

Risk Register to Support the Otago CDEM Group Plan

April 2017

For Further Adaptions and Amendments See Versions Log

Currently under review/rewriting

Dr. Leon Goldsmith and Michael Goldsmith Block

Seven Limited

April 2017

Versions Log

Version 1 03/2017 - Block Seven

Version 2 06/2017 - Block Seven

Version 3 07/2017 - Sarah Hexamer (Additional information relating to sections 2.2/2.3 specifically Fruit industry)

Version 4 -

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BIBLIOGRAPHIC REFERENCE

Goldsmith, L., and Goldsmith, M. 2017. Risk Register for the Otago CDEM Group Plan, *Block Seven Limited Consultancy Report 2017/03*.

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Overview

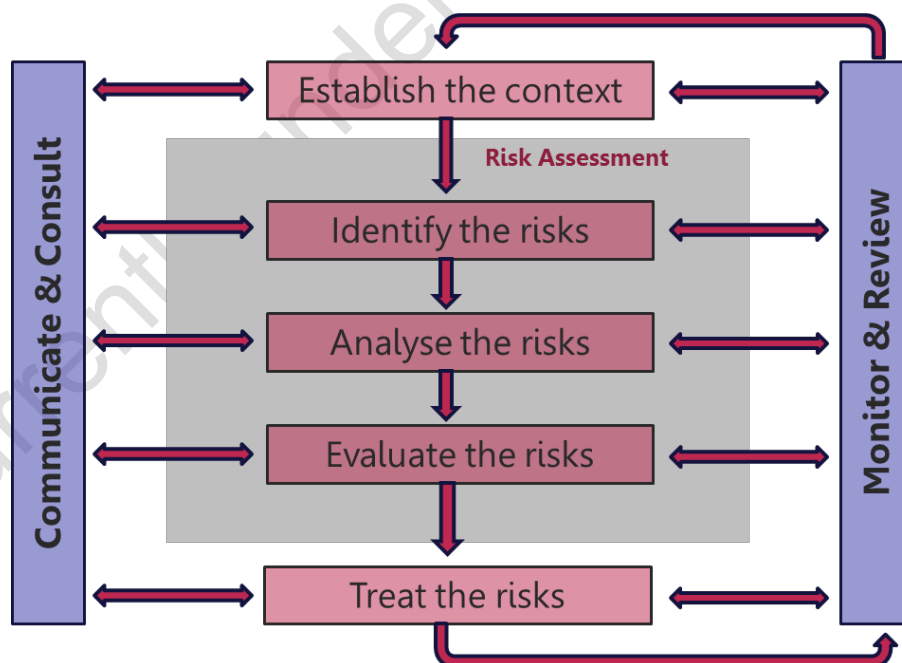
The previous version of the Risk Register in the Otago CDEM Group Plan (developed in 2012) was largely generic, and did not cover all risks in the Otago Region, nor describe the risks in sufficient detail. Additional work on natural hazards, in particular, has also been undertaken since 2012, which has been used to help inform this updated Risk Register (see Appendix A).

In general, the responsibility of the Otago CDEM Group is to respond to sudden or catastrophic events, rather than long-term processes.¹ The purpose of the Risk Register is to describe the risks to Otago's social, natural, built and economic environments (i.e. the people, the land, the buildings/infrastructure and the economy).

The definition of risk for the purpose of this report is taken from *ISO 31000:2009 Risk Management – Principles and Guidelines*, which is considered to be the most current and up-to-date international standard setting out principles and guidelines for risk management processes.²

The sections of this Risk Register describe the risks relevant to the Otago CDEM Group Plan thematically according to the four broad categories of Otago's social, natural, built and economic environments. Subsections of these themes will provide further detail of the specific risks in each sector as well as discussion of risk awareness and risk interactions across sectors. The social environment sub-sectors include health and education; the natural environment includes farming, viticulture, apiaries, and fruit growing; the built environment includes airports and other vital lifelines; finally the economic environment is divided between business and tourism – the latter being an important industry in the Otago region.

The final part of the updated register summarises and critically examines the contemporary risk profile of the Otago region, with particular attention to the potential impacts and flow-on effects of the most significant risks. Risk areas and interactions that may require new approaches or greater awareness in terms of the affected themes are also discussed



¹ For example, the immediate effects of shoreline erosion on people and property may be dealt with by the Group as part of the response to a storm event, while the gradual and ongoing process of coastal erosion would be dealt with through District Plans and council infrastructure works programs.

² Tonkin & Taylor, (2016). *Risk Based Approach to Natural Hazards under the RMA*

Methodology

Risk Management Principles and Processes

This review of the Risk Register for the Otago CDEM Group Plan has considered the risk management principles and processes established in the ISO 31000 standard. In particular, it is noted that an organisation³ should be able to understand its risks so that their significance can be judged, and appreciate whether the risk should be accepted or modified.

Other guidance provided by the ISO 31000 standard, and its relevance to the review of the register is listed below:

- The standard defines risk as “*the effect of uncertainty on objectives*”, and it encourages decision makers to understand the overall complexity and uncertainty of relevant systems, as well as their significance for the particular outcomes that an organisation is seeking. Therefore, to gain a full understanding of a risk profile of the Otago Region, the review of the register has taken a “whole of system” approach, with consideration given to the overarching outcomes (or goals) the Otago CDEM Group is seeking; the full range of consequences that may arise from various hazards and processes; the complex range of interactions between multiple risk sources; and the nature and extent of uncertainty with respect to how people or systems will behave, or how events may occur.
- The ISO 31000 standard provides a flexible approach to how risk can be characterised or expressed, and for this project, a more descriptive and qualitative approach has been taken, rather than a fully quantitative method.
- It is noted that the risk profile of Otago, as provided by the updated register, forms an integral part of the risk management process for the region, as illustrated in the figure below.

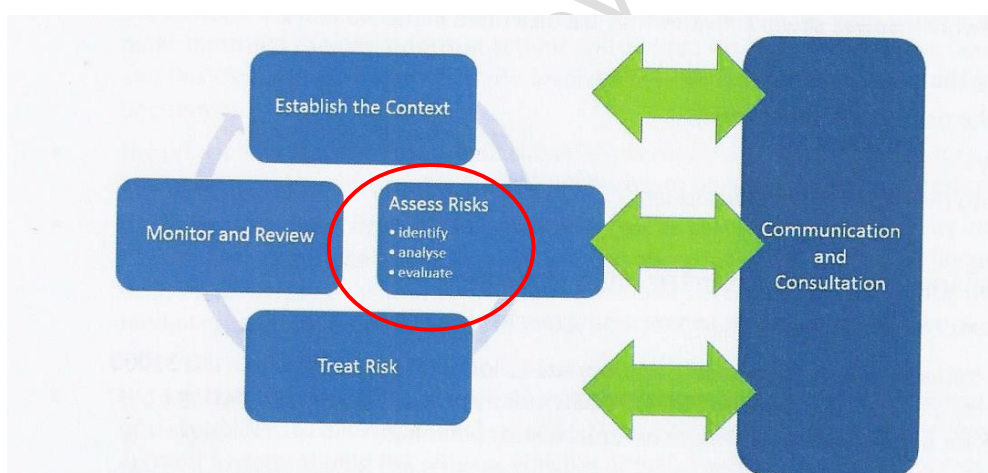


Diagram illustrating the iterative risk management process (taken from Tonkin & Taylor, 2016). The identification of the risk profile for a particular area or agency forms part of this cycle, and is marked in red.

Data collection methods

The key method used to collect information to update the Otago CDEM Group Plan Risk Register was primary data gathering from key stakeholders. A 1-day workshop was held at Alexandra, Central Otago on 7 March 2017. This workshop provided an opportunity to gather data directly from stakeholders, to supplement natural hazard and ‘lifelines’ information previously published by the Otago Regional Council (ORC) and other agencies. The workshop allowed for greater detail to be added to existing information contained in the previous version of the Otago CDEM Group Plan.

³ In this case, the organisation is the Otago CDEM Group.

Alexandra was selected to provide a central location to facilitate attendance from experts in each sector from across the region.

The workshop was structured to allow expert representatives from each sector to explain their specific risk profiles and risk perceptions via short presentations. The second part of the workshop involved 5 rounds of cross-sector discussion of around 15 minutes each. These discussions were captured into a matrix template, where participants noted cross-theme / cross-sector risks, and ranked those risks as either **low**, **medium** or **high**.

The matrix (see Appendix D) cross tabulated specific sectors with 6 key potential hazard areas. These included:

- *pandemic*
- *natural hazards*
- *biosecurity*
- *economic crash/crisis*
- *political instability, and*
- *man-made disaster.*

The objective of the workshop was to obtain essential primary data from participants and foster crucial dialogues between different themes / sectors around risk and risk interactions in the Otago region. The results from this workshop have been valuable in informing this updated risk register for the Otago CDEM Group Plan.

A much larger sample of respondents, as well as quantifiable social, economic, and environmental data (both historical and contemporary) would need to be gathered and thoroughly analysed in order to constitute any scientific certainty around the level of specific risk in each sector. This limitation has been largely offset in this work by targeting the most qualified available key informants capable of speaking to a range of issues in each theme/sector. A number of experts who were unable to attend the workshop were interviewed separately, and these people are listed separately in AppendixC.

It is noted that the comments and issues included in this report are based on the opinions of the experts from each sector who participated in the workshop, or who were interviewed separately. Additional research has been incorporated where necessary, along with key knowledge held by the authors and the Otago CDEM Group.

Hazards and Risks in Otago

The review and development of the risk register for the Otago CDEM Group Plan in 2017 considered the risk management principles and processes established in the ISO 31000 standard.

Otago is at risk from natural hazard events such as earthquakes, floods, severe weather, and landslides which can damage property and threaten human life. The Otago Regional Council has identified and studied numerous hazards. Flooding is the most regular event, with the July 2017 and June 2015 floods affecting communities in Dunedin and coastal Otago. An earthquake from the Alpine Fault is assessed as the maximum credible risk to the region. Local faults including the Akatore near Dunedin have also been identified as posing a significant risk. Other threats include biosecurity, pandemics, coastal erosion, climate change and man-made catastrophes such as terrorism.

- Otago has the second largest land area of any region in New Zealand, covering approximately 36,000 sq km or 12% of New Zealand's land area. Otago is bordered by Southland to the south, the West Coast to the west, and Canterbury to the north.
- The two main rivers are the Waitaki River on the northern boundary and the Clutha River in the south, and the region also includes the large lakes Hawea, Wanaka and Wakatipu as well as man-made lakes at the Clyde and Roxburgh dams.

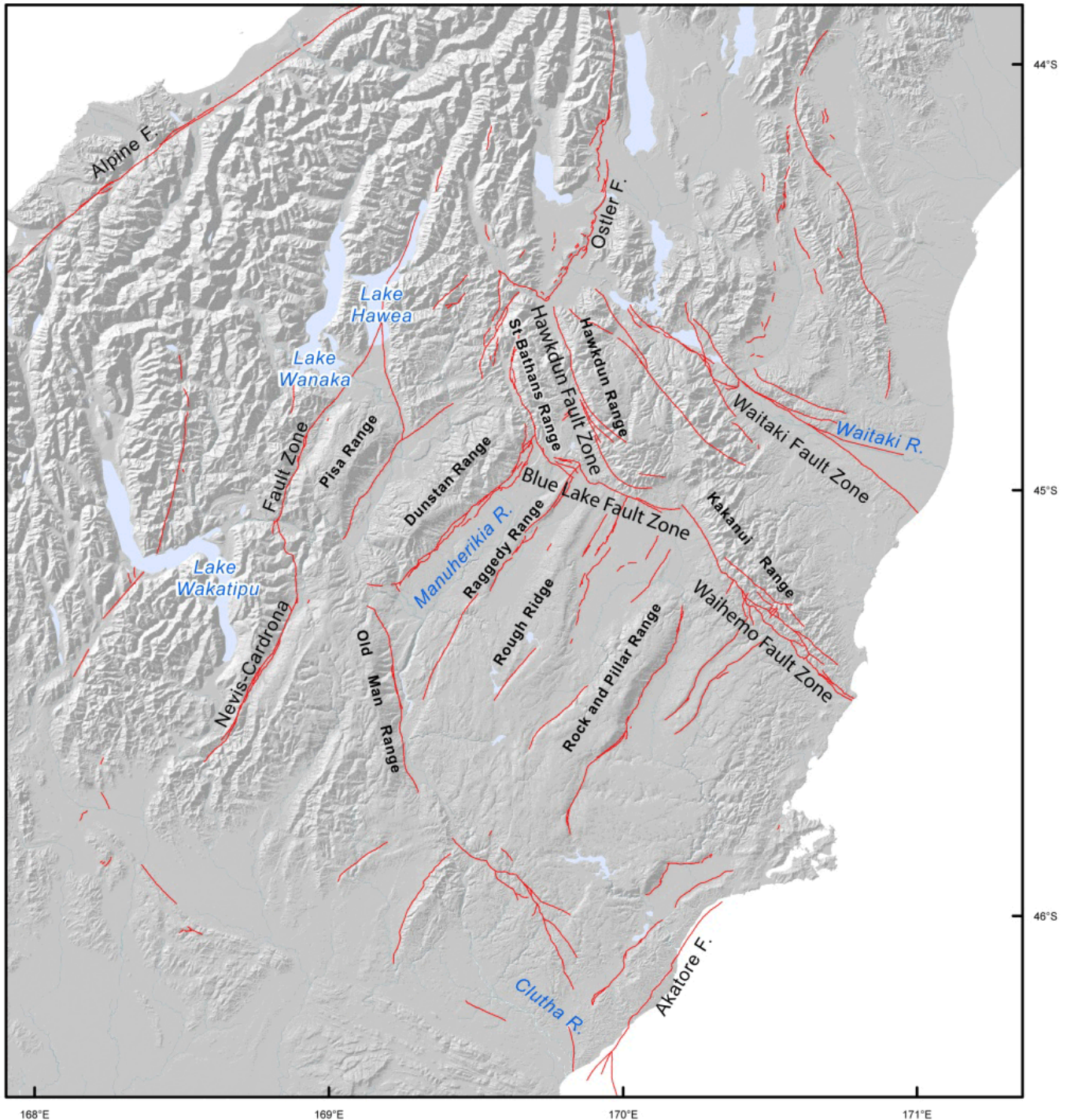
- Otago has a relatively dispersed population of 229,200¹. This, plus the nature of Otago's economy and infrastructure, has several implications for CDEM:
 - Limited access to major population areas makes many residents dependant on the ongoing support and maintenance of supply chains.
 - The rapid and sustained growth in residential dwellings, retail development and subdivisions in the Queenstown Lakes and Central Otago districts create challenges and opportunities for Otago's overall resilience, response, and recovery throughout a significant event.
 - The high numbers of tourists and holiday home owners in Queenstown Lakes and Central Otago districts create major challenges. Most visitors to the area are transient and have little awareness or understanding of the local hazardscape. Preparing them for the unexpected and informing them during an emergency is more challenging than reaching the resident population, and they will have very different needs during and after an event.
 - Queenstown Lakes District resident population is forecast to grow by 2.6% each year each year over the next 10 years and visitor numbers by 2.4% per annum.²
 - Dunedin, Queenstown Lakes and Central Otago are also experiencing significant growth in residential and commercial developments. The National Policy Statement for Urban development recognises Central Otago and Queenstown Lakes are experiencing high growth and Dunedin is noted as having medium growth. This growth will create increased need for CDEM capacity in these districts.
 - Otago University has 21,000 ([Otago University Quick Stats Data](#)) students in Dunedin, of whom 17,000 are from outside the city so have less awareness of the local hazardscape. Surveys consistently show that young people have less interest in preparing for emergencies, making this group a challenge for increasing resilience.
 - The size and influence of the tourism industry also means that the group area is susceptible to economic impacts if a major disaster deters tourists from coming to the area.
 - Otago's electricity generation facilities and the HVDC link are nationally important.
- The importance of primary production and processing to economy makes it more vulnerable to events that disrupt these sectors such as drought, flooding and snowfall.
- The relative importance of key sectors (e.g. tourism, agriculture, education) varies considerably between different parts of Otago, meaning that the CDEM issues and appropriate responses vary across the region.
- Climate change is predicted to increase frequency and severity of emergency events, such as more intense rainfall and associated flooding, more frequent and intense droughts, more damaging winds and increased wildfire risk, sea level rise and a change in wave patterns especially in eastern areas.

¹ Data collected from Stats NZ estimated population data 2018. <https://www.stats.govt.nz/information-releases/subnational-population-estimates-at-30-june-2018-provisional>

² Otago Regional Council Long Term Plan 2018-2028 pg26

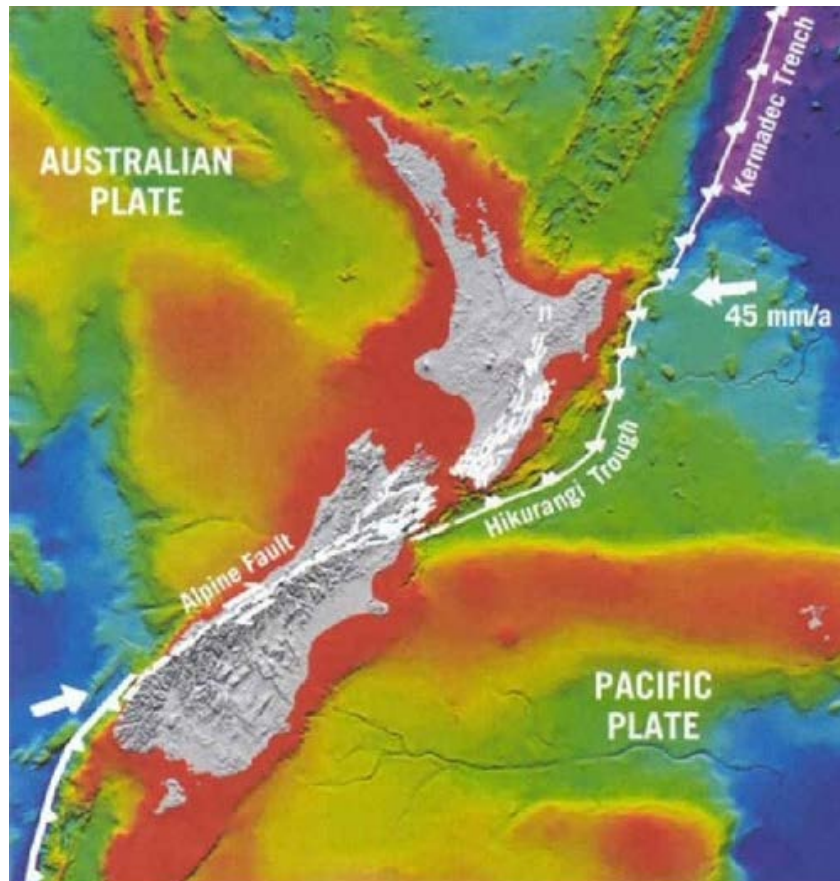
Seismic Risk in Otago

A severe earthquake in a major urban area (Dunedin, Oamaru, Queenstown, Wanaka, Alexandra, Balclutha) could have substantial social, environmental and economic consequences, as experienced in Christchurch in 2010 and 2011. There are several active faults in Otago which increase earthquake vulnerability near the Otago boundaries and within the region itself. There are faults with evidence of activity in the Holocene period (last 10, 000 years) which includes the Cardrona, Dunstan, Rough Ridge, Hyde, Taieri Ridge, Waihemo and Akatore faults (Murashev & Davey, 2004). These faults also pose significant risks to key roads and other lifelines in rural areas (ibid).



The Alpine Fault

The Alpine Fault connects two subduction margins where the ocean floor descends into the earth's mantle and the surfaces of the Australian tectonic plate and the Pacific tectonic plate meet (Davies, 2017). There may be no warning of an Alpine Fault rupture and a series of large earthquakes followed by aftershocks causing significant damage is expected, based on scientific research. Secondary hazards from an alpine fault rupture may include landslides, rock avalanches, flash flooding, lake tsunamis and liquefaction. Similar to the Christchurch earthquakes, aftershocks and secondary hazards may continue for months or years.



The Alpine fault

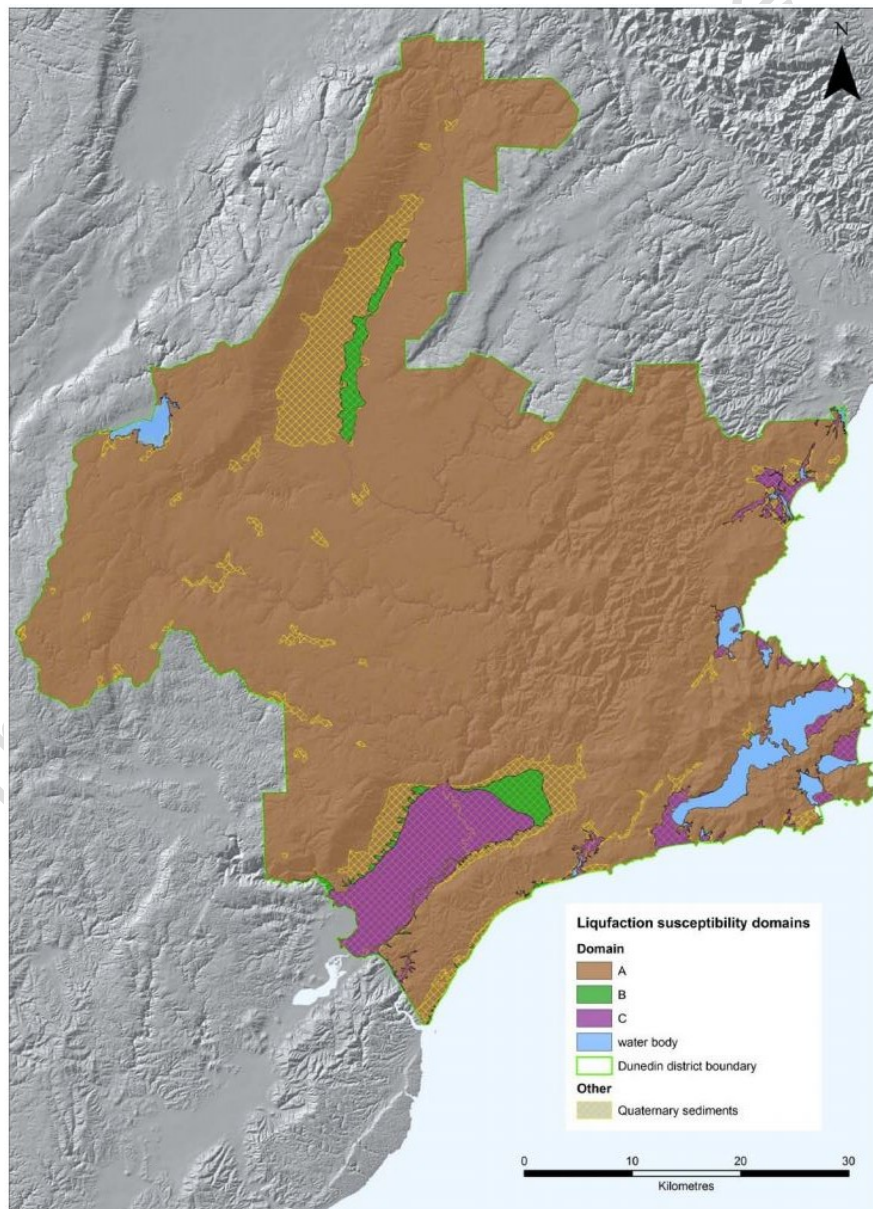
The Alpine Fault is unique in that it has consistently produced a magnitude 8 plus earthquake on average every 300 years for the past 8000 years. The last time was in 1717. It is Otago's most credible devastating threat with an estimated probability of 30 to 50% likelihood in the next 50 years. An earthquake of this magnitude will have a significant impact on the Queenstown Lakes District where at any one time up to 70,000 visitors may be present. They constitute a vulnerable population with no or little understanding of the hazard and a natural expectation that they will arrive in the area and leave again the same day or soon thereafter. While the airport may be useable the roads in and out of the town are likely to be damaged and impassable. It is clear from the seismic modelling done by GNS Science and Project AF8 that all parts of Otago will be directly impacted to a greater or lesser degree by a rupture on the Alpine Fault. Planning for this as Otago's maximum credible event provides confidence that the planning, training and exercising we undertake will enable an effective response to any lesser emergency.

[Project AF8](#) is a significant ongoing project that is now in its third year in 2018. The SAFER Framework enables a coordinated a South Island wide response based on consistent action within districts both collaboration and cooperation across districts.

Liquefaction

Liquefaction is a process where earthquake shaking causes poorly constructed, groundwater-saturated, geological materials to lose strength and stiffness, due to increased groundwater pore pressure in the material (Barrell et al., 2014). As sediments are shaken, they act like a fluid or shaken jelly, causing deformation, cracking, subsidence of the ground and sometimes lateral spread towards rivers or lakes. Liquefaction can cause severe damage to infrastructure, such as breaking of foundations, fracturing of pipes and buoyant rises of light buried structures such as tanks (ibid). Areas with unconsolidated sediments, soils, and high groundwater tables have a high risk exposure to liquefaction and settlement of soils. Locations close to active faults have a higher risk exposure to liquefaction due to intense ground shaking.

GNS completed an assessment of the liquefaction hazards in the Dunedin district in 2014. The report divided the district into liquefaction susceptibility domains (**Error! Reference source not found.**). Domain B includes areas underlain by river or stream sediments and has a low to moderate likelihood of saturated liquefaction-susceptible sediments. Domain C includes areas underlain by young marine or estuarine sediments and includes South Dunedin and the Taieri Plains. These areas have a moderate to high likelihood of containing liquification-susceptible sediments.



Overview of Map of liquefaction susceptibility domains for the Dunedin district (GNS)

Flooding

Floods are the most common emergency in Otago. Our communities often experience inundation from rivers and streams and we are also more regularly experiencing significant surface flooding after intense localised rain, requiring a response to this hazard at any time of the year. Floods become a hazard when they may affect public safety, property, transport routes and infrastructure which supports communities.

During major coastal storms, coastal inundation can flood low-lying areas all along Otago's coast with increased erosion of cliffs and beaches.

Otago has multiple areas with single access road routes which are susceptible to flooding. This poses significant challenges for those living in these communities ability to return home from work or evacuate away from the hazard during an extreme weather event.

The Otago Regional Council's monitoring network tracks rainfall and river flows from storms and the ORC flood management team works closely with forecasters to predict and model the impact of rainfall and with Otago CDEM during events. In partnership with the other councils, the regional council's flood team provide warnings to affected communities and the media, to better inform those at potential or actual risk.



Henley Flood 2017



Toko Mouth - single access route in flood 2007

Landslides

A landslide describes a wide range of ground movements, such as rockfalls, deep failure of slopes and shallow debris flows. Soil and rock can fail to bind across the surface of a slope or deep below the surface, causing movement of debris. Landslides are often unpredictable and can be caused by intense rain, an earthquake, construction work, or even freeze/thaw effects during the winter season. The nature of the slope and its vegetation cover has a significant effect on the risk. A landslide may be several metres wide or several hundred metres wide. Otago is particularly vulnerable to landslides due to its geographical make up.

Historical landslides include the Abbotsford Landslide in Dunedin, 1979, where slope failure damaged residential homes. Intense rainfall in June 2015 and July 2017 caused many landslips along the Otago Peninsula which blocked and damaged roads. Known landslides in Otago are mapped on the natural hazards database.

Heavy rainfall in 2017 and 2018 created significant landslips on the Otago Peninsula and Roxburgh.



Roxburgh landslip 2018



Otago Peninsula landslip 2017

Coastal erosion

Coastal erosion is the wearing away of land and beach sediments by waves, tidal currents, drainage and high winds. The Otago coastline has cliffs, gravel beaches, and sandy bays that are all susceptible to erosion from the sea and other natural processes. The rate of erosion can be unpredictable and is often increased during storms or high tides.

Much of the Otago coastline is vulnerable to coastal hazards which include erosion from waves, tidal currents, strong winds and storm surge. Rapid rates of shoreline change can occur on sandy beaches due to coastal erosion.

Rock walls have been built at St Clair in Dunedin and Oamaru to mitigate the effects of coastal erosion. At St Clair, rock wall mitigation has increased the wave energy further down the beach and resulted in increased erosion of middle/St Kilda beaches. Sand sausages have been used to prevent ongoing erosion of the sand dunes.



Erosion of the fore-dune at St Kilda beach in July 2007 (left) and September 2007 (right) (Goldsmith and Sims 2014)

Storm surges

A storm surge is a higher than normal sea level, due to changes in atmospheric pressure and wind, which can result in inundation of roads and coastal property over an extended period. Storm surges can accelerate coastal erosion, flood coastal communities, destroy homes, and strand travellers.

Flooding can also occur inland as the surge enters estuaries and lagoons, impeding normal river flows and keeping river levels higher than normal. If severe weather has already been experienced inland, then these rivers may already be high, increasing the risk or extent of flooding in the lower reaches.



Storm surge affecting Pounaweia, April 2006

Storms

Storms are a common occurrence throughout Otago and may bring high winds, heavy rain, flooding, snow or coastal storm surges. The frequency, intensity and duration of storms are difficult to predict, although forecasting has become more accurate. Some communities may be at risk from several types of storm hazards.

Winds

Damaging wind can be caused by several of the weather patterns that regularly flow over Otago. MetService issues a strong wind warning when winds of more than 87km/hr are expected over land.

Severe winds can affect power and telecommunications networks, uproot trees, and peel off roofs. High-sided vehicles such as trucks and campervans are at risk. Previous gales have damaged roofs, fences, signs and resulted in closure of airports, power lines being brought down and electrical sparks igniting fires.

Snow storms

Snowstorms can be a severe hazard for people in Otago. While some communities, such as Queenstown and Wanaka, are accustomed to dealing with heavy snow and its consequent disruption semi-annually, deep snow can also accumulate in densely populated coastal areas. The most common effects of blizzards are disrupted power supplies and blocked roads; disrupted flights and delays in the delivery of fast-moving consumer goods. Snow storms can occur through most parts of Otago during winter and have been known to cut off isolated communities for days. Depending on many factors, such as access, power can sometimes take days to possibly weeks to be restored. Telecommunications networks can be similarly affected. Rural communities are familiar with these problems, often having lived with severe weather patterns for generations. Having back-up generators and alternative forms of heating at the ready is important in these rural areas, because of their exposure to severe weather. Urban communities are less prepared in relation to alternative power sources but may similarly be affected if sustained power outages occur.

Coastal Tsunami

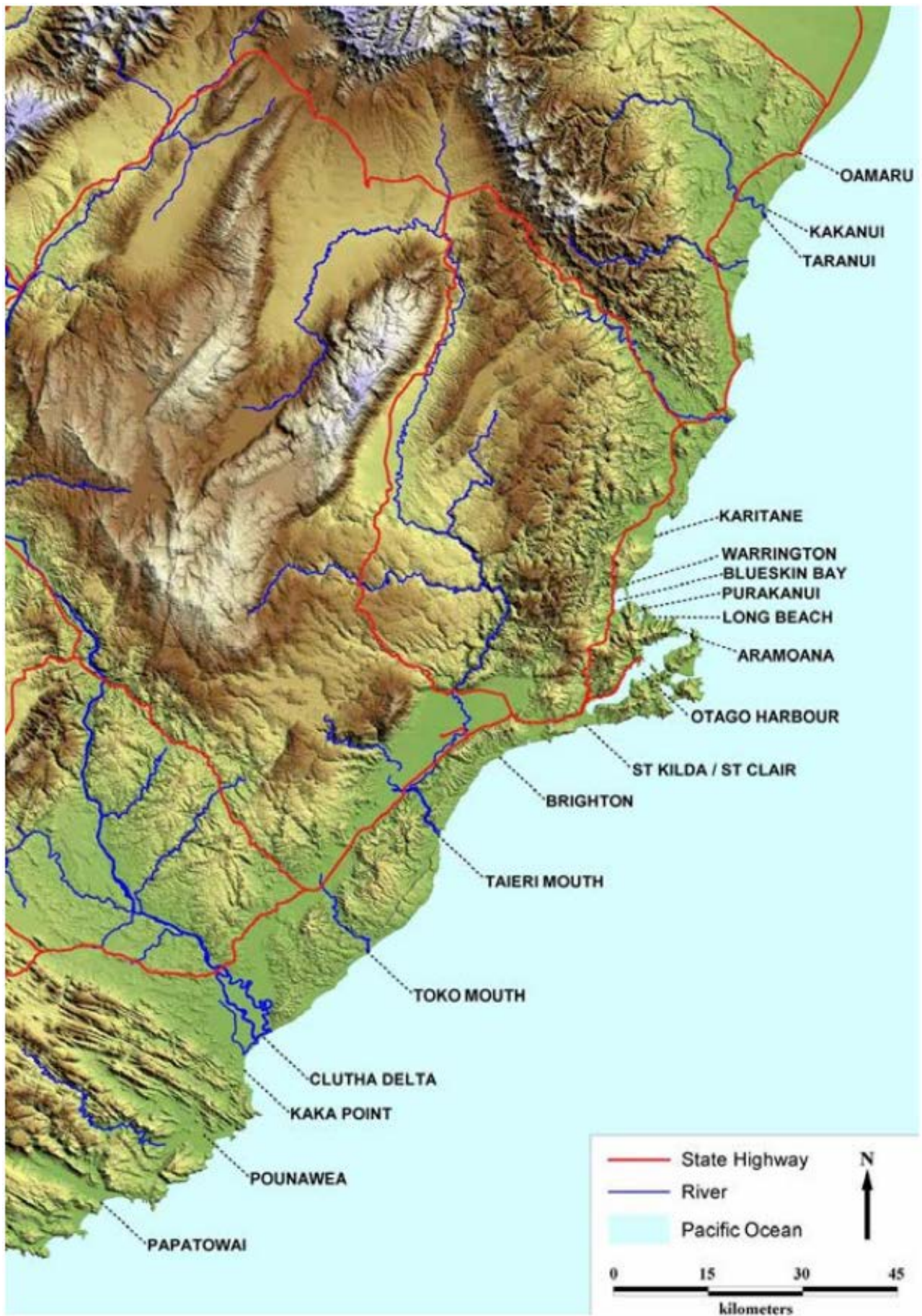
A tsunami is a natural phenomenon consisting of a series of waves or surges caused when a large mass of earth on the bottom of the ocean drops or rises, rapidly displacing the water above it.

Tsunami are generated from earthquakes, volcanic eruptions or underwater landslides. The source of the disturbance may be close to the New Zealand coastline or across the other side of the Pacific Ocean.

A **near-source tsunami** is generated close to the coastline. The water level will fall rapidly past the low tide mark and then quickly return, potentially several metres high. If this happens, there won't be enough time to issue an effective warning so MCDEM has created a public education programme centred on the message that if an earthquake lasts more than a minute or is so strong that it's difficult to remain standing, people near the coast should "get gone" without waiting for an official instruction. An earthquake centred on the Puysegur Trench, off the coast of Southland, or a regional fault such as the Akatore or Green Island fault could trigger a near-source tsunami which may affect coastal communities south of Otago Peninsula.

A **distant source tsunami** may start as far away as South America, taking much longer to reach New Zealand and affecting more of the coastline, potentially to a height of several metres. National warnings will be issued by the Ministry of Civil Defence and Emergency Management. These warnings are sent to Civil Defence, emergency services, and to the general public through the National Emergency Mobile Alerting System. Warnings are also broadcast to the public on radio and television. A small number of Otago communities have sirens that may be triggered in the event of a tsunami.

Distant source tsunami may affect coastal communities along the Otago coast and people living near the mouth of a river (for example along the Taieri and Clutha rivers) Urban areas which could be affected by a tsunami include South Dunedin and Oamaru. Otago Regional Council has modelled inundation zones for the localities in Figure 7 which identifies tsunami risks and online maps identifying tsunami evacuation zones for the whole Otago coast are online at www.otagocdem.govt.nz.



Coastal Communities which could be affected by a tsunami (Goldsmith, 2012)

Dam Failure/Inland Tsunami

Although the risk of a dam break is relatively low, especially for the major hydro dams which are built to a very high standard, there is still a degree of risk across Otago if a major seismic event occurred. An earthquake may not damage the dam but may create both a seiche³ or an inland tsunami, caused by significant movement of the lake bed, or substantial rockfall into the lake. Lake tsunami can also send flood waves downstream. A tsunami occurred in Charles Sound after the Fiordland earthquake in 2003. Due to the remoteness nobody was affected, however a rockslide caused a 4-5 meter tsunami 800 metres away (Mackey and Goldsmith, 2015). NIWA has mapped sediments on the bed of Lake Tekapo to establish evidence of previous lake tsunami (Mountjoy et al 2018), and identified that this study will be relevant for similar lakes, including Wakatipu and Wanaka.

These events are likely to occur so quickly a warning is unlikely to be issued. When a major earthquake occurs (i.e. so strong that you might not be able to stand) the national message is; ***“If an earthquake is long or strong, get gone”***. People living around lakes and reservoirs need to be aware of their surroundings and where a safe location is, should a strong or prolonged earthquake occur.

Fires

Vegetation fires are an annual hazard across many areas of Otago. They most commonly occur in summer and autumn but are a potential risk at any time – particularly in the “Red Zones” around Queenstown Hill and Mt Iron in Wanaka, where a total fire ban is in place year-round. The drier areas of Central Otago and the Strath Taieri are also at-risk areas.

Alluvial Fans

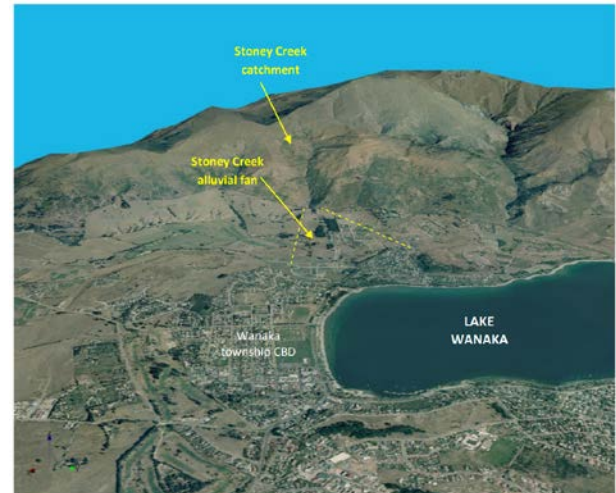


Image showing west Wanaka, including the Stoney Creek catchment and indicative fan area

An alluvial fan is a build up of river or stream sediments which form a sloping landform, shaped like an open fan or a segment of a cone and typically occur near the boundary between hill slopes and valleys. Flooding on alluvial fans can be damaging as the fans have steeper gradients than floodplains. Inundation from flood water, debris flow, debris flow deposits, channel migration, deposition and erosion are all hazards. Otago Regional Council has identified ‘high hazard’ alluvial fans which are vulnerable. Parts of Queenstown, Wanaka and Roxburgh are exposed to intermittent alluvial-fan hazards as well as communities in the Makarora Valley (Woods, 2011)

³ To visualise a seiche, imagine you are sitting in a fairly full bath and rock back and forth. After a short period, you’ll find that your rocking which will cause waves to grow until they overflow the bath

Pandemic

The Ministry of Health has identified that influenza pandemic is the most likely event to cause a large-scale health emergency in New Zealand. Three major influenza pandemics occurred in the 20th century, reaching New Zealand in 1918, 1957 and 1968. Recent estimates put mortality from the 1918 pandemic at between 50 million and 100 million worldwide. In New Zealand, the 1918 pandemic is estimated to have infected between a third and one half of the entire population, causing about 8,000 deaths, of which at least 2,160 were Māori. 496 deaths from this “Spanish Flu” pandemic were recorded in Otago. However, the first wave of influenza A (H1N1) 2009 reminds us that some pandemics may have only a small impact on death rates.

The New Zealand standard planning model assumes a severe pandemic wave in which 40 percent of the New Zealand population (more than 1.9 million people) become ill over an eight-week period. The peak incidence in the model occurs in weeks three to five, when about 1.5 million people – a third of New Zealand’s population – would be ill, convalescing or just recovered.⁴

The standard planning model assumes a total case fatality rate of 2 percent, within which about 38,000 deaths would occur over the eight-week period, peaking at about 23,500 in week four (compared with New Zealand’s normal weekly death rate of around 599). This is not a prediction – it is not possible to make any such forecast before a pandemic develops. A 21st-century pandemic may not reflect the course, incidence or fatality rates of the 1918 pandemic.

Long term threats

Climate Change

While not considered a natural hazard, climate change is a factor impacting on the frequency and intensity of existing hazards. Climate change has the potential to affect the entire region. Areas already vulnerable to natural hazards such as South Dunedin will become more exposed. Central Otago may become more vulnerable to droughts and fires over the summer period, and harsh frosts

over the winter period. More extreme weather events can also increase the likelihood of flooding, storms, coastal erosion and landslides.

In New Zealand, changes in climate such as temperature and rainfall are already occurring. These changes will occur to differing extents in different parts of New Zealand throughout this century and beyond. Based on the latest climate projections for New Zealand, by the end of this century the Ministry for the Environment and NIWA predict we are likely to experience:

- Higher temperatures – greater increases in the North Island than the South, with the greatest warming in the northeast (although the amount of warming in New Zealand is likely to be lower than the global average)
- A change in rainfall patterns – with increased summer rainfall in the north and east of the North Island and increased winter rainfall in many parts of the South Island.
- Rising sea level which will affect coastal communities such as South Dunedin, Aramoana, Oamaru, and Brighton
- Increased severity of extreme weather events including storms, heavy rainfall and drought which can result in flooding, landslips and causes stress for communities who require extra resources to cope with changing weather conditions.

Drought

A drought is a prolonged period of no or minimal rainfall resulting in a shortage of water. Droughts develop slowly and can extend over a wide area. Central Otago is at risk from drought over the hot summer months if there is a lack of expected rainfall.

Social impacts of drought include challenging and stressful conditions for people and conflict over water resources. Environmental impacts include loss of vegetation, increased soil erosion and reduced air quality. There may be economic impacts from dependence on pastoral industries and stock losses. The Otago Natural Hazards database provides a series of maps identifying low, unusually low, annual and seasonal precipitation totals.

⁴ These figures are based on the New Zealand population statistics published by Stats New Zealand 2013 – 4,766,140.

1. Risks to Otago's Social Environment

Otago's 'Social Environment' includes the key areas of health and education.⁵ The health sector in Otago is under the responsibility of the Southern District Health Board (SDHB). Education provision in the region includes many primary and secondary education providers, as well as the tertiary education sector which is primarily represented by the University of Otago and the Otago Polytechnic. Other smaller tertiary education providers include Aoraki Polytechnic, Southern Institute of Technology (SIT), NZ School of Tourism, Queenstown Resort College and Mainland Air.

Substantive risks to the health and education sectors pose threats to the Otago region's social well-being. It is noted that the SDHB and the University of Otago also represent substantial factors in Otago's built and economic environment in terms of infrastructure, employment and bringing people into Otago from outside the region.

1.1 Risks to Otago's Health Sector

The SDHB is responsible for health provision in the Otago region. The SDHB identifies pandemic/health crisis and natural hazard risks as significant in terms of potential impact on its capacity to provide healthcare to the Otago population.

The potential for a **pandemic** or other major health crisis is a key risk to healthcare provision. Such an event could occur at the national, regional, or local level. In the event of a pandemic the resources of the SDHB in terms of medical supplies, staffing levels and capacity of infrastructure to cope with increased demand would test the resilience of this sector. The 1918 Influenza Pandemic is often used as a benchmark for considering possible impacts of a severe health crisis. The 1918 pandemic caused 496 deaths in Dunedin and Otago, which had total population of about 132,000 at that time. The national death-toll from the pandemic was 8,600.⁶ If such an event were to occur today, it could lead to staffing shortages for 2 months or longer with flow-on effects on lifelines and reduced essential services at a time of greatly increased demand.

Major natural hazards also pose risks to healthcare provision. A major (magnitude 8+) **earthquake** on the Alpine Fault of the South Island (AF8) poses a serious risk to the capacity for healthcare provision in the region. Damage to infrastructure, access issues to urban and rural communities and loss of communications, lifelines and utilities are all factors to consider in terms of the resilience of healthcare provision in Otago. Major earthquakes on other faults (including 'blind' or currently unmapped faults) also present a risk to healthcare facilities and services.

In coastal and relatively low-lying parts of Otago, natural hazards such as **tsunami**, **storm surge**⁷, and **heavy rainfall / flood** events present a risk to healthcare provision. For example; in Dunedin, the regions primary healthcare facility could be affected by an extreme rainfall or flood event, while local health providers and other infrastructure in low-lying South Dunedin are vulnerable to inundation from a range of hazards.

Severe weather events are another risk to health. For example, serious snow storms would impact the SDHB's capacity for getting adequate staffing in place to manage ordinary (or potentially increased) demand for healthcare services.

Other risks from natural hazards include **disruption to logistics** in terms of the SDHB's national supply chain. A major natural disaster could create delays in the delivery of essential medical supplies. For example, if an Ebola virus (or similar) outbreak were to occur, getting sufficient personal protective equipment (PPE) to healthcare staff could be delayed or prevented due to logistical challenges.

⁵ There are many other components which comprise Otago's 'Social Environment', such as quality of housing, rates of poverty and vulnerable groups. These parameters have not been investigated as part of this report as it is likely that, during a major coordinated CDEM response, they will require limited attention from the Otago CDEM Group. However, it is noted that the risks to the education and health sectors discussed here may also present a risk to other components of the social environment.

⁶ Geoffrey Rice, *Black November: the 1918 Influenza Pandemic*, University of Canterbury Press, 2005.

⁷ Also referred to as 'Elevated sea-level'.

The SDHB considers **large public events** to be a potential risk to healthcare in the region if an event involving concentrated numbers of people coincided with either a rapid health crisis, natural hazard or man-made disaster. For example, the *University of Otago Orientation Week* or the *Rhythm and Alps* music festival could both pose possible risks for healthcare services, in terms of being overwhelmed by unexpected numbers of casualties.

Summary of Key Risks to Health

- Pandemic
- Major natural hazards, including earthquake, tsunami, storm surge, flood or severe weather events
- Disruption to logistics
- Large public events

1.2 Risks to Otago's Education Sector

The education sector forms a large part of Otago's social and economic fabric. Otago's education sector comprises early education, primary and secondary schools, tertiary education, as well as public and private training institutions across the region.

In 2016-17 there were 145 primary and secondary schools populated by approximately 32,000 students and 2,420 teachers within the area covered by the Otago Group Plan.⁸ The University of Otago is the largest single education provider in Otago with 21,000 students and 3,500 staff in 2017. The University, therefore, represents a significant proportion of Otago's population during semester periods.

The biggest risk to the University of Otago is reputational, as it operates in a highly competitive national and international market. Therefore, any major risk to the University of Otago may have significant flow-on effects for the entire region's social and economic well-being and resilience.

The University operates campuses in Auckland, Wellington, Christchurch, Dunedin and Invercargill, all of which must be considered in evaluating risk to the University. Therefore, the University has both a national and local focus to its risk awareness and planning.

The education sector is susceptible to major **natural hazards** – for example, significant ground shaking, liquefaction or lateral spread associated with a major earthquake event. The University, with its large amount of built infrastructure as well as a high concentration of students and staff in the North Dunedin area is particularly vulnerable. Educational facilities in low-lying or liquefaction-prone areas such as South Dunedin and the Taieri Plain are also vulnerable. The risk of injury, damage to assets and infrastructure, and loss of life from a natural hazard event is therefore high.

The education sector could suffer severe economic impacts from a major natural disaster. For example, the **reputational harm** to the sector (and the University of Otago in particular) could produce negative impacts. This applies to major natural disasters centred on other parts of the South Island or even nationally. This is due to international perceptions of whether New Zealand as a whole is a 'safe' destination to study or not.

In terms of man-made hazards, the potential for **terrorism, bombings** or an **active shooter** situation represents a risk to the University of Otago and the wider education sector, as they may be seen as a 'soft target' for terrorism and other criminal acts. This type of man-made hazard is significant in light of the increasing frequency of attacks on educational providers around the world in recent decades. The potential impacts include loss of life, reputational harm and economic impacts. In

⁸ NZ Ministry of Education, <http://www.educationcounts.govt.nz/know-your-region>

recent years, the University of Otago has experienced bomb threats, which turned out to be hoaxes but nonetheless raise the question of risk from terrorism as a genuine possibility.

The education sector is susceptible to the risk from a **chemical and/or biological emergency**. The University of Otago is particularly vulnerable to this hazard due to its extensive science laboratories and storage facilities, while secondary schools may also be vulnerable. Again, possible impacts include loss of life, economic impact and reputational damage. The demolition of old buildings also creates potential man-made risk of **asbestos exposure** to students, staff and the community.

Related to the extensive built infrastructure of the education sector is the risk of **building fires**. These could occur either as a result of man-made disaster, chemicals catching fire, or as a consequence of natural disasters. The risk for loss of life is particularly high due to the high concentration of people in and around the University of Otago campus. Economic impacts as well as reputational harm would be potential flow-on effects of this risk.

The University is particularly prone to the effects of **pandemic** and major health crises, primarily due to the dense concentration of the North Dunedin area and the high level of interaction among students.

Summary of Key Risks to Education

- Major natural hazards
- Reputational harm
- Terrorism or an active shooter
- Chemical and/or biological emergency
- Building fires
- Pandemic

1.3 Risk Interactions for Otago's Social Environment (health and education)

This section describes some of the flow-on effects and complex risk interactions between the social environment (health and education in particular) and the economic, natural and built environments. It is not possible to provide a complete picture of all the possible interactions – rather, this section provides some important snapshots of particular issues, as identified by the experts who contributed to this project. The issues and interactions noted below help to describe Otago's overall risk profile however, and in some cases, it may be possible to undertake additional work to reduce those risks. Summary tables are provided, which help to illustrate how the health and education sectors understand the risk associated with other hazards, in terms of how it may affect them.

Health

A pandemic would have negative impacts on Otago's economic environment. Staffing issues for business are dependent on business size and major employers could experience serious economic impacts from quantitative issues with staffing. In addition, the reputational damage from a pandemic event could negatively affect Otago's agricultural export and tourism industries with potential flow-on socio-economic effects and related health and social well-being issues. Conversely, an economic crisis could lead to potential socio-economic related issues such as family violence. In addition, an economic crisis would lead to potential loss of GDP and reductions in government funding due to fiscal constraints.

A major natural hazard, such as an extreme flood or earthquake event, would likely have significant negative impacts on Otago's social environment, including sanitation and waste disposal issues, with flow-on effects for agriculture and health.

While New Zealand has effective controls in place at its air and sea ports to protect against biosecurity risks, a major biosecurity incursion could have negative impacts on public health in Otago. For example, mass animal carcass burials from a Foot and Mouth Disease outbreak (FMD) pose substantial health risks.

Political instability is closely related to socio-economic factors in the context of risks to health.

Risk Perception for Health

	Pandemic	Natural Hazard	Biosecurity	Economic Crisis	Political Instability	Man-made Disaster
Risk for Health sector	High	High	Medium	Medium	Medium	High

Education

The education sector in Otago, including early education, schools, tertiary education, and private training institutions is vulnerable to multiple risk sources. The most significant cross-sector risk for Otago's largest educational institution, the University of Otago, is the potential economic impacts on the wider region, including business resilience, employment and reputational harm to the region, which is partly due to the University's international profile.

A major health crisis or pandemic would have severe impacts on the education sector. A pandemic could lead to potential student and / or staff deaths. The risk is particularly high in North Dunedin, where there is a high density of young students, many of whom are living away from their family support network, and in cramped flats or halls of residence. A major health crisis could potentially overwhelm local health services, civil defence emergency services and other welfare provision services.

In terms of natural hazards, the University of Otago has more concern for its Wellington and Christchurch campuses than the Dunedin campus, which it perceives to be subject to lower risk from natural disaster. An economic crisis is also perceived by the University as a low risk in the short term. It could lead to a downturn in student numbers over the longer term; however, this would fall outside the scope of the Otago CDEM Group Plan's focus on immediate civil defence emergencies. The same low risk applies to political instability. This is in contrast to many overseas universities, which are often the scene of political and civil unrest.

A biosecurity emergency affecting the agricultural sector would have a low direct impact on the education sector. A potential impact for education could be the imposition of travel bans, but this will be time-dependent according to beginnings and endings of academic terms and semesters.

Man-made disasters pose a high risk to the education sector, largely due to the threat of active shooters or terrorism events. Cyber security and hacking also poses a major risk to education alongside other man-made events such as arson and burglary.

Table 2. Risk Perception for Education

	Pandemic	Natural Hazard	Biosecurity	Economic Crisis	Political Instability	Man-made Disaster
Risk	High	Medium - High	Low	Low	Medium	High

2. Risks to Otago's Natural Environment

The natural environment of Otago underpins a major part of the region's economic and social resilience. Agricultural, horticultural and wine products as well as tourism are primarily dependent on the natural environment. This sector is particularly vulnerable to severe weather events, biosecurity risks and natural hazards, as well as sudden economic fluctuations. The following section includes discussion of risks to the farming, horticulture, forestry and viticulture sectors.

2.1 Risks to Otago's farming sector

The farming sector (comprising dairy, sheep, beef and venison) is vulnerable to severe weather events, major natural hazards, biosecurity emergencies, fires and economic crises. The most commonly occurring hazard for the farming sector is severe weather events – including drought and extreme rainfall. While this is something that farmers deal with regularly, there may be some value in more specific profiling and better understanding the specific risks to farmers from extreme weather, especially given changing/fluctuating climate conditions at both global and local levels.

Major natural hazards (such as an AF8 **earthquake** event) constitute a severe risk to the farming sector in Otago. Possible consequences of a major earthquake include severe damage to farm infrastructure, serious environmental issues, damage to pasture, animal welfare issues, damage to water and chemical storage facilities, and isolation due to road closures. Milk collection services would be highly impacted and potentially cease, leading to economic losses. It is noted that farming experts consulted as part of this research were aware of, and concerned about the relatively high likelihood of a major earthquake occurring on the Alpine Fault in the next 50 years.

Severe storms can have a wide range of effects on farming and rural communities. These include damage to farm infrastructure such as irrigators, buildings and fencing. Heavy rainfall during storm events can result in surface flooding, elevated groundwater levels and high river flows, with related issues around effluent disposal and sedimentation. This can cause environmental issues as well as economic hardship related to the challenges of meeting resource consent obligations and ORC regulations.

Major storm events also can compromise essential water and electricity supplies for farmers and isolate rural communities due to road closures. Severe weather events may also cause disruption to milk collection routes, cause animal welfare issues, and result in damage to pasture. The effects of severe storm events can result in significant economic costs for farmers and rural communities.

Droughts constitute another form of risk from severe weather events. The risk from drought includes a lack of feed for livestock, loss of essential water supplies, animal welfare issues, and safe disposal of animal carcasses.

Snow storms can also result in farms and rural communities becoming isolated due to road closures and can disrupt milk collection services. In addition, snow storms impact farmers' capacity to provide adequate stock feed. As per drought, snow storms create risk around animal welfare, safe disposal of animal carcasses, effluent issues and potential electricity loss.

The risk from **uncontrolled fire** is another hazard for farmers and rural communities. Aside from the impacts common with severe weather events, fire poses the risk of smoke damage, stock displacement and ongoing issues with feed supply.

Apart from a major earthquake event, one of the largest risks to the farming sector is that associated with a **major biosecurity incursion**. This risk could potentially cripple the farming sector in the short and long term. An exotic disease outbreak such as Foot and Mouth Disease (FMD) among livestock is the major agricultural biosecurity risk to the farming sector. Any confirmed case of FMD would lead to the immediate cessation of all stock movements and strict quarantine conditions would be imposed while containment and eradication programmes were undertaken.

A FMD incursion could potentially result in severe **reputational risk** for the farming sector and its

international exports. Overseas export partners would require substantive reinsurance before trade

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could recommence. This would severely compromise the ability of farmers to find markets for their produce.

A useful comparative benchmark for the likely impacts of a major biosecurity incursion is the United Kingdom's FMD outbreak in 2001. This event took 12 months to contain, involved several thousand veterinarians and required a whole of government approach including the army and police to assist in the containment and eradication process. The UK FMD outbreak effectively crippled the UK farming sector. The risk from this hazard is therefore extreme for the Otago farming sector, with the potential for 1 infected animal to theoretically affect all livestock in the region and possibly the whole country. Estimates suggest a FMD outbreak could lead to around 500 infected properties, and result in approximately 14.6 billion NZD in lost export earnings for up to 12 months. The cost of eradication measures and compensation is estimated at around 1.2 billion NZD.

Small biosecurity incursions are dealt with regularly by the farming sector; the major risk is presented by the potential for a major biosecurity incursion, which would have potentially severe impacts on the socio-economic well-being of the farming sector and rural communities.

2.2 Risks to Otago's wider agricultural sector

Biosecurity hazards also present risk for the wider agricultural sector, including the horticulture, viticulture, forestry, fruit growing, honey and aquaculture industries. **Customs** plays a large role in preventing a major biosecurity incursion through our air and sea ports. 100,000 risk goods are seized at the borders annually with 11,000 of these listed as undeclared items.

The fruit growing industry faces quite serious risk from noxious insect pests such as fruit fly and perhaps more so from stink bug. The fruit and honey industry has a potential vulnerability to Myrtle Rust, although this is not prevalent in the South Island at present. An incursion of different strains of honey bee diseases could be devastating for the honey industry.

Additional biosecurity hazards include **Bovine Spongiform Encephalopathy (BSE)**, which poses a risk to the region's **dairy industry**. The **forestry industry** would be affected negatively by an outbreak of **Pine Pitch Canker (PPC)**.

All of these in addition to other biosecurity risks present economic risks to the region and its natural environment.

Box 3. Summary of Key Risks to farming and the wider agricultural sector

- Natural hazards, including earthquakes, severe storms, droughts, snow storms.
- Uncontrolled fire.
- Major biosecurity incursion
- Customs breaches, including Bovine Spongiform Encephalopathy (BSE), Pine Pitch Canker (PPC) Stink Bug and Fruit Fly, Myrtle Rust and Honey Bee diseases

2.3 Risk Interactions for Otago's Agricultural Sector

This section describes some of the risk interactions between the natural environment (agriculture in particular) and the social, economic and built environments. It does not provide a complete picture of all the possible interactions – rather, this section provides some important snapshots of particular issues, as identified by the experts who contributed to this project. The issues and interactions noted below help to describe Otago's overall risk profile however, and in some cases, it may be possible to undertake additional work to reduce those risks. Summary tables are provided, which help to illustrate how experts from the

agricultural sector understand the risk associated with other hazards, in terms of how it may affect them.

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Natural hazards, and in particular a major earthquake or an extreme flood or tsunami event, represent a high risk to some sectors of the farming, apiary, viticulture, forestry and fruit growing industries. The recovery process from such an event is likely to be long, and will vary depending on location and vulnerability. Loss of life-lines and infrastructure following a natural or man-made disaster would have dramatic economic impacts on the agricultural sector. For instance, loss of water or power supplies would be economically damaging to the fruit growing industry; resilience would be dependent on salvaging plants/crops, which could be productive in the following season.

A major biosecurity incursion in the agricultural sector will have serious economic impacts as discussed above. Reputational loss will be difficult to recover and will impact the region and New Zealand's position in the world primary export market. Social consequences could also ensue from a serious stink bug incursion, which could attack homes as well as crops, crippling rural townships and communities.

A pandemic has medium risk as the farming sector and rural communities are better able to isolate themselves from infected population centres. However, the capacity for incoming freight and produce haulers to reach farms may be affected. Rural schools and community centres may also be at risk in the event of a major health crisis. Fruit farmers will be affected by lack of access to vital migrant labour. An important health cross-over with agriculture is mental well-being of farmers and rural communities through periods of adverse environmental and economic conditions. Social- psychological stress among farmers lead to risk of suicide and mental health issues.

Reputational risk from natural and biosecurity hazards could present potential risks to Otago's extensive tourist industry in terms of tainting the regions' reputation as a safe and "pure" destination.

Cross-over risk from an economic crisis will be felt unevenly across Otago's agriculture sector. Farming and fruit growing are more vulnerable to economic crises as they have only limited time windows in order to sell product. Conversely, viticulture, forestry and apiaries have more leeway to withhold distribution until more beneficial economic circumstances permit.

There are several political risks to the agricultural sector. Rapid changes in public policy around water consents, for instance, could be crippling for farming and the fruit growing industries especially. In addition, changes to immigration laws could have a negative impact on the fruit growing industry's access to seasonal migrant labour

Table 3. Risk Perception for the agriculture sector, differentiated by industry where applicable

	Pandemic	Natural Hazard	Biosecurity	Economic Crisis	Political Instability	Man-made Disaster
Risk	Medium (Farming)	High	High	High (Farming/Fruit)	Medium	High
	High (Fruit)			Medium (Viticulture, Forestry, Apiaries)		

3. Risks to Otago's Economic Environment

The economic environment of Otago underpins the region's social resilience and depends extensively on the natural and built environment. This is especially the case for Otago's extensive tourism industry. Therefore, as for the agricultural sector, a large part of Otago's economic resilience is linked to the risks associated with the natural environment.

Experts from Otago's business sector (outside of the tourism industry) said that they considered there was a high risk attached to natural hazards; for example, in terms of business resilience to flood events in low-lying areas like South Dunedin. They also identified a greater vulnerability to economic crises than the agricultural, educational and health sectors. The following section includes discussion of risk to the tourism and business sectors. It is noted that there is a large degree of overlap between neighbouring CDEM Groups, particularly in respect to the tourism industry, as it operates across the boundary from the Queenstown-Lakes area into Southland, Fiordland, Westland and Canterbury.

3.1 Risks to Otago's Business Sector

The risk profile of businesses in Otago are considered to be reasonably similar across the region. The Otago Chamber of Commerce and Otago-Southland Employers Association have developed economic strategies with risk mitigation in mind. The University of Otago has been involved in these risk discussions due to its importance to Otago's economic environment.

Natural hazards such as **flooding** and **earthquake** (including secondary effects such as **liquefaction** and **lateral spread**) could have a significant effect on commercial and industrial land in Otago. For example, flooding issues have been identified as a major risk to commercial activity in South Dunedin, Mosgiel, Queenstown / Wanaka and Alexandra. Interruptions to business continuity have been addressed with advisory services such as the "Shut Happens" resource,⁹ which was used by the Dunedin Chamber of Commerce to inform and assist business in South Dunedin affected by flooding in June 2015.

The business sector perceives risk in terms of **confidence** and **resilience** during and after a natural hazard event. The business sector is also subject to external confidence measures by national and international ratings agencies and investors.

The business sector is conscious of a need to increase its hazard and risk awareness and response strategies. The need to mitigate risks is underpinned by the economic necessity to maintain confidence and ongoing **investment** in the region. The business sector has identified a requirement to create up to 10,000 new jobs in the region in order to sustain Otago's economic and social wellbeing. Uncertainty around risk and risk resilience could potentially be an impediment to this objective.

3.2 Risks to Otago's Tourism Sector

The tourism industry is an important and growing component of Otago's economic environment, accounting for over 6 per cent of the regions total GDP, attracting up to 3.5 billion NZD in annual tourism spending, and employing approximately 10,000 people in recent years.¹⁰ Tourism is **fragile**, however, and is vulnerable to reputational risk following any hazard event. The Otago tourism industry attracts large numbers of foreign visitors and any decrease in visitors would have a negative effect on Otago's economy.

Natural hazards pose the most serious risks to the tourism sector, with **earthquakes** (the most significant likely to be an AF8 event), **tsunamis** (coastal, fiords, or inland lakes), **landslides**, and **severe weather** all posing a relatively high level of risk. This is illustrated by Real Journeys, which

⁹ A guide for business created by 'Resilient Organisations' - a collaboration between the Universities of Canterbury and Auckland, with support from the Natural Hazards Platform and industry partners. See www.resorgs.org.nz

¹⁰ MBIE website <http://www.mbie.govt.nz/info-services/sectors-industries/tourism/tourism-research-data/monthly-regional-tourism-estimates>; BERL Economics, *Otago Economic Overview 2013 Final report*, May 2014.

hosts approximately 1 million visitors per year in the Otago – Southland regions, sometimes in highly **remote areas** which are particularly vulnerable to natural hazards

The potential for large numbers of tourists becoming isolated due to road closures is high. For example, the closure of the Wilmot Pass from an earthquake/landslip event would be a major problem in terms of evacuating people trapped in the adjacent Fiordland area.¹¹ The combination of high volumes of visitors and natural hazard risk in remote areas could provide unique challenges for CDEM in terms of responding to emergencies.

Tourism relies on an overarching image of New Zealand as “100 % Pure.” Therefore, any risk that tarnishes that image could have negative impacts on tourism in Otago. For example, a biosecurity incursion could bring **reputational risks**. A natural hazard event such as an earthquake could lead to serious concerns around the perception of Otago as a safe destination.

Tourism is prone to man-made disaster at the more localised level. For example, Ngai Tahu Tourism takes seriously the risk of **jet boat** or **helicopter accidents** and has well-rehearsed response measures in place. There is also a low likelihood of a **terrorist** or other **criminal/political attack**. Otago's high profile international destinations, such as downtown Queenstown, could be a potential target. While the likelihood of this type of event is low, the potential impact is high.

3.3 Risk Interactions for Otago's Economic Environment

Taken together, the business and tourism sectors comprise a major component of Otago's economic environment. In addition to direct risks to the economy, the possible flow-on effects of risks to the region's economic environment include complex risk interactions with the social, built and natural environments. Summary tables are provided at the end of this section, which help to illustrate how representatives from the economic sector understand the risk associated with other hazards, in terms of how it may affect them.

The large numbers of foreign and domestic visitors that visit the Otago region means that a significant natural hazard event could have flow-on effects for the social environment, and healthcare in particular. For example, there can be up to 100,000 people (visitors and residents) in the Queenstown Lakes District at any one time. Should a major earthquake (AF8 or similar) occur, this would place extreme pressure on the resilience of local healthservices.

The risk interaction between the economic and built environment is less pronounced than in other sectors such as education and health. However, access issues with lifeline failures and communications, especially for populations in Central Otago and remote areas, are a major consideration for the CDEM Otago and Southland Group Plans.

Changes in the physical environment may present issues for the business sector in the future, for example in low-lying coastal areas prone to increased frequency of flooding due to sea-level rise. Although these are more related to long-term physical processes and, therefore, fall outside the scope of the CDEM Otago Group Plan, an increase in the frequency and intensity of sudden events like flooding remains a concern for the Group.

Tourism in Otago/Southland depends on the natural environment for its future development and resilience. A major natural hazard event could have serious impacts in terms of injury or loss of life among visitors and residents. Reputational effects in terms of safety perceptions could have long lasting impacts on the tourism industry and the wider Otago economy.

An important dimension of the tourism industry risk profile is the lack of in-depth crisis planning by those involved in this sector. Several experts identified that there is a disconnect between the high perception of risk for tourism (on a par with the natural / agricultural sector - see table 8); yet there is a concerning lack of focused awareness by tourism operators around how to manage/mitigate risk to the tourism sector.

¹¹ Although outside of the Otago Group CDEM area, a combined Southland and Otago response may be required for such an

event, due to the cross-boundary nature of tourism activities in the two regions.

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This is possibly due to the innate character of the tourism/hospitality sector, which focuses its energy on promoting a positive approach and imagery around the Otago region as an “aspirational destination”. Therefore, a more realistic, upfront and cautious approach to the existence of different types of risk could be detrimental to the objectives of the tourism sector in the short term. However, **apathy** towards strategic planning – interfacing with other sectors and emergency response agencies – could be harmful for tourism and the wider economic environment of Otago, over the long term. There was agreement that accommodation providers should all have comprehensive crisis plans, and tour operators should have plans in place which look beyond their own immediate needs to how they interface with the wider community. This research identified that there are some opportunities for the Otago CDEM Group to engage with, and work more closely within the ‘economic environment’, and the tourism sector in particular.

Box 4. Summary of Key Risks to the Business and Tourism Sectors

- Natural hazards, including flooding, tsunamis, landslides and severe weather events.
- Business confidence
- Investment confidence
- Industry fragility
- Working in remote areas
- Reputational risks
- Apathy

Table 4. Risk Perception for the Business sector

	Pandemic	Natural Hazard	Biosecurity	Economic Crisis	Political Instability	Man-made Disaster
Risk	Medium – High	High	High	High	Medium	High

Table 5. Risk Perception for the Tourism sector

	Pandemic	Natural Hazard	Biosecurity	Economic Crisis	Political Instability	Man-made Disaster
Risk	Medium	High	Low	High	Low	High

4. Risks to Otago's Built Environment

Otago's built environment includes the assets and essential lifelines that allow the region to sustain its social, economic and natural environments. Roads, railways, utilities, built structures and communication networks provide services that are both subject to risk as well as being crucial to the region's resilience during hazard events. The risk profile of Otago's key lifelines was described and assessed in 2014,¹² with a further review due in 2017.

As part of this project, it was considered necessary to include a more in-depth risk assessment for the major sea and air ports of the region, as the risks to these essential gateways could have important flow-on effects for Otago's economic, natural and built environments. The experts who contributed to this work identified that air and sea ports are particularly vulnerable to risk from both natural and man-made disasters.

4.1 Risks to Otago's Airport industry

The air industry is an important component of Otago's built environment. There are numerous airports, aerodromes, and helicopter pads across the Otago region. The most important airports in terms of passenger volume are located in Dunedin and Queenstown. Dunedin Airport processes over 850,000 passengers per year, while Queenstown airport has around 1.8 million passengers per year and employs 600 staff. Wanaka airport has no public transport function but processes hundreds of small aircraft and has around 200 staff.

The Otago airport industry sees **major natural disasters** and **operational failure** as its main sources of risk.

A **natural disaster**, such as an earthquake, presents high risk for Otago airports. The risk from natural hazards is relatively high for both Queenstown (seismic hazard – shaking and lateral spread) and Dunedin (seismic and flood hazard) airports. Queenstown airport would also face a test of its resilience from a societal perspective. In the event of a natural disaster, the airport would likely be inundated with people wanting to depart the Wakatipu Basin and surrounding areas. Visitors with no local support networks would likely arrive at Queenstown Airport either seeking assistance or hoping to depart.

The major risk from **operational failure**, or man-made disaster, in Otago's airport sector are **aircraft accidents**.

4.2 Risks to Otago's Sea Port Sector

The major port facilities for the region are located on the Otago Harbour and are operated by Port Otago Limited. The major risks for Port Otago were identified as **natural hazards** and **man-made disasters**.

A **tsunami** event could cause sudden fluctuations of sea currents and channel depth in Otago harbour, which could lead to ship groundings in the harbour and damage to ships at berths.

An **earthquake** event could lead to relative shifts in the level of the sea bed, as occurred along the Kaikoura coast in 2016, and also lead to liquefaction and lateral spread in reclaimed land areas occupied by Port Otago at Port Chalmers and Dunedin. A major earthquake could cause damage to the rail network connecting Otago's ports. This could disrupt the supply chain for many weeks.

Severe weather events pose a medium risk to the sea port sector. A major 'weather bomb' coinciding with extra high tides could lead to flooding and other effects on port shipping operations.

¹² *Otago Lifelines Project. A Vulnerability and Interdependency Assessment of Otago's Lifeline Infrastructure*, prepared for the Otago CDEM Group. This report provided an assessment of the impacts on lifeline utility assets from failure of another lifelines service and/or following a natural hazard event. It included an analysis of 'hotspots' (where a number of critical assets are co-located), 'pinch-points' (single points of vulnerability in individual networks), and potential mitigation measures to improve resilience in the lifelines sector.

Man-made disasters pose the other main source of direct risk to the sea port sector. **Pilot error** or **mechanical failure** could lead to ships running aground, or a ship to collide with container cranes at Port Chalmers, causing them to collapse. This could lead to 3 months' stoppage for Port operations, with flow-on effects for agriculture and the Otago economy. The likelihood of pilot error is low to medium but the consequences could be high. Otago Harbour is one of the most challenging for navigation in New Zealand, with a narrow entrance and lack of depth, which adds to the potential for man-made disaster.

The upper harbour between Port Chalmers and Dunedin is shallow and narrow, yet is a major conduit of high risk cargo, including, fertiliser, oil and gas. The highest risk from shipping operations is an **LPG tanker explosion**. The explosion radius would be around 1.5 kilometres and includes residential areas in North Dunedin, West Harbour and the Otago Peninsula, and the industrial zone near the harbour. A collision with another ship would be the most likely cause of an **LPG tanker explosion**. A worst-case scenario could be an LPG tanker explosion while a major event was taking place at Forsyth Barr Stadium, whereby casualties could be in the thousands.

The likelihood of this type of man-made disaster is very low as careful precautions are taken by Port Otago, including prohibiting other ships from turning while LPG tankers are in port. However, the consequences of this hazard are extremely high. It should be noted that part-loaded gas and oil tankers pose a greater risk than fully loaded tankers due to inert gas in their tanks. Risk from other chemical cargoes is relatively low. Ammonium Nitrate is a potentially dangerous cargo regularly transported in Otago Harbour, however, the risk is low as it is transported in low quantities.

4.3 Risk Interactions for Otago's Built Environment

The key risk interactions between the sea and air port sectors and the social, economic and natural environments are discussed below. As for previous sections, it provides some important snapshots of particular issues, as identified by the experts who contributed to this project. These interactions help to describe Otago's overall risk profile, and additional work to help reduce those risks may be possible. Summary tables are provided, which help to illustrate how experts from the air and sea port sector understand the risk associated with other hazards, in terms of how it may affect them.

The airport sector sees pandemic or other major health crises as a medium to high risk. Airports could act as quarantine shelters, with designated self-catering facilities. The sea port sector, however, views pandemic as a low risk as ships are self-contained in terms of being able to quarantine infected people. Port Otago has a large workforce, including many part-time shift workers, who could be mobilised to continue operations in the event of a major health crisis.

The airport industry sees natural hazards as being a high risk. Business continuity would be challenged by several possible factors in the event of a major natural hazard, including, getting key personnel to work and the logistics of providing welfare for visitors. Water supplies could be compromised also. Continuity of operations would also be challenged by the need to quickly source new supplies of jet and aviation gas. In addition diesel fuel would be required in order for contractors to be able to repair damage to airport infrastructure caused in a natural disaster. The sea port sector also considers natural hazards as a high risk due to the potential flow-on effects from a possible shutdown period of 3 months, or up to 2 years of limited operations after a major natural disaster.

Both the air and sea port sectors view biosecurity risks as low-medium due to the strict controls that they have in place around biosecurity threats.

Airports view economic crises as a high risk due to their reliance on leisure travellers, this would test the business resilience of the Queenstown airports especially. Port Otago, however, views economic crises as being a low risk, with potential long term effects that would fall outside the scope of the Group Plan. Both air and sea ports viewed political instability as being a low risk to their sectors.

Man-made disasters are a high risk in the built environment, with aircraft crashes, ship groundings or tanker explosions being amongst the highest risk hazards.

Table 6. Risk Perception for air ports

	Pandemic	Natural Hazard	Biosecurity	Economic Crisis	Political Instability	Man-made Disaster
Risk	Medium – High	High	Low	High	Low	High

Table 7. Risk Perception for sea ports

	Pandemic	Natural Hazard	Biosecurity	Economic Crisis	Political Instability	Man-made Disaster
Risk	Low	High	Low-Medium	Low	Low	High

5. Conclusions

Given the uncertain nature of risk, it is not possible to identify every hazard and source of risk across the Otago region. This updated risk register has, however, given an important cross-section of risk, risk perception, and risk interactions over the social, natural, economic and built environments.

A feature of the risk profile of the region is that perception of risk is not always matched by preparedness to manage or mitigate risk. This is especially the case for the economic environment and tourism sector, which has a high perception of risk but has a concerning lack of comprehensive crisis planning. Conversely, agriculture also has a high perception of risk, which is matched by a high level of preparedness and strategic planning to deal with the worst-case scenarios – in the case of agriculture this could be a major biosecurity incursion.

The social environment, including health and education has a medium to high perception of risk and is less concerned about biosecurity risk and more concerned with potential pandemic, natural hazard and man-made disasters.

The built environment (comprising lifelines and ports) had the lowest perception of risk among the different sectors. This is possibly due to the confidence that these sectors have in their measures for containing health, biosecurity and economic crises.

The most consistently high-risk hazard was man-made disaster. This was an interesting result, as outside of the built environment respondents, other sectors gave few examples of possible man-made hazards.

As has been set out clearly in the AF8 Project and in the previous version of the Otago CDEM Group Plan risk register, the likelihood and consequences of a major earthquake event make this the major risk to the Otago region. This has been largely corroborated by the data gathered in this updated register in terms of consistent high risk associated with natural hazards.

There does appear a need, however, for the Otago CDEM to continue to increase awareness of the risk posed by an AF8 event in terms of fostering an integrated response across sectors to provide the maximum possible resilience for the Otago region.

It is noted that new information will be produced throughout the lifespan of the Otago CDEM Group Plan (2017-2022), in regards to hazards and risk across the Otago Region. The Group Plan should ensure that monitoring is undertaken by stakeholders to ensure they understand the risks within their areas of responsibility, so that, where necessary, action can be taken to mitigate that risk. A process of collating this information should also be determined, so that changes in the state of risks over time can be tracked.

Table 8. Combined Cross-Sectoral Risk Perception

	Hazards>	Pandemic	Natural Hazard / AF8	Biosecurity	Economic Crisis	Political Instability	Man-Made Disaster	Risk/ theme
Environ-ment	Sector	<i>Risk</i>	<i>Risk</i>	<i>Risk</i>	<i>Risk</i>	<i>Risk</i>	<i>Risk</i>	<i>Risk</i>
Social	Health	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	High (3)	Medium-High (2.29)
	Education	High (3)	Medium-High (2.5)	Low (1)	Low (1)	Medium (2)	High (3)	
Natural	Agriculture	Medium-High (2.5)	High (3)	High (3)	Medium-High (2.5)	Medium (2)	High (3)	High (2.66)
Economic	Business	Medium-High (2.5)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (2.63)
	Tourism	Medium (2)	High (3)	Medium (2)	High (3)	Medium (2)	High (3)	
Built /Lifelines	Air ports	Medium-High (2.5)	High (3)	Low (1)	High (3)	Low (1)	High (3)	Medium (2.0)
	Sea ports	Low (1)	High (3)	Low-Medium (1.5)	Low (1)	Low (1)	High (3)	
Overall risk perception		Medium-High (2.7)	High (2.9)	Low-Medium (1.5)	Med - High (2.3)	Med. (1.8)	High (3)	Medium - High (2.35)

Scale

Score	1	1.5	2	2.5	3
Range	0.6 > 1	1.1 > 1.5	1.6 > 2.0	2.1 > 2.5	2.6 > 3
	Low	Low-Med	Medium	Med-High	High

Appendix A. Recent work to describe lifeline vulnerability and hazard characteristics in Otago.

Note that this is not a complete list, and does not include knowledge held by agencies such as territorial authorities, lifeline providers, and major industry groups (e.g., Otago Chamber of Commerce).

- Otago Lifelines Project (2014). Prepared for the Otago CDEM Group.
- Natural hazards investigations prepared for the Dunedin City District, including for the review of the District Plan.
 1. The Natural Hazards of South Dunedin, ORC, 2016.
 2. Active landslides in the Dunedin area, ORC, 2015.
 3. Flood hazard on the Taieri Plain (revised), ORC, 2015.
 4. Identification of areas possibly susceptible to landsliding in the coastal sector of the Dunedin City district, GNS Science, 2015.
 5. Extent and characteristics of alluvial fans in the northeastern sector of the Taieri Plain, GNS Science, 2015.
 6. Flood hazard of Dunedin's urban streams, ORC, 2014.
 7. Review of Dunedin City District Plan: Natural Hazards, ORC, 2014.
 8. Coastal hazards of the Dunedin City District, ORC, 2014.
 9. Assessment of liquefaction hazards in the Dunedin City District, GNS Science, 2014.
 10. The hazard significance of landslides in and around Dunedin City, GNS Science, 2014.
 11. Attributing and reconciling source of landslide data within the Dunedin City Council area, GNS Science, 2012.
 12. Natural hazards on the Taieri Plains, Otago, ORC, 2012.
- Natural hazards reports prepared for other districts within the Otago Region, and available from the Otago Natural Hazards Database (www.orc.govt.nz).
 1. Seismic hazard in Queenstown Lakes District, ORC, 2015.
 2. Coastal Otago Flood event 3 June 2015, ORC, 2015.
 3. Lake Wakatipu / Queenstown CBD flood hazard, ORC, 2015.
 4. Lake Wanaka flood hazard, ORC, 2015.
 5. Kingston flood hazard, ORC, 2015.
 6. Glenorchy flood hazard, ORC, 2015.
 7. Flood and erosion hazard in the Arrow River at Arrowtown, ORC, 2015.
 8. Flood and erosion hazard in the Clutha River/Mata-Au between Queensberry and Lake Dunstan ORC, 2014.
 9. Coastal morphology of South Otago, ORC, 2014.
 10. Community vulnerability to elevated sea levels and coastal tsunami events in Otago, ORC, 2012.
 11. Otago alluvial fans: high hazard investigation, ORC, 2011.
- River morphology and riparian management strategies and reports (assessing potential for riverbank erosion and morphological change)
 1. Pomahaka River, ORC, 2016.
 2. Taieri River, ORC, 2016.
 3. Pomahaka River, ORC, 2016.
 4. Kakanui River, ORC, 2015.
 5. Channel morphology of the Kakanui and Kauru rivers, North Otago, ORC, 2015.
 6. Channel morphology of the Waianakarua River, North Otago, ORC, 2015.
 7. Channel morphology of the Shag River, North Otago, ORC, 2014.
 8. Channel morphology of the Rees River, ORC, 2013.
- Otago Tier 2 Oil Spill Response Plan (reviewed in 2016).
- Milton 2060 Flood Risk Management Strategy, ORC & CDC, 2012.

Appendix B. The Goals of the Otago CDEM Group

Goal 1 Increasing community readiness by ensuring awareness, understanding, preparedness and participation in Civil Defence Emergency Management through public education initiatives and community-led CDEM planning.

Goal 2 Reducing the risks from hazards in the Group area by improving the Group's understanding of hazards and by developing and monitoring a Group-wide risk reduction programme which demonstrates how individual agency initiatives contribute to overall regional risk reduction.

Goal 3 Enhancing the Group area's ability to respond to civil defence emergencies through developing sufficient numbers and capability of CDEM staff and by having effective plans, systems and procedures in place to respond to emergencies.

Goal 4 Enhancing the Group area's ability to recover from civil defence emergencies through a continued focus on recovery plans, training and exercises.