor all the regions rivers while there is only limited historical data on those that are monitored.

Between 2004 and 2008, 21 flow events exceeded the mean annual flood discharge on rivers that the ARC monitors. However, these events were too small to breach the channel banks and flood the neighbouring land. Rainfall data over the same period showed that Auckland's urban area experienced the greatest annual hourly rainfall events in region. Recorded high rainfall intensity events occurred:

- On 2 February 2004, 49mm was recorded in one hour in Pakuranga (a one in 43 year return event).
- On 1 October 2006, 36mm was recorded in one hour at Onehunga (a one in 20 year return event) and 129mm of rain fell near Waimaukau over a 24 hour period (a one in 83 year return event). The latter was the highest rainfall intensity event recorded in a rural area.

'Quick' flood peaks (the highest water level attained during a flood) can be experienced in the region's urban areas as a result of its relatively short waterways, large expanses of impervious surfaces that do not allow rainwater to soak into the ground, and extensive stormwater networks that channel excess water into the waterways (see Wastewater and stormwater in Chapter 3: Pressures, pg 61).

Hydrology monitoring programme

River levels and flow at 44 sites and rainfall at 40 sites are currently monitored by the ARC. The council also has access to river level and flow data at monitoring sites operated by NIWA, giving an overall total of 48 sites. This allows the ARC to determine whether rivers are approaching flood levels and to provide appropriate warnings to civil defence and emergency management agencies.

Rainfall intensity maps can provide flood hazard information by highlighting areas that are potentially vulnerable to flooding and where river flow is not monitored. In the Auckland region this information is important because there are many small rivers that cannot be monitored directly, and the large amount of impermeable surfaces in the urban area can result in a sudden influx of water from heavy rainfall entering the stormwater networks and rivers.

Indicator 4: Number and impact of floods

Between 2004 and 2008, 21 flow events exceeded the mean annual flood discharge on monitored rivers. However, the flow events that were recorded were, on most occasions, too small to breach the channel banks and flood neighbouring land. Recent flood damage has been poorly reported or is held as confidential by the insurance industry so it is difficult to determine the true impact on the Auckland region.

Storm events in 2007 and 2008 caused widespread damage across northern New Zealand and also impacted the Auckland region. No lives were lost but damage claims from surface flooding in the Auckland region totalled about $2 million. This figure does not include costs incurred through the loss of productive agricultural land and disruption to people's economic activities.

Droughts

An area is considered to be in drought when there is a scarcity of rainfall over an extended period of time. The Auckland region can experience two types of drought, an agricultural drought which is measured by the deviation below the normal soil moisture deficit or an hydrological drought which is measured by a lack of precipitation or river flow (e.g. a low flow event).

Drought monitoring programme

The hydrology monitoring network described previously can also detect hydrological droughts in the Auckland region.

Indicator 5: Number and impact of droughts

Two droughts occurred in early 2003. A one in 41 year low flow event lasting 135 days was recorded at Waitangi, south of the Manukau Harbour. Over the same period, a one in 25 year low flow event lasting 123 days was recorded at Waimaukau. These low flow events were significant because both occurred in areas that have a high dependency on water for agricultural and horticultural activities as well as for domestic use.

The impacts of recent droughts have been poorly reported so it is difficult to determine the real effects on the Auckland region. Anecdotal evidence suggests that the impacts were felt amongst agricultural sectors, with loss of income and psychological stress occurring in southern areas during the 2003 events.

Auckland's urban area was considered relatively drought-free between 2004 and 2008 as monitored river levels did not fall below the Mean Annual Low Flow level. The urban area is supplied by Watercare Services Ltd, which reports sufficient storage capacity to withstand a 1 in 200 year drought.

Tornados

Tornados have potential to cause great damage and occur regularly in the Auckland region. However, their size limits their impact as events occur for short durations and cause extremely localised damage paths created by tornados are usually between 10m to 30m wide and 1 to 5km long.

Indicator 6: Number and impact of tornadoes

Since 2004, one or two tornados have occurred in the Auckland region each year while seven have made landfall. Approximately 40 homes experienced varying degrees of structural damage (particularly roofing) from these events. The cost of the damage resulting from all of the tornado events did not exceed $200,000 in insurance claims.

Landslides

Landslides are common on steep slopes in the Auckland region, particularly during prolonged and/or heavy rainfall. When rainfall is absorbed by soil, the cohesiveness of the soil may be decreased sufficiently to result in a landslide.

Indicator 7: Number and impact of landslides

In 2008 the Auckland region experienced very wet winter months, with 150 per cent more rain than the average. The rainfall, though moderate in intensity, was prolonged and kept the soil saturated. This increased the susceptibility of slopes to landslides during short periods of higher intensity rainfall. Between June and August 2008, 69 landslides were reported and it is likely that hundreds more were unreported. Major landslides were reported at Torbay, Kawakawa Bay, Glenfield, Swanson and Little Huia. Most landslides occurred towards the end of several episodes of heavy rainfall, during which about 50mm to 120mm of rain fell over periods of five to 10 days.

Landslides in urban areas threatened development on steep slopes with 50 people evacuated from 21 houses in North Shore City and Waitakere City during July and August 2008. A summary of reported damaging landslides that occurred during this period is given below:

- At Torbay, 65mm of rainfall over 48 hours triggered movement of a deep-seated landslide on 29 and 30 July. Monitoring after the event showed maximum vertical movements within the landslide of 700mm over 24 hours, indicating that movement was continuing. This prompted the evacuation of 14 houses in immediate danger and drainage of the landslide to stop further movement. Most of the residents returned home following a preliminary site inspection although one house was condemned and demolished, equating to over $400,000 in property loss.

  Later site investigations indicated that the landslide was an older feature which had been reactivated by rainfall. Recent development above the landslide may have increased the soil moisture level in the landslide body, which promoted its failure.
- At Kawakawa Bay and Little Huia, old deep-seated landslides were reactivated and resulted in property damage. In both cases a large amount of weathered soil overlying impermeable bedrock became saturated by persistent rainfall during June and July and started moving down slope during periods of heavier rainfall in August. The 1500 residents of Kawakawa Bay were isolated for four weeks by landslides at Turei Hill that closed the Clevedon-Kawakawa Bay Road (see case study Turei Hill, Kawakawa Bay, Manukau City (2008).
- At Swanson and Glenfield, a number of new landslide events were generated. In July, deep-seated landslides were large enough to threaten properties while the velocity of their movement down slope caused the evacuation of four and two houses respectively. Slope instability issues continued at the Glenfield site for another six months resulting in two homes being condemned equating to property losses exceeding $800,000, pending the resolution of litigation issues between the residents and North Shore City Council.
- At Little Huia, a landslide created significant ground deformation on surrounding properties with tension cracks and scarps up to 1m high forming across the landslide. Tension cracks occurred under building structures as the landslide moved although this ceased after emergency drainage was installed to stabilise the slope.

Numerous small, shallow landslides were also reported along major highways and arterial routes where slopes have been cut for roading. Although all the landslides reported during 2008 were triggered by rainfall, it is important to note that landscape modification was a likely factor leading to landslide events in urban areas.

Extensive remedial work was undertaken to clean up, repair and stabilise slopes across the Auckland region following the 2008 landslides.

In rural areas:

- large-scale earthworks began at Kawakawa Bay to drain and stabilise the landslide.
- slopes that failed in June and July in a number of locations along State Highway 1 in Rodney District required immediate clean-up to allow traffic movement.
- $140,000 of stabilisation work was performed along Scenic Drive, Titirangi in 2009 to remedy damage from a landslide in July 2008.

In urban areas:

- $200,000 was spent to repair a damaged section of road at Mulberry Place, Glenfield.
- an unstable cliff above the Parnell Baths, Parnell was deemed unsafe and required about $270,000 of repair works to lower the risk to bathers from future rock falls.

Natural hazards

- a landslide at Redoubt Road in Manukau City destroyed 100m of a water supply pipeline, cutting water to 3000 houses, and required remedial work that included slope grading and earth removal.
- houses affected by the Glenfield landslide required between $285,000 and $370,000 of engineering works to stabilise the site.

The landslide events of 2008 were not part of a catastrophic natural hazard event. However, the cumulative costs borne by Auckland communities from the resultant property damage, lost economic productivity, remedial work and clean-up costs exceeded millions of dollars while the extensive disruption caused to evacuees through relocation, time off work and theft was immeasurable.

Coastal hazards

Coastal erosion

The erosion of beaches and cliffs is an ongoing issue for the Auckland region. Erosion is a natural process operating on the region's beaches and rocky coastline as landforms respond to changes in wave energy, sediment supply, sea level (e.g. tides) and climate. The process becomes a hazard when development is located near an eroding coastline and is subsequently threatened or damaged.

Beach erosion

The susceptibility of the Auckland regions beaches to erosion broadly depends on their exposure to wave energy. Beach erosion modelling based on historic erosion rates and sea level rise scenarios suggests that beaches on the west and north-east coasts are likely to experience the largest amount of landward retreat from their present foredune toe or vegetation line.

Assuming that sea level will rise around the region by 500mm by 2100, it is predicted that west coast beaches are predicted to retreat by 46m to 54m over the next century. On the north-east coast, the spits at Omaha and Mangawhai-Pakiri are predicted to retreat 55m and 48m respectively. Sheltered beaches bordering the Manukau Harbour and inner Waitemata Harbour are expected to retreat 7m while those along the East Coast Bays beaches are predicted to retreat between 8m and 15m. North-facing beaches on Waiheke Island are expected to experience retreat rates of between 24m and 34m, similar to other exposed beaches.

All of these landward retreat rates are future predictions that show how the present state of beach erosion may vary over the next century. However, the actual retreat rates experienced will be controlled by many natural factors (e.g. changes in wave climate, sediment supply) as well as human activities such as sand extraction and shoreline modification.

Beach erosion monitoring programme

The ARC's beach profile monitoring programme records long-term changes in the shape of 16 beaches around the Auckland region and helps the council to understand how much sand is being transported onshore and offshore. The monitoring record ranges between 10 and 30 years.

All beaches that are monitored display variability, with phases of erosion and accretion. The degree of variability appears to be linked with local wave exposure. The west coast beaches of Muriwai and Piha show the greatest fluctuations in sand volume in response to high energy waves driven by the prevailing westerly winds. North-east coast beaches at Mangawhai, Te Arai, Pakiri and Omaha are exposed to moderate energy waves and can experience large variations in sand volume and beach width, primarily in response to north-easterly storms that cause erosion. In contrast, sheltered sites in the inner Hauraki Gulf (e.g. Kawakawa Bay, Maraetai and Orere Point) show the smallest variations. Changes in sand volume and beach width along the east coast bays are not as pronounced as north-east beaches but are greater than sheltered beaches.

Indicator 8: Amount and impact of beach erosion

Since 2004, beaches around the Auckland region have remained in a stable state despite short-term fluctuations in sand volume and beach width. Over the same period there has been no significant erosion damage to any developments located opposite beaches. However, the construction of new protection measures to slow any potential coastal erosion did result in significant costs over this period. For example, restoration of the sheltered beach at Kohimarama in 2006 cost $6 million, although the enhanced amenity value and improved infrastructure protection made this feasible.

Erosion on beaches that are exposed to higher levels of wave energy (such as those on the west coast) are treated differently, as engineering solutions often do more harm than good or are not feasible due to cost. In 2008, the decision was made to relocate the Muriwai Surf Club since the alternative, a protective seawall, would increase erosion along the beach.

Cliff erosion

Cliff erosion is not monitored consistently in the Auckland region but a recent review provided some estimates on the potential rates of cliff erosion over the next century (up to 2100). The predicted erosion rates were based on the modelling of historical erosion rates, geological conditions and predicted future sea level rise.

The geology (rock type and structure) of coastal cliffs is an important factor in determining their ability to resist erosion and this is reflected by the predicted rates for cliff erosion around the Auckland region over the next century, as shown in Figure 2.

The predicted erosion rates vary from zero for cliffs within the Hauraki Gulf composed of hard basalt to 347m in the soft alluvium cliffs along the exposed west coast of the Awhitu Peninsula. Much of the east coast within the Auckland urban area is bordered by cliffs composed of alternating beds of sandstone and siltstone. At present, these cliffs retreat at an average rate of 0.2m to 10m every century. These rates are most likely to represent episodic erosion events as the brittle nature and alternating sequence of rock types makes them susceptible to landslides. Over the next century, sandstone and siltstone cliffs are predicted to retreat between zero and 59m, potentially threatening a large number of coastal properties. Similarly, the greywacke cliffs bordering Waiheke Island and Maraetai are expected to retreat between 6m and 54m, which may threaten the stability of some cliff top buildings.

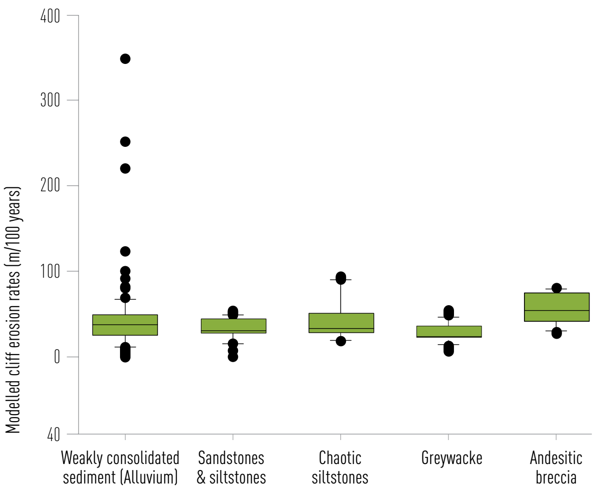

FIGURE 2 Range of modelled erosion rates for cliffs of different rock types around the Auckland region. (Source: ARC).

Indicator 9: Amount and impact of cliff erosion

Coastal cliff erosion has caused considerable impacts on Auckland properties in recent times. Within the last five years two highly publicised cliff failure events occurred: one at Little Shoal Bay in 2003 and the other at Bucklands Beach in 2008. 10m to 15m of cliff erosion occurred at both sites resulting in damage (or the threat of) to adjacent buildings.

At Little Shoal Bay, a property worth $1 million was decommissioned after heavy rainfall triggered a cliff failure. Remedial work could not be undertaken to save the house due to the size of the landslide.

In 2008, a cliff at Clovelly Road in Manukau City was destabilised during heavy rainfall, causing the evacuation of six properties. The loss of land and property totalled $1.5 million with further costs incurred by the property owners from site investigations and remedial work that was required to stabilise the cliff face.

The east coast of the Auckland region may continue to experience property loss and/or damage due to dense urban development on the top of actively eroding coastal cliffs.

Coastal flooding

High tides, storm events and large waves can combine to temporarily raise the sea level at the coast, causing flooding of low-lying coastal land. Around the Auckland region, the likelihood of coastal flooding is dependant on several factors that include the elevation of sea level (this can vary due to atmospheric pressure and the season), elevation of the coastline and the distance inland that waves run up.

Coastal flooding levels were modelled for the east coast of Rodney District in 2005 and for North Shore City in 2008, based on a ‘worst case’ scenario with a 1 per cent annual chance of occurrence (Figure 4). The amount of coastal flooding was calculated for present-day, 2050 and 2100 sea level to demonstrate how risk could increase in response to a future rise in sea level. The results suggest that coastal flood levels may rise 3m to 5.9m above Mean Sea Level (MSL) in Rodney District and between 3.1m and 4.6m along North Shore city. Variations in flood levels along these coastlines are the result of local variations in the type of shoreline, amount of exposure to waves and the tidal heights.

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Natural hazards

Higher coastal flood levels, possibly more than 4m above MSL, are more likely to occur on shorelines that are exposed to high wave energy, such as those along the outer Hauraki Gulf or coastal sites that are armoured with coastal protection structures such as Gulf Harbour (this site has a potential to be inundated to 5.9m above MSL).

At Browns Bay on the North Shore, the modelled coastal flood level of 4m above MSL corresponds reasonably well with the approximate level of 3.5m above MSL that was recorded during the 1936 storm (this storm produced the region's worst coastal flooding in the last 100 years).

Indicator 10: Number and impact of coastal flood events

No significant coastal flood events were reported between 2004 and 2008, although minor incidents are known to have occurred along the east coasts of the Rodney and Franklin districts during storms in the winter of 2007 and September 2008.

Tsunami

A tsunami is a series of waves that form when an underwater earthquake, landslide or volcanic eruption displaces the seawater. In deep water, these waves are almost unnoticeable, but as they approach more shallow water near the coast they slow down and water piles up vertically to create extremely high and powerful waves. Some tsunami waves can be tens of metres high when they break onshore.

Historic and geological records indicate that the east coast of the Auckland region is most at risk from tsunami events in the long-term. The east coast is exposed to a number of areas around the Pacific Rim that can potentially generate tsunami waves. These areas can be classified as distant, regional and local sources.

Distant sources are located around the outer Pacific Rim where the Pacific plate boundary collides with various other tectonic plates. Historical records show that the distant tsunamis most likely to impact the Auckland region are generated off the Chilean coast. The largest historical event from this distant source occurred in 1960, when an earthquake produced a tsunami with estimated wave run-up heights above MSL of 2.9m on Great Barrier Island and 1.5m at East Tamaki.

Regional and local sources of tsunami waves often produce wave heights that are, locally, much larger than those from distant sources. Historically, the Kermadec Island area is the most frequent source of tsunami waves although these have tended to be small with an average wave height of 100mm above MSL.

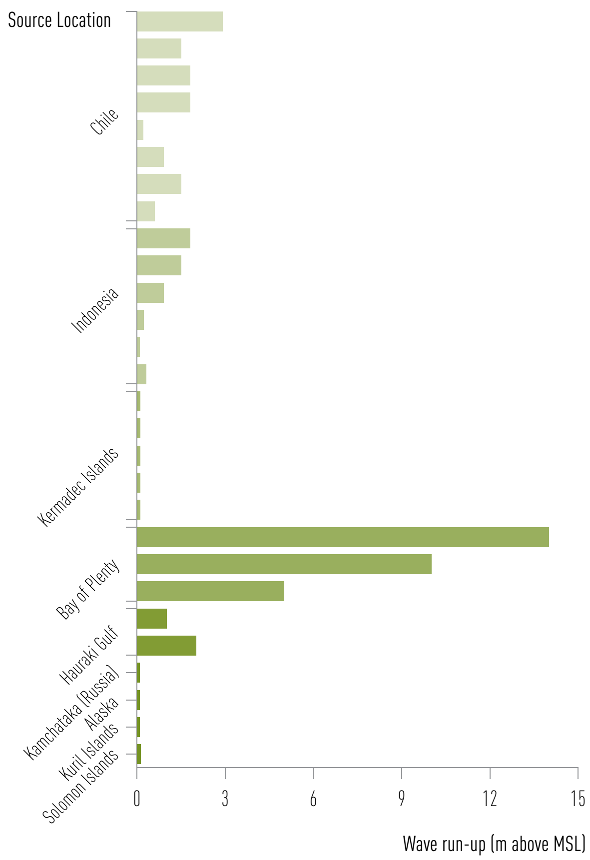

FIGURE 3 Source locations and tsunami wave run-up heights for historic and prehistoric tsunami events that have impacted the Auckland region. (Source: ARC).

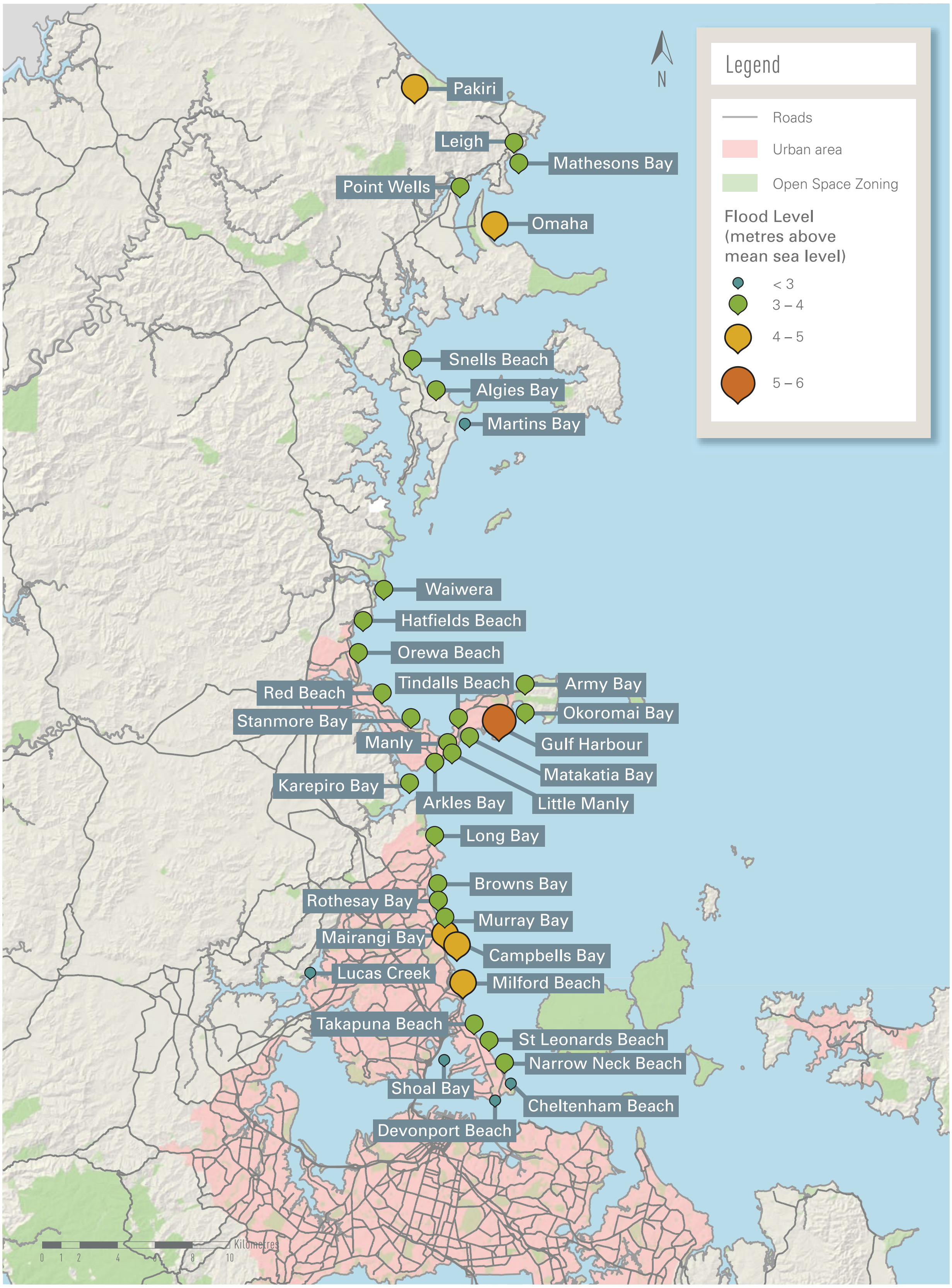

FIGURE 4 Predicted height of coastal flooding along the east coast of Rodney District and North Shore City, 2005. (Source: Tonkin and Taylor).

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Natural hazards

Geological records indicate that considerably larger tsunami events have occurred in the past, possibly generated off the Bay of Plenty. Three events with estimated wave run-up heights between 5m and 14m are thought to have occurred within the last 2600 years (a return period of once every 870 years) although tsunami waves of this magnitude have not occurred in recent times. A similar event in the future will pose an extreme hazard to low-lying land on the east coast of the Auckland region, as tsunami waves from regional and local sources can arrive within one to three hours, giving people and the emergency services little time to respond.

The potential consequences for various tsunami scenarios has been modelled by GNS Science (Table 2).

Scenario modelling does have limitations when attempting to predict an outcome from infrequent events, but the GNS Science study provides an insight into how a tsunami event could impact the Auckland region. A one in 500 year tsunami event generated off the Chilean coast is likely to result in wave heights of 1.7m to 3.6m in the Auckland region, with larger waves affecting eastern coastlines. These waves would have a 50 per cent chance of causing about $2.16 billion in damage to buildings along with 120 deaths and 1230 injuries across east coast cities. In reality, deaths and injuries would be less for a tsunami originating off the Chilean coast as there would be a 12 hour to 15 hour warning time for coastal evacuation.

TABLE 2 Possible shoreline wave heights, building damage costs, deaths and injuries in urban areas in the Auckland region resulting from tsunami. (Source: Adapted from GNS Science).

City/ District	Wave height at shoreline (m)	Cost ($m)	Deaths	Injuries
Auckland (East)	3.6	1300	36	400
Auckland (West)	1.7	0	0	0
Manukau (East)	3.4	300	34	340
Manukau (West)	1.7	0	0	7
North Shore	3.5	430	28	300
Waitakere (East)	3.5	130	22	190
Waitakere (West)	1.7	34	2	33

The values shown in Table 2 will increase for regionally sourced tsunami events that could reach Auckland within one to three hours and create wave heights greater than 5m on the east coast.

Tsunami monitoring programme

Tsunami are measured from tidal gauges located on both the east and west coasts of the Auckland region. The tidal gauges are administered by external organisations (NIWA, Land Information New Zealand (LINZ) and the Ports of Auckland). The ARC has access to the tidal records.

Indicator 11: Number and impact of tsunami

Two tsunami events were detected by the tidal gauges in the Auckland region between 2004 and 2008:

- On 26 December 2004, an earthquake generated tsunami in the Indian Ocean was recorded on tidal gauges in the Kaipara, Manukau and Waitemata harbours. This tsunami originated 9,000km north-west of the Auckland region, therefore only small rises in the coastal water levels were noticed around the region. On the west coast, the tsunami wave varied between 0.22m and 0.31m and this decreased to 0.08m on the east coast as the tsunami wave was refracted around New Zealand. The west coast was closest to the tsunami generation area and therefore experienced the greatest tsunami wave height.
- Similarly, a 0.11m tsunami wave near the Solomon Islands on 1 April 2007 was recorded at Anawhata.

State of preparation for natural hazard events

The vulnerability of people, property and businesses to the impacts of natural hazard events depends not only on the likelihood of an event but also on people's preparedness to respond effectively and lessen the impact.

Advance preparation by individual households can limit vulnerability to harm both during and after a natural hazard event. Advanced preparation by businesses, and infrastructure that is engineered to withstand the impacts of natural hazard events, serve to reduce the level of social, physical and economic disruption to human populations and speed the return to normal conditions.

Household preparation

The relative infrequency of some types of natural hazard event in the Auckland region and a lack of firsthand experience of their consequences often makes it difficult to effectively communicate the importance of preparation. A 2008 survey found that people in the Auckland region are less prepared for natural hazard events than those in the rest of New Zealand, with 59 per cent admitting that they are not well prepared – or are not at all prepared – for a disaster, compared to the national average of 45 per cent.

Natural hazards

Knowledge of natural hazards is relatively poor, with a quarter of all the people in the region and almost half of non-Māori or New Zealand European ethnic groups unaware of the types of natural hazards that threaten the area. In addition:

- only 35 per cent of Auckland households have an emergency survival plan, compared to the national average of 50 per cent.
- only 32 per cent of Auckland households have sufficient water for each occupant for three days, compared to the national average of 46 per cent.
- only 67 per cent of Auckland households have emergency survival items, compared to the national average of 79 per cent.

This lack of knowledge or desire to participate in disaster planning is of concern, as it means there is a poor level of preparation amongst households in the Auckland region.

Emergency survival plans, sufficient water and emergency survival items can be used for all types of natural hazard events. A significant number of Auckland households need to improve their level of preparation for natural hazard events if their occupants want to lessen their vulnerability, protect themselves and ease their dependency on emergency services.

Business preparation

There is currently a lack of knowledge about the amount of advance preparation and disaster planning done by businesses in the Auckland region.

Insurance

Insurance plays an important role in creating communities that are resilient to natural hazards. Individuals and businesses that insure against natural hazards can reduce their economic losses substantially, as insurance can prevent or reduce the need to pay for damage, home and business displacement or relocation. It can also cover income and productivity losses during the recovery period following an event. Information on the total percentage of Auckland households and businesses insured against natural hazards is sensitive, but all households are covered by the Earthquake Commission (EQC) for damage caused by earthquake, landslide, tsunami, volcanic eruption, storm and flood (residential land only) and hydrothermal activity. If a house is impacted by these events, the EQC will pay up to $120,000 for damage to property and possessions, with insurance companies covering any remaining damage that is insured. The ARC encourage households and businesses that may be located in hazardous areas to insure themselves against natural hazard events.

Conclusions on natural hazards

The Auckland region was impacted by a variety of natural hazard events between 2004 and 2008. The majority of events were triggered by climatic hazards with flooding, landslides (including coastal cliff instability) and tornados experienced by a number of communities. These events had localised impacts that often resulted in property damage, infrastructure failure and/or disruption to normal life.

Climatic hazard events caused the most damage, with a spate of floods and landslides during the winter of 2008 affecting thousands of people and causing millions of dollars in property damage, clean-up and remedial works. Other associated (but immeasurable) costs to affected individuals and communities resulted from disruption to daily routines and loss of livelihood. On an individual basis, the climate-induced hazard events that affected the Auckland region were not catastrophic though their cumulative impact was regionally significant. Future climate change could potentially increase the frequency and intensity of heavy rainfall events leading to more flooding and landslides (see Climate change in Part 1).

Geological hazards had a minimal impact on the Auckland region when compared to climatic hazards. Although these types of natural hazard are known to threaten the Auckland region, they occur far less frequently than climatic hazards. Nevertheless, it remains important to assess the consequences that geological hazard events may have on communities in the Auckland region. For example, a volcanic eruption in the Auckland region could have a significant impact on businesses, particularly in terms of job losses, and result in a substantial decline in both regional and national GDP. However, the depth of the resulting economic downturn could be reduced somewhat by suitable advance preparation by regional businesses.

Up-to-date regional information on natural hazards and their impacts is vital to enable the ARC to implement risk reduction mechanisms in the best and most effective way. Our involvement in planning, civil defence emergency management and education also helps to reduce the risks that natural hazard events pose to Auckland communities. However, our involvement is only a part of creating communities that are prepared to deal effectively with natural hazard events because, ultimately, individuals need to take ownership of their risk. A significant number of Auckland households need to improve their levels of natural hazard awareness and preparation.

5.1

Natural hazards

ARC responses

Natural hazard management and planning

Preservation of human life is the most important aspect of natural hazard management and planning. The ARC currently plays a leading role in co-ordinating natural hazard management across the Auckland region. Natural hazard management is undertaken through various regulatory and non-regulatory actions that involve a number of groups from local authorities, central government, infrastructural organisations, emergency services, crown research institutes, universities and the public.

The Auckland Regional Policy Statement (ARPS) identifies natural hazards in the Auckland region, and was amended in 2005 to clarify roles and responsibilities in natural hazard management. These amendments also covered a wider range of natural hazards and hazard management responses, as required by new or amended legislation including the Civil Defence Emergency Management Act (2002), the Building Act (2004) and the Resource Management (Energy and Climate Change) Amendment Act (2004).

The ARPS includes policies and methods that try to direct development and land use activities to avoid or lessen the impacts of natural hazards. Further provisions provide local authorities with the means to undertake non-regulatory measures to try and lessen the potential impacts of natural hazard events that occur only occasionally in the Auckland region (such as volcanic eruptions and earthquakes).

The Auckland Regional Plan: Coastal contains policies and methods that relate to natural coastal hazards (particularly coastal erosion and flooding). It promotes the avoidance of natural hazard events and the reduction of risk from coastal erosion, and contains criteria and rules for coastal hazard protection works.

The Proposed Auckland Regional Plan: Air, Land and Water contains policies and rules to address stormwater runoff and flooding. The rules cover discharges to land and water, the building of structures, works in riverbeds and land drainage activities, and aim to avoid or minimise the likelihood of creating a stormwater or flood hazard. The plan emphasises the need to undertake land use activities in such a manner that flooding of adjacent land or the exacerbation of existing flooding problems are avoided.

The Auckland Regional Plan: Sediment Control deals with soil erosion issues, particularly for land development or redevelopment activities that involve vegetation clearance and/or earthworks. Emphasis is placed on the sediment and erosion control initiatives.

Natural hazard risk assessment

Natural hazard risk assessment for the Auckland region is currently carried out by the ARC, local councils (either independently or in partnership with the ARC), GNS Science, NIWA and some universities, particularly the University of Auckland. The likely impacts of natural hazard events on communities are identified from recent events and also from scenario modelling based on historical events.

Information generated by these organisations is used to improve our understanding of natural hazards and the risks that they pose to the Auckland region. This provides a basis for developing the policies and rules in regional, district and city plans, in catchment management plans, public education policies, emergency management planning and exercises, and infrastructural development.

Research into natural hazards and the likely impact of events is vital to reduce the level of risk to people throughout the Auckland region. For example, by providing a snapshot of the consequences that people in the Auckland region could face from events they have not yet experienced.

Working with the community

The ARC currently works with other councils and organisations to improve public awareness of natural hazards, and to limit the potential impacts of natural hazard events on communities throughout the Auckland region:

→ Information provision. Provision of natural hazard information to the public through its website (and the Auckland Region Civil Defence Emergency Management Group website), group presentations, answering public enquiries, and online technical publications and fact sheets.

→ Civil Defence Emergency Management. Assisting the Auckland Regional Civil Defence Emergency Management Group in public education and provide natural hazard information for emergency management planning and exercises.

→ Natural hazard prevention. Provision of a range of courses and workshops to assist industries involved with land modification to limit erosion and flooding impacts. Auckland also has a number of Beachcare groups that are run by volunteers enabling local communities to take action on environmental issues affecting their coastlines. Support is provided to these groups including guidance on how to rejuvenate and maintain coastal systems (such as sand dunes) to improve both the environment and natural hazard management.

→ Lifelines Groups. The Auckland Engineering Lifelines Group is a voluntary group of 'lifelines' organisations (e.g. gas, electricity, water, transport) with representation from councils including the ARC who assists with administration and research to help identify natural hazards and lessen their effects on the lifeline utilities.

Case Study: Turei Hill Landslide, Kawakawa Bay, Manukau City (2008)

On 24 August 2008, a prolonged period of rainfall triggered a 500m³ landslide on Turei Hill closing the major access road to the coastal settlement of Kawakawa Bay and isolating residents.

Ground investigations following the landslide revealed it to be a part of an older 150,000m³ to 250,000m³ landslide that was sliding toward the Clevedon-Kawakawa Road and Kawakawa Bay houses (Figure 1).

FIGURE 1 Aerial view of the 24 August 2008 landslide that blocked the Clevedon-Kawakawa Bay Road. The larger landslide which threatened a house is indicated by the white dash line. (Source: Manukau City Council).

Monitoring the landslide's movement revealed that five homes and the Clevedon-Kawakawa Bay Road were in imminent danger from slope failure. The homes were evacuated and the road closed for four weeks until the slope movement ceased. During this time, 1,500 residents had to travel an extra 100km or walk over Turei Hill to get to work or school. The community's isolation also impacted local businesses. In the month following road closure, the Beachcomber Motel had one customer (a lost driver) while Kawakawa Bay Motors petrol sales dropped more than 50 per cent. The community's isolation and loss of business revenue demonstrates the indirect impacts of a landslide event.

Remedial works to stabilise the landslide began in September 2008, when the rain eased (Figure 2). To ease pressure on the slope toe 66,000m³ of earth was removed from the upper slope after a decommissioned house was demolished.

The entire landslide was buttressed at the slope toe by 12.5m and 24.5m high retaining walls backfilled with 34,000m³ of earth from the upper slope. A network of 35 drains was constructed to remove groundwater while 70 rock anchors (each 45m long) hold in place retaining walls and cut slopes. On completion of earthworks the slope will be revegetated to cover bare soil and improve visual amenity.

The large-scale remedial works to stabilise Turei Hill required nine months of seven day working weeks. Opus International Consultants indicated the cost of these works was about $5.3 million which was jointly funded by Manukau City Council, the New Zealand Transport Agency and the Earthquake Commission. This option was preferred over an alternative road into Kawakawa Bay and removal of five threatened houses at a cost of $13 million.

The 2008 Turei Hill landslide demonstrated how relatively common natural hazards can cause major disruption to communities in the Auckland region.

FIGURE 2 Aerial view of the earthworks being undertaken in May 2009 to stabilise the Turei Hill landslides. (Source: Manukau City Council).

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Natural hazards

References and further reading

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