BAY OF PLENTY EMERGENCY MANAGEMENT GROUP

CIVIL DEFENCE

Bay of Plenty Hazardscape Report

Te Moana-a-Toi Kia Haumaru, Kia Kaha, Mā Tātau Katoa.
A safe, strong Bay of Plenty, together.

BAY OF PLENTY EMERGENCY MANAGEMENT GROUP

Bay of Plenty Hazardscape Report

Strategic Policy Publication 2025/03
ISSN 1176-4112 (Print)
ISSN 1178-3907 (Online)

Bay of Plenty Civil Defence Emergency Management Group
C/O Emergency Management Bay of Plenty
Regional House
1 Elizabeth Street
Tauranga 3110
New Zealand

Contents

Waihi Beach, western Bay of Plenty.
Source: GNS Science. Photographer: Lloyd Homer

Foreword

The Bay of Plenty region is exposed to a diverse range of hazards due to its geological and climatic conditions that can impact communities, infrastructure and the environment.

This Bay of Plenty Civil Defence Emergency Management (CDEM) Group Hazardscape Report highlights that our unique set of geological, meteorological, and technological hazards pose several risks to our community and whānau; risks that we have seen play out many times across our region. From floods to earthquakes, plant and pest diseases, volcanic eruptions, oil spills, infrastructure failure and pandemics.

The term hazardscape refers to the overall landscape of hazards in a region, encompassing both natural and human induced risks. It includes the types, frequency, and potential impact of hazards that affect an area, as well as the environmental, social, and economic factors that influence vulnerability and resilience.

Understanding the hazardscape of the Bay of Plenty is essential for helping to build a resilient region.

With the Bay of Plenty's hazardscape front of mind, the reduction of the impacts from hazards requires coordinated efforts from local, regional and national agencies to manage hazard risk. Working with the members of the Bay of Plenty CDEM Group: Bay of Plenty Regional Council; Kawerau District Council; Ōpōtiki District Council; Rotorua Lakes Council; Tauranga City Council; Western Bay of Plenty District Council; Whakatāne District Council; and our science and partner agencies supports the management of our hazardscape through hazard research; planning; and coordinated response and recovery efforts.

Continued efforts in assessing hazard risk, ensuring preparedness, and ongoing efforts to reduce hazard risk will help our communities to adapt and respond effectively to the broad range of impacts from hazards. Being prepared for an emergency is a critical step in ensuring the safety and resilience of communities in the Bay of Plenty. The Bay of Plenty Hazardscape Report has been developed to inform Bay of Plenty communities of hazards impacting the region to support community preparedness.

Te Moana-a-Toi Kia Haumaru, Kia Kaha, Mā Tātau Katoa.
A safe, strong Bay of Plenty, together.

Mark Crowe
Director | Emergency Management Bay of Plenty

Climate change

Climate change is predicted to have significant and wide-ranging impacts for communities within the Bay of Plenty region. Increases in the frequency, intensity, and duration of extreme weather events (e.g. heatwaves, droughts, floods, and storms) have the potential to impact many aspects of the environment as well as cultural wellbeing and the economy within the region. The Bay of Plenty is already experiencing significant climate change effects, leading to increased environmental and economic risks.

Key climate change impacts for the Bay of Plenty in the future are:

- **Sea-Level Rise** – Rising sea level in past decades has already affected human activities and infrastructure in coastal areas, with a higher base mean sea level contributing to increased vulnerability to storms and tsunami. There will be increased risk of flooding and damage to coastal infrastructure.
- **More Extreme Weather Events** – There will be stronger storms, heavier rainfall, and higher risk of flooding and landslides. The Bay of Plenty Region's coastline is exposed to extreme storm tide events, and this exposure will increase further with sea-level rise. Changes in large-scale weather patterns will influence the frequency and intensity of extreme weather events (e.g. flooding, drought, damaging wind).
- **Rising Temperatures** – Warmer temperatures leading to more heatwaves and shifting seasonal patterns will increase. Much of the Bay of Plenty will experience more drought conditions in the future than at present, with plants and soil losing more water than they receive. Drought has significant impacts on primary industries in the Bay of Plenty. Increasing temperatures will impact all types of crops, as plant growth and development may occur at a faster rate.
- **Changing Rainfall Patterns** – There will be more intense rain leading to floods, but also potential for longer dry periods and droughts. For primary production, rainfall is one of the most important climate drivers, as there are limits (both too much and not enough water) where plants cease to grow or experience harm.
- **Marine Impacts** – Changes in water temperature and ocean currents into the future, because of climate change, may result in species (including pests and pathogens) not usually seen in New Zealand waters to arrive and establish. Sea temperatures are projected to climate change projections and impacts for the Bay of Plenty will increase.
- **Biodiversity Changes** – Native species struggling to adapt, with increased threats from pests and diseases. Climate change is widely regarded as one of the greatest challenges facing indigenous ecosystems. Climate change will create new biosecurity challenges by allowing establishment of new exotic pest animals, weeds and diseases which are currently prevented by New Zealand's climate.

What we can expect in the Bay of Plenty

To understand the risks we face in the Bay of Plenty, based on the climate changes we know are coming, a climate change risk assessment for the Bay of Plenty has been completed.

The assessment takes a comprehensive look at climate risk across all aspects of our environment, our people, and our economy and sets a baseline for us all to collectively build upon and respond to climate change risks.

www.boprc.govt.nz/climate-change > risk assessment

Climate change projections and impacts for the Bay of Plenty

Alternatively, check out our interactive mapping tool which enables you to look at a number of climate change projections for Bay of Plenty.

Source: Bay of Plenty Regional Council

Rain induced landslide, Ōhiwa, Bay of Plenty, July 2004.
Source: GNS Science Photographer: Graham Hancox

Section 1: Natural – Geological

In this section:

Volcanic

Earthquake (severe)

Tsunami

Liquefaction

Geothermal systems

Slope instability

Regional deformation

New Zealand's geology

New Zealand lies in the southwest Pacific Ocean astride a distinct belt of volcanic and earthquake activity spanning the Pacific Ocean. This is the Pacific Mobile Belt, better known as the 'Ring of Fire'.

The Ring of Fire is a horseshoe-shaped area encircling the Pacific Ocean, stretching about 40,000 km. It's known for intense seismic and volcanic activity due to the movements of tectonic plates, particularly the Pacific Plate.

New Zealand is highly geologically active, sitting on the boundary between the Pacific and Indo-Australian plates. This tectonic activity has contributed to the dramatic landscapes and unique natural features we see in New Zealand.

Map – 'Ring of Fire'. Sourced and adapted from Wikimedia

New Zealand's geology includes:

Volcanoes

The North Island has two main active volcanic zones – the Auckland Volcanic Field to the north and the Taupō Volcanic Zone extending from Whakaari (White Island) through to Tongariro in the central North Island. In this zone sits Mount Ruapehu, Mount Tongariro and White Island (Whakaari) are some of New Zealand's most active volcanoes. The Taupō caldera, created by a massive eruption around 1,800 years ago, remains a significant site for monitoring.

Earthquakes

New Zealand frequently experiences earthquakes, particularly along fault lines like the Alpine Fault in the South Island and the Wellington Fault in the North Island.

Geothermal systems

New Zealand has areas of geothermal activity, especially in the Rotorua region, famous for its hot springs, geysers, and mud pools. These features are byproducts of volcanic and tectonic activity in the region.

Hazard: Volcano

What is a volcano?

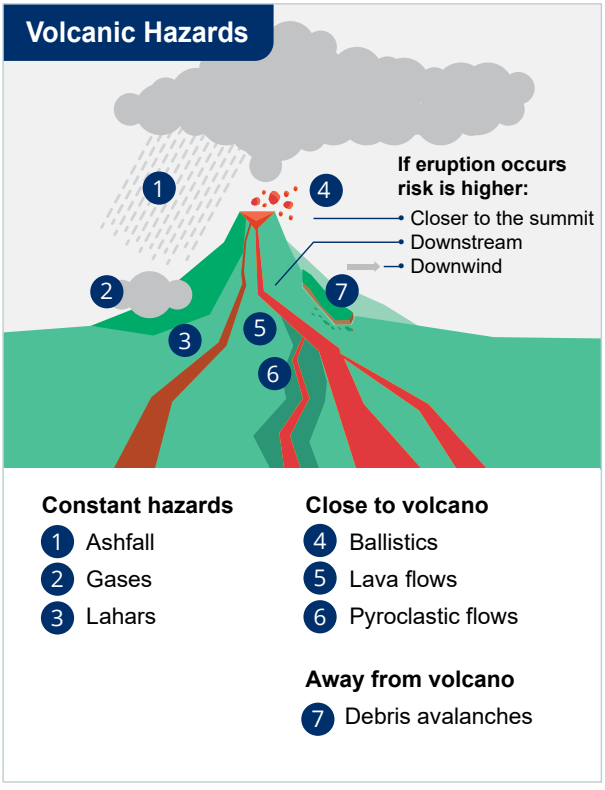
Volcanoes are openings in the Earth's crust that allow magma, gases, and ash to escape from below the surface. Volcanic eruptions vary widely in intensity and can include explosive blasts, pyroclastic and lava flows, ashfall, lahars and the release of volcanic gases.

Hazards from volcanic activity

Volcanic activity is a natural phenomenon with events involving either a volcanic eruption or sustained levels of volcanic unrest, which may or may not be a precursor to an eruption.

Volcanic activity can produce various hazards, including:

- **Ashfall** or tephra, includes fine particles and larger rock fragments ejected during an eruption. Ash can travel hundreds to thousands of kilometres, affecting wide areas far from the eruption site.
- **Lava flows** are streams of molten rock that move from the vent of a volcano. While they are generally slow-moving and pose little threat to human life, they can destroy infrastructure, homes, and agricultural land.
- **Pyroclastic flows** are fast-moving, hot clouds of ash, lava fragments, and gases that can travel down a volcano's slopes at speeds of up to 700 km/h. These flows are highly destructive and can obliterate everything in their path.



Volcanic hazards. Sourced and adapted from: GNS Science

- **Ballistics** are fragments of magma and old (i.e., pre-existing) rocks ejected during an explosive eruption at variable velocity and angle on cannon ball-like trajectories.
- **Lahars** are volcanic mudflows or debris flows composed of volcanic ash, rock, and water. They can be triggered by heavy rain, melting snow, or the sudden release of water from glaciers or crater lakes. Lahars can travel long distances, with impacts including valleys and river systems.
- **Landslides and debris flows** occur when large masses of volcanic material on a steep slope become unstable, potentially due to an eruption, earthquake, or heavy rainfall. These landslides can be catastrophic, especially when combined with water to form lahars.
- **Volcanic gases** such as sulphur dioxide, carbon dioxide, and hydrogen sulphide can cause air pollution (volcanic smog or "vog") and, in high concentrations, can be deadly. Prolonged exposure to volcanic gases can also harm vegetation, water supplies, and human health.

Volcanoes in New Zealand

New Zealand has numerous volcanoes, mostly located along the North Island due to its position on the Pacific Ring of Fire, where the Pacific and Australian tectonic plates meet.

- The country's volcanic activity is centered in the Taupō Volcanic Zone. Volcanoes in the Taupō Volcanic Zone include Mount Ruapehu, Mount Tongariro, Mount Ngauruhoe, Lake Taupō and the Ōkataina Volcanic Centre.
- There are also volcanoes offshore to the New Zealand coast: Whakaari/White Island and the Kermadec Ridge has several submarine and island volcanoes, which are highly active.
- The Auckland Volcanic Field has over 50 small volcanic cones scattered throughout the city.
- Mount Taranaki is part of the Taranaki Volcanic Lineament, a chain of volcanic structures resulting from tectonic activity associated with the Australian and Pacific plates.

The largest and most unpredictable of New's Zealand's volcanoes are calderas. These are volcanoes that have erupted so explosively that the ground has collapsed to form large craters, many kilometers in diameter. There are 8 caldera volcanoes in the central part of the Taupō Volcanic Zone, between Rotorua and Taupō.

Image right: Volcanic Zones.
Source: Natural Hazards Commission | Toka Tū Ake – Adapted from GNS Science

What is caldera unrest?

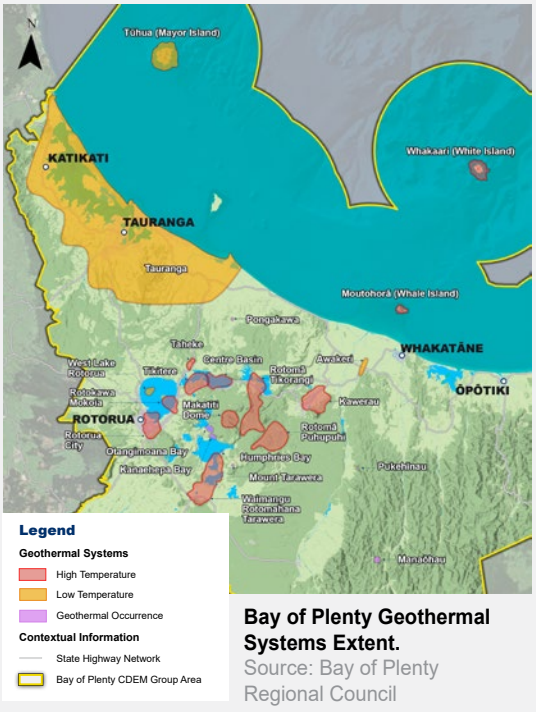
Caldera unrest is simply volcanic unrest at a caldera volcano. Volcanic unrest is defined as increased activity indicating possible eruptive reactivation in a dormant volcano including increased seismicity; ground uplift; physico-chemcial changes in fumaroles and hot springs; increased heat flow; and changes in the gravimetric and magnetic fields.

Our Story
Bay of Plenty context

In the Bay of Plenty, volcanic hazards primarily stem from the Taupō Volcanic Zone which marks the southern end of the Tonga–Kermadec–New Zealand active volcanic arc. This zone stretches approx. 300km in length from Whakaari (White Island) to Mount Ruapehu.

The Bay of Plenty region contains five active volcanic areas. These volcanic areas, except for Tūhua (Mayor Island), are part of the larger Taupō Volcanic Zone.

- **Ōkataina Volcanic Centre**. The Ōkataina Volcanic Centre is located near Rotorua and Kawerau. The caldera last collapsed about 64,000 years ago. Since then, eruptions from many vents in the caldera floor have built dome volcanoes and partly filled in the hole left by that collapse. Tarawera is one of a number of dome volcanoes in the Ōkataina Volcanic Centre.
- **Tūhua** (Mayor Island). Tūhua (Mayor Island) is an offshore caldera volcano that has erupted on average once every 3,000 years for the past 130,000 years. This caldera volcano is 15km wide with a large 3km caldera depression at its centre.
- **Whakaari** (White Island) is New Zealand's most active volcano. Whakaari (White Island) is a partially submerged andesite volcano located 50 km offshore from the Bay of Plenty coast from Whakatāne. Whakaari (White Island) is an extremely active volcano and is almost in a constant state of unrest and minor eruption.
- **Pūtauaki** (Mount Edgecumbe) is a young, multiple vent, dacitic cone complex located 50 km east of Rotorua and 3 km east of Kawerau.
- **Rotorua Caldera** is located between Ōkataina and Rotorua; and is the youngest caldera and was formed by the collapse associated with the eruption of Mamaku Ignimbrite 220,000 years ago.



Bay of Plenty Geothermal Systems Extent.
Source: Bay of Plenty Regional Council

Tūhua (Mayor Island).
Source: GNS Science. Photographer: Lloyd Homer

There are other volcanoes within the North Island capable of producing eruption events that could affect the Bay of Plenty region. These include the southern Taupō Volcanic Zone volcanoes of Tongariro, Ngauruhoe and Ruapehu, as well as Taranaki in the western North Island.

A map showing the locations of calderas and active volcanoes in the Bay of Plenty Region is highlighted in:
BayHazards > Te Puia | Volcano

Bay of Plenty events

2019 Whakaari (White Island) Eruption

On 9th December 2019, Whakaraai (White Island) erupted while 47 people were on the island. 22 people died and numerous others were severely injured. The eruption produced an explosive release of ash, steam, and gases, with pyroclastic material affecting the immediate vicinity. There was an immediate response to help those on the island, their whānau and affected communities. As a majority of those affected by the eruption were international visitors, there was strong international attention. This event prompted a review of safety protocols for visiting active volcanoes in New Zealand. Whakaari (White Island) has remained active since, with eruptions of varying intensity continuing to occur.

Whakaari (White Island)

1886 Mount Tarawera Eruption

The eruption of Mount Tarawera on 10th June 1886 was one of the most devastating volcanic events in New Zealand's history. It produced explosive activity along a 17 km fissure and destroyed several Māori villages, resulting in the loss of around 120 lives.

The eruption also created the Waimangu Volcanic Valley and buried the famous Pink and White Terraces, which were a popular tourist attraction at the time. Ash from the eruption spread across the Bay of Plenty, affecting agriculture, water sources, and air quality throughout the region. Today, Tarawera as part of the Ōkataina Caldera is monitored by seismographs, continuous GPS stations, and lake monitoring and levelling; due to its history and proximity to populated areas.

Mount Tarawera in Eruption 10 June 1886 from Near White Terrace. Source: Canterbury Museum

Te Wairoa (close to shore of Lake Tarawera, near Rotorua), "The Buried Village". Source: Wikipedia

Painting of the 'White Terraces' by Charles Blomfield. Source: Wikipedia

Mount Tarawera volcano. Source: Lloyd Homer / GNS Science

Hazard impacts

The impact of volcanic hazards can vary depending on the volcano and the size of the eruption. For example, while Tūhua and Whakaari are likely to impact only the area immediately surrounding the volcano, eruptions from the Ōkataina Volcanic Centre, Pūtauaki, and the Rotorua Caldera could affect the mainland, with ashfall being the dominant effect on the Bay of Plenty region.

Health

Volcanic ash, gas and heat can cause respiratory problems, burns, eye and skin irritation, headaches, dizziness, difficulty breathing and eye discomfort for people exposed to it, particularly for vulnerable groups including those with pre-existing respiratory conditions. Gases like sulfur dioxide, carbon dioxide and hydrogen sulfide, which can be especially dangerous at high concentrations near volcanic vents; and exposure to extreme heat from lava flows can cause burns and thermal injuries to skin and airways. Ash inhalation is a concern as it can lead to short- and long-term health issues.

Infrastructure

Ashfall from eruptions can disrupt essential services such as water supply, electricity, and communications. Volcanic ash can contaminate water sources, clog drainage systems, and damage electronic equipment. Volcanic ash can cause flashover, which is an unintended electrical discharge over or around an insulator, in power generation systems. This can lead to widespread outages and disruption to power supply. Roads, especially major routes within the Bay of Plenty, can become hazardous or impassable.

Agricultural

Ashfall can damage crops, degrade soil, and harm livestock, impacting the Bay of Plenty's agriculture. Ash covering plants can inhibit photosynthesis, reduce crop yields, and contaminate pasture land, making it unfit for livestock grazing until cleaned or naturally dispersed.

Economic

Volcanic eruptions pose an economic risk to industries such as agriculture, tourism, and fisheries, which are vital to the economy. Volcanic hazards that impact the natural landscape or create health risks can reduce tourism, affecting local businesses and employment.

Environmental

Volcanic eruptions can disrupt ecosystems by depositing ash and gases that alter soil chemistry and affect aquatic environments. In addition, volcanic events can cause long-term changes to landscapes, such as the formation of new geothermal areas or volcanic cones, which can impact biodiversity and alter natural habitats. The 1886 Mount Tarawera's eruption drastically reshaped the surrounding landscape, creating the Waimangu Volcanic Valley.

Psychosocial and community

Volcanic hazards can have a significant psychological impact on communities, causing stress, anxiety, and trauma, especially following high-profile events. The 2019 Whakaari (White Island) eruption was a tragic reminder of the potential risks involved, leading to increased caution and awareness but also a lasting emotional impact on the community and those directly affected. Displacement due to evacuations and the loss of property or livelihood can exacerbate these impacts.

Hazard management – what to do and what this means for you

What to do if there is a volcanic eruption

Monitor the Geonet website which provides information on the Volcanic Alert Levels and additional information via Volcanic Activity Bulletins The New Zealand Volcanic Alert Level system is based on 6 levels and is intended to describe the current status of each active volcano.

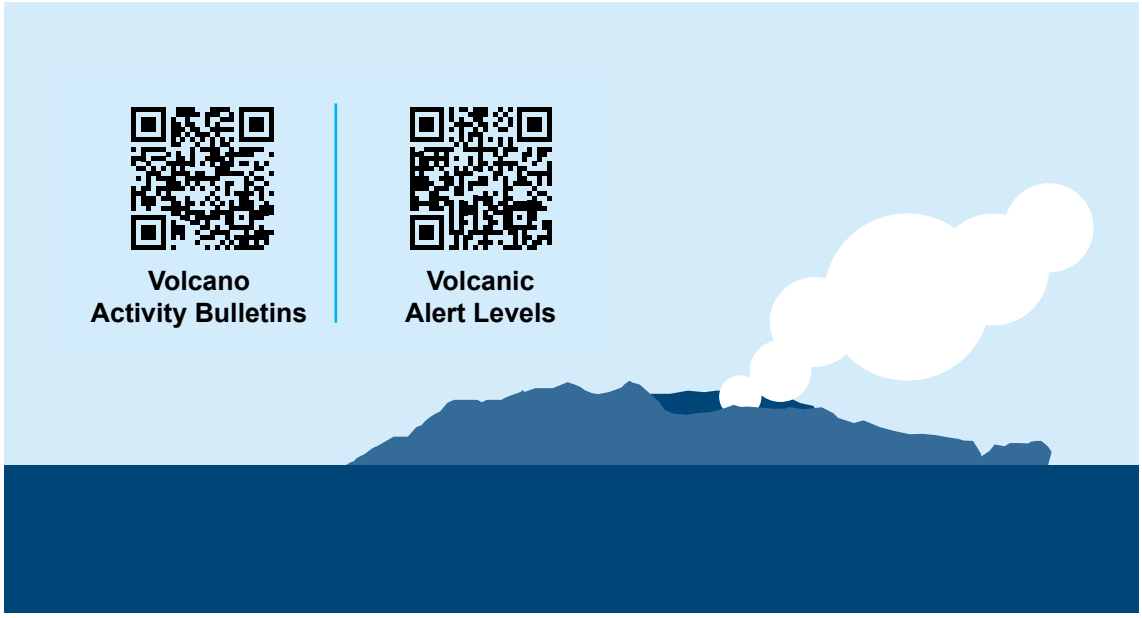
	Volcanic Alert Level	Volcanic Activity	Most Likely Hazards
Eruption >	5	Major volcanic eruption	Eruption hazards on and beyond volcano
Eruption >	4	Moderate volcanic eruption	Eruption hazards on and near volcano
Eruption >	3	Minor volcanic eruption	Eruption hazards near vent
Unrest >	2	Moderate to heightened volcanic unrest	Volcanic unrest hazards, potential for eruption hazards
Unrest >	1	Minor volcanic unrest	Volcanic unrest hazards
>	0	No volcanic unrest	Volcanic environment hazards

For regional information on volcanoes:
What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from: Bay of Plenty Civil Defence Emergency Management Group > Volcanic Activity Page.

Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency. Visit **www.getready.govt.nz**

Volcano Activity Bulletins

Volcanic Alert Levels



To prepare for a volcanic eruptions

In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

For information on how to prepare for volcanic activity:
www.getready.govt.nz
Get Ready for Volcanic Activity.

Acknowledgements and references

We would like to acknowledge GNS Science on the development; and information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- GNS Science | Te Pū Ao – **www.gns.cri.nz**
  - 2022 National Seismic Hazard Model: Bay of Plenty region
- GeoNet – **www.geonet.org.nz**
- Natural Hazards Commission | Toka Tū Ake – **www.naturalhazards.govt.nz**
  - Quake Safe Your Home
- National Emergency Management Agency New Zealand – **www.getready.govt.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
  - BayHazards – Bay of Plenty Natural Hazards Viewer
  - Volcanic hazards
  - Bay of Plenty Regional Volcanic Hazards – Scoping Study
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**
  - Know your hazard > volcano

Hazard: Earthquake

What is an earthquake?

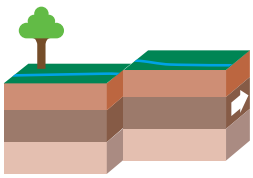
An earthquake is the shaking of the Earth's surface resulting from a sudden release of energy in the earth's crust.

The earth's outermost layer, the crust, is made up of massive slabs of solid rock, ranging from a few hundred to thousands of kilometres across. These are known as tectonic plates, and there are seven major ones which are constantly moving, at slightly different speeds and in slightly different directions, continuously reshaping Earth's landscapes. It's at the boundaries between these plates that most earthquakes are concentrated. In New Zealand, earthquakes are a common occurrence due to the country's location on the boundary between the Pacific and Australian tectonic plates. This tectonic setting leads to significant geological activity, making New Zealand one of the most seismically active regions in the world.

Most earthquakes are caused by the movement of ground along a fault. Faults are fractures in the Earth's crust where pressure builds up until it slips, releasing built up energy as seismic waves. This release results in ground shaking, surface ruptures, and in some cases, secondary hazards like landslides or tsunamis.

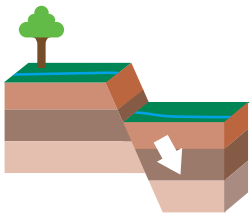
Faults can be classified into three main types:

Strike-strip



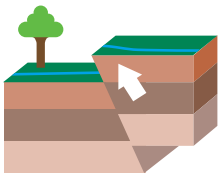
Strike-strip faults are steep structures where the two sides of the fault slip horizontally past each other.

Normal



Normal faults occur mainly in areas where the crust is being extended such as a divergent boundary.

Reverse (thrust)



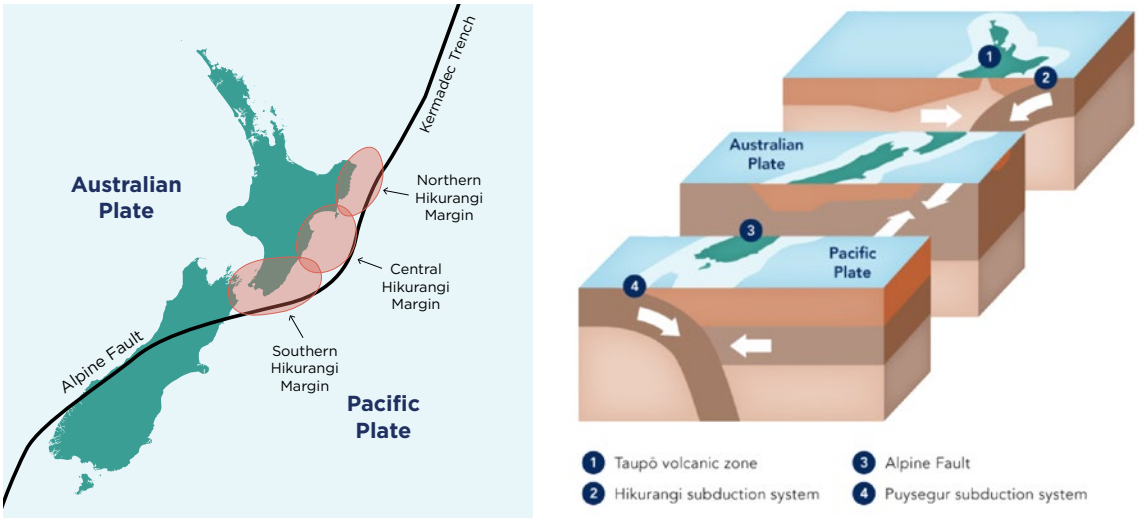
Reverse (thrust) faults occur in areas where the crust is being shortened such as at a convergent boundary.

Normal and Reverse faulting are examples of dip-slip, where the displacement along the fault is in the direction of dip and where movement on them involves a vertical component.

Earthquakes that are part of a sequence can be part of a cluster; aftershock; or swarm. Earthquake clusters consist of small tremors that cause little to no damage. An aftershock is an earthquake that occurs after a significant earthquake, the mainshock. Sometimes an aftershock can be larger than the mainshock. Earthquake swarms are sequences of earthquakes striking in a specific area within a short period. They are different from earthquakes followed by a series of aftershocks by the fact that no single earthquake in the sequence is the main shock, so none has a notably higher magnitude than another.

On average, there are over 20,000 earthquakes a year in and around New Zealand with about 100 to 150 of these earthquakes big enough to be felt. The smaller earthquakes are not felt but still recorded by the large network of seismological instruments across New Zealand.

New Zealand is at the boundary between two major tectonic plates, the Australian Plate and the Pacific Plate. In the North Island, the Pacific Plate is being pushed under the Australian Plate. This setting, with one plate going down beneath another, is called subduction. At the southern end of the South Island, the opposite situation occurs, with the Australian Plate diving down beneath the Pacific Plate. While the plates are trying to push against or past each other, often they're stuck, and stress is just building up. When the stress is big enough, the faults move suddenly and cause earthquakes.



Cross-section of New Zealand's plate boundary.
Source: GNS Science

In New Zealand there are faults everywhere. There are the big plate boundary ones, like the Alpine Fault (600-kilometre-long main plate boundary fault), but there are also many hundreds of smaller faults on the North and South Island and extending out into the oceans, and each of them can host earthquakes.

Through the North Island, earthquakes are generally smaller but can often occur in swarms. Swarms can include hundreds of events and can continue for days, weeks or months. Earthquake swarms can indicate volcanic eruptions and other volcanic activity.

Our story
Bay of Plenty context

Earthquakes are a significant natural hazard in the Bay of Plenty. Situated along the Boundary between the pacific and Australian tectonic plates, the Bay is part of the highly active Taupō Volcanic Zone, increasing exposure to both small frequent earthquakes and larger, potentially damaging events. This risk is heightened by the presence of several significant faults within the Bay of Plenty, including the Whakatāne, Waiohau, Edgecumbe, Waimana, and Paeroa faults.

The region lies upon several faults, including the Whakatāne, Waiohau, Edgecumbe, Waimana, and Paeroa faults. It also contains part of the Taupō Volcanic Zone fault system.

A map with the location of active faults in the Bay of Plenty Region is highlighted in: **www.boprc.govt.nz/bayhazards** > BayHazards > Active Faults

The 1987 Edgecumbe earthquake surface rupture occurred mainly in the Rangitāiki Plains.
Source: GNS Science. Photographer: Lloyd Homer

Bay of Plenty events

1987 Edgecumbe Earthquake

The 1987 Edgecumbe earthquake was a significant seismic event in the Bay of Plenty and occurred in the rifting section of the northern Taupō Volcanic Zone. At 1.35 p.m. on 2nd March 1987, a magnitude 5.2 earthquake struck. Minutes later at 1.42 p.m., a larger mainshock occurred with a magnitude of 6.3 and was centred north of Edgecumbe. Four aftershocks with magnitudes greater than 5 occurred in the next six hours, and smaller aftershocks were felt for weeks. The Edgecumbe Fault identified as the source. A fissure up to three metres wide and three to four metres deep opened up along much of the fault. The movement from the earthquake resulted in significant movement along the fault. Some land dropped by up to two metres. The quake was among the most impactful seismic events in New Zealand's recorded history and led to extensive damage in the region, distorting railway tracks, cracking roads and damaging buildings. There were no fatalities, but 25 were reported injured during the Edgecumbe earthquake.

Damage to Railway lines, Edgecumbe.
Source: Archives New Zealand, CC BY-SA 2.0

Edgecumbe earthquake main rift across McCracken Road. Source: GNS Science Photographer: Lloyd Homer

Derailed by 1987 Edgecumbe earthquake.
Source: Archives New Zealand, CC BY-SA 2.0

Building damaged by Edgecumbe Earthquake, 1987.
Source: GNS Science Photographer: Lloyd Homer

2023 Kawerau Earthquake swarms

Kawerau experienced a number of significant earthquake swarms in recent years: 2018; 2019 and 2023. These swarms are typical in the Taupō Volcanic Zone.

The swarm in March 2023 included over 600 earthquakes, with the largest reaching a magnitude of 4.8; and the majority of earthquakes between magnitude 2.0 and 2.9. These swarms, though intense, are generally not linked to volcanic activity but rather to tectonic stresses and fault movement in the region.

The earthquake swarms caused significant anxiety for the Kawerau community. Several slips and cracks had appeared around the Kawerau-township including the Stoneham walk along the river edge and the walkway on Monika Lanham Reserve. A number of significant slips were reported that had a significant effect on state highways around the district, these included: major slip in Kawerau; slips on the State Highway network with 21 slips on State Highway 30 (between Lake Rotomā and Kawerau); and 16 slips on State Highway 34.

Recorded earthquakes in the Kawerau area from 17 March - 19 March 2023. Source: GNS Science

Slip | Council land behind Tamarangi Drive, Kawerau.
Source: Sunlive

Slip | Council land behind Tamarangi Drive, Kawerau.
Source: Rotorua Daily Post

Hazard impacts

Infrastructure and building damage

Earthquakes, especially larger ones, can cause severe damage to buildings, roads, bridges, and utility lines. For example, the 1987 Edgecumbe earthquake (magnitude 6.5) damaged or destroyed hundreds of homes, warped railway tracks, cracked roads, and impacted factories and mills in the region. Earthquakes can also impact the roading network due to slips. Traffic management and road closures occurred recently on State Highway 34 and 30 due to the 2023 Kawerau earthquake swarms.

Industrial and geothermal plant shutdowns

Bay of Plenty hosts several geothermal power plants, especially around Kawerau, where earthquake swarms are common. During significant swarms, these plants often automatically shut down to avoid damage. For instance, the 2018 swarm in Kawerau caused geothermal plants to activate safety systems, which led to temporary closures and reduced energy output.

Economic

Earthquake damage to industrial areas and commercial properties causing disruption to supply chains can have substantial economic effects. The 1987 Edgecumbe earthquake disrupted production in local factories, while frequent seismic activity in Kawerau affects businesses. Insurance claims, repairs, and rebuilding efforts also represent long-term economic burdens on both individuals and communities.

Psychosocial and community

Repeated tremors, especially during earthquake swarms, create ongoing stress for residents, impacting mental health and community resilience. The 2023 earthquake swarms in Kawerau highlighted impacts to the community. The 2023 Kawerau earthquake swarms made people leave Kawerau due to the on-going earthquakes.

Hazard management – what to do and what this means for you

Living in an earthquake-prone country like New Zealand means you should be prepared.

What to do in an earthquake

- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency. **www.getready.govt.nz**

For regional information on earthquakes:
What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from: Bay of Plenty Civil Defence Emergency Management Group > Earthquake Page.

- **Drop**, **Cover**, and **Hold** during a large earthquake.

DROP down on your hands and knees.

COVER your head and neck (or your entire body if possible) under a sturdy table or desk (if it is within a few steps of you). If there is no shelter nearby, cover your head and neck with your arms and hands.

HOLD on to your shelter (or your position to protect your head and neck) until the shaking stops.

GET READY

Drop, Cover and Hold is the right action to take in an earthquake. Learn how to Drop, Cover and Hold at **www.getready.govt.nz**

- **If it is Long or Strong, Get Gone!** People near the coast and lake fronts should move to higher ground as soon as it is safe to do so, especially if they hear loud noises or see unusual sea or lake action during earthquake activity. If you are near or on steep slopes or cliffs, keep an eye out for falling rocks and cracking.

To prepare for earthquakes

- **Practise Drop, Cover and Hold.** You can do this by taking part in New Zealand ShakeOut.
- **In an emergency, you may be stuck at home for three days or more.** Figure out what supplies you need and make a plan to work out what you need to get through including water and food.
- For information on how to **prepare your house for earthquakes**, check out **naturalhazards.govt.nz** Toka Tū Ake EQC's advice for homeowners and renters.

EQC's **Quake Safe Your Home** guide shows you how to prepare your home and protect your whānau.

www.naturalhazards.govt.nz

Acknowledgements and references

We would like to acknowledge all Councils in the Bay of Plenty and GNS Science on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- GNS Science | Te Pū Ao – **www.gns.cri.nz**
  - 2022 National Seismic Hazard Model: Bay of Plenty region
- GeoNet– **www.geonet.org.nz**
- Natural Hazards Commission | Toka Tū Ake – **www.naturalhazards.govt.nz**
  - Quake Safe Your Home
- National Emergency Management Agency New Zealand – **www.getready.govt.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
  - BayHazards – Bay of Plenty Natural Hazards Viewer
  - Living in the Bay > Natural Hazards > Active Faults
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**
  - Know your hazards > earthquake

Hazard: Tsunami

What is a tsunami?

A tsunami is a series of powerful ocean waves caused by sudden movements in the seafloor. A tsunami wave is not just seawater. It picks up debris as it moves, which gives it added destructive power. A retreating tsunami wave can cause as much damage as the initial forward surge. In low-lying coastal areas, tsunamis can travel a long way inland.

Tsunamis are not just moving waves on the ocean's surface, they also include hollows. Sometimes the hollow reaches the coast first. When this happens, the ocean first draws back, sucking water away from coastline. It then rushes in with enormous speed and force as the wave arrives.

What causes a tsunami?

Tsunamis are usually caused by an earthquake under the seafloor. Other triggers include landslides, undersea volcanic eruptions, and meteorite impacts. These sudden disturbances cause a displacement of water and a large wave is created. These waves can travel hundreds of kms, eventually reaching land.

Tsunamis impacting New Zealand

New Zealand is vulnerable to tsunamis due to its position on the 'Pacific Ring of Fire' which is the highly active tectonic belt of volcanoes and earthquakes around the Pacific Ocean. Tsunamis impacting New Zealand are often generated by tectonic activity along nearby fault lines, such as the Kermadec Trench and the Hikurangi Subduction Zone. A Subduction Zone is where two plates converge and one is subducted underneath another).

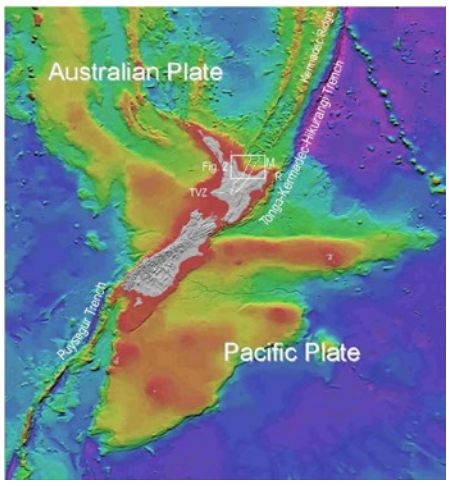


Image right: Geophysical setting for New Zealand.
Source: GNS Science

Sources of tsunami impacting New Zealand

There are different sources of tsunami that may impact New Zealand.

- **Local, "near-source" tsunami** are generated by large offshore earthquakes, landslides, and volcanic eruptions close to New Zealand. If the tsunami is caused by a local earthquake, the shaking associated with the event may be the only warning people get before this kind of tsunami arrives. Other natural signs could also include loud or unusual noises from the sea or a sudden unexpected change in sea level at the coast. Such a tsunami can arrive within minutes, before there is time to issue an official warning.
- **Regional source tsunamis** can be generated by large offshore earthquakes in the Kermadec Trench and the Hikurangi Subduction Zone. These tsunamis may reach New Zealand within one to three hours after the initial earthquake. While this allows time for a warning, the window for action can be quite short.
- **Distant source tsunami** – Pacific-wide events can be caused by a distant earthquake on the other side of the Pacific, like South America or Alaska. These events allow sufficient time for officials to produce warnings to be issued before the tsunami waves arrive. They would typically impact New Zealand from several hours to more than half a day after the initial event.

Tsunami that have impacted New Zealand

New Zealand has experienced several significant tsunami events throughout its history. Significant events to note are:

- **1947** – A magnitude 7.1 earthquake just off the coast of Gisborne triggered a tsunami with waves up to 10 metres.
- **2011** – A magnitude 9.1 earthquake, termed the Tōhoku earthquake, triggered a significant tsunami that resulted in waves affecting areas over 40 meters above sea level.

  Although New Zealand is approx. 8,000 kilometers from Japan; the tsunami waves traveled across the Pacific Ocean, with waves up to 1.6 meters observed in Whitianga and the Chatham Islands.

Tōhoku tsunami – Waves in Miyako, Iwakea.
Source: Wikipedia

Video: 2011 Tōhoku (Japan) tsunami in Whitianga.

- **2016** – A magnitude 7.8 earthquake near Kaikōura caused a local tsunami with waves up to 4 metres.
- **2022** – the Hunga Tonga-Hunga Ha'apai eruption offshore from Tonga triggered a tsunami with waves up to 15 metres high in Tonga. The waves reached up to 1.5 meters in some parts of New Zealand, particularly along the north and east coasts, including Northland, Bay of Plenty, and East Cape.

Our story
Bay of Plenty context

The Bay of Plenty faces a diverse range of potential sources of tsunami either within the Bay of Plenty, along nearby plate boundaries, or remotely across the Pacific Ocean.

Local and Regional sources

- The **Tonga-Kermadec-Hikurangi Trench** is a subduction zone about 3,500 km long, to the north of New Zealand that can produce large earthquakes up to magnitude 9 (severe to violent). An earthquake along the Hikurangi Subduction Zone – which is the southernmost segment of this extensive system stretching from the East Coast of New Zealand down to the South Island, could trigger a local tsunami potentially reaching the Bay of Plenty within an hour.
- The **Kermadec Trench** is prone to major undersea earthquakes. The March 2021 Kermadec earthquakes highlighted this plate boundaries tsunami-generating capacity, as waves produced from this event reached the coast shortly after these earthquakes
- **Regional active faults** provide many sources within the Bay of Plenty. They primarily include faults in the offshore Taupō Volcanic Zone. This major zone of active rifting extends between Whakatāne and Tauranga, with faults between Matatā and Whakatāne are also of significance.
- **Landslide** complexes located to the east and north of the East Cape have the potential to trigger tsunamis. There have been significant landslide events thousands of years ago warranting inclusion of this source of tsunami. Large submarine landslides will undoubtedly produce large tsunamis. Smaller landslides are possible within the Matakaoa Volcanic Complex (near the Matakaoa Peninsula) and in the submarine canyons of the Bay of Plenty. Local landslides including sector collapse of seamounts, can provide sources within the Bay of Plenty. In particular, landslide sources at the heads of Tauranga and Whakaari (White Island) canyons are considered as possible sources.
- **Offshore volcanoes** are also sources of tsunami in the Bay of Plenty and include Tūhua (Mayor Island) and Whakaari (White Island). There are also numerous smaller submarine volcanoes on the Bay of Plenty continental shelf.

Distant source

The Bay of Plenty is also at risk from distant source tsunami, for example those generated off the coast of the Americas. Earthquakes along the western coasts of both North and South America can generate large trans-pacific tsunami. These events typically allow for 12–15 hours of warning time before reaching the Bay of Plenty coast. While these distant source tsunamis are typically smaller than those generated locally, they still pose a significant risk to our coastlines.

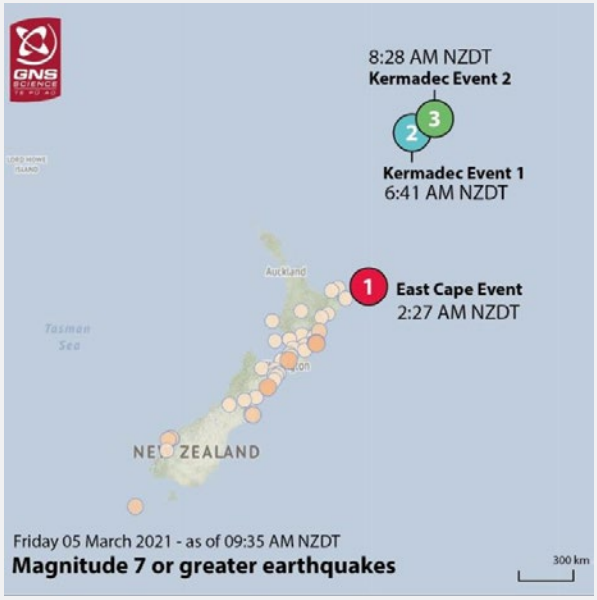
Tsunami in the Bay of Plenty

There have been a number of events that have triggered tsunamis over time that have impacted the Bay of Plenty. A summary of these events include:

- **1868 Arica (Peru-Chile) Earthquake and Tsunami.** This tsunami was triggered by a magnitude 8.5–9.0 earthquake off the coast of Chile. In the Bay of Plenty and along the eastern seaboard of New Zealand, unusual sea levels and strong currents were reported, causing damage to coastal boats and infrastructure.
- **1883 Krakatoa | Letusan Krakatau Eruption Tsunami.** In the Bay of Plenty, wave surges and irregular tides were observed.
- **1960 Valdivia (Chile) Earthquake and Tsunami.** The magnitude 9.5 earthquake, generated a Pacific-wide tsunami. When it reached the Bay of Plenty, several hours later, it caused significant changes in water levels, strong currents, and minor flooding in some coastal areas.
- **2011 Tōhoku (Japan) Earthquake and Tsunami.** The magnitude 9.0 earthquake generated a destructive tsunami that reached New Zealand's shores about 12 hours later. In the Bay of Plenty, waves of up to 1 metre were observed, resulting in strong currents and minor damage to boats and coastal infrastructure.

5 March 2021 – Hikurangi and Kermadec Earthquakes and Tsunami

On 5 March 2021, three large earthquakes occurred offshore of New Zealand. The first earthquake occurred at 2.27am (a Magnitude 7.3 off East Cape) and was followed by two earthquakes in the Kermadec Islands,(a Magnitude 7.4 earthquake at 6.41am and a Magnitude 8.1 earthquake at 8.28am). These earthquakes generated tsunami that overlapped and were recorded around New Zealand.



Left: Hikurangi and Kermadec Islands earthquakes. Source: NEMA

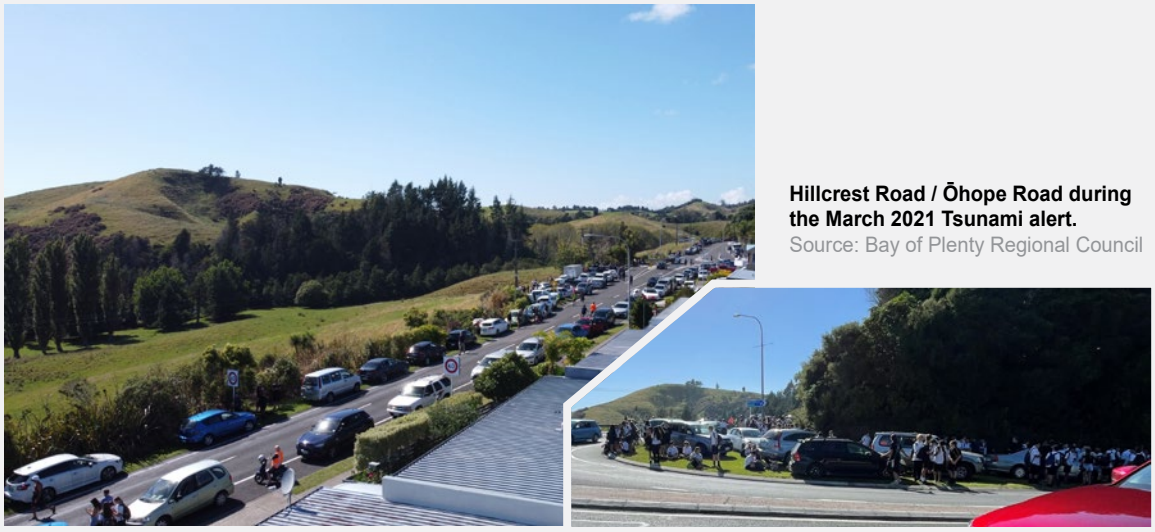
Above: Twitter Alert. Source: NEMA

The earthquakes triggered tsunami evacuations in many coastal areas, including the Bay of Plenty. Emergency Mobile Alerts (EMAs) at regional and national level were issued due to the threat to land and marine areas.

The widespread evacuations disrupted daily life, with schools, businesses, and local transport impacted. Although many people did the right thing and moved out of evacuation zones, some people who were not in tsunami evacuation zones also evacuated unnecessarily and could have stayed safely at home. Others rushed to collect children from school – even if that meant heading into designated tsunami evacuation zones – only to find schools had already taken children to tsunami safe locations. Even when people evacuated as they were meant to, lots of people waiting in safe zones for the all-clear realised they had not brought emergency supplies like water, snacks and protection from the weather.

Although the waves were small, this event highlighted the vulnerability of the region.

Cars showing evacuations on Ōhope hill between Whakatāne and Ōhope.
Source: Bay of Plenty Times



Hillcrest Road / Ōhope Road during the March 2021 Tsunami alert.
Source: Bay of Plenty Regional Council

Hazard impacts

A tsunami in New Zealand's Bay of Plenty region could lead to extensive impacts, especially due to the region's coastal population. Due to the speed and force of these waves, tsunami impacts can include substantial damage to homes, businesses and infrastructure; economic losses; and environmental impacts, such as soil salinisation and habitat disruption. A large tsunami event would not only impact the Bay of Plenty, but other regions in New Zealand.

Loss of life and casualties

There are over 110,000 people who live within the Bay of Plenty tsunami evacuation (blue) zone across the region, of which over 50% of the population is found within Tauranga City boundaries. If a local or regional earthquake triggers a tsunami, there might be limited warning, heightening the risk of casualties among coastal residents, particularly in highly populated residential and popular tourist areas.

Psychosocial and Community

Evacuations and potential property loss would have long-term effects on the mental health and stability of affected communities. Following a large tsunami event, high levels of support would be required for people and communities due to the significant toll on social wellbeing, including psychosocial effects. There would also be a high demand for services to assist with the social implications (i.e. medical, financial support, counselling, housing, schooling). Many of these services will be reduced regionally and nationally following a large tsunami event and services that are available would be oversubscribed. Services in other regions will also be impacted. Many families will not be able to return to their homes following a tsunami with thousands of displaced people requiring permanent or long-term alternative accommodation.

Infrastructure and building damage

A tsunami would cause significant impacts on infrastructure across the region including Waihi, Mount Maunganui, Sulphur Point, Pāpāmoa, Whakatāne and Ōpōtiki.

Low-lying coastal infrastructure, including homes, schools, hospitals, and commercial and industrial buildings, could be flooded. Roads, bridges, and ports may be heavily impacted, potentially cutting off access to essential services and evacuation routes. Damage to ports and marine infrastructure can also disrupt supply chains, affecting both local industries and broader economic systems reliant on the Bay of Plenty's ports and fisheries. Cell phone coverage will likely be reduced across coastal areas. Transport infrastructure such as major roads, railway and Tauranga Port will be impacted by loss and damage to infrastructure.

Economic

Many key economic sectors in the Bay of Plenty would be adversely affected in the long-term with a risk that some sectors may be lost entirely from the region. The local economy, especially industries like tourism, agriculture, and fisheries, would be significantly disrupted by both immediate damage and longer-term impacts, such as loss of coastal facilities and reduced visitor numbers. Clean-up and repair costs could place a heavy burden on local and regional resources.

Environmental

Tsunamis can cause soil salinisation, impacting coastal farmlands and estuaries. Aquatic habitats, particularly sensitive ecosystems like those in Tauranga Harbour, may suffer from changes in water salinity and debris accumulation, which can disrupt local marine biodiversity and habitats.

Hazard management – what to do and what this means for you

What to do in a tsunami

If you are at the coast and experience any of the following:

- Feel a strong earthquake that makes it hard to stand up, or a weak rolling earthquake that lasts a minute or more.
- See a sudden rise or fall in sea level.
- Hear loud and unusual noises from the sea.
- Receive an alert.

Move immediately to the nearest high ground, or as far inland as you can. Walk or bike if possible.

DO NOT WAIT FOR OFFICIAL WARNINGS!

For a local source tsunami which could arrive in minutes, there won't be time for an official warning. It is important to recognise the natural warning signs and act quickly.

A **LONG** or **STRONG** earthquake could be your only warning.

For regional information on tsunami:
What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from Bay of Plenty Civil Defence Emergency Management Group.
www.bopcivildefence.govt.nz > Tsunami Page.

Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency. Visit **www.getready.govt.nz**

Tsunami evacuation route sign, Tay Street, Mount Maunganui.
Source: Bay of Plenty Regional Council

To prepare for a tsunami

- **Know if you are in a Tsunami Evacuation Zone.** The Bay of Plenty CDEM Group wanted to make the region's tsunami evacuation maps as easy to understand as possible.
- **In a potential tsunami, *get out of the blue***: head inland or to higher ground right away.

Bay of Plenty Tsunami Evacuation Map – sign at Ōhope.
Source: Bay of Plenty Regional Council

Find out if you live or work or visit a tsunami evacuation zone by looking at your area's Bay of Plenty Tsunami Evacuation Maps.

BayHazards
This map displays a continuous tsunami evacuation zone map across the Bay of Plenty region.

Acknowledgements and references

We would like to acknowledge all Bay of Plenty Councils and GNS Science on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- GNS Science Te Pū Ao – **www.gns.cri.nz**
  - 2022 National Seismic Hazard Model: Bay of Plenty region
  - New Zealand Tsunami Database
- GeoNet – **www.geonet.org.nz**
- National Emergency Management Agency New Zealand
  - **www.getready.govt.nz** > Get Ready > tsunami
  - **www.civildefence.govt.nz** Hikurangi and Kermadec-Island Earthquakes Post Event Report
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
  - BayHazards – Bay of Plenty Natural Hazards Viewer
  - Tsunami
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**
  - Know your hazards > tsunami

Hazard: Liquefaction

What is liquefaction?

Liquefaction occurs when saturated soil—usually sand or silt—temporarily loses its strength and behaves like a liquid during intense ground shaking, such as that caused by an earthquake. When the soil structure collapses, it can cause ground surfaces to sink, spread, or even eject water and sand to the surface, which can damage buildings, roads, and underground utilities. This phenomenon is especially relevant in low-lying coastal and river-adjacent areas, where soil is often loose and water-saturated.

The liquefaction process

Before the earthquake

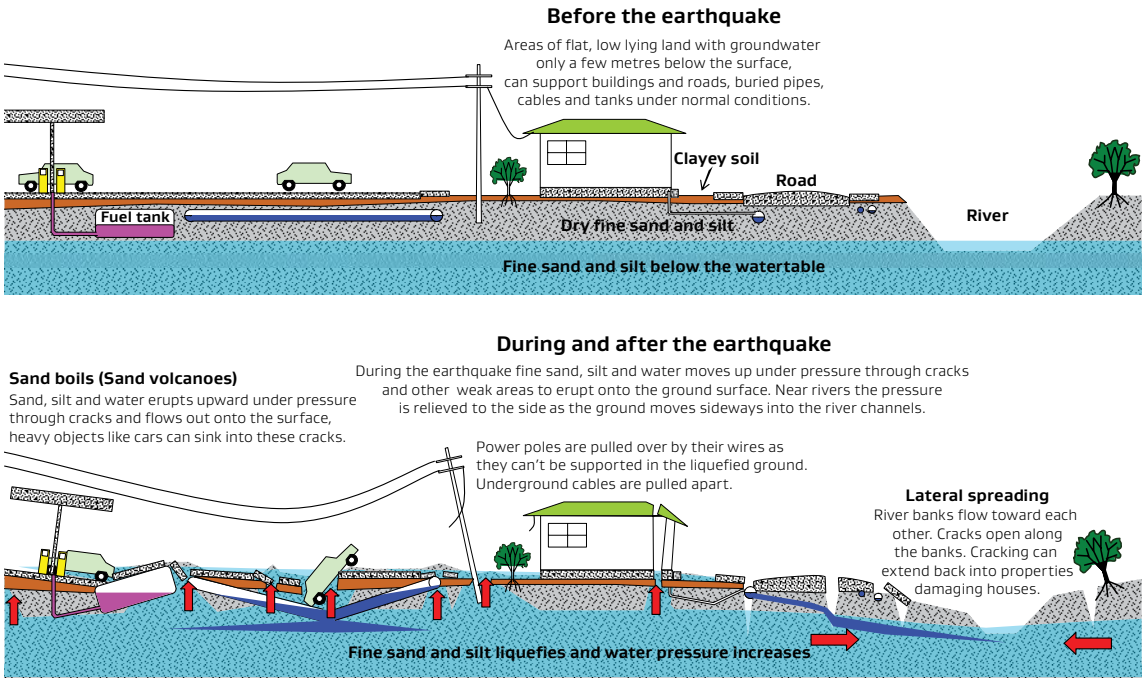
Areas of flat, low-lying land with groundwater only a few meters below the surface can support buildings and roads, buried pipes, cables and tanks under normal conditions.

During and after the earthquake

During the earthquake, fine sand, silt and water move up under pressure through cracks and other weak areas to erupt on to the ground surface. This process is called lateral spreading and was seen throughout Christchurch during the Canterbury earthquake sequence in 2010-2011.

There are several ground effects:

- **Sand boils:** Sand, silt, and water erupt through cracks in the ground surface.
- **Lateral spreading:** Ground near rivers or slopes moves sideways, causing cracks and damage.
- **Subsidence:** Land settles and consolidates, often unevenly, leading to ground distortion.



Concept sketch showing effects of liquefaction and lateral spread hazard on the built environment.
Source: MBIE (2017) after IPENZ

Liquefaction in New Zealand

In New Zealand, liquefaction is a significant hazard due to the country's frequent earthquake activity. The 2010–2011 Canterbury earthquake sequence demonstrated the devastating impacts of liquefaction. The 2011 Christchurch earthquake triggered extensive liquefaction across Christchurch, damaging roads, buildings, and infrastructure. In some areas, water, sand, and silt were ejected from the ground, causing severe disruptions and extensive property damage. Around 400,000 tonnes of silt were estimated to have been removed due to liquefaction in this earthquake sequence.

Extensive and severe liquefaction, Christchurch.
Source: GNS Science. Photographer: R.D. Beetham

Extensive and severe liquefaction, Christchurch.
Source: GNS Science. Photographer: R.D. Beetham

Our story
Bay of Plenty context

Liquefaction susceptibility in the Bay of Plenty region varies across its landscape, influenced by soil composition, proximity to waterways, and groundwater levels. The region's coastal and river-adjacent areas, with loose, sandy, and water-saturated soils, are particularly susceptible to liquefaction during seismic events.

As a low-lying coastal city, Tauranga is also susceptible to liquefaction. With its significant residential and commercial developments, liquefaction in Tauranga could impact transportation networks, water, and wastewater systems, especially in reclaimed and filled areas near the waterfront.

View the maps showing the potential for liquefaction-induced ground damage resulting from an earthquake for the Bay of Plenty Region.

boprc.govt.nz/bayhazards

Tauranga City Maps showing liquefaction vulnerability and liquefaction induced land damage caused by different sized earthquake events.

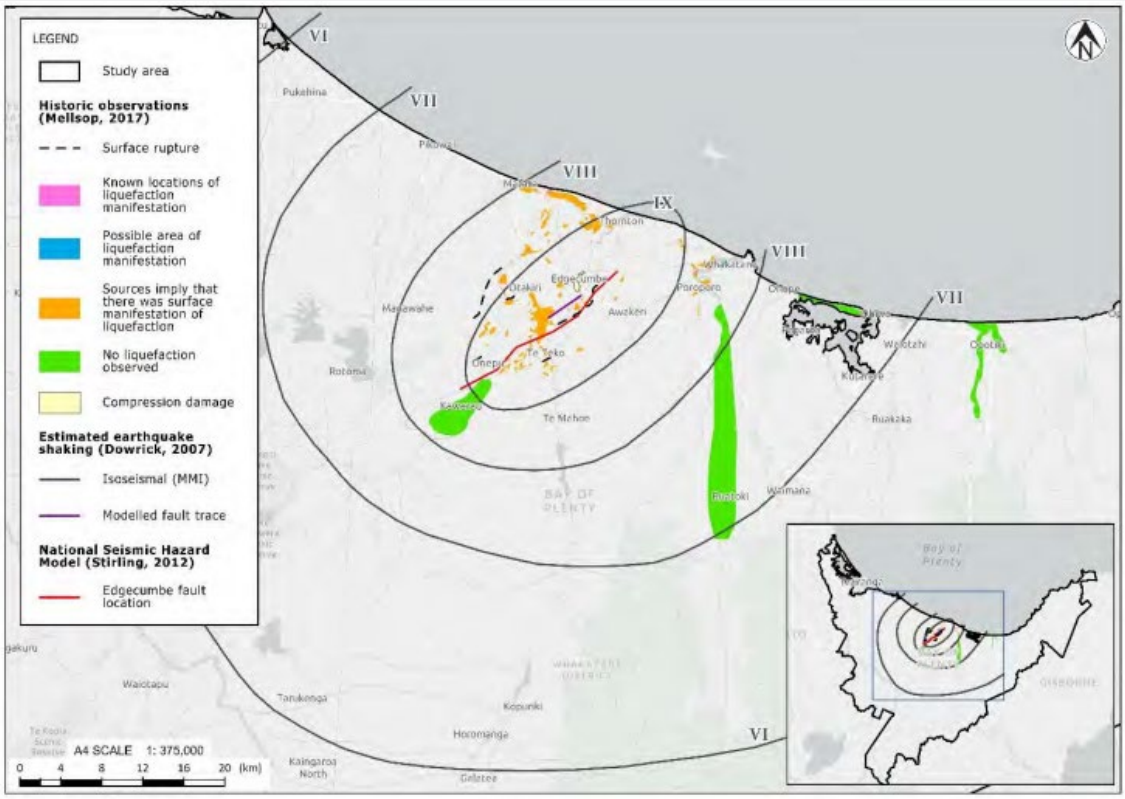
gis.tauranga.govt.nz/liquefaction

Bay of Plenty events

1987 Edgecumbe Earthquake

The most notable liquefaction event in the Bay of Plenty occurred during the Edgecumbe earthquake on 2 March 1987. This 6.3-magnitude earthquake caused widespread liquefaction in areas with loose, water-saturated soils, particularly in Edgecumbe and Whakatāne. Liquefaction led to sand boils, ground cracking, and subsidence, damaging homes, roads, bridges, and industrial facilities. The town of Edgecumbe experienced extensive ground deformation, and some buildings tilted or collapsed as the ground shifted beneath them.

Sand boils and liquefaction after Edgecumbe Earthquake, 2 March 1987. Source: GNS Science Photographer: Lloyd Homer



Recorded land damage following the Edgecumbe Earthquake. Source: Tonkin & Taylor

2016 Kaikōura Earthquake effects in the Bay of Plenty

Although the 2016 Kaikōura earthquake was centered far from the Bay of Plenty, it caused liquefaction in parts of the region. Minor liquefaction effects were observed in Tauranga and Whakatāne, particularly in areas with reclaimed or loose soils near waterways. While these effects were less severe than those seen in Edgecumbe, they highlighted the region's susceptibility to liquefaction, even from distant seismic events.

Hazard impacts

Liquefaction poses a significant risk in the Bay of Plenty due to the region's loose, water-saturated soils and seismic activity. Impacts of liquefaction on the Bay of Plenty can be extensive, affecting buildings, infrastructure, and communities.

Community

Liquefaction may cause community disruption and displacement – initially due to damage to buildings and infrastructure, then the complex and lengthy process of repairing and rebuilding. There are also potential ongoing health issues (e.g. respiratory and psychological health issues).

Infrastructure and buildings

Liquefaction can cause buildings; road, port and railway infrastructure; and pipelines to distort, sink, tilt, or collapse due to the ground losing its strength. Structures built on loose, sandy soils are particularly vulnerable, as these soils are most likely to liquefy during intense shaking. During the 1987 Edgecumbe earthquake, for example, large areas of land around Edgecumbe and Whakatāne liquefied, severely damaging roads, bridges, and buildings.

Critical lifeline utilities

There can be damage to underground services due to ground deformations (e.g. pipes that carry drinking, waste, and storm water – often referred to as "three waters", power, and gas networks). Underground utilities, such as water and wastewater pipes, can crack, dislocate, or burst when the surrounding soil liquefies and shifts.

Transportation networks, including roadways, can become impassable due to surface deformation and cracking. Liquefaction in Tauranga and Whakatāne could disrupt critical services and transport, impacting the movement of people and goods across the region. Following the Edgecumbe earthquake, extensive repairs were required for damaged utilities and the roading network.

Long-term ground instability

Liquefaction can cause permanent ground displacement, leading to unstable land that may not be suitable for future development or require costly reinforcement . Areas that have experienced liquefaction are prone to re-liquefying in subsequent earthquakes, presenting a continuous risk for residents and businesses in places like Edgecumbe, which experienced ground settlement and changes in soil structure post-earthquake.

Environmental

Liquefaction may cause discharge of sediment into waterways, impacting water quality and habitat. Fine airborne dust from dried ejecta, may impact air quality. There may be potential contamination issues from ejected soil and the potential alteration of groundwater flow paths and formation of new springs as a result of liquefaction.

Economic

Repairing infrastructure, stabilising land, and rebuilding damaged areas after a liquefaction event can be extremely expensive, putting a significant economic burden on councils and Central Government. The financial impact is often significant, with costs incurred for emergency response, repairs, and business losses due to prolonged disruptions. After the Edgecumbe earthquake, the cost of rebuilding and stabilising liquefied land and damaged infrastructure was substantial.

Hazard management – what to do and what this means for you

What to do if there is liquefaction

- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.
- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

GET READY

getready.govt.nz

Further information on liquefaction

To assess Increased Liquefaction Vulnerability see the Increased Liquefaction Vulnerability Factsheet

www.naturalhazards.govt.nz

Planning and engineering guidance for potentially liquefaction-prone land – Resource Management Act and Building Act aspects Report

www.building.govt.nz

Acknowledgments and references

We would like to acknowledge all Councils in the Bay of Plenty and GNS Science on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

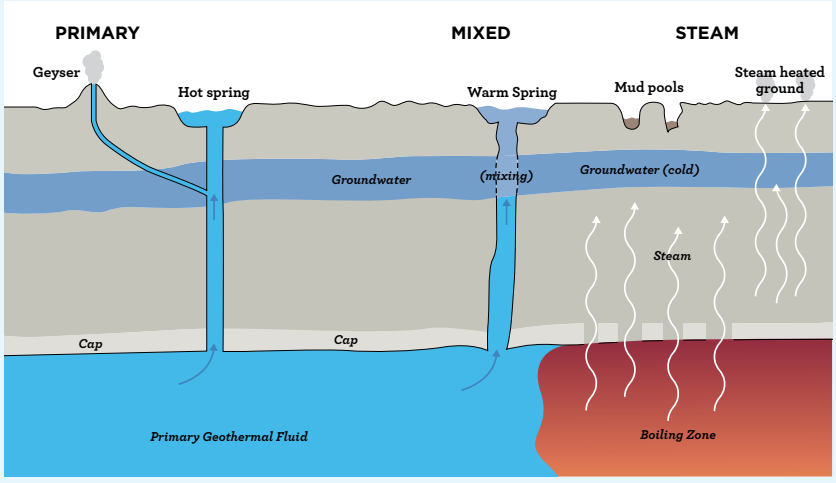
- GNS Science | Te Pū Ao – **www.gns.cri.nz**
- Natural Hazards Commission | Toka Tū Ake – **www.naturalhazards.govt.nz**
- National Emergency Management Agency New Zealand – **www.getready.govt.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
  - BayHazards – Bay of Plenty Natural Hazards Viewer
  - Tonkin & Taylor Report for BOPRC: Bay of Plenty Regional Liquefaction Vulnerability Assessment, April 2021
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Geothermal systems

What do we mean by geothermal activity?

Geothermal activity is the surface sign of the thermal energy from hot rocks and buried magma bodies at depth, shown as surface features like geysers and hot springs. This activity can be associated with areas of active or inactive but relatively recent magmatic activity. Deeply circulating groundwater is heated by the hot rocks or magma at depth, most times mixing with some magmatic fluids, then rises to the surface to form those surface features . There are many types of surface features, the most common being hot pools and springs; heated and steamy ground; and fumaroles. Magmatic gases commonly emanate associated with those features, the most common and abundant Carbon Dioxide (CO_2) and Hydrogen Sulphide (H2S), but can also include Methane (CH_4), Sulphur Dioxide (SO_2) and many others at much smaller concentrations.

Aspects of geothermal feature types



Watch the video: Aspects of the geothermal feature types (in the Taupō Volcanic Zone)

Aspects of geothermal feature types. Source: GNS Science / Bay of Plenty Regional Council

Our story
Bay of Plenty context

The Bay of Plenty , as part of the Taupō Volcanic Zone, is home to many of New Zealand's geothermal areas (approx.15 out of the 35 geothermal systems in New Zealand). There are about 3000 surface geothermal features recognised in the Bay of Plenty. There are a wide variety of types including some of New Zealand's last remaining geysers and the largest geyser in the Southern Hemisphere – the Pohutu Geyser in Rotorua.

The Bay of Plenty region contains 13 geothermal systems, each with unique characteristics. These systems include:

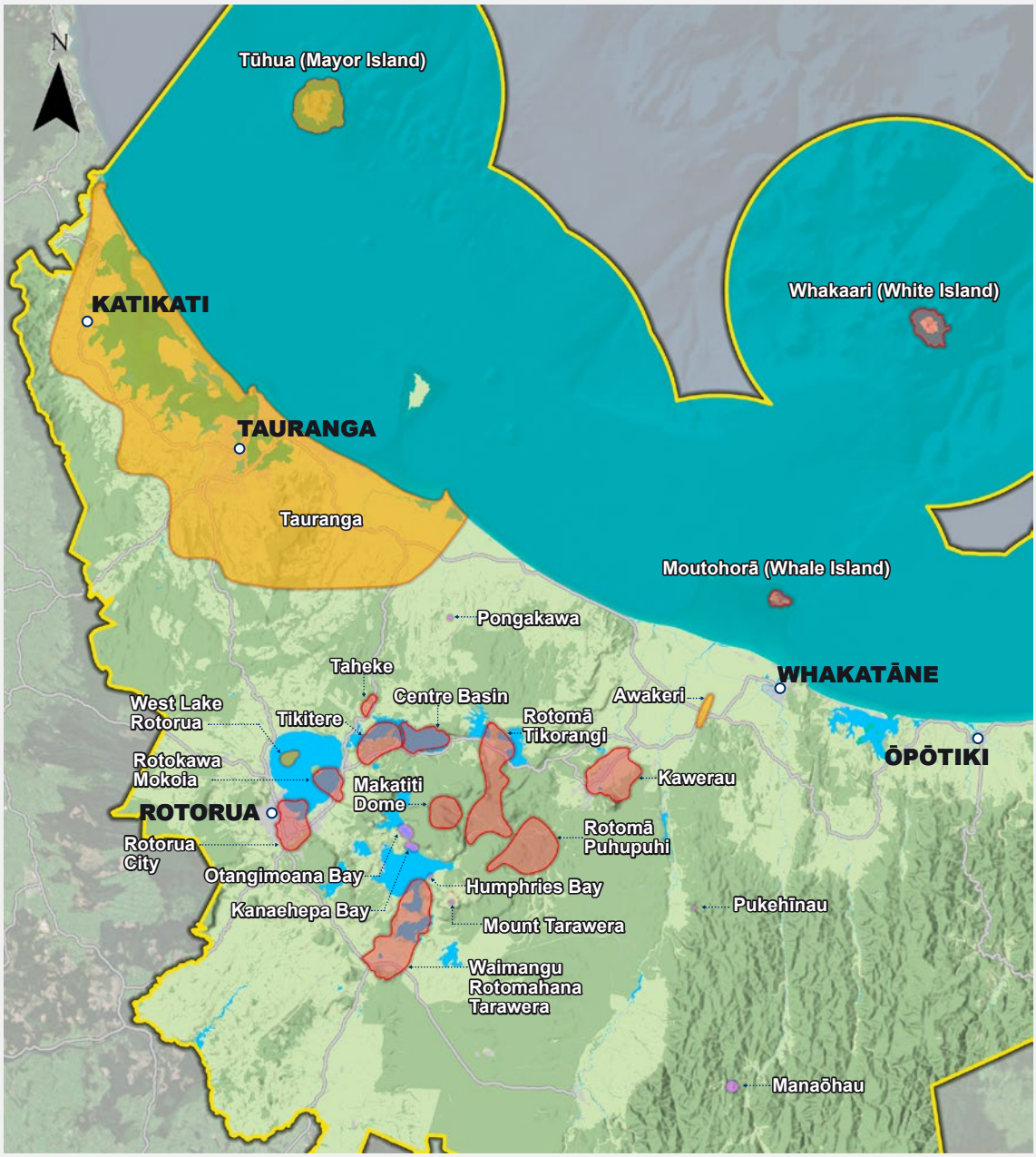
- **Rotorua Geothermal System:** This is one of New Zealand's most well-known geothermal systems which also supports tourism, provides energy for space heating, commercial, municipal and domestic hot water and space for heating and for mineral pool bathing and therapies. Rotorua is one of New Zealand's most well-known geothermal areas, featuring hot springs, mud pools, and geysers. While this geothermal activity attracts tourism, it also poses risks such as hydrothermal eruptions (explosions of steam and hot water), ground collapse, and gas emissions. The Rotorua Geothermal System is actively managed to balance tourism, resource use, and community safety.

Rotorua Kuirau Park geyser erupting.
Source: GNS Science
Photographer: Ashley Cody

Source: Bay of Plenty Regional Council

- **Tāheke Geothermal System:** A moderate-sized geothermal system featuring hot ground, fumaroles, and warm to hot springs near Lake Rotoiti. Exploration of the field has been undertaken identifying a moderate-size potential for electricity generation; and a resource consent has now been granted for such activity.
- **Tikitere – Ruahine Geothermal System:** This area includes Hell's Gate, Maraeroa, Ruahine and the Parengarenga and Manupirua Springs on the shore of Lake Rotoiti. This system is an expansive area with hot ground, fumaroles, mud pools, and springs.
- **Waimangu-Rotomahana-Tarawera Geothermal System:** Located near Rotorua, this geothermal system was formed after the 1886 eruption of Mount Tarawera. While the eruption created many geothermal features, it also destroyed the natural wonders Otukapuarangi and Te Tarata (the Pink and White Terraces). Waimangu is home to Frying Pan Lake, the world's largest hot springs. The Waimangu Valley-Lake Rotomahana developed as a tourist attraction.
- **Tauranga Geothermal System:** This system is a low-enthalpy warm water system (temperatures ranging between 30-70°C). A few warm springs are found at the surface which historically in the past have been used for bathing, with the system being tapped by many bores utilising the waters for commercial and domestic purposes.
- **Kawerau Geothermal System:** The Kawerau geothermal system is used for both energy production and industrial processes, such as timber processing. Kawerau's geothermal energy provides an important renewable resource but requires careful management to avoid accelerated depletion and other adverse effects like ground subsidence and water and air contamination by discharges.

Geothermal systems within the Bay of Plenty Regional Boundary



Legend

Geothermal Systems

- High Temperature
- Low Temperature
- Geothermal Occurrence

Contextual Information

- State Highway Network
- Bay of Plenty CDEM Group Area

Map of geothermal systems.
Source: Bay of Plenty Regional Council

Bay of Plenty events

Rotorua has experienced several hydrothermal explosions in recent times. Some of these events are described below.

2016 Hydrothermal eruption

On 28 November 2016, a large hydrothermal eruption occurred near Ohinemutu on Lake Rotorua. The explosion sent water and steam 25–30 metres (80–100 feet) into the air and was the first hydrothermal eruption in the area in 15 years. One resident described the event as a “geyser” of water shooting 20 metres to 30 metres in the air. A second, smaller explosion occurred on 30 December 2016.

2023 Mud pool activity

In August 2023, a mud pool in Rotorua experienced increased steam flow, which caused the clays in the pool to soften and reform into hydrothermal muds and erupt like a mud volcano. Rotorua Lakes Council cordoned off the area and advised residents to stay 10–20 metres away from where the mud was landing.

2024 Geothermal bore blasts

In March 2024, a geothermal bore at the Ambassador Thermal Motel in Rotorua produced a blast during scheduled maintenance. The bore was shared with four other premises, and the blast caused bubbles and steam to billow from the driveway. Water and steam at approx.150°C was thrown up in the air for a few days until the well could be contained and safely abandoned. Bore failure is a common issue in Rotorua as bores age, degrade and fail to contain fluids.

Geothermal ‘mud pot’ at Whakarewarewa.
Source: Rotorua Daily Post

Geothermal activity outside the Ambassador Thermal Motel, Whakaue Street, Rotorua.
Source: Rotorua Daily Post

Hazard impacts

Geothermal resources are used extensively within the Bay of Plenty and are valued for a range of reasons. Uses include, for electricity generation, direct use for space and water heating, home heating, public pool heating, industrial use, horticultural purposes and tourism.

Rotorua City is globally unique as it has been built over an active geothermal system creating particular hazards which require methods to control the actual or potential effects of the use, development or protection of land to avoid or mitigate natural hazards. Risk management is key to keep people safe from natural hazards, but they cannot be fully eliminated and it is, to some extent, part of life in Rotorua to live with a tolerable level of risk. The Rotorua Geothermal System underlies a large portion of downtown Rotorua. The geothermal system extends from Whakarewarewa to beneath Lake Rotorua.

Source: Bay of Plenty Regional Council

Geothermal activity can pose various hazards to communities, including:

Hydrothermal eruptions

Hydrothermal eruptions can occur in any part of a high-temperature geothermal system when there is an abundance of gas and steam present. They are difficult to predict and vary greatly in size. While large eruptions are very rare, small eruptions are reasonably common. Small eruptions only affect up to 10-15 m of the surrounding area from the vent. Small hydrothermal eruptions are most likely to occur in places where the geothermal heat flow is very high, where there are boiling springs and fumaroles with high steam flows. Geysers are a form of repeated hydrothermal eruption. Such events can cause injury or damage to infrastructure, particularly in places like Rotorua, where visitors may be unaware of the dangers and those events mostly happen without warning.

Geothermal gases

Geothermal areas, particularly in Rotorua, can release Hydrogen Sulphide (H_2S), Carbon Dioxide (CO_2), Methane (CH_4) gases – the distinctive rotten egg odour. As the hot fluids rise to the surface they carry the dissolved gases in them from the magma below. The gases are released when the fluid reaches the surface, just like opening a can of fizzy drink. These gases can have unpleasant odours and potentially cause health issues, serious injury or death at high concentrations. Those concentrations can be found in low-lying ground, as those gases are heavier than the air, or in confined or semi-confined spaces. These gases can be harmful to respiratory health.

Geothermal bores

Geothermal bores are located across the Rotorua city within the geothermal system and were drilled to extract geothermal hot fluids from the aquifer below to produce energy. Bore deterioration can affect residential buildings and their occupants.

Those bores degrade over time and fail, or can fail due to poor construction practices even just after drilling. Geothermal bore failure is commonly catastrophic, effectively creating a 'man-made' (induced) hydrothermal eruption. Normally it takes several days to identify the culprit contain the bore. Even when there is no such catastrophic failure, the lack of fluid containment lead to uncontrolled release of hot water and toxic gases, exposing people and propriety to its hazards.

Small scale steam and hot water eruption (geysering), Whakarewarewa Village. Source: GNS Science

Deterioration of bores can lead to warm-hot ground, elevated emission of geothermal gases and surface features. Similar deterioration also occurs with infrastructure such as those related to visitor access and safety such as trails, fences and viewing platforms.

Ground subsidence

Subsidence can occur if large scale geothermal systems are overused. The extraction of geothermal fluids for energy and industry, particularly in areas like Kawerau, can lead to ground subsidence, where the ground sinks or becomes unstable. The rock formations at depth are dewatered and the pores collapse. This can affect local infrastructure, homes, and even cause damage to the environment if not properly managed.

Ground collapse

Collapse of ground occurs frequently in geothermal areas. Subsurface material can be eroded through chemical and/or physical processes – the dissolution of material by acidic steam and condensates; downward percolating groundwater. This causes the overlying surface to lose stability and collapse into a void which is a hole that is often filled with water and steam at boiling temperature and toxic gases.

Water and soil contamination

In some geothermal areas, the release of geothermal fluids or chemicals can contaminate nearby water supplies, affecting both human consumption and agricultural irrigation. Freshwater can naturally contain geothermal input from surface features or have been contaminated by unmanaged discharge of geothermal fluids by users, making them unsuitable for ingestion or horticultural use. This is because geothermal fluids often have increased levels of metals like arsenic, boron, mercury and many other potentially toxic chemical species. This can cause ecological effects and bioacumulation in mahinga kai as well, making them unsuitable for consumption.

Similarly, geothermal soils can be naturally contaminated or have been contaminated by the discharge of geothermal fluids into the environment, to a level that requires management.

Geothermal surface features

Fumaroles, hot springs, mud pools and pots can be close to or at boiling temperatures. Small spouting springs and geysers can jet and splash water out of the immediate vent area. This can also occur for hot pools that experience irregular vigorous boiling. Jetting and splashing also occurs from mud pools and mud pots at times and can eject mud to small distances outside the feature. The impact area is usually 3-5 metres. Surface features can cause burns and scalds. Likewise, those features are often isolated to avoid people falling in them and suffering severe injury or death.

Meade Street, Rotorua. Source: GNS Science

Heated ground

Heated ground is a special type of geothermal surface feature because it occurs across large areas rather than as a localized point source, like a spring. To some degree, this is similar to geothermal gases hazards. There is a wide range of temperatures that can occur in heated ground, from just above ambient temperature, like about 20-30°C to just above 100°C. Both high temperature and the extreme temperature variations can rapidly degrade the building materials and foundations of the constructions. It also creates secondary issues like poor quality of the habitable / living environment and subsequent health issues. Using impervious building materials make the issue worse because it creates a barrier that interferes with the natural exchange of the heat (and gas) between the ground and the atmosphere, and it also suppresses the process of natural cooling through rainfall and water infiltration to the ground. Appropriate engineering design and building materials is key to enable safe constructions in areas of natural high heat (and gas) flux.

Building material deterioration

Building material deterioration can compromise the structural integrity of the constructions. Accelerated deterioration is a key issue in geothermal areas, where high heat and gas flux coupled with the presence of acidic / highly mineralised geothermal fluids can be found at subsurface, at a level that it can interact with the construction. This issue is handled by ensuring that the build is engineered and constructed to the ground conditions, including careful selection of its building materials.

Hazard management – what to do and what this means for you

What to do if there is geothermal activity

- Look for the warning signs. Warning signs include:
  - Patches of dying grass and trees other than geothermal kānuka.
  - Unusually warm or cracked hard surfaces, such as paths and driveways with a white tinge, corroded or discolored.
  - Holes or steam from the ground.
  - Hot surface water or groundwater.
  - Dead birds and other animals in thermal areas
- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.

GET READY

getready.govt.nz

Disasters Happen! The good news is it's easy to make sure you are ready. Whether at home, at work, at school or out in the community, there are things we can all do to prepare.

For information on the sustainable management of geothermal in the Bay of Plenty region go to: **www.boprc.govt.nz/geothermal**

Source: Bay of Plenty Regional Council

Source: Bay of Plenty Regional Council

Acknowledgements and references

We would like to acknowledge all Councils in the Bay of Plenty and GNS Science on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- GNS Science | Te Pū Ao – **www.gns.cri.nz**
- Natural Hazards Commission | Toka Tū Ake – **www.naturalhazards.govt.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
  - BayHazards
  - GNS Science and Bay of Plenty Regional Council Report: Ngā pūnaha ngāwhā o Te Moana-ā-Toitehuatahi – Bay of Plenty Geothermal Systems – The Science Story
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**
- Rotorua Lakes Council – **www.rotorualakescouncil.nz**
  Identifying and designing for Geothermal Hazards: Guidelines for Buildings and Associated Site Works in Rotorua District, June 2024

Hazard:
Slope instability

What is slope instability?

Slope instability, also known as land instability or landslides, refers to the downward movement of soil, rock, or debris on a slope.

Why does slope instability (landslides) happen?

It can be triggered by natural events such as heavy rainfall, earthquakes, or volcanic activity, as well as human activities like deforestation, construction, and land use changes.

1. **Steepness of slope**
The steeper a slope is, the more unstable it will be.

2. **Lack of vegetation**
Vegetation, specifically its roots, holds the soil in place and makes it more resistant to erosion.

3. **Bedding planes**
Surfaces that separate a layer of stratified rock or bed from another. Lack of frictional resistance between these layers can cause slope instability.

4. **Sudden shocks**
Earthquakes, hurricanes, volcanic eruptions, the passage of heavy trucks, blasting and others may trigger the sudden movement of the soil in slopes.

5. **Joints and fracture**
Cracks in the slope surface, or in the rock layers underneath, are vulnerable to disturbance or degradation.

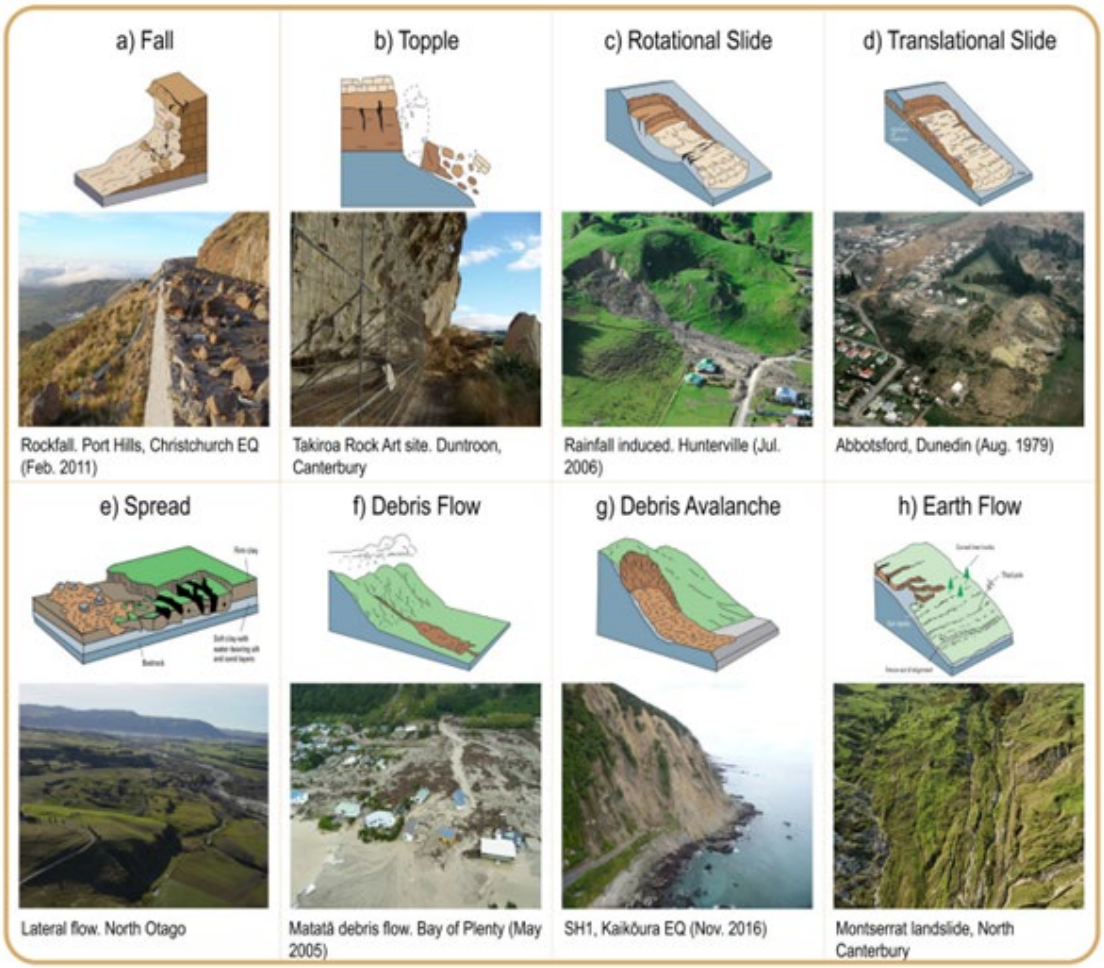
6. **Loose soil composition**
Different types of soils will have very different characteristics when it comes to frictional resistance to erosion and cohesion between the grains.

7. **Excessive water and inadequate drainage** During heavy rain when the soil becomes saturated and water takes the place of air between the grains of soil, the earth in slopes becomes a lot heavier and more prone to movement.

Causes of slope failure. Source: GNS Science

Slope instability (landslides) in New Zealand

New Zealand is highly susceptible to landslides due to its varied and often steep topography. This along with the impact of natural events such as heavy rainfall, earthquakes, and volcanic activity can lead to landslides. Landslides can occur in both rural and urban areas.



Different landslide types and example landslides. Source: GNS Science

New Zealand has a high number of landslides because:

- Rocks are often weakened by geological folding and faulting.
- There are frequent earthquakes.
- Much of the land is hill country, formed by rivers cutting into soft clay rocks.
- Many soft and easily erosion prone slopes have been cleared of vegetation as a result of agriculture.
- Slopes can be unstable as a result of weak layers of volcanic ash and other fine windblown sediments.
- The impact of rainfall on already unstable slopes.

Our story
Bay of Plenty context

The Bay of Plenty region includes significant areas of steep hilly terrain underlain by a variety of materials that are prone to landsliding. Some of the more significant landslide events in New Zealand have occurred in the Bay of Plenty.

Photo right: Rain induced landslide, Ōhiwa, Bay of Plenty, July 2004.
Source: Bay of Plenty Regional Council

View the maps showing the areas susceptible to landslide as a result of rainfall and earthquake for the Bay of Plenty Region.

boprc.govt.nz/bayhazards

Tauranga City Maps showing landslide susceptibility to rainfall or earthquakes

gis.tauranga.govt.nz/landslide

2005 – Matatā Debris Flow

The Matatā Debris Flow occurred on 18 March 2005 and was caused by intense rainfall (more than 200 mm in some areas over a short period), which saturated the soil and led to a large-scale landslide in the Matatā area, The debris flow, which was a combination of mud, rocks and vegetation, quickly moved downhill, causing severe damage to properties and infrastructure. The flow affected around 15 properties, causing significant damage and displacing residents. The event also blocked roads, including State Highway 2, which cut off access to the town.

Matatā post-event. Source: Whakatāne District Council

Matatā post-event. Source: Whakatāne District Council

2010-2011 – Ōhope Landslides

Between May 2010 and June 2011, a series of high rainfall weather events passed over the Eastern Bay of Plenty, triggering a number of landslides within the escarpment slopes that form the backdrops to Whakatāne and Ōhope Beach. Ōhope was the most severely affected area, with some 22 houses being directly affected by landslide debris. Those landslides resulted in a severe injury in 2010 and a fatality in 2011. The Whakatāne Escarpment was affected to a much lesser extent, although five residential dwellings were damaged by debris and Muriwai Drive was closed to traffic on several occasions.

Landslides Whakatāne and Ōhope escarpment slopes. Source: Whakatāne District Council

Hazard impacts

Slope instability in the Bay of Plenty is a significant hazard due to the region's steep terrain, volcanic soils, and high rainfall. Landslides and debris flows can be triggered by heavy rainfall, earthquakes, volcanic activity, or human activities such as construction or land clearing. Landslides and debris flows have a variety of social, economic, and environmental impacts.

Social

Landslides can destroy homes and infrastructure, leading to displacement and significant disruptions. Landslides also have the ability to isolate communities as they can damage vital transport links and some communities in the Bay of Plenty are particularly at risk of being cut off by landslides. Communities in high-risk areas may face temporary or permanent relocation due to repeated landslides or the ongoing threat of instability. In communities like Matatā landslides (2005) caused severe damage to properties and roads, resulting in evacuations. Though less frequent, landslides can lead to fatalities or injuries, particularly when they occur in populated areas.

Economic

Landslide events are costly, as they involve repairing roads, lifeline utilities and homes.

The Bay of Plenty is a key agricultural region, and landslides can lead to soil erosion, loss of crops, and contamination of water supplies. Areas affected by landslides may see declines in tourism, which impacts local businesses and the economy.

Environmental

Landslides can destroy vegetation, disrupt habitats, and lead to increased sedimentation in rivers and streams, which impacts aquatic ecosystems. Erosion caused by landslides often results in the contamination of water sources with silt and debris, degrading water quality and impacting agricultural or drinking water supplies.

Matatā post-event. Source: Whakatāne District Council

Hazard management – what to do and what this means for you

Slopes and retaining walls can crack, move or even collapse, particularly if they're affected by weather events, earthquakes or other natural hazards. If you can see slips, ground movement or debris on your property there may be a chance that the land is undermined and may fail.

What to do?

- **Call 111 in an emergency.**

For regional information on landslides:
What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from:
Bay of Plenty Civil Defence Emergency Management Group
www.bopcivildefence.govt.nz > know your hazard > landslides

- If there is property damage (i.e. **damage to buildings**, not land) but no injuries call your local council to assess if the buildings are safe to occupy.
- Stay away until authorities give the all-clear, as further landslides are likely. Landslides can occur progressively, often some time (hours or days) after the first slip. Be aware of any changes to your property/ground following a landslide or major rainstorm/earthquake. In particular you should look for new cracks or ground bulging.
- Check for injured and trapped persons and animals near the slide, without entering the slide area. Direct rescuers to their locations.
- Report damaged lifeline utilities (water, gas, electricity) to the appropriate companies. Reporting potential hazards will get the utilities turned off as quickly as possible, preventing further damage or injury.
- If you can do it safely, take photographs of the damage – this may help with an insurance claim later.

What to look for – has your property been impacted by a landslide?

- new cracking in the ground around your house
- recent movement such as leaning power poles, trees, and retaining walls
- muddy water flowing down slopes or springs forming
- loss of power or other utilities
- new cracks appearing inside the house e.g. in gib/plaster, tiles
- jamming doors and windows can be a warning sign but are common in humid conditions, so if this occurs look for other warning signs
- unusual sounds such as trees cracking, rumbling or rocks falling or knocking together
- pavements sinking or finding new rocks, soil, or other debris on or around your house and property.

To prepare

Look after slopes and retaining walls: Natural Hazards Commission **www.naturalhazards.govt.nz** > be-prepared > homeowners > slopes and retainingwalls

- **Living on a sloping property**
  - If you have a sloping property, make sure you know how the slope and surrounding buildings and structures might be affected in the event of heavy rain, storms, earthquakes or other natural hazards.
  - If you live near a hill or steep slope, watch for cracks or movement that could be a warning sign. Make sure any retaining walls are well maintained and look around to see if neighbouring retaining walls or slopes could affect your property.
  - Take occasional photographs of your slopes and retaining walls and compare the photos over time, especially after heavy rainfall, flooding or an earthquake.
  - Check Natural Hazards Commission | Toka Tū Ake (previously EQC) **www.naturalhazards.govt.nz/insurance-and-claims** or discuss with your private insurer to make sure that damage to retaining walls from a disaster will be covered by insurance.
- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.

getready.govt.nz

In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

Other information

- **Natural Hazards Portal: Past Natural Hazards**
  www.naturalhazardsportal.govt.nz/s/natural-hazard-risk/past-natural-hazard-events
- **GNS Science – Landslide Planning Guidance**
  – Reducing Landslide Risk through Land-Use Planning, January 2024
  www.gns.cri.nz/assets/MS-144-Landslide-Planning-Guidance_2024-UPDATE.pdf
- **Bay of Plenty Regional Council – Landslides**
  www.boprc.govt.nz/living-in-the-bay/natural-hazards/landslide
- **WSP Technical Report for the Bay of Plenty Regional Council**
  Bay of Plenty Regional Landslide Susceptibility Study, February 2024
  https://atlas.boprc.govt.nz/api/v1/edms/document/A4616223/content
- **Tauranga City Council – Land instability and slope hazards**
  www.tauranga.govt.nz/living/natural-hazards/land-instability-and-slope-hazards
- **Landslides New Zealand** https://landslides.nz
- **Natural Hazards Commission Toka Tū Ake – Landslips**
  www.naturalhazards.govt.nz/be-prepared/natural-hazards-where-you-live/landslips
- **GNS Science – Landslide Database** https://data.gns.cri.nz/landslides
- **New Zealand Geotechnical Society – National Landslides Database**
  www.nzgs.org/national-landslide-database
- **Types of Retaining Walls** www.buildmagazine.org.nz/articles/show/retaining-walls
- **Retaining Wall regulations**
  www.building.govt.nz/projects-and-consents/planning-a-successful-build/scope-and-design/check-if-you-need-consents/building-work-that-doesnt-need-a-building-consent

Acknowledgements and references

We would like to acknowledge GNS Science and all Councils in the Bay of Plenty on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- GNS Science | Te Pū Ao – **www.gns.cri.nz**
  - Landslide Planning Guidance | Reducing Landslide Risk through Land-Use Planning, January 2024
- Natural Hazards Commission | Toka Tū Ake – **www.naturalhazards.govt.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
  - WSP Technical Report for the Bay of Plenty Regional Council | Bay of Plenty Regional Landslide Susceptibility Study, February 2024
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**
- Whakatāne District Council – **www.whakatane.govt.nz**
  - Managing Landslide Hazards from the Whakatāne and Ōhope Escarpments, July 2013

Hazard: Regional deformation

What is regional deformation?

Regional deformation refers to the gradual movement or warping of the Earth's crust over large areas due to tectonic forces. Regional deformation in New Zealand is the result of the movement of the tectonic plates beneath the earth's crust and the resulting deformation of the crust at the surface. This is primarily caused by the interaction of the Pacific Plate and the Australian Plate along the Hikurangi Subduction Zone.

Contributing factors to regional deformation

- **Tectonic Plate Movement.** New Zealand straddles the boundary of two major tectonic plates. The **Pacific Plate** is being subducted beneath the **Australian Plate** in the North Island, while the reverse occurs in the South Island. The constant movement of these plates causes gradual deformation of the landscape, including horizontal shifts and vertical changes.
- **Uplift and Subsidence**
  - **Uplift:** Gradual or sudden raising of the land occurs due to tectonic forces or volcanic activity. Coastal areas may experience uplift after large earthquakes.
  - **Subsidence:** Sinking of the ground can occur in geothermal regions, such as Rotorua, where underground fluid extraction weakens the land.
- **Earthquake-Driven.** Large earthquakes along faults in the region can cause significant and abrupt deformation. The 1987 Edgecumbe Earthquake is a prominent example in the Bay of Plenty, where land subsided in some areas and uplifted in others. Fault ruptures may create visible scars in the landscape and damage to infrastructure.
- **Volcanic Influence.** The Taupō Volcanic Zone is a geologically active area. Volcanic activity contributes to crustal deformation as magma moves underground, causing land uplift or sinking.
- **Slow Slip Events.** In some areas, especially near the Hikurangi Subduction Zone, slow slip events occur. These are gradual movements along a fault line that release stress without causing a noticeable earthquake. These Slow Slip Events contribute to long-term deformation.

Our story
Bay of Plenty context

The Bay of Plenty is significantly affected by regional deformation due to its location within the Taupō Volcanic Zone and near the Hikurangi Subduction Zone. In the Bay of Plenty, regional deformation manifests as land uplift, subsidence, and horizontal shifts, often occurring over long timescales. However, deformation can also be abrupt during events like earthquakes or volcanic activity. Ongoing subsidence linked to geothermal activity has caused structural issues for buildings and altered drainage patterns in Rotorua.

1987 Edgecumbe Earthquake

At 1.35 p.m. on 2 March 1987, a magnitude 5.2 earthquake struck Edgecumbe. Minutes later at 1.42 p.m., a larger mainshock occurred with a magnitude of 6.3 and was centred north of Edgecumbe. Four aftershocks with magnitudes greater than 5 occurred in the next six hours, and smaller aftershocks were felt for weeks. (See Earthquake Hazard Page).

Surface rupture – 1987 Edgecumbe Earthquake. Source: GNS Science Photographer: Lloyd Homer

The earthquake caused extensive regional deformation, with impacts evident across a large area.

- **Surface Ruptures:** The earthquake produced a 7-kilometre-long surface rupture along the Edgecumbe Fault. Displacement of up to 2 metres occurred, with some areas experiencing vertical uplift and others sinking.
- **Ground Subsidence and Uplift:** Parts of the Rangitāiki Plains experienced subsidence. Areas were uplifted, altering drainage patterns and creating challenges for local land use and infrastructure.
- **Widespread Ground Cracking:** The earthquakes caused extensive cracking in the land, especially near Edgecumbe and Te Teko.
- **Liquefaction:** In areas with saturated soils, liquefaction occurred, causing the ground to lose strength (See Liquefaction Hazard Page).

Ground cracking – 1987 Edgecumbe Earthquake. Source: GNS Science Photographer: Lloyd Homer

Damage from Edgecumbe Earthquake 2 March 1987.
Source: GNS Science Photographer: Lloyd Homer

Sand boils and liquefaction after 1987 Edgecumbe Earthquake. Source: GNS Science Photographer: Lloyd Homer

Hazard impacts

Infrastructure

Earthquake-related deformation causes ground ruptures that damage roads, bridges, pipelines, and buildings. The 1987 Edgecumbe Earthquake resulted in significant land subsidence and ground rupture, severely impacting homes, farms and transportation networks in the Rangitāiki Plains. Long-term deformation with subsidence (gradual land sinking) affects infrastructure, leading to cracks in buildings, disruption of drainage systems, and increased maintenance costs.

Agricultural

Subsidence and deformation alter drainage patterns, affecting farmland productivity. Waterlogging or poor drainage can harm crops and pasture.

Community

Communities in high-risk areas may face displacement and in some instances relocation due to ongoing subsidence or sudden tectonic shifts.

Long-term coastal changes

Regional deformation impacts coastlines, with gradual uplift or subsidence influencing erosion, sediment deposition, and vulnerability to sea-level rise

Natural hazard amplification

- Deformation increases the likelihood of landslides, especially during heavy rainfall or after earthquakes. It also influences volcanic activity, with uplift potentially signaling magma movement.
- Deformation is often a sign that a region is under tectonic stress. As a result, these areas often experience an increased quantity of earthquakes.
- In areas like Rotorua, geothermal fluid extraction contributes to land subsidence. This can affect urban areas and infrastructure stability. Subsidence has implications for building safety and can lead to costly repairs or relocations.

Hazard management – what to do and what this means for you

To prepare

For regional information: What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from:
Bay of Plenty Civil Defence Emergency Management Group
www.bopcivildefence.govt.nz > get ready

- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.

getready.govt.nz

In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

Other information

Natural Hazards Portal:
Past Natural Hazards
www.naturalhazardsportal.govt.nz

Deformation Monitoring Network,
Land Information New Zealand
Toitū Te Whenua
www.linz.govt.nz

New Zealand Active Faults map,
GNS Science **– www.gns.cri.nz**

Active faults in New Zealand are defined as those that have ruptured and/or caused ground deformation during the last 125,000 years (except for in the Taupō Volcanic Zone, where the definition of activity is restricted to the last 25,000 years).

Twisited railway tracks near Edgecumbe caused by Edgecumbe Earthquake March 1987.
Source: GNS Science Photographer: Lloyd Homer

Acknowledgements and references

We would like to acknowledge GNS Science and all Councils in the Bay of Plenty on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- GNS Science | Te Pū Ao – **www.gns.cri.nz**
- Natural Hazards Commission | Toka Tū Ake – **www.naturalhazards.govt.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**
- Land Information New Zealand | Toitū Te Whenua – **www.linz.co.nz**

Section 2: Natural – Meteorological

In this section:

Hazard: Severe weather

What is severe weather?

Severe weather is the occurrence of extreme weather conditions that causes significant damage to the built and/or natural environment as well as potential loss of life.

Severe weather includes heavy rainfall, strong winds, thunderstorms, hail, snowstorms and heatwaves. These events can lead to significant hazard impacts like flooding, landslides, coastal erosion, and disruption of services, posing risks to people, property, and the environment.

Rainfall

Heavy rainfall is one of the most frequent and widespread severe weather hazards to affect New Zealand. It is defined as rainfall greater than 50 mm in 6 hours; or 100 mm in 24 hours. Heavy rainfall occurs over New Zealand mainly because of the following common weather systems:

- Tropical and ex-Tropical Cyclones.
- North Tasman Sea lows moving to New Zealand.
- Depression/lows from the south.
- Cold fronts.

New Zealand's mountains tend to modify and amplify precipitation, and this often causes the frequent heavy rainfall New Zealand experiences. Heavy rainfall tends to be most common over the western coastal region of the South Island and the middle and upper North Island, and least common on the east side of the South Island (due to the prevailing westerlies and the topography). For a large part of the country the rainfall is spread evenly through the year. The greatest contrast is found in the north, where winter has almost twice as much rain as summer.

Towering cumulus and shelf cloud thunderstorm. Source: Dave Allen – NIWA.

Thunderstorms

Cauliflower-like clouds mean that a thunderstorm might be on the way. Thunderstorms can occur anywhere in New Zealand at any time of the year. In New Zealand, the conditions that favour summer thunderstorm formation occur most often inland (where heating is strongest) and over high ground. The North Island's Central Plateau and ranges, the upper Canterbury plains and the South Island high country are prime breeding grounds. At coastal locations, like Auckland and frequently in the Bay of Plenty, local sea breeze convergence plays a key role.

Thunderstorms can bring torrential, short duration rainfall, large hail, strong winds or tornadoes. Thunderstorms are not as common as many think, the north and western parts of New Zealand experience the greatest number, where thunder is heard on 15-20 days a year. On the east coast of the South Island the average is commonly less than five.

Extreme winds / windstorm

Due to its position in the 'Roaring Forties', a belt of strong winds in the Southern Hemisphere which generally occur between the latitudes of 40 and 49 degrees, contribute to New Zealand being a windy country.

Source: WeatherWatch

There is no widely accepted definition for 'extreme wind'. In New Zealand, in the context of building design, an extreme wind is a wind gust which is strong enough to be dangerous for people, or cause significant damage to buildings and property. Extreme wind gusts are the result of intense turbulence within vigorous storms systems such as ex-tropical cyclones or mid-latitude storms. These systems contain bands of generally strong winds associated with areas of large pressure gradients and these are usually near the centre of low-pressure.

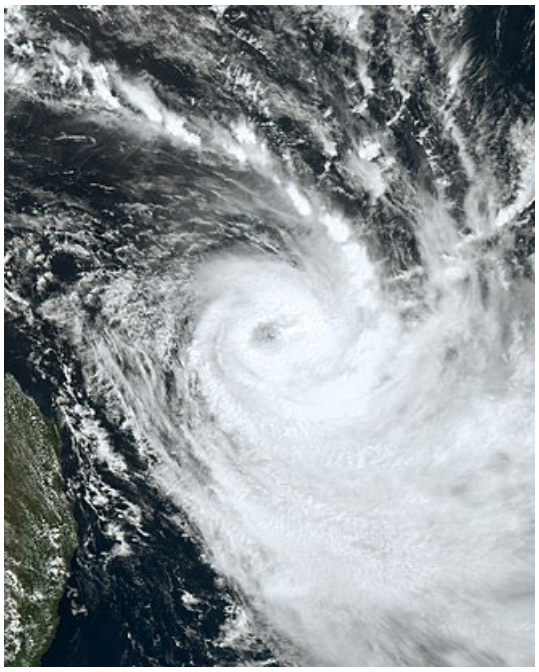
Tornado

A Tornado is a large rotating column of air (or vortex) that occurs in association with a thunderstorm. It has winds that travel at very high speeds around a central area of very low atmospheric pressure. Extreme winds can on occasion also be caused by Tornadoes and convective downbursts from isolated thunderstorms not associated with a large storm systems. An average of about 20 Tornadoes and water-spouts are recorded in New Zealand each year, but most of these are small but still have the ability to cause damage to property.


Tornado in Auckland. Source: Inside Government

Tropical cyclones

A tropical cyclone is a large rotating, organised system of clouds and thunderstorms that originates over warm tropical or subtropical waters. These systems are fueled by heat and moisture from the ocean and are a key feature of tropical weather. Tropical cyclones occasionally affect New Zealand, particularly during the cyclone season (November to April). They are accompanied by torrential rain, large waves, strong winds and possible coastal inundation that can cause flooding and coastal storm surge.



Source: Wikipedia

The severity of a tropical cyclone is ranked in categories from 1 (weakest) to 5 (strongest). The category given to a cyclone is based on its maximum mean wind speed. It doesn't indicate the severity of other hazards the cyclone may bring. For example, a Category 1 cyclone can have significant impact through heavy rain and flooding.

Frost and snow

Frost is the formation of ice crystals on surfaces when the temperature of those surfaces drops below the freezing point of water (0°C). Frost is a local phenomenon and its frequency of occurrence can vary widely over small areas. Areas most likely to be subjected to frost are flat areas, where air is not able to drain away on calm nights, and inland valleys, where cold air is likely to drift from higher areas. Frosts are infrequent in the Bay of Plenty and are often localised in the higher inland areas.

Source: NZ Herald

Snow is a form of precipitation consisting of ice crystals that form in clouds when water vapor freezes directly into ice. These ice crystals stick together to form snowflakes, which fall to the ground when the air temperature near the surface remains below or close to freezing. Snow is more frequent in southern and alpine regions, especially in the South Island (e.g., the Southern Alps) and the North Island's higher altitudes (e.g., Mount Ruapehu).

Severe Weather in New Zealand

Severe weather in New Zealand includes a range of extreme conditions, such as heavy rain, strong winds, heatwaves, hail, and snow. These events are influenced by New Zealand's location in the South Pacific, where it experiences both subtropical and temperate weather patterns. Severe weather is primarily caused by cyclones, atmospheric rivers, polar blasts, and rapid temperature changes.

Examples of severe weather in New Zealand

Some of the worst storms in New Zealand include:

- **1968 Wahine storm** when ex-tropical cyclone Gisele hit the Wellington region. Fifty three people lost their lives when the Wahine ferry sank in Wellington Harbour.
- **1998 Ex-Tropical Cyclone Bola** when very heavy rains and hurricane-force winds struck the east coast of the North Island causing extensive severe damage and flooding.
- **2023 Auckland Anniversary Severe Weather** in January 2023 caused unprecedented flooding and significant disruption across Auckland and neighbouring regions.
- **2023 Tropical Cyclone Gabrielle** was a devastating weather event that struck New Zealand in February 2023, causing widespread destruction and loss of life.

Tornados:

- **2004 Taranaki**, a Tornado near Waitara destroyed a farmhouse and killed two people.
- **2007 Taranaki**, several Tornados on the same evening caused damage to homes and other property worth seven million dollars in Oakura and New Plymouth.
- **2011 Auckland**, a Tornado in Albany killed one person, injured several others, as well as causing several million dollars' worth of damage
- **2012 Auckland**, a Tornado in Hobsonville and Whenuapai areas killed three people, injured seven others and was responsible for an estimated $13 million in cleanup costs, and $6.5 million in insurance claims.
- **2021 Auckland**, a Tornado in Papatoetoe caused extensive damage to over 1,200 homes and leaving around 60 houses uninhabitable. One person tragically died, and several others were injured. The Tornado also destroyed trees, power poles, and shipping containers at a yard in the Wiri Business Area, some weighing up to 30 tonnes.

Our story
Bay of Plenty context

The topography of the North Island has a profound effect on the weather of the Bay of Plenty region. The sheltering provided by high country on three sides produces a climate that is one of the sunniest and least windy in New Zealand. The annual rainfall is quite plentiful compared with some eastern parts of the country, although there is considerable rainfall variability. Most of the rainfall in the region, and especially heavy rain, occurs when northerly airstreams of tropical origin are forced to ascend over the land. Temperatures too are subject to considerable variability.

While thunderstorms and hail may occur in the Bay of Plenty region in any month, thunderstorms are most frequent in the summer and hail is more likely in winter. Thunder and hail both occur more frequently in and near the high country than in other parts of the region. The eastern Bay of Plenty experiences thunderstorm events in the late spring/early summer. These events can cause power outages as they blow transformers and are also associated with heavy downpours which can cause flash flooding.

Tornadoes can occur in the Bay of Plenty. During the period 1981-2012, 17 damage-causing Tornadoes were reported in the Bay of Plenty region.

Snow is rare in most parts of Bay of Plenty region and is unknown near the coast. Several snowfalls occur each winter on the high country of the Raukumara and Huiarau Ranges and an average of one fall per year has been recorded at Kaingaroa Forest. The Rotorua area records, on average, one snowfall every three years.

2009 Bay of Plenty Severe Weather

Over the period 8-14 May 2009, thunderstorms, waterspouts, and a severe hailstorm hit parts of Bay of Plenty, causing disruption and damage. Around 15,000 lightning strikes were recorded in 24 hours, most of them in the Bay of Plenty area, which caused short-term power cuts. An intense hail storm was experienced in western Bay of Plenty, with hail stones of marble size, and some were half the size of golf balls. The hail caused up to $10 million in damage to kiwifruit crops (more than 2.4 million kiwifruit were damaged). Ice made driving hazardous and caused short term flooding due to blocked drains. Five waterspouts were observed off the coast near Maketu.

2023 Waihi Tornado

In February 2023, a Tornado struck Waihi Beach causing significant damage to properties and power infrastructure. The Tornado, which formed from a waterspout, moved ashore, ripping roofs off homes, destroying parts of structures, and downing power lines, leaving approximately 1,500 properties without electricity. Some roads, including parts of Seaforth Road, were temporarily blocked by debris, prompting emergency responses from local authorities and contractors to secure and repair affected areas.

2023 Auckland Anniversary Severe Weather

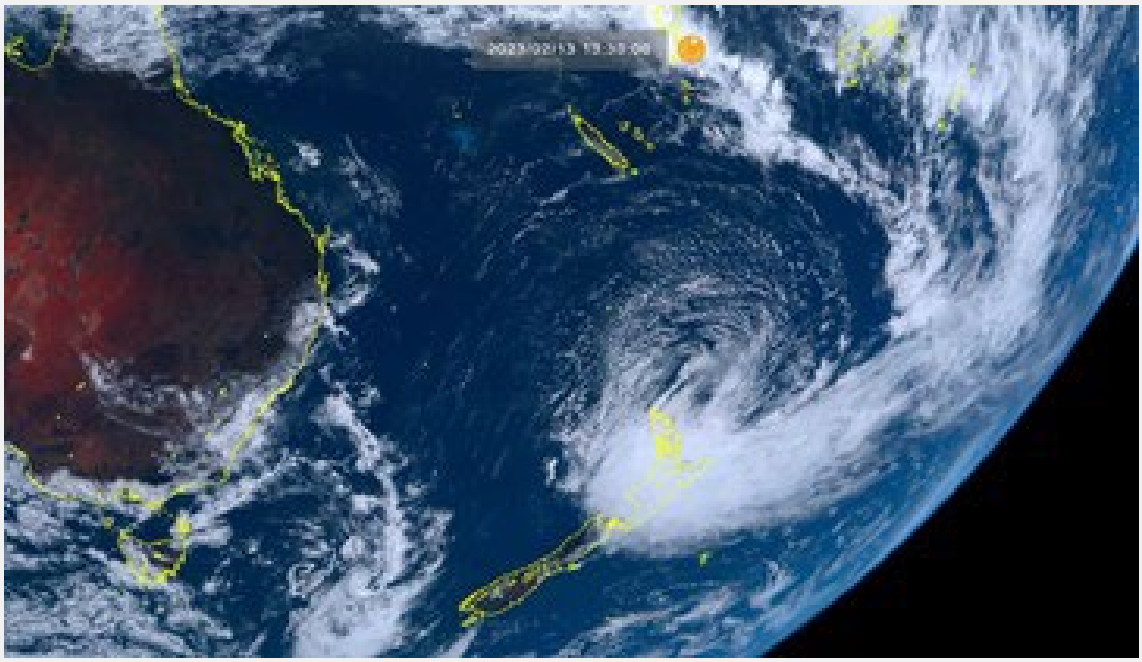
The Auckland Anniversary Weekend severe weather event occurred in January 2023. A period of intense rainfall and flooding caused widespread destruction across Auckland and parts of the North Island including the Bay of Plenty. Prolonged heavy rainfall from 27-29 January exacerbated by an atmospheric river, led to widespread surface flooding, slips, and infrastructure disruptions. Tauranga and surrounding areas experienced localised flooding, particularly in urban zones with poor drainage.

Landslide at Maungatapu, Tauranga. Source: NZ Herald

Greerton Rugby Club, Tauranga. Source: NZ Herald

2023 Tropical Cyclone Gabrielle

In February 2023, Tropical Cyclone Gabrielle devastated the North Island and impacted Northland, Auckland, the Waikato, Bay of Plenty, Tairāwhiti, Hawke's Bay and Manawatū-Whanganui regions. In the Bay of Plenty, Tropical Cyclone Gabrielle caused widespread flooding and landslides. Homes and businesses were inundated, critical roads were damaged, and power outages affected thousands of residents. Local emergency management teams coordinated evacuations and recovery efforts.



Satellite image Tropical Cyclone Gabrielle. Source: NZ Herald

Hazard impacts

Severe weather in the Bay of Plenty region has caused significant impacts over time, disrupting communities, damaging infrastructure, and affecting local ecosystems. The region's geography and climate make it particularly vulnerable to events such as heavy rain, cyclones, windstorms, and flooding.

Key Impacts of Severe Weather

Heavy rainfall causes widespread flooding and landslides, damaging homes, roads, and bridges. Communities can face evacuations, and prolonged road closures. Strong winds and high seas during cyclones or storms have led to erosion along coastal areas, impacting properties and marine habitats (See Flood page; Coastal Hazards page; Slope Instability page).

Power and Telecommunication Outages

Severe wind and storm events frequently lead to power cuts. For example, during Cyclone Gabrielle, power outages affected thousands, disrupting daily life and emergency responses.

Economic and Agriculture

Cyclones and floods have had substantial economic impacts on the region's kiwifruit orchards, dairy farms, and forestry operations.

Retail and service industries lose income due to closures and damaged goods. Prolonged rain and storms damage crops and farmland.

Transport and Infrastructure

Severe weather causes road closures and other transport infrastructure such as bridges and railway, making access difficult' for residents and emergency services. The 2023 rising water levels in Lakes Rotoiti and Rotomā led to road damage and restricted access for nearby communities. Severe winds and floods damage residential and commercial properties.

Community and Health Risks

Floods can lead to contaminated water supplies, increasing the risk of waterborne diseases. Severe events often force evacuations. Long-term displacement from homes also affects mental health and well-being.

Hazard management – what to do and what this means for you

What to do?

- **Call 111 in an emergency.**
- National Emergency Management Agency
  www.civildefence.govt.nz > What to do during a storm

For regional information on Severe Weather:
What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from Bay of Plenty Civil Defence Emergency Management Group > Severe Weather

To prepare

- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.
- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

GET READY

getready.govt.nz

Other information

Natural Hazards Portal: www.naturalhazardsportal.govt.nz
Past Natural Hazards

- **MetService** – metservice.com
  - What are: Severe Weather Warnings and Watches
  - Weather on your mobile phone
  - Notifications for Red Severe Weather Warnings and Extreme Fire Danger
  - How to read Weather Maps
- **National Institute of Water and Atmospheric Research** – weather.niwa.co.nz > Weather

Acknowledgements and references

We would like to acknowledge the MetService and all Councils in the Bay of Plenty on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Metservice – **www.metservice.com**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
- National Institute of Water and Atmospheric Research (NIWA) – **www.niwa.co.nz**
  - The Climate and Weather of Bay of Plenty, 3rd Edition, 2013
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**
- Natural Hazards Commission | Toka Tū Ake – **www.naturalhazards.govt.nz**

Hazard: Flood

What is a flood?

Flooding occurs when a river, stream, lake or drainage canal cannot contain the water flowing into it. Flooding can vary in severity, from minor surface water ponding to extensive inundation affecting wide areas, or rainfall exceeding drainage capacity, or overwhelming storm water systems. Flooding poses risks to property, livelihoods, and lives, especially when it occurs suddenly (flash floods) or over prolonged periods.

Causes of floods

Floods are usually caused by heavy or prolonged rainfall but can also occur due to landslides triggered by heavy rainfall or earthquakes, failure of dams or hydraulic structures, or high sea levels. Catastrophic flash flooding can occur where meteorological circumstances or dam failures produce a surge of water. Flooding from ponding, the accumulation of water on poorly drained or blocked land, can occur in both urban and rural areas. Flooding can occur from a local event such as heavy rain or a thunderstorm, or from rain falling in the distant hills feeding a river.

Flooding Edgecumbe – stopbank failure. Source: Whakatāne District Council

Flooding in New Zealand

New Zealand has widespread flooding hazards due to its geography, temperate climate and the location of settlements next to rivers and the coast. Floodwaters follow a downslope direction and pond where outflow is constricted and carry sediment and build flood plains. Many New Zealand communities are located on these flood plains and coastal areas.

New Zealand has experienced numerous significant flood events impacting communities, infrastructure, and the environment. Some of the more notable floods include:

- **2004 Manawatū Flood** in the Manawatū-Whanganui region. Severe storms and heavy rain caused rivers, including the Manawatū River, to overflow.
- **2014 Christchurch Floods** in Canterbury. Intense rainfall caused urban flooding in Christchurch.
- **2017 Edgecumbe Flood** in the Bay of Plenty. Heavy rainfall from Ex Tropical Cyclone Debbie caused the Rangitāiki River to breach a stopbank in Edgecumbe.
- **2020 Napier Floods** in Hawke's Bay. An intense downpour brought more than 250 mm of rain in 24 hours.

Flooding Awakeri. Source: Whakatāne District Council

Our story
Bay of Plenty context

Flooding is one of the most common and significant natural hazards in the Bay of Plenty region, often resulting in damage to homes, infrastructure, and farmland. The region's geography, with rivers, low-lying areas (including those low-lying areas with a high water table), and urban development, makes it particularly vulnerable to flood events.

Increasing rainfall intensity and rising sea levels are expected to worsen flooding risks in the Bay of Plenty as a result of climate change.

The Bay of Plenty region has eight major rivers that flow into the Bay, which are the Wairoa, Kaituna, Tarawera, Rangitāiki, Whakatāne, Waioweka, Mōtū and the Raukokore river. The region also faces challenges with urban development, with expanding cities like Tauranga needing to address issues such as the management of stormwater and reducing flood impacts on growing populations.

2004 Eastern Bay of Plenty – Whakatāne and Ōpōtiki Floods

In July 2004, widespread flooding in the Rangitāiki Plains, Ōpōtiki and surrounding rural areas caused significant agricultural and infrastructure losses. Rivers, including the Rangitāiki and Whakatāne Rivers, overflowed, inundating urban and rural areas. The floods were caused by an extreme weather event that brought over 300mm of rain within a short period. Homes were severely damaged or destroyed. Floodwaters also inundated farms causing substantial damage to crops and infrastructure. 17,000 ha of farmland were under water, and large areas were still flooded two weeks after the event. Landslides were aggravated by a swarm of earthquakes that occurred at the same time as the flooding. 3200 homes were evacuated, and 211 homes were declared uninhabitable after the event. One person was killed in a landslide, and another was killed when a tree fell on a car. Damage from the event was estimated at $52 million, including 500 insurance claims for flooding.

SH2 Reids Central Canal Bridge, Rangitāiki Plains 2004 Flood. Source: Bay of Plenty Regional Council

2017 Edgecumbe Flood

In April 2017, intense rainfall from Ex Tropical Cyclone Debbie caused the Tauranga, Whakatāne and Rangitāiki rivers to reach their highest ever recorded levels. A stopbank on the Rangitāiki River failed, leading to the sudden inundation of Edgecumbe. Over 1,600 residents were evacuated, and hundreds of homes were damaged. Farmland was inundated, causing significant losses to crops and livestock. Roads and utilities were heavily affected, disrupting transport and communication.

Flooding Edgecumbe – stopbank failure. Source: Whakatāne District Council

2018 Ngongotahā Flood

On 29 April 2018, the Rotorua district was subjected to a severe weather event. There was 145mm of rain recorded in 6 hours with 62.5mm of rain falling in one hour due to a thunderstorm. The Ngongotahā Stream reached its highest recorded level and overflowed its banks in several places. While flooding occurred throughout the Rotorua district, the Ngongotahā catchment experience was extreme and resulted in evacuations as floodwaters inundating many homes and several businesses.

Ngongotahā Flood Paradise Valley Road. Source: Rotorua Lakes Council

Hazard impacts

Flooding in the Bay of Plenty has had significant social, economic, and environmental impacts, affecting communities, infrastructure, and natural ecosystems. The Bay of Plenty's geography, with rivers, low-lying areas and urban development, makes it particularly vulnerable to flood events.

Social and health

Flooding impacts include the displacement of residents due to evacuation and health risks. Flood events, such as the 2017 Edgecumbe flood, forced the evacuation of hundreds of families. Floods can lead to long-term stress and trauma; and mental health issues such as anxiety and depression for affected individuals and communities. Stagnant floodwaters increase the risk of waterborne diseases and exposure to contaminants.

Economic

Impacts can include damage to infrastructure; loss of agricultural productivity; and significant insurance and recovery costs. Floods frequently damage roads, bridges, and utilities, disrupting transportation and communication networks. (See: Infrastructure Failure) Urban flooding can often overwhelm stormwater systems, requiring costly upgrades and repairs. Flooding inundates farmland, destroying crops and washing away topsoil, as seen in rural areas. Farmers face additional costs for recovery, such as replanting, repairing fences, and feeding livestock during floods. All these impacts result in increased insurance claims for property and vehicle damage. Claims can run into the millions, increasing premiums for residents and businesses.

Environmental

Flooding can cause disruption to ecosystems; coastal and riverbank erosion; and pollution. Floodwaters can damage sensitive ecosystems, such as wetlands and estuaries, through sedimentation and pollution. Contaminants from urban or industrial areas (e.g. oil, chemicals) often enter rivers and coastal areas during floods, impacting aquatic life. (See: Contaminants Hazard Page). Floods accelerate erosion, particularly in riverbanks and coastal zones, altering landscapes and habitats. Floodwaters can carry sewage, industrial waste, and agricultural runoff into waterways, degrading water quality in places like Tauranga Harbour.

Hazard management – what to do and what this means for you

What to do in a flood

- **Call 111 in an emergency.**
- **Put safety first.** Don't take any chances. Act quickly if you see rising water.
- Floods and flash floods can happen quickly. If you see rising water **do not wait for official warnings**. Head for higher ground and stay away from floodwater.
- **Listen to your local radio stations as emergency management officials** will be broadcasting the most appropriate advice for your community and situation.
- **Lift valuable household items and chemicals** as high above the floor as possible.
- **Turn off utilities** if told to do so by authorities as it can help prevent damage to your home or community. Unplug small appliances to avoid damage from power surges.
- **Avoid contact with flood water** whenever possible. Floodwaters can carry bugs that cause disease from the ground surface, septic tanks and sewerage systems.
- **Do not attempt to drive or walk through floodwaters** unless it is absolutely essential. Even shallow floodwaters can be enough to sweep you off your feet.
- **Report flooding in your area.** Contact the Flood Room Duty Flood Manager: +64 7 922 3375.
- **Report Urban Flooding.** Flooding issues within the Bay of Plenty's towns and cities are managed by the local District or City Councils. Problems with stormwater flooding, public/municipal drinking water supplies and sewage overflows can be directed to your local Council.
  Contact details are detailed through the Bay of Plenty Regional Council website **www.boprc.govt.nz > Flood Hub.**

To prepare

For regional information on flooding: What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from: **Bay of Plenty Civil Defence Emergency Management Group > Flood.**

- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.
- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.
- National Severe Weather Information - MetService is New Zealand's only authorised provider of Severe Weather Alerts - **www.metservice.com/warnings**

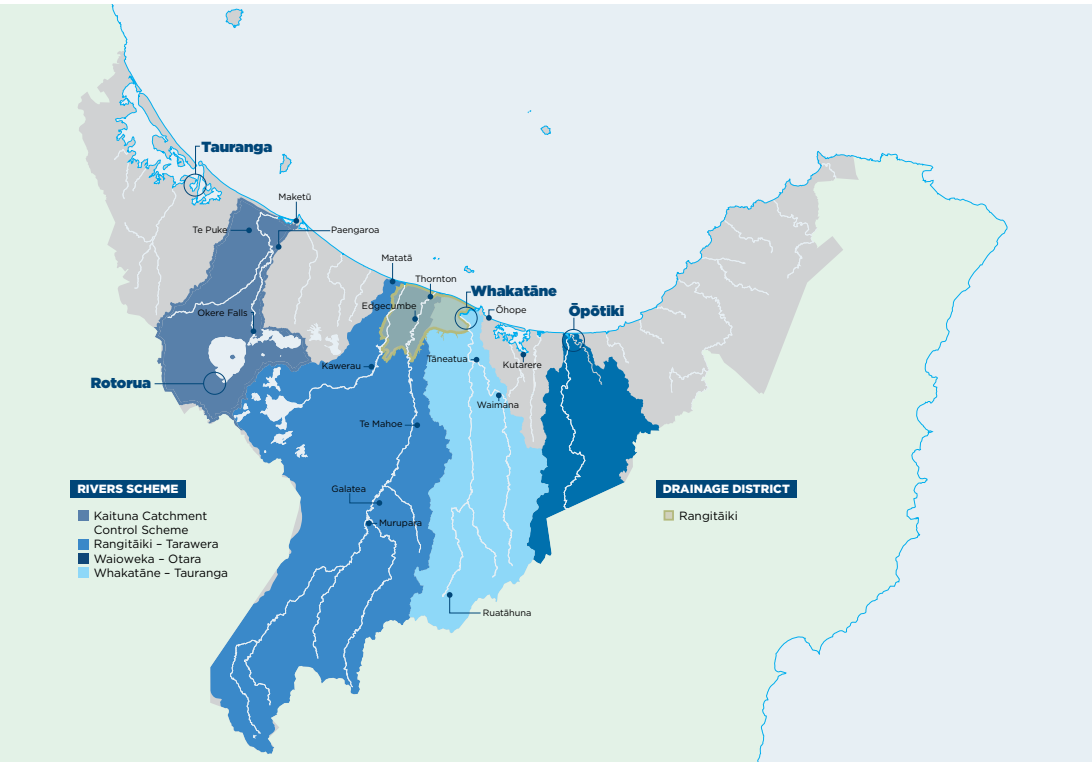
GET READY

getready.govt.nz

Other information

Bay of Plenty Regional Council – visit the website www.boprc.govt.nz for information on:

- **The Flood Hub.** Local information, national advice and useful contacts, to help you prepare for future flood events and severe weather.
- **Rainfall and River Levels**
- **Flood Defences** – The Bay of Plenty Regional Council manages and maintains nearly $440m worth of flood protection defences, including stopbanks, floodwalls, floodgates and pump stations, across major river and drainage schemes.



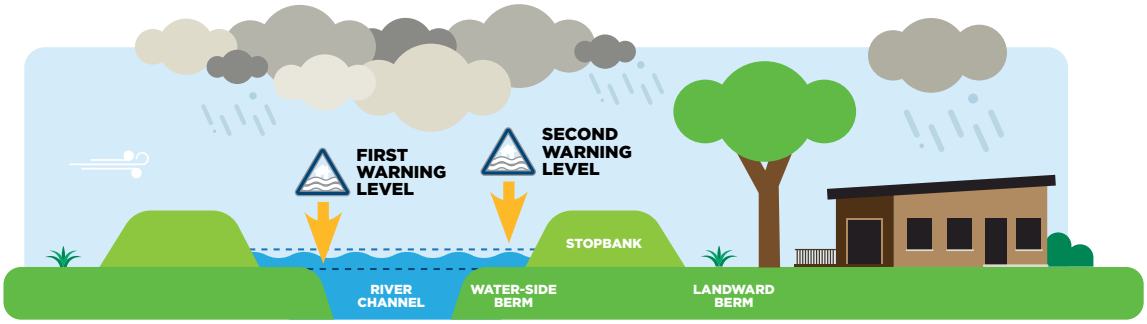
Map of River Schemes. Source: Bay of Plenty Regional Council

- **Flood Room**. During a flood, weather events or even periods of heavy rain, the Regional Council flood team supports a range of agencies (such as emergency services and local councils) with real-time environmental information (such as rainfall data and river levels) that can assist with their planning and response with local communities.

National Institute of Water and Atmospheric Research (NIWA)
> **Flood Frequency Tool.** Provides the most comprehensive assessment of flood hazard across New Zealand rivers.

What is meant by river warning levels?

- **First warning level** – the river level has reached its normal channel capacity.
- **Second warning level** – the river has overtopped the channel banks and has flooded the area next to river (berm). This is still well within the flood defences around the river (such as a stopbank or floodway).



River Warning Levels. Source: Bay of Plenty Regional Council

Acknowledgements and references

We would like to acknowledge the Bay of Plenty Regional Council on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Bay of Plenty Regional Council – **www.boprc.govt.nz**
  - Natural Hazards – Flooding
  - Improved Hazard Mitigation in the Whakatāne District, October 2007
  - Rotorua Lakes Council – Ngongotahā Flood Review Action Plan, July 2019
- Independent Review Ngongotahā Flood Event for Rotorua Lakes Council, December 2018
- National Institute of Water and Atmospheric Research (NIWA) – **www.niwa.co.nz**
  - The Climate and Weather of Bay of Plenty, 3rd Edition, 2013
- New Zealand Flood Pics – **www.nzfloodpics.co.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Coastal inundation and erosion

What are coastal hazards?

Weather-related coastal hazards include coastal erosion, coastal storm inundation, and rising/salinisation of coastal groundwater. While coasts are by nature dynamic, changing environments that can periodically advance and retreat, coastal erosion is the long-term retreat of the shoreline.

Coastlines are forever changing with the tide, as wind and waves influence the shape of the shoreline. These processes can generate hazards that pose risks to property and infrastructure such as coastal erosion and inundation (flooding from the sea or harbour). The loss of land due to coastal processes such as wave action and nearshore currents can occur, especially when very large waves over a long period coincide with high tide.

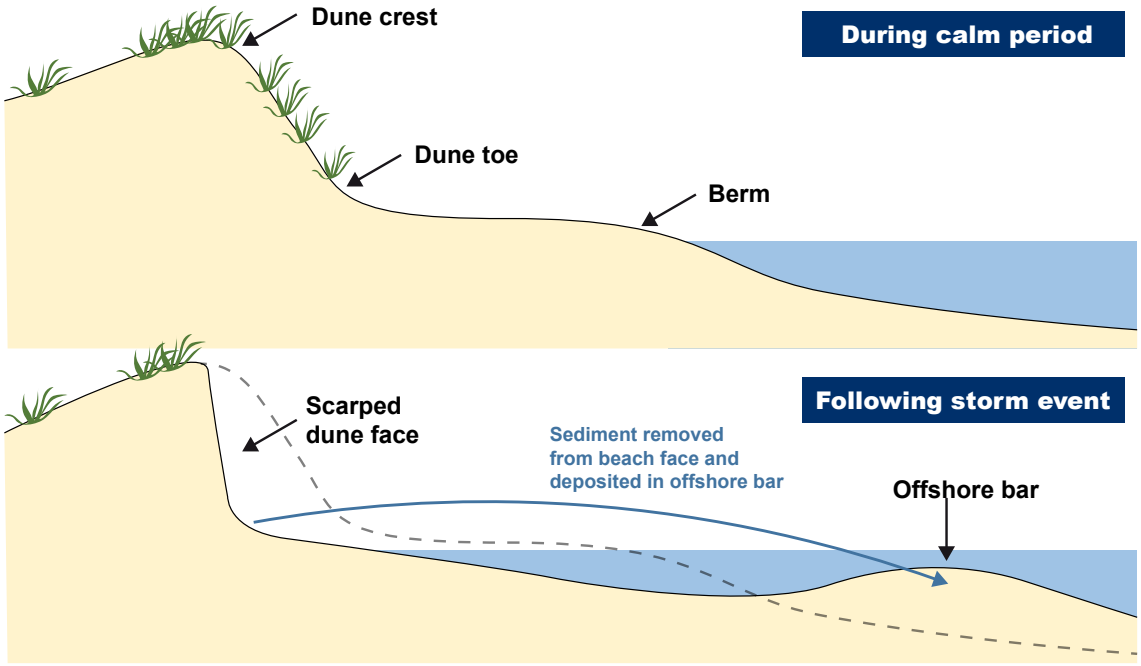
Climate change is expected to increase the magnitude of coastal hazards over time as sea levels rise and cause these hazards to extend further inland.

Coastal erosion

Coastal erosion is where the shoreline retreats (either temporarily or permanently). There is a loss of land due to coastal processes such as wave action and nearshore currents. Erosion can occur suddenly in response to storm events, or slowly over time. This can cause instability of dunes and coastal cliffs as the base sediment erodes and is moved either offshore or along the coast. Erosion becomes a hazard when it threatens people's activities or settlements.

Erosion on beach accessway at No 183 Pukehina Parade, 2020. Source: Western Bay of Plenty District Council

Coastal erosion is a major concern for New Zealand, with local councils, central government and scientists working to address its impacts through long-term planning and climate adaptation measures.



How coastal erosion occurs. Source: Bay of Plenty Regional Council

Coastal inundation

Coastal inundation (also called coastal flooding) occurs when normally dry, low-lying land is flooded by the sea. Coastal inundation is mainly caused by severe weather events such as storms where low-pressure weather systems, large waves and strong winds combine with high tide to raise water levels.

The worst flooding occurs when larger-than-normal tides and storms occur at the same time. New Zealand has low-lying coastal areas that are vulnerable to inundation (flooding) by the sea, especially during storms.

Storm surge is a part of inundation along with tides and wave effects.

Storm surges are temporary increases in ocean and estuary water levels caused by storm conditions that last from hours to days. Storm surge is a combination of two weather and ocean processes:

- low barometric (air) pressure allows sea levels over a large area (100 square kilometres or more) to rise above the pre storm sea level.
- strong, persistent winds blowing onshore cause water to ‘pile up’ against the coast, raising water levels.

Rising/salinisation of coastal groundwater

Salinisation occurs when seawater infiltrates freshwater aquifers near the coast, making groundwater too salty for drinking, irrigation, or ecological use. This issue is particularly significant in low-lying coastal areas and regions with high agricultural dependence on groundwater.

Rising sea levels could reduce the availability of freshwater in some parts of New Zealand.

Sea-level rise

After at least a thousand years of little change, sea level around the world began to rise around the latter half of the 19th century, and increased at a rate of around 1.7 millimetres a year during the 20th century – that is a total of approx. 20 centimetres this century. Since satellite measurements began in 1993, the global average sea level has risen more quickly, at 3.3 millimetres a year. The increase is due partly to natural climate variability and partly to warming of the atmosphere and oceans.

Sea level rise in New Zealand is a pressing issue as the country experiences the effects of global climate change. Projections suggest that sea levels could rise by up to one metre or more by 2100 if global greenhouse gas emissions remain high.

View a map of the predicted sea-level rise around New Zealand
www.searise.nz > maps

Coastal hazard events in New Zealand

Coastal hazards have had both an historic and ongoing impact across coastal New Zealand irrespective of climate change and sea-level rise. However, climate change will generate increasing risk across coastal Aotearoa, which will be ongoing for centuries due to sea-level rise and other climate change effects.

Source: Bay of Plenty Regional Council

Our story
Bay of Plenty context

The Bay of Plenty is particularly vulnerable to coastal hazards due to its extensive coastline, low-lying areas, and reliance on coastal ecosystems, infrastructure places of historical significance. These hazards include coastal erosion, inundation, storm surges, and sea-level rise, which are exacerbated by climate change and increasing storm intensity.

Coastal inundation (flooding) in Tauranga

Tauranga has a long history of being impacted by large storms, the most significant of which are ex-tropical cyclones coming out from the tropics. One of the most significant storms to affect Tauranga was ex-tropical Cyclone Giselle (1968). The storm generated a 0.88m high storm surge in Tauranga Harbour.

The sea flooding on to normally dry land at Memorial Park during a low-pressure storm in January 2018. Source: Tauranga City Council

2004 Cyclone Ivy

Cyclone Ivy passed through the Bay of Plenty on 28-29 February 2004 and generated a sizeable storm surge and localised flooding.

Storm surge extent in carpark at Ōhope Beach, West End. Source: Bay of Plenty Regional Council

2023 Tropical Cyclone Gabrielle

In February 2023, Tropical Cyclone Gabrielle's combination of heavy rain, powerful winds and very large waves caused storm surges which resulted in significant flooding in low-lying coastal areas and coastal damage in parts of the Bay of Plenty. Key areas affected in the region included Waihi Beach, Athenree, Maketū, and Little Waihi, where around 50 homes were evacuated due to rising water levels and inundation.

Moturiki (Leisure Island) and the Mauao base track remain closed pots-Cyclone Gabrielle. Source: Stuff NZ

Hazard impacts

The Bay of Plenty is highly susceptible to storm surges, coastal inundation and erosion. Storm surges often coincide with high tides, amplifying their impacts. The region's extensive coastline and low-lying areas make it particularly vulnerable. Coastal inundation in the Bay of Plenty, caused by high tides, storm surges, or rising sea levels, poses significant challenges for communities, particularly around Waihi Beach, Tauranga, Whakatāne, and Ōpōtiki.

The impacts of coastal hazards include damage to commercial and residential buildings; damage and disruption to lifeline utilities; and disruption to ecosystems in coastal areas. The impacts from coastal hazards are expected to intensify with climate change, making proactive management crucial for protecting the Bay of Plenty's communities, economy and environment.

Coastal erosion

Coastal Erosion reduces beaches and dunes, affecting recreational spaces (particularly at popular locations like Mount Maunganui and Pāpāmoa), and ecosystems. Roads, residential buildings and lifeline utilities near the coastline face increased damage from erosion. Ecosystems can be disrupted. Coastal habitats like wetlands and estuaries may be lost or degraded, impacting biodiversity.

Coastal inundation and storm surge

Coastal Inundation and storm surge can cause flooding in low-lying areas and damage to residential and commercial buildings, often leading to costly repairs or abandonment of properties in high-risk areas. Roads and railways near the coast are frequently disrupted. Lifeline utilities are often damaged leading to outages.

Environmental impacts can include:

- coastal erosion;
- degradation of ecosystems: Wetlands, estuaries, and other coastal ecosystems from saltwater intrusion and sediment deposition; and
- pollution of flood waters.

Economic cost impact may be to agriculture and tourism with inundation of farmland leading to soil salinisation and crop losses; and erosion and flooding of coastal tourist attractions. Inundation can force evacuations, disrupt communities, and result in long-term challenges for relocated populations.

Sea level rise

Rising seas have local impacts. This includes flooding, rising groundwater levels, coastal erosion, and salinisation of wetlands and aquifers.

Groundwater salinisation

An example of the impacts of ground water salinisation is a reduction in crop yields for farmers – this impacts regions like the Bay of Plenty. Coastal communities relying on groundwater face increased challenges in accessing clean drinking water, requiring expensive desalination or alternative water sources. Coastal ecosystems, such as wetlands and estuaries, may be degraded by higher salinity levels, threatening biodiversity. Management of salinised water sources and adapting infrastructure to prevent further intrusion can incur significant expenses.

Hazard management – what to do and what this means for you

What to do?

- **Call 111 in an emergency.**
- National Emergency Management Agency
  www.civildefence.govt.nz > What to do during a storm

For regional information on Severe Weather:
What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from: Bay of Plenty Civil Defence Emergency Management Group > Severe Weather

To prepare

- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.
- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

GET READY

getready.govt.nz

Ōmokoroa Wharf – 5 January 2018 during Storm Surge event. Source: Western Bay of Plenty District Council

Other information

- **Bay of Plenty Regional Council** – www.boprc.govt.nz > Coastal Hazards
- **Western Bay of Plenty District Council** – www.westernbay.govt.nz > Coastal inundation
- **Tauranga City Council** – www.tauranga.govt.nz
  - Coastal erosion
  - Coastal flooding
  - Inundation Maps
- **Ōpōtiki District Council** – www.odc.govt.nz > Natural Hazards
- **NZ Sea Rise** – www.searise.nz – Predicted sea-level rise around New Zealand
- **Ministry for the Environment** – environment.govt.nz
  - Factsheet Coastal Erosion
  - Factsheet Coastal flooding due to storms
  - Factsheet Storm surge
  - Factsheet Sea-level rise
  - Factsheet Waves
  - Coastal Hazards and Climate Change Guidance
  - Coastal Hazards and Climate Change: Guidance for Local Government
- **National Institute of Water and Atmospheric Research (NIWA)** – niwa.co.nz
  - Coastal Storm inundation
  - Coastal erosion and sediment systems
  - Storm surge and wave forecasting
- **Metservice** – www.metservice.com – Coastal Marine Weather Forecasts and Conditions

New Zealand Storm Surge Data Tool (summary of past data)

Storm Surge Event at Ōmokoroa. Source: Western Bay of Plenty District Council

Spinifex on dune face, Ōhope Beach. Source: Bay of Plenty Regional Council

Acknowledgements and references

We would like to acknowledge all the Councils in the Bay of Plenty on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Ministry for the Environment – **www.environment.govt.nz**
- Metservice – **www.metservice.com**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
- National Institute of Water and Atmospheric Research (NIWA) – **www.niwa.co.nz**
  - The Climate and Weather of Bay of Plenty, 3rd Edition, 2013
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Heatwave and marine heatwave

What is a heatwave?

There is no worldwide consensus of what qualifies as extreme heat or a heatwave. Different countries have different conditions for extreme heat events based on their local climate, which may include factors related to heatwave formation such as maximum daily temperature, average daily temperature, daily minimum (night-time) temperature, duration and humidity.

The World Meteorological Organisation defines a heatwave as a period where local excess heat accumulates over a sequence of unusually hot days and nights.

Other risk factors and impacts may exacerbate the effects of a heatwave and cause more widespread disruption during a period of extended heat.

Examples include:

- disruption to transport networks when road surfaces deteriorate due to the heat.
- traffic congestion, which keeps people in cars for long periods.
- interruption to power supplies, particularly during times of drought or due to increased electricity use to run air conditioning units.
- limited availability of and access to air conditioning.
- reduced air quality with no wind.
- reduced water quality due to algal blooms.
- odour, dust and vermin infestations.
- fires and smoke.
- water shortages.

Heatwaves and marine heatwaves in New Zealand

There is no formal definition for heatwaves in New Zealand. Heatwaves and marine heatwaves are quite different.

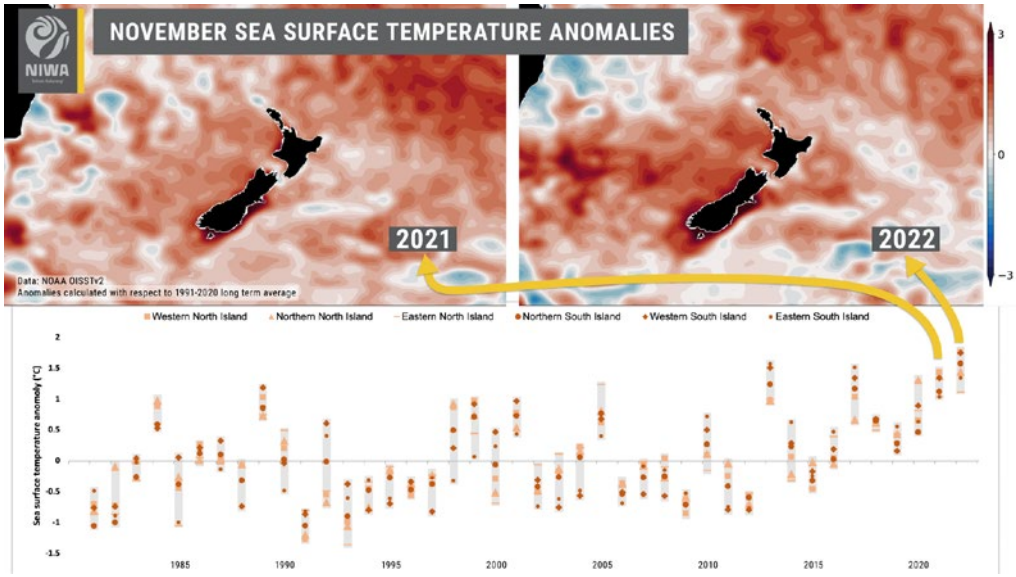
Climate change is predicted to cause both average and maximum temperatures to rise, and the number of hot days and nights experienced in New Zealand are expected to increase. In New Zealand, heatwaves typically occur during summer months and can significantly impact human health, agriculture, infrastructure and the environment.

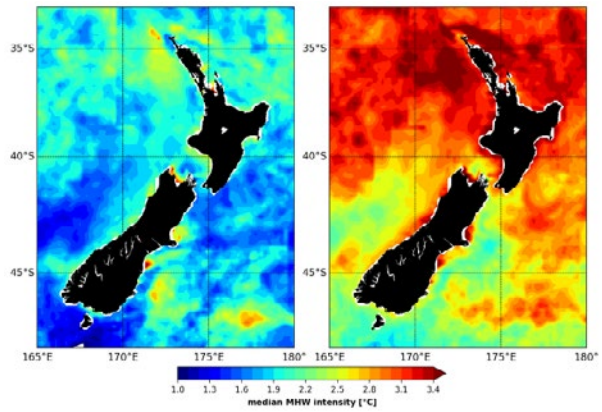
Heatwaves can be serious events that cause death and illness. In Australia, heatwaves are responsible for more deaths than any other natural hazard. A heatwave in Europe in 2003 was estimated to cause over 70,000 deaths across the continent. In New Zealand, heatwaves of this magnitude are rarely experienced, but in Auckland and Christchurch an average of 14 high-heat-related deaths occur per year in people aged over 65 years. This number is likely to increase as climate change causes temperature levels in New Zealand to rise.

Average temperatures are projected to continue rising, and extreme weather events – including extremely high temperatures and heatwaves – are also expected to become more likely due to climate change. The number of days when temperature exceeds 25 degrees Celsius is expected to increase between 40 and 100 percent by 2040 and between 40 and 300 percent by 2090.

A marine heatwave is a period of prolonged warming of the sea surface temperatures that can extend thousands of kilometres. The average temperature of the ocean is now 1.5°C higher than it was 100 years ago, and in the past 30 years, the frequency of marine heatwave events has doubled. Climate change has also contributed to observed increases in the frequency, intensity and duration of marine heatwaves over recent decades.

Recent marine heatwaves in all oceans have been longer and more intense causing widespread impacts on marine species with changes in distribution, loss of biodiversity, collapse of foundation species including coral, kelp and seagrass and the ecosystems they support, and declines in fisheries. Localised marine heatwave events have been occurring in coastal waters near Northland, Auckland, Bay of Plenty, and Fiordland.





Above: November 2022 Sea Surface Temperature anomalies.
Source: NIWA

Left: Marine heatwave conditions: left – today, right – 2100.
Source: NIWA

Our story
Bay of Plenty context

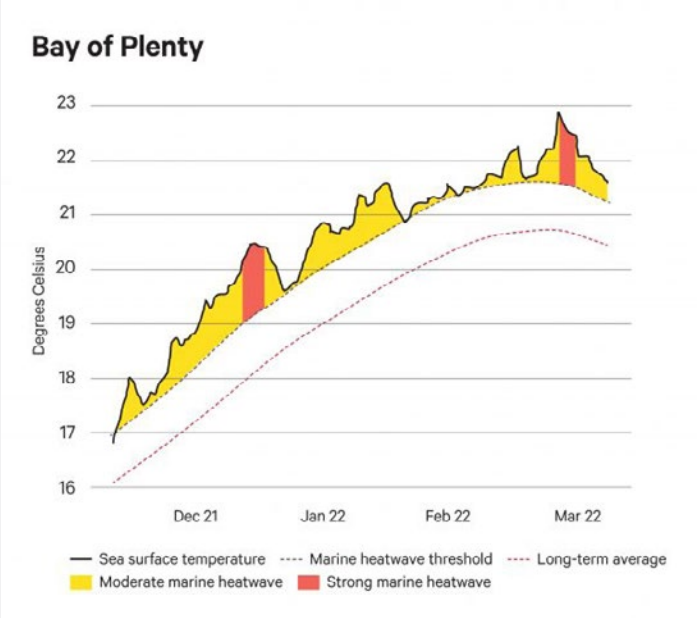
The Bay of Plenty has experienced short-term heat events that have:

- Disrupted kiwifruit and avocado production, two major horticultural exports for the region.
- Elevated wildfire risks, particularly in drier forested areas such as Rotorua's forestry zones.
- Caused water shortages in rural areas, putting pressure on local water management systems.
- Caused health impacts for the elderly and those affected by certain medical conditions.

Longest continuous marine heatwave recorded in Bay of Plenty

In 2022 'Moana Project' reported that Marine heatwave conditions in Bay of Plenty have lasted a year (since November 2021) – the longest continuous marine heatwave so far recorded for New Zealand. Marine heatwaves can adversely affect ocean life, including kelp forests, fish and marine mammals. Ocean temperatures affect not only marine life, but also the weather generally.

Project data highlighted that sea surface temperatures remained on average 1.6 °C warmer than the long-term average. The conditions lasted through winter when temperatures were 2.4 °C above normal. This warming is unprecedented over at least the past 40 years and is not only affecting the surface. Moana Project temperature observations collected in collaboration with commercial fishers show that noticeable warming has extended to depths of at least 60 metres.



Bay of Plenty sea surface temperature and marine heatwave chart.
Source: New Zealand Geographic, Issue 175, May-June 2022.

Hazard impacts

Heatwaves

Human health

Heatwaves can be serious events that cause death and illness. Heatwaves may increase the risk of heat-related illnesses such as heatstroke and dehydration, particularly among vulnerable populations like the elderly, young children, individuals with chronic health conditions, and those pregnant. Temperature extremes can also worsen chronic conditions, including cardiovascular, respiratory, and cerebrovascular disease and diabetes-related conditions. As a result, there may be a strain on healthcare services due to higher incidences of temperature-related conditions. Heat can not only affect the physical health of individuals, but it also has effects on mental health. During increased temperatures both during heatwaves and at higher ambient temperatures mental health can worsen with increased mental health related harm, violence and aggression.

Communities

- **Rural:** Heatwaves also disproportionately affect primary industries such as farming. Rural communities are more vulnerable during periods of hot weather than those living in urban and suburban centres, particularly in terms of water and food security and access to health services.
- **Urban:** The effects of heatwaves are more keenly felt in urban areas due to the larger area of heat-absorbing materials such as pavement and reduced evaporation and shading from a lack of plants and trees, greater inputs of heat from buildings and transport, and higher levels of air pollution.

Agriculture

Stress on crops and livestock can lead to reduced yields and financial losses for farmers. There can be an increased demand for irrigation, potentially straining water resources.

Environment

Heatwaves can elevate the wildfire risk due to drier conditions and higher temperatures. Heat stress on ecosystems can include aquatic habitats, impacting biodiversity.

Infrastructure

In heatwaves there can be heat-related wear and tear on infrastructure, such as roads, railways, and power systems. There can also be an increase in energy demand for cooling systems, potentially leading to power outages.

Marine heatwaves

Marine heatwaves can have devastating effects on marine ecosystems and industries. Marine heatwaves have stressed aquaculture operations, including mussels and oysters, and disrupted ecosystems such as seagrass beds and kelp forests.

Marine ecosystems

Marine heatwaves can cause heat stress which in turn can bleach corals and degrade kelp forests, which are vital habitats for marine biodiversity. Warmer waters can drive some species (e.g., fish) into cooler regions, disrupting local ecosystems and food webs. Species may struggle to adapt, leading to declines in marine biodiversity.

Fisheries and aquaculture

Warmer waters can impact fish stocks and shellfish, affecting commercial fisheries and aquaculture. Elevated temperatures increase the risk of disease outbreaks and mortality in farmed and wild marine species.

Economic

Reduced fishery yields and aquaculture losses have economic consequences for industries dependent on marine resources. Tourism, especially in areas like the Bay of Plenty, may suffer if marine biodiversity or water quality declines.

Oceanographic

Marine heatwaves can also alter ocean currents and nutrient cycles that can have an impact on the broader marine environment.

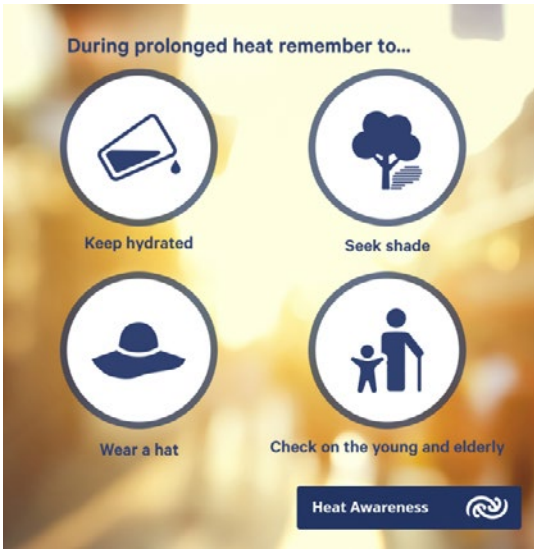
Hazard management – what to do and what this means for you

What to do – Heatwave?

- **Call 111 in an emergency.**
- Call Healthline: 0800 611 116.
- Slip, Slop, Slap and Wrap. Slip on clothing and into the shade, Slop on sunscreen, Slap on a hat and Wrap on sunglasses.

To prepare

- **MetService** – Heat Alerts - Tips for managing in hot weather events
- **Moana Project** – forecast for marine heatwaves in New Zealand.



Tips – Heatwave. Source: MetService

- **Health New Zealand Te Whatu Ora** – info.health.nz – Health effects from heat and Keeping cool in heat.
- **Toi Te Ora Public Health Bay of Plenty** – toiteora.govt.nz – Heat and Heatwaves
- **Worksafe** – www.worksafe.govt.nz – Temperature at work. Advice on how to identify, control, and monitor the health and safety risks associated with temperature at work.
- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.
- **Emergency Management Bay of Plenty** – Get Ready. www.bopcivildefence.govt.nz/get-ready

Tips – Animals during heatwave. Source: MetService

Acknowledgements and references

We would like to acknowledge MetService on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- World Meteorological Organization | Heatwave
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
- Te Whatu Ora – **www.tewhatuora.govt.nz** Heat Health Plans Guidelines, December 2018
- Te Whatu Ora | Toi Te Ora Public Health Bay of Plenty
- Ministry for the Environment – **environment.govt.nz**
- Worksafe – **www.worksafe.govt.nz**
- National Institute of Water and Atmospheric Research | NIWA – **niwa.co.nz**
  - NIWA | Scenarios of Regional Drought under Climate Change Report – June 2021
- MetService – **www.metservice.com**
- Climate Change & Nature – **www.climateandnature.org.nz**
- Marine Heatwaves International Working Group – **www.marineheatwaves.org**
- Moana Project – **www.moanaproject.org** (Moana Project is an ocean project funded by the NZ Ministry for Business, Innovation and Employment).
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Drought

What is drought?

Drought is an extended period of unusually dry conditions or below normal rainfall which can have serious impacts for plant growth, food and fibre production, and water availability (quality and quantity). Depending on the time of the year, it can take from two weeks to three months with insufficient rainfall before a drought occurs.

Prediction of drought

Scientists can predict the likelihood of a drought by careful monitoring of rainfall, river flow, and soil moisture. National Institute of Water and Atmospheric Research (NIWA) has extensive rainfall records – some records go back to the late 1850s. This depth of information, along with historical information on El Niño and La Niña weather patterns, enables NIWA scientists to provide a comprehensive assessment of the likelihood of flood or drought in any given area of New Zealand.

Causes of drought

Drought is caused by insufficient precipitation – combined with high evapotranspirarion rates (largely a factor of heat and hot, dry winds) – over an extended period of time. In turn, this can lead to the ground drying up and can also reduce the volume of water in rivers/streams, lakes/dams and subterranean reservoirs.

Drought in New Zealand

Drought is a recurring natural hazard in New Zealand, affecting regions differently due to the country's diverse climate and geography. Droughts typically result from prolonged periods of below-average rainfall, often associated with climatic conditions like El Niño, which causes drier conditions in certain parts of New Zealand.

Recent examples of drought around New Zealand

- **2007** – Low rainfall and significant soil moisture deficits persisted throughout summer and autumn with record low rainfall totals occurring in many northern and eastern areas. This resulted in a severe shortage of feed for livestock, and lower than normal spring lambing and beef numbers, costing more than $500 million.
- **2008** – Much of New Zealand encountered very dry conditions at the start of 2008, with the Waikato experiencing its driest January in a century. Severe moisture deficits continued throughout the North Island until April/May, with the estimated cost to agriculture exceeding $1 billion, and an 11% fall in sheep numbers.
- **2010** – The worst drought in Northland in 60 years occurred when record low rainfall levels were recorded between Nov 2009 and April 2010, leading to parched soils, significantly reduced pasture growth, and decreased farm productivity.
- **2019-2020** – The 2019-2020 summer season was especially dry, leaving the entire North Island in severe meteorological drought. Auckland was especially hard hit; 77 continuous days of drought in 2020 contributed to the city's driest January-April period on record.

Drought and Climate Change – the future

New Zealand's future climate will be different to the one we have experienced so far. Scientists expect wind and rainfall patterns to shift, bringing more rain to western regions, with the east becoming drier. Between 2070 and 2090, that overall trend will intensify to the point where most of the country – with the likely exception of the West Coast of the South Island – will experience more time in drought. Even under very mild climate change, the Canterbury Plains will experience more frequent droughts.

Dry weather and drought conditions. Source: AdobeStock

Our story
Bay of Plenty context

Recent drought events in Bay of Plenty

Drought conditions have occurred multiple times in recent years, with notable events in 2020 and 2023 that led to water restrictions, financial impacts on the farming community and environmental stress on local ecosystems.

In 2020, growers and residents in the Bay of Plenty were urged to consider reducing their water use, in case more dry weather resulted in a drought. During 2020 the Bay of Plenty experienced exceptionally dry weather, with just 60-80 percent of the usual rainfall.

The Bay of Plenty Regional Council reported that some waterways were lower than they should be, which is dangerous for the ecosystem.

Water Shortage Event Levels

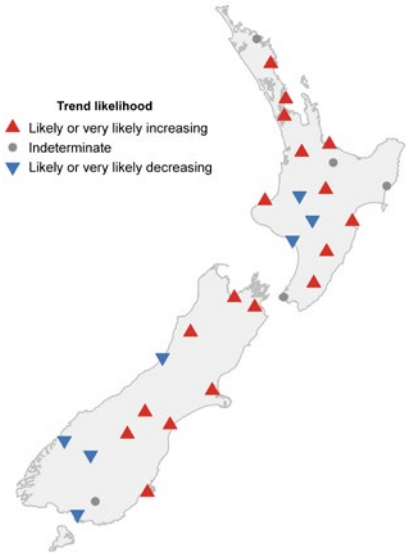
The following levels can be in place for the whole of the Bay of Plenty, or only apply to certain Focus Zones. Focus Zones can refer to specific waterbodies, whole catchments, multiple catchments, or districts. The Focus Zones will always be identified via a Focus Zone map.

LEVEL 0	**No water shortage concerns** Streams, groundwater and rainfall within expected range. No issues of concern.
LEVEL 1	**Reducing water availability** Lower than expected levels of any of the following occurring: rainfall, stream flows, groundwater and/or soil moisture.
LEVEL 2	**Impending water shortage** Any or all of the following occurring: continued reduction in stream flows and/or groundwater levels, lack of rainfall i.e. growing risk to waterway health.
LEVEL 3	**Water shortage event** Low flow and/or drought conditions affecting waterways i.e. risk to waterway health.

Source: Bay of Plenty Regional Council

Hazard impacts

Droughts are becoming more frequent in the Bay of Plenty, with significant economic, environmental, and social impacts. Farmers are particularly affected as crops fail and grass becomes insufficient for grazing livestock. The resulting reduction in farmers' incomes creates a ripple effect, impacting retailers and service industries. Even after soil moisture levels recover, the consequences for pastures, livestock, and farm finances can persist. Additionally, river flows, groundwater, and irrigation dams often take months to return to normal. Drought is one of the major reasons for malnutrition and famine in many parts of the world.



Meteorological drought frequency trends at 30 New Zealand sites, 1972–2022.
Source: Stats NZ (using data from NIWA)

Agricultural

Agriculture is one of the sectors most heavily affected by drought. Water shortages impact crop yields, pasture growth, and livestock production, leading to loss in productivity and/or increased operational costs for farmers who may need to invest in supplementary feed and water. For example, the 2020 drought in the North Island severely impacted dairy farms and horticulture, leading to financial strain on rural communities.

Economic

Economic effects can be significant, affecting not just the agriculture sector but also the food supply chain, local businesses, and export revenue, as New Zealand is a major exporter of dairy, meat, and produce.

Water supply and environmental

Droughts reduce the availability of water for drinking, irrigation, and industrial use, necessitating water restrictions. Impacts include reduced river and lake levels, which can affect aquatic habitats and biodiversity. Lower water levels impact fish, birds, and other wildlife and reduce water quality, which can lead to further ecological degradation.

Social and health

The financial and operational challenges of drought can lead to stress and mental health issues among farmers and rural communities. Drought can create a sense of uncertainty and hardship for those who rely on predictable weather patterns and water availability for their livelihoods.

Increased wildfire risk

Hot, dry, windy conditions dry out vegetation, raising the risk of wildfires, especially in regions with significant rural and forested areas (See Wildfire Hazard Page).

Hazard management – what to do and what this means for you

What to do in a drought?

- Find out how to deal with drought conditions, access on farm support, and food safety during droughts and heatwaves on the Ministry for Primary Industries website **www.mpi.govt.nz**

Dealing with drought conditions	On Farm Support	Food safety during droughts and heat waves

- Figure out what supplies you need and make a plan to work out what you need to get through including water and food. **www.getready.govt.nz**

Other information

- **Bay of Plenty Regional Council** – www.boprc.govt.nz
  - Dry Weather Water Management
- **NIWA** – www.niwa.co.nz
  - Drought Forecasting Dashboard
  - Drought
  - New Zealand Drought Monitor
  - New Zealand Drought Index Map (updated daily)
- **Taumata Arowai** – www.taumataarowai.govt.nz > Preparing for dry weather
- **Ministry for Primary Industries** – www.mpi.govt.nz > Preparing for El Niño
- **Dairy NZ** – www.dairynz.co.nz > Summer Management
- **Beef + Lamb NZ** – https://beeflambnz.com
  - Drought resources
  - Factsheet: Strategies used by Farmers in Drought

Sheep in dry summer drought conditions, coastal farm, New Zealand. Source: Adobe Stock

Acknowledgements and references

We would like to acknowledge the Ministry for Primary Industries on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- NIWA – National Institute of Water and Atmospheric Research – **www.niwa.co.nz**
  - Drought in a Changing Climate
  - Scenarios of Regional Drought under Climate Change Report – June 2021
- Ministry for Primary Industries – **www.mpi.govt.nz**
- Stats New Zealand | Drought – **www.stats.govt.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard:
Space weather

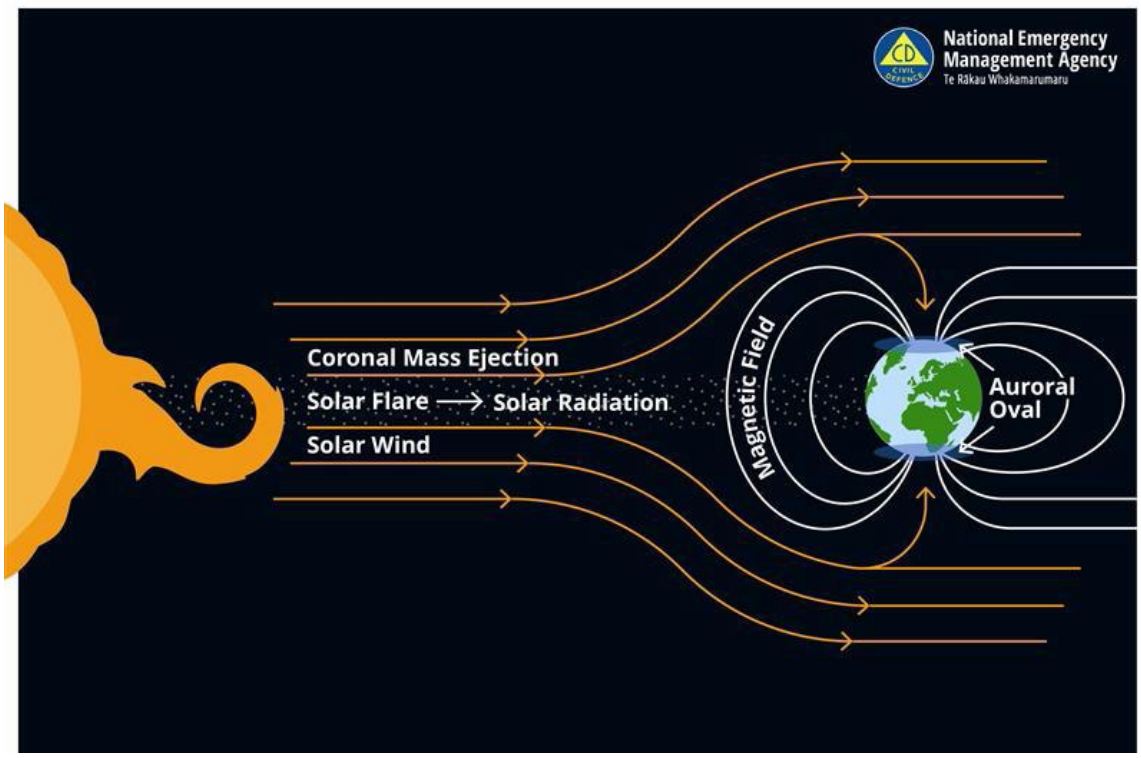
What is space weather?

‘Space weather’ refers to an array of phenomena originating from the Sun. Space weather occurs continuously, much like weather on Earth, and normally with no tangible effects.

Space weather phenomena

Space weather phenomena that can cause impacts on Earth are:

- Solar flares
- Coronal mass ejections.
- Solar radiation storms
- Geomagnetic storms.



Space weather phenomena. Source NEMA

Solar flares

Explosions on the Sun's surface release solar flares with immense amounts of energy that result in electromagnetic emissions. These flares travel at the speed of light and arrive at Earth within 8 minutes.

Coronal mass ejections

Large portions of the Sun's outer atmosphere can be explosively blown into space, sending billions of tonnes of plasma in Earth's direction. These ejections take between 12 and 36 hours to reach Earth, with larger ejections travelling more quickly. They have their own magnetic field, resulting in geomagnetic storms.

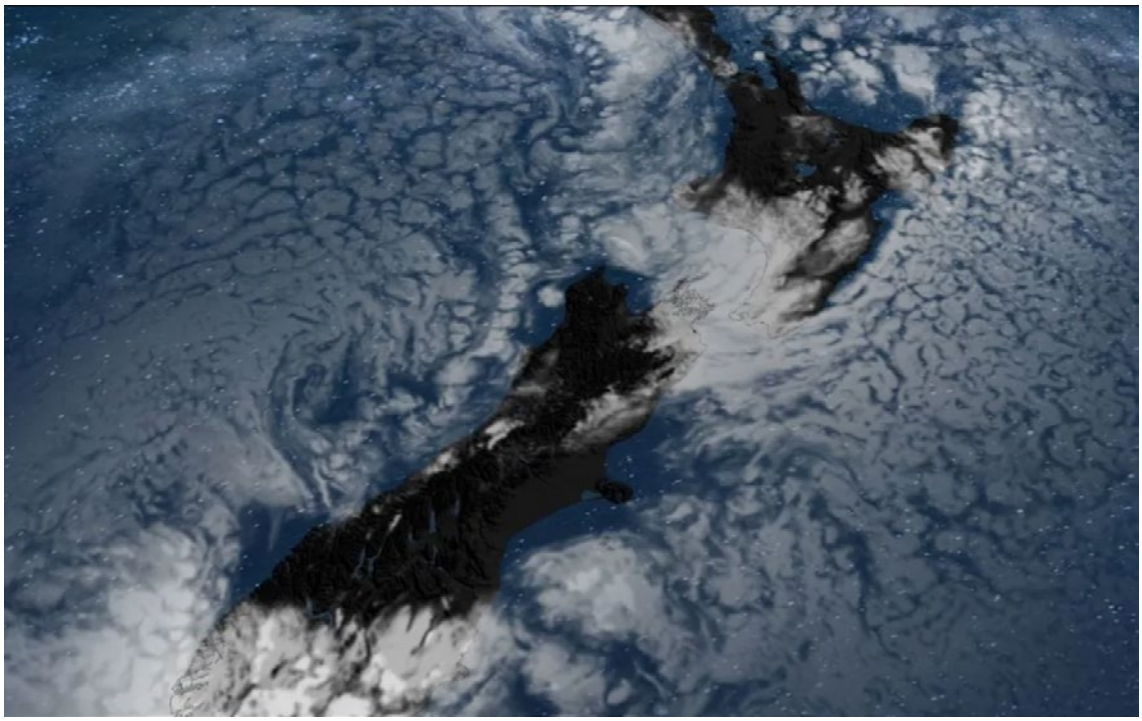
Solar radiation storms

Coronal mass ejections and solar flares can accelerate charged particles. These particles arrive at Earth from every direction. The fastest of these particles can affect Earth tens of minutes after a solar flare occurs.

Geomagnetic storms

Geomagnetic storms are a temporary disturbance of the Earth's magnetic field and typically associated with stronger solar winds. Significant geomagnetic storms are caused by coronal mass ejections. The greatest space weather disturbances are usually caused by solar flare and coronal mass ejections, and subsequent radio and geomagnetic storm activity.

The greatest space weather disturbances are usually caused by solar flare and coronal mass ejections, and subsequent radio and geomagnetic storm activity.



A severe solar storm. Source: X/NIWA

Space weather events in New Zealand

Space weather has always existed, but in today's interconnected world, bursts of solar energy thrown out by the Sun can have catastrophic impacts. They can impact our electricity, satellites, and global supply chains.

May 2024 Geomagnetic Storm

In May 2024, a significant geomagnetic storm reached severe to extreme levels, leading to several consequences in New Zealand:

- **Power grid precautions:** Transpower, the national grid operator, declared a grid emergency and proactively removed certain transmission lines from service to protect equipment. This action was taken to prevent potential damage from geomagnetically induced currents, ensuring the stability of the power supply.
- **Aurora observations:** The storm has been creating vivid colourful skies around the world, including in New Zealand. Auroras, known as the Aurora Australis, were visible across various parts of the country. These natural light displays were a direct result of the heightened geomagnetic activity.

Beyond New Zealand, this event caused the largest mass migrations of satellites on record, shortened the lifespan of satellites and international flights were minutes from grounding.

The last time there was such a strong storm was in 2001, when a transformer at Halfway Bush (near Dunedin) was burnt out.

It is important to acknowledge that leading New Zealand scientists estimate that this event is approximately 100 times smaller than what New Zealand can expect in the future.

The aurora seen from Whakatāne, on 11 May, 2024. Photographer: Bodhi Saunders

Hazard impacts

Extreme space weather is a low probability event, but it could have far reaching, potentially catastrophic consequences. Space weather can disrupt critical infrastructure like electricity, gas, rail, airways, and communication networks. It can also affect systems that these services rely on, such as GPS navigation, Global Navigation Satellite Systems (GNSS) and radio communications.

If critical infrastructure is damaged, the recovery period may be prolonged due to the significant international demand on replacement equipment, with New Zealand potentially competing with larger markets. Space weather can have a significant influence on modern technology, infrastructure and everyday life. The Bay of Plenty region, like the rest of New Zealand, is vulnerable to these impacts, which can disrupt essential services and systems. The key effects include:

Satellite services

Solar radiation storms can disrupt and degrade positioning navigation and timing systems, global navigation satellite systems, and Earth observation satellites. Degraded services can lead to the disruption of dependent critical infrastructure systems and technology.

Electricity

Geomagnetic storms from coronal mass ejections can induce currents into the transmission network. Transformers are particularly vulnerable to these currents, which can produce voltage instability and harmonics that threaten the security of electrical supply. Electricity outages may occur because of instability, network damage, proactive grid reconfiguration, or proactive disconnection of vulnerable generation assets. Such outages will disrupt the complex interconnected system of critical infrastructure, causing potential outages.

Communications

Solar flares release bursts of radio noise that can disrupt communications networks. This disruption occurs within minutes of the solar flare and could last for tens of minutes. Coronal mass ejections may cause further impacts on position navigation and timing services and the electricity network. These impacts would be noticeable within hours of the first coronal mass ejection arriving.

Social

The social impacts are less well understood because of the lack of recent events to learn from. However, the complex nature of the hazard means there may be impacts caused to communities beyond the physical impacts. The extent of social impacts may be influenced by concurrent events or recent emergencies which inherently reduces risk tolerance and the ability for communities to cope. Social impacts are likely to include: confusion around the nature of the event and around warnings; concern around personal security; health impacts, including reduced ability to heat or cool homes and delayed or interrupted health services; public health issues around food spoilage, drinking water and sewage; and mental health impacts including anxiety.

Hazard management – what to do and what this means for you

What to do?

Call 111 in an emergency.

To prepare

- The risk of an extreme solar event impacting the power system is small. But New Zealanders need to remember that all infrastructure can be vulnerable at any time to a natural disaster or other major event so should always be prepared.
- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.
- People who need power for medical reasons are asked to ensure they have a backup plan in place.
- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

GET READY

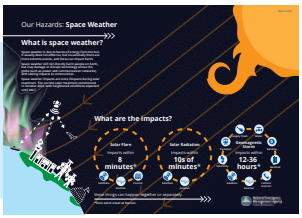
getready.govt.nz

For regional information: What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from: Emergency Management Bay of Plenty.

Night sky. Source: Bay of Plenty Regional Council

Other information

National Emergency Management Agency Space Weather Information



- The New Zealand National Space Weather Response Plan adopts the Australian Space Weather Alert System to ensure consistency with the international space weather alerts. The alert system uses 3 scales:
  - G-scale for geomagnetic storms
  - S-scale for solar radiation storms
  - R-scale for radio blackouts.

  Each scale ranges from 1 to 5. An event of the weakest intensity is 1 and the strongest is 5.5 An event at 3 or higher may require operators of technology systems in some space sectors affected by weather to mitigate risks. Also, the ranges can help to determine whether operational action is required when corresponding organisational thresholds are met.

Geomagnetic teams across the globe measure and monitor the Earth's magnetic field to provide Space Weather warnings of solar disturbances and forecast magnetic storms that can affect human activities.
www.geonet.org.nz > Geomagnetic Dashboard

- The **Solar Tsunami Endeavour Programme** is an international collaboration led by the University of Otago to understand how New Zealand's energy infrastructure will be impacted by an extreme space weather event. www.solartsunamis.otago.ac.nz

Acknowledgements and references

We would like to acknowledge the National Emergency Management Agency (NEMA) on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- National Emergency Management Agency – **www.civildefence.govt.nz** – National Space Weather Response Plan (Version 2, November 2024 |
- GNS Science – **www.gns.cri.nz** > Space Weather
- CAA – **aviation.govt.nz** > Space Weather
- Transpower – **www.transpower.co.nz** > space weather and the power system
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Section 3: Disease

In this section:

Infectious disease

Disease: animal and plant

Hazard: Infectious disease

Infectious diseases

Infectious diseases are caused by organisms such as bacteria, viruses, fungi, or parasites; and can be transferred from an infected person to another. Health New Zealand | Te Whatu Ora collects data on more than 50 diseases and monitors infectious diseases of public health significance to prevent; detect and investigate infectious disease outbreaks, biological and emerging threats. For example: Chicken Pox, Dengue Fever and Influenza.

Pandemic

A pandemic is an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people. A pandemic caused by a respiratory pathogen – in particular, a virus – is the most likely event to cause a large-scale health emergency.

A **pandemic** occurs when an epidemic becomes widespread around the world. An epidemic occurs when there is an abnormally high level of a disease in a country at a particular time. The term usually refers to **infectious diseases**, but it is also possible to have epidemics of non-infectious diseases such as heart disease and diabetes, and obesity.

Human Pandemics by their nature are unpredictable. While we know there will be another pandemic, we don't know when. We also won't know how severe it will be, or who will be most affected, until it happens. There a number of well-known human pandemics:

- Influenza Pandemics (1918-19; 1957-58; 1968-69 and 2009-10). The 1918/19 pandemic caused the highest number of known influenza deaths.
- Coronavirus disease (COVID-19) Pandemic (2020-2021).

Coronavirus disease (COVID-19) Pandemic

The Coronavirus disease (COVID-19) is a highly contagious disease caused by the SARS-CoV-2 coronavirus. It usually spreads between people in close contact. The most common symptoms are fever, chills, and sore throat, but there are a range of others (COVID-19 symptoms).

The first cases of the Coronavirus disease were detected in China in December 2019. The disease caused by the virus rapidly spread around the world in early 2020. The World Health Organisation declared a Public Health Emergency of International Concern (PHEIC) on 30 January 2020; and characterised the COVID-19 outbreak as a pandemic on 11 March 2020. Over 760 million cases and 6.9 million deaths have been recorded worldwide since December 2019, but the actual number is thought to be higher.

In New Zealand, the first case of COVID-19 was reported on 28 February 2020. New Zealand introduced a four-tiered alert level system to manage COVID-19 in March 2020. This system evolved into the COVID-19 Protection Framework using vaccination and community transmission rates to assess restriction levels. Over the COVID-19 pandemic in New Zealand (February 2020 – August 2023, over 2,270,000 cases were recorded and over 3,000 people died as a result of COVID-19.

New Zealand had comparative success to other countries in containing the virus restricting incoming international visitors, compulsory managed isolation and quarantine; and testing and vaccination programmes managed by the health sector.

Since the World Health Organisation characterised the COVID-19 outbreak as a pandemic, there have been continued waves of variants of the virus. Every week there are 1,000s of reported cases of people in New Zealand contracting the virus; and testing in New Zealand's Wastewater also confirms that COVID-19 remains in the community. The World Health Organisation is continuing to track new variants of the virus.

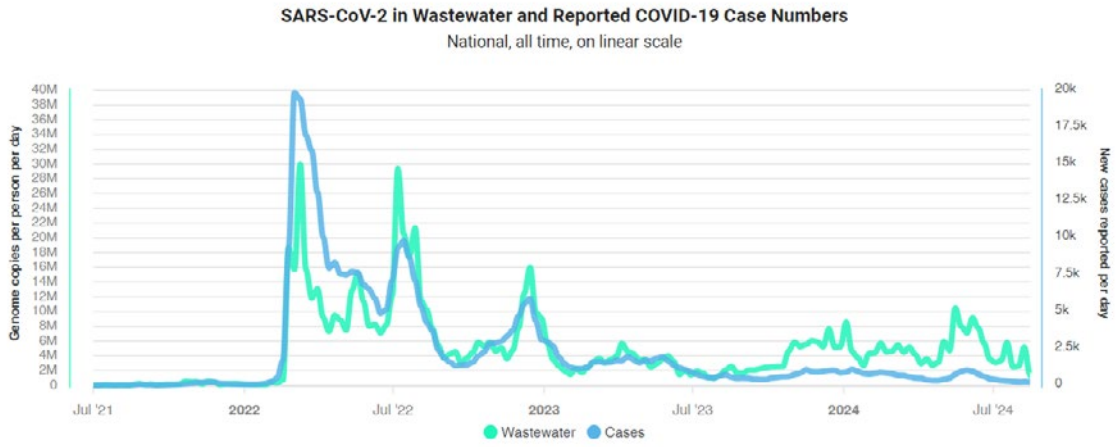


Figure 1: The average SARS-CoV-2 genome copies detected per person per day in wastewater for Aotearoa, along with the reported case numbers.

Science for Communities | Wastewater Surveillance | New Zealand. Source: ESR

1918 Influenza Pandemic

The 1918 influenza pandemic struck between October and December 1918. In two months New Zealand lost almost as many people to influenza than it did during the entirety of the First World War. No other event has killed so many New Zealanders in such a short time.

Life changed in New Zealand during the outbreak of Influenza in 1918. Though the war was over, many public celebrations of armistice were delayed until the following year, with public officials scared of increasing the spread. In Auckland, public buildings such as schools were turned into temporary hospitals and morgues, including the recently constructed Northcote Infants School, and the Ellerslie Racecourse grandstand. Everyone was involved in helping, including the boy scouts, who ran errands such as collecting prescriptions.

Communities worked together in the spirit of national cooperation that had blossomed during the war. By uniting en masse and listening to government restrictions, the outbreak waned by December in New Zealand, though it still resulted in around 9000 deaths.

Infectious diseases – measles

Measles is a virus. Measles is severe and highly a contagious disease. It can cause serious problems, including brain swelling, chest infections, or death. Measles is also vaccine preventative.

In 2017, New Zealand was verified by the World Health Organization as having eliminated endemic measles. This means that there has not been sustained transmission of measles for longer than a year in New Zealand since 2014. However, measles is often imported into New Zealand following international travel.

Measles is usually an uncommon infection in New Zealand, but in 2019 there was an extensive Measles outbreak in New Zealand with more than 2000 people were infected with measles.

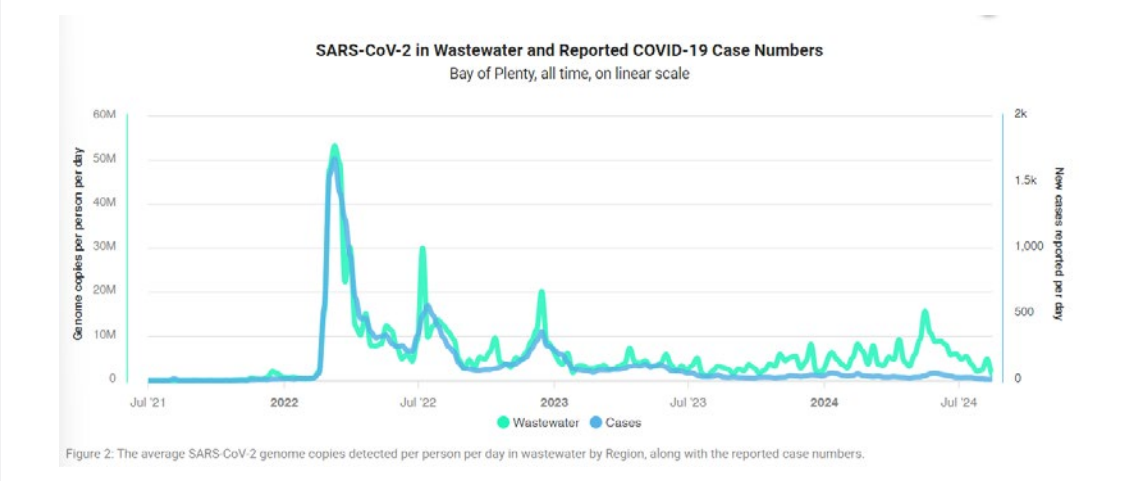
The majority of cases were in Auckland and Canterbury, and the virus spread across many other parts of New Zealand and into neighbouring Pacific countries. More recently, New Zealand experienced two separate outbreaks in February and May 2023, with both located in Auckland. Both outbreaks were contained.

Our story
Bay of Plenty context

Coronavirus disease (COVID-19) in the Bay of Plenty

In comparison to other regions in New Zealand, the Bay of Plenty overall had lower numbers of reported cases in the height of the pandemic.

The Bay of Plenty region, along with all regions across New Zealand still report cases of COVID-19 and detect of the virus in community wastewater.



Science for Communities | Wastewater Surveillance | Bay of Plenty region. Source: ESR

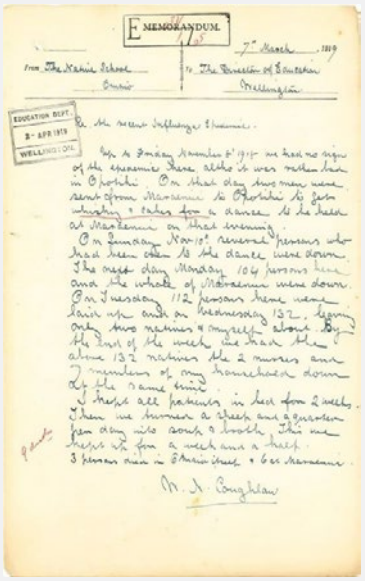
COVID-19 vaccination programmes in alignment to the COVID-19 Protection Framework were implemented across the Bay of Plenty including diversifying programmes to offer the vaccine to everyone in the Bay of Plenty, most especially our vulnerable, hard-to-reach communities. An example beyond the 'drive-in' vaccination clinics was the 'fly-in' service to offshore islands.

The fly-in, drive-through COVID-19 vaccine rollout to Mōtītī Island
Source: Health New Zealand | Te Whatu Ora

Stan and a team member at a Western Bay of Plenty COVID-19 Vaccination Centre. Source: BOPCDEMG

1918 Influenza Pandemic – a Bay of Plenty story

Ōmāio at the beginning of the 20th Century was home to a whaling and commercial farming community, all owned and managed by Te Whānau-ā-Apanui. As the First World War came to an end, everyone was eager to see their boys come home and families reunited. However, there was one passenger they were unaware of: H1N1. This novel strain of Influenza A was brought into New Zealand by returning military and medical forces, and the population was quickly overwhelmed. H1N1 Influenza virus came to Ōmāio on 08 November 1918 when "two men were sent from Maraenui to Ōpōtiki to get whiskey and cakes for a dance to be held at Maraenui that evening". The virus had already swept through Ōpōtiki, so when the men went to gather supplies they exposed themselves, and their community, to a deadly new strain of flu. It didn't take long for several attendees of the dance at Maraenui to come down with the illness. A week later, 137 people had caught it, and had been placed in strict isolation in bed for two weeks. Nine people were lost to this outbreak in the Maraenui/ Ōmāio area. Whilst the numbers of deaths were relatively low, the virus shut down the community entirely, as seen in the notice and report put out regarding the closure of the local native school.


MEMORANDUM

Māori Schools Policy – closure of schools owing to influenza epidemic. Source: Archives New Zealand

Measles in the Bay of Plenty

During the 2019-2020 measles outbreak in New Zealand, there were over 60 confirmed cases and 250 suspect cases reported in the Bay of Plenty. In early 2023, a case of measles was reported in New Zealand which was the first case since the 2019 outbreak. Whilst the case resided in Auckland, they did visit a number of Bay of Plenty locations whilst infectious, highlighting the ease of spread across New Zealand.

Protect Te Moana a Toi against Measles (part of Matinal Measles Campaign) Source: Health New Zealand Te Whatu Ora

Immunisation is very effective in preventing measles. It only takes on case of measles to start an outbreak. The vaccine that protects against measles is the MMR (Measles/Mumps/Rubella) vaccine.

An example of localised measles vaccination campaigns included the campaign launched at Te Wananga o Aotearoa's Tauranga campus in March 2021 administering free MMR vaccinations targeting 15-30 year-olds from Te Pare ō Toi kaupapa Māori community nurses. This campaign was extended to clinics and pop-up stands across the Bay of Plenty's as part of the National Campaign.

Hazard impacts

The impacts from previous pandemics experienced in New Zealand can be applied to any human pandemic.

Our experience from the post recent pandemic, COVID-19, showed that pandemics impact communities locally, regionally, nationally and internationally. COVID-19 substantially impacted New Zealand society with significant implications for education, faith communities, holidays, mass gatherings, sports and recreational activities. COVID-19 also accelerated a change to how people work, with many more working from home. The New Zealand economy was hit hard. Tourism and hospitality businesses had significant losses to their business due to no tourists being in New Zealand throughout the lockdowns.

Economic

By comparison to other parts of New Zealand, the hit to the Bay of Plenty economy was not as hard. The economic uncertainty caused by COVID-19 also increased the pace at which decisions to close unviable businesses were taken. In the Bay of Plenty this change of pace was evident with decisions related to the Kawerau and Whakatāne mills. While the Whakatāne mill closure was ultimately avoided due to outside intervention, the Kawerau mill has not been so fortunate and there has been a toll, on both communities despite the end result. Some parts of the region, like Rotorua, faced a much more substantial hit to their local economy, due to the higher concentration of economic activity focused on tourism.

Agricultural

The agriculture sector was one of the most resilient sectors during COVID-19. However, the Bay of Plenty is home to some of the largest seasonally affected sectors in the country. Much of NZ's horticulture exports are driven out the Bay of Plenty, with a large percentage of export kiwifruit grown in the Bay of Plenty, as well as the largest share of avocados also grown. As a result of COVID-19, the kiwifruit sector has put significant effort into shifting away from reliance on migrants. Now 70% of the sector's permanent workforce are local.

Social and health

The COVID-19 pandemic led to social isolation, mental health challenges and disruptions in education. Community events were canceled or postponed, affecting social cohesion and cultural activities. The region experienced multiple waves of COVID-19 infections. Healthcare services faced increased demand, resulting in resource strain and delays in non-urgent care.

Hazard management – what to do and what this means for you

Infection prevention and control

For guidance on all infection prevention and control measures.

Pandemics

With new COVID-19 strains coming to the fore and surges in case numbers worldwide, response and planning activities remained a key activity. This includes creating and continually improving the Bay of Plenty CDEM resurgence plan and has involved working with our partner agencies to ensure there is a consistent understanding of roles and responsibilities.

For the latest information and to find out about COVID-19 symptoms, testing, isolation, vaccines and masks: **info.health.nz** > conditions and treatments > Infectious diseases > COVID-19

Infectious diseases

Since the COVID-19 pandemic, people now have greater awareness of infectious diseases and ways they can spread such as coughing and high contact surfaces. It suggests less tolerance for other people spreading disease and a greater sense of responsibility to avoid spreading disease themselves.

To find out about any infectious disease of concern in New Zealand including disease symptoms, treatment and protection and what to do if you think that you have an infectious disease:
info.health.nz > conditions and treatments > Infectious diseases

Further information

Immunisation

For information on immunisation in New Zealand including immunisation programmes.

info.health.nz > immunisations

Regional Public Health advice in preparation for/and during an emergency across a range of hazards including flooding; smoke from fires; volcanic ash; and heatwaves:

toiteora.govt.nz > health topics > emergency management

Source: Adobe Stock

Acknowledgements and references

We would like to acknowledge Toi Te Ora Public Health | National Public Health Service in development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- World Health Organisation – **www.who.int** COVID-19
- Ministry of Health – **www.health.govt.nz**
  - New Zealand Pandemic Plan: A framework for action (Interim update – July 2024)
  - Verian | Report for the Ministry of Health | Life since the pandemic: How the COVID-19 pandemic experience has shaped public attitudes and beliefs on public health, infectious disease and vaccination
- Health New Zealand | Te Whatu Ora – **www.tewhatuora.govt.nz**
- Te Whatu Ora | Health New Zealand | Hauora a Toi Bay of Plenty – **www.bopdhb.health.nz**
  - News and Notices: Mōtītī island - Bay of Plenty COVID-19 vaccine rollout
  - News and Notices: Protect Te Moana a Toi against Measles
- Toi Te Ora Public Health – **www.toiteora.govt.nz**
- ESR | Science for Communities – **www.esr.cri.nz** Wastewater Surveillance
- Bay of Plenty CDEM Group – **www.bopcivildefence.govt.nz** Annual Report 2022/21
- Te Ara | The Encyclopedia of New Zealand – **www.teara.govt.nz**
  - Epidemics
- New Zealand History – **www.nzhistory.govt.nz**
  - The 1918 influenza pandemic
- Archives New Zealand – **www.archives.govt.nz**
  - The 1918 Influenza Outbreak in New Zealand
- Wikipedia – **en.wikipedia.org**
  - 2019-2020 New measles outbreak
- Deloitte – COVID-19 scenario analysis – Bay of Plenty
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
  - Infometrics - Economic Impacts of the COVID-19 pandemic on the Bay of Plenty Region – Early Estimates for Bay of Plenty Regional Council
- Bay of Plenty Regional Skills Leadership Group Summary Report 2021

Hazard: Disease – animal and plant

Pests and diseases refers to agricultural and environmental pests, animal and plant disease-causing organisms, and their vectors, which present a biosecurity risk to New Zealand. They may cause economic losses, unwanted environmental impacts, and be harmful to human health and damage our socio-cultural values.

What is animal disease?

Animal disease affects the normal functions of an animal or its organs an can be caused by, bacteria, virus, fungus, protozoon, parasite, other another organism or agent.

It includes illnesses that affect livestock, wildlife, or companion animals, with potential impacts on human health, the environment, and the economy. These diseases can spread through direct contact, contaminated food or water, vectors like insects and environmental factors including land-use changes, habitat loss and contamination.

Diseases like foot-and-mouth disease, bovine tuberculosis (TB), or avian influenza pose significant risks to New Zealand's biosecurity, livestock industry, and ecosystems.

Animal diseases to note are:

Avian influenza

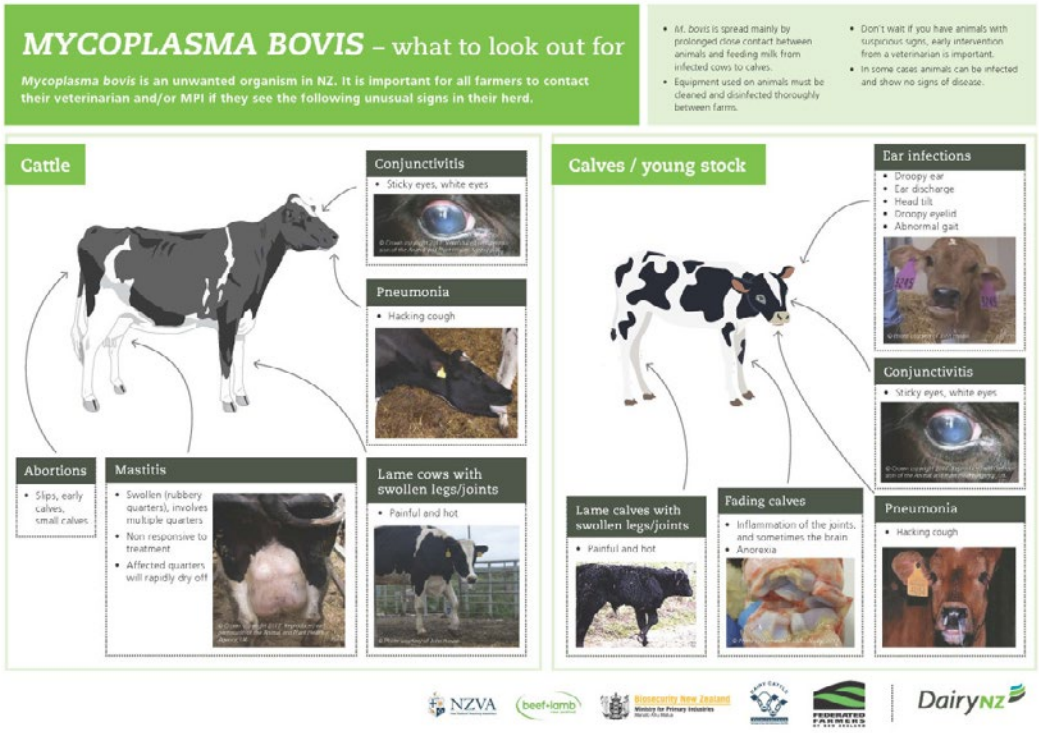
Avian influenza, also known as bird flu, is a highly contagious viral disease that mainly affects birds. However, it can also spread to mammals – including people. There are 2 main types of avian influenza:

- High pathogenicity avian influenza (HPAI), which can cause severe signs and high death rates in birds. There are a number of strains including H5, H7, and H9.
- Low pathogenicity avian influenza (LPAI), which typically causes few or no signs in birds but can possibly mutate to HPAI.

LPAI is present in wild birds in New Zealand. The Ministry for Primary Industries has an active surveillance programme for LPAI and test around 2,000 samples from wild birds each year. LPAI causes few or no signs of illness in wild birds. However, when a low pathogenicity strain of avian influenza is introduced to chickens, it can mutate into a high pathogenicity strain. Strains of HPAI have circulated globally for years. Many countries have seasonal outbreaks in poultry every year. New Zealand has been monitoring the spread of HPAI globally for the past 20 years. Biosecurity New Zealand and partner agencies have surveillance programmes in place to detect the arrival of HPAI and other exotic diseases.

Mycoplasma bovis

Mycoplasma bovis (M. bovis) is a bacterial disease that creates an animal welfare and productivity issue. It can cause serious health conditions in cattle, including mastitis (udder infection), pneumonia, arthritis, and ill-thrift in calves. Less commonly, it can cause progressive neurological disease in calves, conjunctivitis, and reproductive losses. It is not considered a threat to human health and does not affect meat or milk safety, but its economic and emotional impact on farmers is significant. As of 2023, New Zealand had significantly reduced the prevalence.



Clinical signs of M. bovis. Source: MPI

Foot and mouth disease

New Zealand has never had a case of foot and mouth disease (FMD). A case in New Zealand would have serious effects on our farmers, rural communities, primary industries, and the economy.

Foot and mouth disease (FMD) is caused by a virus that only infects cloven-hooved animals. An animal is cloven-hooved if its foot is divided in two. In New Zealand this includes cows, pigs, sheep, goats, deer, alpaca and llama. The disease doesn't affect other animals, such as rodents, cats, dogs, birds, or horses. FMD is an animal health disease. Even though it has a similar name, it differs completely from the human condition, 'hand, foot and mouth disease'.

Vector causing diseases

Vectors are transmitters of disease-causing organisms from one animal or human to another, such as viruses, bacteria, parasites and worms.

Exotic mosquitoes

Mosquitoes are known as vectors of disease and can spread can spread mosquito-borne viruses (e.g. Dengue Fever, Chikungunya) and parasitic diseases (e.g. Malaria).

The eradication of the Southern saltmarsh mosquito (*Aedes camptorhynchus*) in 2010 has been the most important change to New Zealand's mosquito profile in recent years.

The last exotic mosquito species to establish in New Zealand was the Saltmarsh Culex (*Culex sitiens*), with larvae identified in the Kawau Parua Inlet, at the bottom of Kaipara Harbour (Auckland region) in 2018. This species was eradicated by the Ministry of Primary Industry (MPI) in 2020. This species was a vector of both Ross River and Japanese Encephalitis Virus.

Pests of public health significance are also known as medical vectors. They are a public health concern because of the role they play in the transmission of diseases. They can carry pathogens from one host to another (such as viruses, bacteria, protozoan parasites). There are numerous medical vectors of potential public health significance including mosquitoes, rats, fleas, lice, bed bugs, cockroaches, ticks, and mites. Border interceptions of unwanted exotic mosquitoes are being managed by public health units at international ports of entry in Auckland and Nelson.

What is plant disease?

Plant diseases are illnesses caused by pathogens such as fungi, bacteria, viruses, or pests that damage plants, reducing their productivity, quality, or survival. Plant diseases can:

- Spread through the air, water, soil, insects, or human activities.
- Impact crops, native plants, and ornamental plants.
- Lead to reduced yields, economic losses, or biosecurity threats if exotic diseases are introduced.

There are a number of diseases affecting New Zealand's native species.

Kauri dieback disease

Phytophthora agathidicida (PA) is a soil-borne pathogen that infects kauri trees through their roots. PA restricts the ability of kauri to transport water and nutrients between their roots and their leaves, causing the condition known as kauri dieback disease, which eventually starves and kills the tree.

Myrtle rust

Myrtle rust is a wind-borne fungal disease that can infect taonga species such as mānuka, pōhutukawa and rātā. The disease causes bright yellow-orange powdery pustules on young leaves, shoots, fruits and flowers of plants in the myrtle family. Myrtle rust cannot be eradicated from New Zealand.

Chronic wasting disease in non-NZ deer

Chronic wasting disease (CWD) is only currently found in members of the deer family in USA, Canada, South Korea and Norway. It's similar to livestock diseases such as BSE (mad cow disease) infecting cattle and scrapie infecting sheep. It could enter New Zealand on dirty hunting and camping equipment (as a contaminant of dirt, blood, and urine). New Zealand deer herds and trophy animals are mostly disease free; and there have not been any cases of CWD in New Zealand.

Toxoplasmosis

Toxoplasmosis is an infection caused by the Toxoplasma gondii parasite. The parasite is common and capable of infecting many animals, including humans. Toxoplasmosis is a confirmed cause of death in Hector's and Māui dolphins and is likely to be a significant human-caused threat to the dolphins' populations. This is especially the case for the critically endangered Māui dolphin.

Our story
Bay of Plenty context

The Bay of Plenty is a significant agricultural and horticultural region in New Zealand, known for its kiwifruit, forestry, dairy farming as well as the region's native flora and ecosystems. Plant and animal diseases pose challenges to these industries, threatening productivity, biodiversity, and economic stability.

2020 Mycoplasma bovis in the Bay of Plenty

In January 2020, a dairy farm in Waiotahi, near Ōpōtiki confirmed the first case of M. bovis. Ministry of Primary Industries (MPI) investigated after the disease was found from a bulk milk test. The farm was being depopulated (culled), followed by a 55-day "decontamination" period, where the property was completely disinfected.

Cow. Source: Bay of Plenty Regional Council

The disease management agency – Operational Solutions for Primary Industries (OSPRI) took over managing the day-to-day delivery of the Mycoplasma bovis (M. bovis) Eradication Programme in November 2023. This includes regular testing of milk and animals to detect any bovis infection; managing any active or newly-detected properties; depopulation and site cleaning of any affected properties; and farmer support.

2018 Rabbit calicivirus confirmed in Bay of Plenty

Rabbit calicivirus (Rabbit Haemorrhagic Disease Virus or RHDV) primarily targets wild and domestic rabbit populations. RHDV is highly contagious and typically fatal, causing symptoms such as lethargy, respiratory distress, and sudden death within a day or two of infection. It spreads through direct contact, contaminated surfaces, insects, or indirect exposure from infected rabbits. There are two major strains of the virus present in New Zealand—RHDV1 and the more recent RHDV2. While RHDV1 was introduced to control wild rabbit populations, RHDV2 was first detected in New Zealand in 2018.

Wild rabbit. Source: Bay of Plenty Regional Council

In June 2018, wild rabbits found on a farm near Rotorua have tested positive for RHDV2. Whilst this strain is positive for landowners in the reduction of the wild rabbit population, the virus can also spread to domestic rabbits. The best defence against RHDV2 is vaccination.

2010 Psa-V outbreak in the Kiwi Fruit Industry in the Bay of Plenty

Pseudomonas syringae pv. actinidiae (commonly referred to as Psa) is a bacterial pathogen that specifically infects kiwifruit vines (Actinidia spp.). It causes a plant disease known as bacterial canker, which can severely impact the health and productivity of kiwifruit orchards.

In November 2010 a highly virulent strain of Psa-V was discovered on an orchard near Te Puke. The kiwifruit industry had never had to deal with any form of serious disease or insect outbreak – unlike other primary sectors. Psa-V was (and still is) considered the most serious bacteria that could impact on the kiwifruit industry.

MPI and Zespri lead the initial response. Early tests for Psa-V could not distinguish between Psa-V and its much less virulent (and essentially harmless) cousin, Psa-LV, leading to confusion about how widespread the new, virulent bacteria was. The industry funded $25 million, which was matched by the Government to provide a $50 million fighting fund. Kiwifruit Vine Health (KVH) was established to take over leadership and co-ordination of the response.

Almost four years (from 2011-2014) since the initial discovery of the highly virulent strain of Psa-V near Te Puke, most kiwifruit growing parts of New Zealand have Psa-V. It is considered widespread around Te Puke. Psa-V has had a major impact on kiwifruit production and exports. The introduction of the G3 (gold) kiwifruit variety, which is more tolerant of Psa, has helped the industry recover.

***Pseudomonas syringae* pv. *actinidiae* (Psa) symptoms on kiwifruit (a) buds and flowers (b) leaf (c) trunk (exudate) (d) new shoot.**
Source: The Potential Global Climate Suitability of Kiwifruit Bacterial Canker Disease (Pseudomonas syringae pv. actinidiae (Psa)) Using Three Modelling Approaches: CLIMEX, Maxent and Multimodel Framework by Hossein A. Narouei-Khandan, Susan P. Worner Suvi L. H. Viljanen, Ariena H. C. van Bruggen, Giorgio M. Balestra, Eirian Jones
Photos credit: G.M. Balestra.

Hazard impacts

Plant and animal diseases can significantly impact New Zealand, particularly in regions like the Bay of Plenty in New Zealand, where agriculture and horticulture are integral to livelihoods and local economies.

Disease outbreaks can disrupt communities, particularly in rural areasand can lead to reduced demand for labour (supporting farmers and growers), processing, and export-related jobs impacting rural communities. Uncertainty from outbreaks can increase insurance premiums and limit financing options for affected farmers and growers. Stress and uncertainty caused by disease outbreaks can affect mental health in communities, with farmers and growers facing pressure to meet financial obligations; disease management; and compliance with biosecurity measures.

Animal disease impacts will include:

- **Economic losses** from disease outbreaks that can reduce productivity in farming, requiring costly treatments, culling, or movement restrictions. Diseases like Mycoplasma bovis (M. bovis) in dairy cattle reduce milk yields and reproductive efficiency, leading to lower productivity and revenue. Infected herds often require culling, which reduces herd sizes and disrupts farm operations. The eradication program for M. bovis alone has cost New Zealand hundreds of millions of dollars. Indirectly, there can be trade restrictions. Export markets may impose restrictions due to disease outbreaks, impacting trade revenue. The cost and logistics of implementing biosecurity protocols, testing, and vaccinations adds to the financial and operational burden for farmers and governments.
- **Public Health risks with zoonotic diseases (those transmissible to humans).** Diseases like brucellosis, leptospirosis, and campylobacteriosis, often associated with livestock, can directly infect humans. Diseases such as avian influenza, H1N1 (swine flu), and coronaviruses highlight the potential for animal diseases to become pandemics. Farmers, veterinarians, and workers in slaughterhouses or meat processing plants are at higher risk of exposure to animal diseases.
- **Biodiversity threats** through diseases in native species can endanger unique wildlife populations causing population decline/ and even extinction; ecosystem disruption; and the spread of disease through an introduced species (possums spread of bovine tuberculosis to native wildlife).
- **Community.** The loss of livestock, particularly in small or family-run farms, can be emotionally devastating for farmers. Outbreaks of diseases disrupt farming operations, requiring culling of herds, restricted cattle movements, and increased compliance costs can directly affects farmers' incomes and can contribute to financial hardship for rural families.

Plant disease impacts will include:

- **Economic losses** with reduced productivity and export potential for key crops like kiwifruit and avocados. New Zealand's horticultural products, including kiwifruit and avocados, are heavily reliant on international markets. Disease outbreaks can reduce exports, damage the country's reputation and result in long-term economic losses. The 2010 outbreak of Psa (*Pseudomonas syringae pv. actinidiae*) in kiwifruit vines cost the New Zealand economy an estimated $900 million. It caused widespread vine death and forced growers to shift to resistant varieties, increasing costs.

- **Forestry and agriculture** will be impacted with diseases like Phytophthora root rot in avocados which reduce crop yields and increase management costs, such as fungicides and improved drainage systems.
- **Biodiversity threats** including diseases like myrtle rust threaten native plant species, impacting ecosystems. Myrtle rust, a fungal disease threatening mānuka and other myrtle species, affects both native biodiversity and the honey industry (e.g., mānuka honey).
- **Community.** Disease outbreak can cause emotional strain for individuals and families. Growers faced immense financial pressure due to crop losses, replanting costs, and uncertainty about the future of their livelihoods. The sudden nature of the outbreak and its devastating effects created significant stress and anxiety. Many growers reported feelings of helplessness and despair as entire orchards were lost to a disease outbreak.

Hazard management – what to do and what this means for you

What to do if you think that you have found an exotic pest or disease?

- **Call 111 in an emergency.**
- For pests – photograph it and catch it, if it's safe
- Report a pest or disease: **Ministry of Primary Industries** – www.mpi.govt.nz
  - Freephone to the Ministry of Primary Industries exotic pest and disease hotline on 0800 80 99 66
  - Report online **report.mpi.govt.nz/pest**

To prepare

For regional information: What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from Bay of Plenty Civil Defence Emergency Management Group **www.bopcivildefence.govt.nz > Get Ready Page**

- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.
- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

GET READY

getready.govt.nz

Other information

- **Ministry of Primary Industries** – www.mpi.govt.nz
- **Biosecurity New Zealand** – www.mpi.govt.nz/biosecurity
  - Find-A-Pest App
  - Pest and disease threats to New Zealand
  - Animal disease threats to New Zealand
  - Foot and Mouth disease
  - Avian influenza: Dairy Cattle and other livestock
  - Bird flu and protecting your birds
  - Mycoplasma Bovis disease Eradication Programme
  - Climate change impacts on plant diseases
- **Department of Conservation** – www.doc.govt.nz > Diseases
- **Science Learning Hub** – www.sciencelearn.org.nz > Kiwifruit and Psa – A timeline
- **Kiwi Vine Health** – https://kvh.org.nz
  - Psa-V
  - Independent Sapere Review - lessons learned from the response to Psa-V
- **Biosecutiy New Zealand** – www.mpi.govt.nz/biosecurity > Pest and diseases
- **Kellogg Rural Leaders Programme Course** – https://ruralleaders.co.nz
  On-farm biosecurity planning
- **Health New Zealand Te Whatu Ora** – www.tewhatuora.govt.nz > Pests of Public Health Significance

Acknowledgements and references

We would like to acknowledge the Ministry for Primary Industries on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Ministry for Primary Industries – **www.mpi.govt.nz**
- Biosecurity New Zealand – **www.mpi.govt.nz/biosecurity**
- Kiwi Vine Health – **kvh.org.nz**
- Te Whatu Ora – **www.tewhatuora.govt.nz**
- Toi Te Ora Public Health Bay of Plenty – **toiteora.govt.nz**
- Department of Conservation | Te Papa Atawhai – **www.doc.govt.nz**
- Ministry for the Environment – **www.mfe.govt.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Section 4: Human-induced

In this section:

Marine oil spill

Major transport accident
Air, Road, Rail, Marine, Port

Contamination
Air, Land, Water, Food

Civil unrest / terrorism

Cyber attack

Tauranga Harbour Oil Spill 2017. Source: Emergency Management Bay of Plenty

Hazard:
Marine oil spill

What is meant by marine oil spill?

A marine oil spill is an actual or probable release, discharge, or escape of oil into the internal or marine waters of New Zealand. (Maritime Transport Act 1994)

Oil spills can and do happen at any time. By far the majority are small in scale and produce only limited and localised impacts. Occasionally, larger scale incidents can also occur and lead to larger regional or even national level responses and impacts. Different factors such as oil type, location of the spill and proximity to sensitive sites, the weather and sea conditions at the time of the spill as well as the response options that are available to responders to mitigate a spill, all have a great influence on the outcomes and impacts. Other factors also have a significant influence such as the priority of saving human life as well as the impact of cargo and other materials that may end up in the ocean as a consequence of a large incident.

There are many potential sources for an oil spill into the marine environment. They include terrestrial (land) and marine (water) based sources. From the land side, spills related to transport and industrial activities are two common examples. From the water side, marine shipping traffic, port operations and re-fueling activities are all potential sources for a larger oil spill. Offshore oil and gas extraction activities can also provide a source of oil spills.

Oil spills can pose risks to marine ecosystems, wildlife, coastal areas and local economies. Some oils have more toxic impacts on the marine environment than others. Light fuels such as petrol and diesel are particularly toxic and pose risks to human life due to risks of fire or explosion. They also pose a risk of inhalation where people or animals are exposed to harmful vapours. Fortunately these fuels do evaporate rapidly, and also dilute and disperse widely in the water. For these reasons they are termed non-persistent oils that naturally break down requiring little clean-up.

Cleaning up oil spill – Pilot Bay, Mount Maunganui.
Source: Bay of Plenty Regional Council

Thicker oils like lubrication oils, tars and bitumen, or some ships fuels can be less toxic but may persist for a longer time in the marine environment unless cleaned up. These oils also may contain trace amounts of heavy metals. Some oils have additives or contain heavy metals that may also change the impacts of a spill on the environment. The response to an oil spill incident is dependent on a number of factors including oil type, oil loading, behaviour of the oil, proximity to sensitive resources and energy exposure level. This information will help determine response options.

Marine oil spill in New Zealand

Marine oil spills are an environmental concern in New Zealand due to the country's extensive coastline, recognising there are a wide range of sensitive resources including economic, cultural and economic interests as well as active shipping routes, and reliance on maritime activities.

New Zealand's only crude oil installation is off the Taranaki coast. Oil spills can also be from any cargo or passenger ship that is undertaking a bunker transfer in New Zealand.

There have been significant incidents of marine oil spill in New Zealand including:

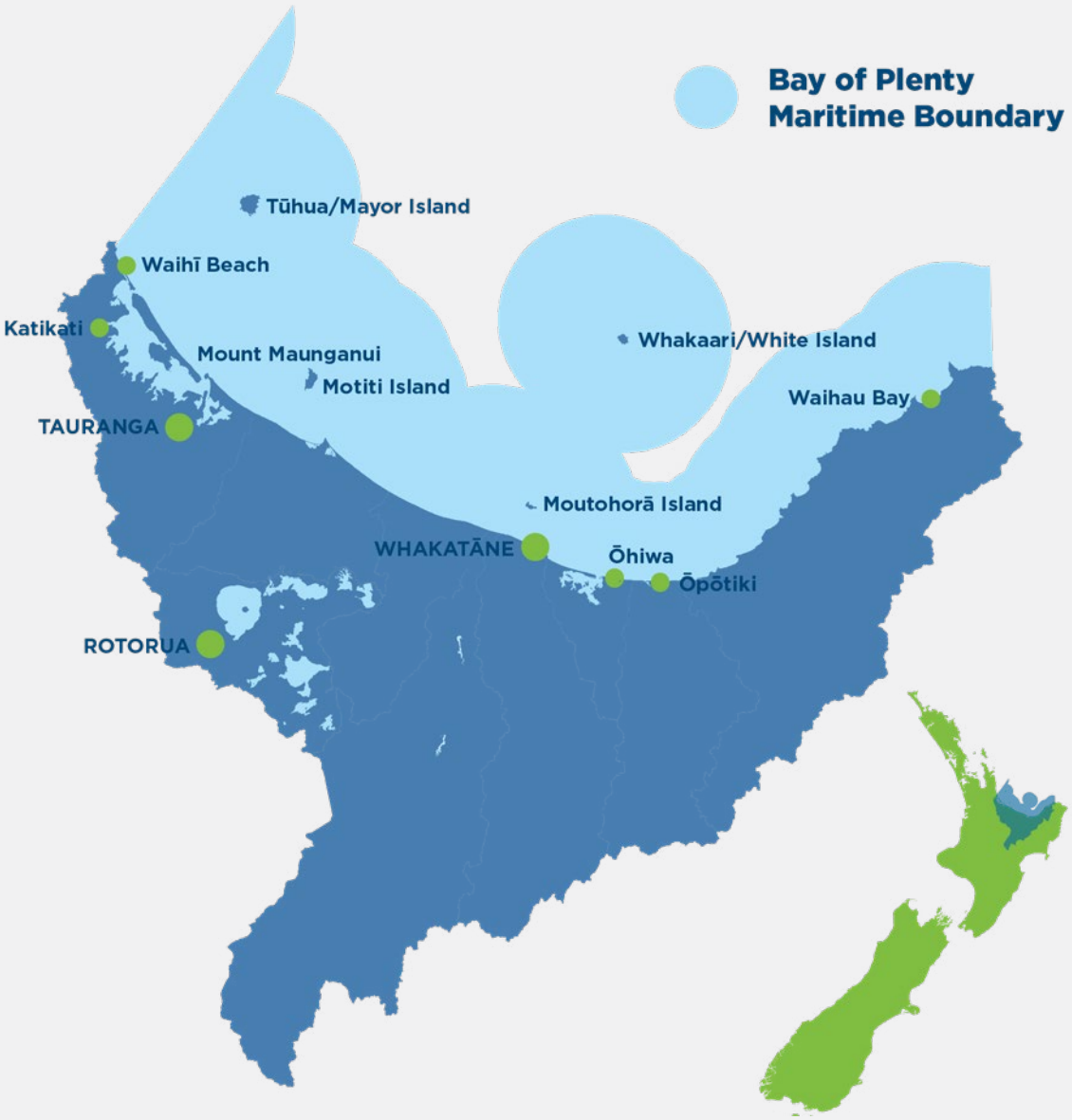
- **2002 Jody F Millennium** – This vessel ran aground in Gisborne after breaking free from her moorings. Poor conditions forced the ship to remain at sea and led to twenty-five tonnes of fuel oil spilling onto surrounding beaches.
- **2011 MV Rena** – The container ship MV Rena struck the Astrolabe Reef off the coast of Tauranga in the Bay of Plenty, resulting in one of New Zealand's largest environmental disasters.

Cleaning Pāpāmoa Beach after oil from the grounded vessel Rena reaches the shore. Source: Maritime NZ

Our story
Bay of Plenty context

Oil spills have occurred in the Bay of Plenty. Spills that have occurred in Tauranga Harbour, other harbours or the coastal areas of the region are generally very small, are of a non-persistent oil nature (petrol, diesels) and occur during pleasure/fishing boat refueling operations. However, there have been larger incidents from the oil spill in 2011 the container ship MV Rena. The MV Rena oil spill was a major event for the Bay of Plenty and other regions, but a small spill by international standards.

The Bay of Plenty Coastal Marine Area is defined as the marine area extending twelve nautical miles to seaward of the high water mark anywhere within the Bay of Plenty region. Broadly, the region is all that area of New Zealand from Potikirua Point in the east, to Orokawa Bay in the west.



2011 MV Rena Oil Spill

On 5th October 2011, the container ship MV Rena struck the Astrolabe Reef off the coast of Tauranga, resulting in one of New Zealand's largest environmental disasters. The 21-year-old 236-metre Liberian-flagged cargo vessel was en route from Napier to Tauranga and travelling at around 21 knots when it struck. Its bow section was wedged on the reef.

The tanker ship Awanuia and a Port of Auckland tug assist in operations to recover oil from the stranded ship Rena off Tauranga. Source: Maritime NZ

Rena was carrying 1,368 containers and 1,733 tonnes of heavy fuel oil (HFO) on board at the time of grounding. The salvors began removing the estimated 1,350 tonnes of oil in various tanks on Rena on 9 October but were hampered by bad weather, equipment breakdown and hazardous and changeable conditions. A storm overnight on 11 October resulted in the loss of an estimated 350 tonnes of oil which spilled into the ocean, affecting extensive areas of the Bay of Plenty's coastline. The oil spill contaminated beaches; impacted local marine life (especially seabirds); and required a significant cleanup effort led by Maritime New Zealand, with support from local volunteers, iwi and advisors from affected Māori communities; and international specialists and key local marine scientists from the Coastal Marine Field Station at the University of Waikato. Volunteers, including large numbers of locals, worked to clean oiled beaches. Wildlife experts from the National Oiled Wildlife Response Team treated oiled birds, including little blue penguins and pied shags, and pre-emptively caught 60 rare New Zealand dotterel to prevent them becoming oiled.

Treatment of a penguin to remove Rena fuel oil. Source: Maritime NZ.

Te Maunga Wildlife Response Centre - The penguin enclosures and swimming pools. Source: Maritime NZ

Container removal operations from Rena began once all of the oil had been removed, with the first container lifted off on 16 November 2011. By 26 December, a total of 341 containers had been removed. On 8 January 2012, Rena separated into two pieces and an estimated 200–300 of the approximately 830 remaining containers were lost overboard.

View of broken Rena in heavy sea swells.
Source: Maritime NZ

A volunteer scrapes oil off rocks.
Source: Maritime NZ

Clean up operations on Waihi Beach after containers, timber, milk powder and other debris washed up on shore from Rena. Source: Maritime NZ

2015 Pipeline Spill

In 2025 there was an oil spill in Tauranga Harbour which was a notable environmental incident involving the cleanup of approximately 60 tonnes of oil waste, which spilled into the harbour during fuel transfer operations on 27 April 2015. The cleanup lasted for four months; and the cleanup cost more than $1,000,000. The oil spill occurred due to a failure in the fuel transfer system of pipework under the wharf edge at a berth at the Port of Tauranga which was operated and maintained by Mobil Oil New Zealand. Following the incident, the Bay of Plenty Regional Council conducted an investigation and took legal action against the spiller for failing to prevent the spill. Experts found the pipe, which was located just above the high tide level, had corroded and the faults should have been picked up during routine inspections. Bay of Plenty Regional Council prosecuted Mobil Oil New Zealand under the Resource Management Act. Mobil was subsequently fined $288,000.

Oil slick at Tauranga Harbour.
Source: Bay of Plenty Regional Council

Damaged pipe after its removal.
Source: Bay of Plenty Regional Council

Hazard impacts

Marine oil spills can have impacts on the Bay of Plenty's environment, wildlife, economy, and communities. Due to the region's busy port and harbour ; and significant marine ecosystems, the Bay of Plenty can be vulnerable to oil spills. In the Bay of Plenty, marine shipping traffic, port operations and re-fueling activities are all potential sources for a larger oil spill. Offshore oil and gas extraction activities are not a source of oil spill for the Bay of Plenty.

The initial impact from an oil spill can vary widely, depending on factors such as the oil type and volumes of a spill, the behavior of the oil and sensitivity of the impacted resources. These impacts can vary from minimal to a large scale within a particular biological community. Spilled oil poses threats to both fresh water and marine environments, affecting surface resources and a wide range of subsurface species that are linked in complex food webs, and includes human food resources.

The actions of winds, waves, and currents (called weathering) causes spilled oil to evaporate or break down and become distributed throughout the water. Oil toxicity is reduced as the oil weathers. An oil spill that quickly reaches a shore will be more toxic to the shore life than if the slick has been weathering at sea for several days before stranding.

Environmental

Oil spills can smother marine plants, contaminate fish, and impact reef communities and other habitats. Oil in the water also reduces oxygen levels, impacting both small organisms and larger marine animals, which can suffer from toxicity and habitat loss.

The Bay of Plenty is known for its coastal ecosystems, which include mangroves,wetlands, rocky shores and beaches. Oil reaching the shore can penetrate into sand, coat rocks, or form a smothering layer. These impacts can result in lasting disruption of marine life and coastal communities, including habitats of birds and shore-dwelling creatures. Some coastal environments can take years to recover from oil contamination. Marine life, such as seabirds, invertebrates, fish,and marine mammals, is particularly vulnerable to oil exposure. This can lead to a number of impacts such as contamination of seafood. In addition, birds can suffer from hypothermia and poisoning when they come into contact with oil, while fish and marine mammals may absorb or ingest toxic compounds that disrupt their reproductive and respiratory systems.

Not all marine oil spills are able to be cleaned up. The coastline can be very hard to access for responding to a marine oil spill. Access and response activities can create unnecessary damage compared to leaving it to weather and letting the natural environment heal itself. Clean-up techniques can be very invasive, e.g. mangroves with soft mud, where it is possible to push the oil subsurface, trapping it where it is unable to weather naturally. Access by water can be difficult due to the water being too shallow or potentially too many obstacles.

Every oil spill is different, and a variety of response options are chosen to minimise the impacts of oil and optimise the recovery of the impacted resources

Economic

In a large event, oil spills can affect the region's fishing industry by contaminating seafood and disrupting marine populations. Fisheries may need to halt operations temporarily, leading to financial losses. Oil spills can also impact commercial activities such as the Port of Tauranga. The contamination risk can also make seafood unsafe, affecting consumer confidence in local products. The Bay of Plenty relies heavily on tourism, especially along its beaches and coastal attractions. An oil spill can result in temporary beach closures and reduced water quality, which deters tourists and impacts businesses reliant on the tourism sector. The visual impact of oil contamination also damages the region's natural beauty, further discouraging visitors.

Health

Oil spills can release harmful chemicals into the air and water, which can pose health risks to communities. Residents may experience respiratory issues, skin irritation, and other symptoms if they come into contact with oil or breathe in volatile organic compounds. Cleanup workers and volunteers are especially vulnerable to health risks without proper safety equipment.

Cultural

In the Bay of Plenty, the sea has significant cultural and spiritual importance. Oil spills can disrupt traditional fishing practices, harm species with cultural value and can impact sacred coastal sites. These impacts are not only ecological but also affect cultural heritage and connections to the land and sea.

Hazard management – what to do and what this means for you

What to do if you are in a marine oil spill incident

- **Consider Safety.**
  - Do not try to clean up an oil spill without protective equipment to protect your body from the oil. Oil vapors can be toxic.
  - If you can smell the oil, move up-wind and keep out of the way.
  - Keep oil and yourself well away from any ignition sources. Fire or explosions can be a high risk with some oils.
- Guidance from Bay of Plenty Regional Council – Any spills of oil or fuel from your boat should be dealt with immediately and cleaned up with special material. Oil contaminated waste must be disposed of at an oily waste licensed waste disposal facility.
- Report any oil or fuel spills or oiled wildlife to the Bay of Plenty Regional Council: **24 hour Pollution Hotline – 0800 884 883**. Any oil spill must legally be reported.
- **For oiled wildlife:**
  - Note location and situation of oiled wildlife.
  - Do not attempt to capture or treat oiled wildlife as wildlife can be stressed and potentially dangerous. Only specialist personnel and equipment can assist in capture, treatment and rehabilitation of oiled wildlife.

Other information

- **Maritime New Zealand** – www.maritimenz.govt.nz
  - Port and Harbour Marine Safety Code.
  - Marine Oil Spill Risk Assessment.
  - Emergency Response. New Zealand has a three-tiered approach to managing all aspects of marine oil spill preparation and response.

Maritime New Zealand – New Zealand Marine Spill Oil Spill Readiness and Response Strategy - 2022-2026

- **Bay of Plenty Regional Council** – www.boprc.govt.nz > Marine Oil Spill Contingency Plan.

Source: Bay of Plenty Regional Council

Acknowledgements and references

We would like to acknowledge Maritime New Zealand and the Bay of Plenty Regional Council on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Maritime New Zealand – **www.maritimenz.govt.nz**
- Independent Review of Maritime New Zealand's Response to the MV Rena Incident on 5 October 2011, March 2013
- Bay of Plenty Regional Council – **www.boprc.govt.nz** > Oil Spill Response
- National Emergency Management Agency New Zealand – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Major transport accident

Air, Road, Rail, Marine, Port

What is meant by a major transport accident?

A major transport accident refers to an event in which a vehicle, vessel, aircraft, or rail system is involved in a significant incident, often resulting in substantial damage, injuries, fatalities, or environmental impact. These accidents can occur across various modes of transport: air, road, rail, and marine/port.

Air transport accidents

These are accidents involving aircraft, including commercial planes, helicopters, or cargo flights. A major air accident may involve crashes during take-off, landing, or mid-flight, leading to severe damage, loss of life, and disruption. Examples include crashes caused by technical failures, human error, or severe weather conditions.

Road transport accidents

These are the most common form of major transport accidents and involve cars, trucks, buses, and other road vehicles. A major road accident could include collisions, pile-ups, rollovers, or other events that cause significant property damage, injuries, or fatalities. They are often impacted by weather conditions, driver behaviour and road infrastructure.

Rail transport accidents

Rail accidents involve trains and tracks. These can include derailments, collisions with other vehicles or objects, or accidents caused by track damage or natural disasters. Rail accidents can be catastrophic due to the speed and mass of trains, leading to multiple casualties and long-term disruptions.

Marine/Port transport accidents

Marine or port accidents involve vessels like cargo ships, cruise ships, or fishing boats. These incidents could include shipwrecks, collisions, or spills, leading to significant damage to ships, ports and the environment.

Our story
Bay of Plenty context

The Bay of Plenty's transportation infrastructure is prone to various types of major transport accidents. These incidents can cause significant damage to local communities, businesses, the environment and public safety.

Road accidents

The Bay of Plenty has a number of busy highways, including State Highway 2 and State Highway 29 including the Kaimai ranges, which are prone to accidents, particularly those involving trucks, heavy goods vehicles, and tourist buses. These accidents can lead to traffic delays, disruption to the flow of goods, and injuries or fatalities.

Maritime accidents

Tauranga Port is New Zealand's largest and busiest port, handling significant shipping traffic. Maritime accidents involving container ships, oil spills, or hazardous cargo pose serious environmental risks. One such example is the 2011 MV Rena disaster (See Marine Oil Spill Hazard Page).

Rail accidents

The Bay of Plenty also has active rail networks, which, while not as heavily utilised as roads or sea routes, are still a key part of the transport infrastructure. Major rail accidents, like derailments or collisions, can block transport routes, delay freight deliveries, and pose risks to nearby communities, especially if hazardous materials are involved.

Air transport accidents

Air crashes often result in loss of life or severe injuries. Major crashes can temporarily affect air services, especially in regions reliant on air travel for business and tourism. Flight delays and cancellations can disrupt supply chains and economic activities. Spills from aviation fuel can lead to pollution in crash areas.

1963 Kaimai air crash

On 3 July 1963, the Bay of Plenty experienced a significant air transport accident with National Airways Corporation (NAC) Flight 441 enroute from Auckland to Tauranga crashing into the Kaimai Ranges due to severe weather conditions. This disaster claimed the lives of all 23 people onboard, making it New Zealand's worst internal aviation disaster.

Wreckage of the NAC DC3. Source: New Zealand History

Wreckage of the NAC DC3 – Flight 441. Source: Stuff

2019 and 2024 – Rotorua bus crashes

On 4 September 2019, a serious bus crash near Rotorua resulted in multiple injuries and fatalities. 27 people were on the bus. The vehicle was operated as a tour bus and all of the passengers were Chinese nationals.

Bus crash near Rotorua. Source: NZ Herald

On 3 November 2024, a serious bus crash occurred near Rotorua, New Zealand, involving Tongan Recognised Seasonal Employer (RSE) workers. The bus, carrying 30 workers heading to Hawke's Bay to begin employment at Mr Apple (New Zealand's largest integrated grower, packer and exporter of apples). The accident resulted in 13 injuries. Ten of the injured individuals were airlifted to various hospitals.

Bus crash near Rotorua. Source: NZ Herald

2017 – Fatal crash at level crossing – Kawerau

In October 2017, there was a fatal collision involving an empty log train and a refuse collection truck at a level crossing near Kawerau. The truck driver died in the accident and the truck was significantly damaged. The Transport Accident Investigation Commission conducted an investigation into this incident. This incident brought attention to the safety of level crossings and l improvements in signage and infrastructure to prevent further accidents at such crossings.

The accident scene. Source: Whakatāne Beacon

2023 – Train derailment

On 29 January 2023, the Auckland Anniversary Severe Weather caused extensive damage across multiple regions, including Bay of Plenty, with notable impacts on transportation infrastructure. The extreme weather led to significant disruptions across road, rail and port networks.

Up to 10 wagons from a freight train derailed near Te Puke. Source: Bay of Plenty Times

Widespread flooding, landslides, and fallen trees severely impacted road connectivity, causing closures and making some areas inaccessible for extended periods. For the rail system, rail lines were damaged and obstructed by landslides, affecting train operations and disrupting supply chains.

Hazard impacts

In the Bay of Plenty, major transport accidents can have wide-ranging consequences, particularly in the sectors of logistics, public safety, and environmental protection. Local communities may face disruptions as well as environmental hazards such as oil spills or hazardous material leaks.

Environmental

Incidents like oil spills from ships or hazardous material leaks from trucks or trains can lead to severe environmental degradation, particularly for the region's coastline, rivers, and lakes. These events can impact local wildlife, agriculture and the fishing industry.

Economic

Major transport accidents can disrupt local businesses, particularly those reliant on the transport of goods. In example, the Port of Tauranga is a vital economic hub, and disruptions there can lead to delays in imports/exports, affecting both regional and national economies.

Public safety and health

Injuries or fatalities resulting from road, rail, or maritime accidents have significant impacts on families and communities.

The MV Rena losing containers as heavy swells wash across the deck on the starboard side on 12 October 2011.
Source: Maritime New Zealand

Hazard management – what to do and what this means for you

What to do – major transport accident?

- **Call 111 in an emergency.**

On the road

- If you have a mobile phone, use it to call a breakdown service.
- If your vehicle is creating a road safety risk, call *555 to alert Police.

Report a road incident (not emergency) call *555
or online: Community Roadwatch.

On the water in an emergency

- Wear your lifejacket.
- Activate your distress beacon.
- Switch radio to full power.
- Call 111 or Radio a MAYDAY (VHF: channel 16/ SSB: 2182kHZ, 4125kHZ, 6215kHZ or 8291kHZ)
- Notify Maritime NZ of an event, incident or situation: Notify Maritime NZ or 0508 22 55 22.
- Report an accident or incident in the Bay of Plenty: Harbourmaster - 0800 5 KNOTS (0800 55 66 87).

Aviation

Report an accident, freephone 0508 ACCIDENT (0508 222 433)
or online: Aviation Safety Concern.

To prepare

Traffic and road information

View active and proposed road closures, roadworks, and emergency road status information.

- New Zealand Transport Agency – **www.journeys.nzta.govt.nz** > Journey Planner
- AA – **www.aa.co.nz/roadwatch** Traffic Watch

Safety

- NZ Police – **www.police.govt.nz**
  - Personal Safety in your vehicle
  - Driving and Road Safety
- New Zealand Transport Agency – **www.nzta.govt.nz** > Driving Safely
- Maritime New Zealand – **www.maritimenz.govt.nz**
  - Boating Safety
  - Crossing the bar guidance
- Bay of Plenty Regional Council **www.boprc.govt.nz** > Boating in the Bay
- Civil Aviation Authority – **www.aviation.govt.nz**
  - Safety
  - Drones
  - Flying your Drone Safely
- Emergency Management Bay of Plenty: **www.bopcivildefence.govt.nz** > Get Ready

In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

Acknowledgements and references

We would like to acknowledge the New Zealand Police and all the Councils in the Bay of Plenty on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- NZ Police – **www.police.govt.nz**
- Maritime New Zealand – **www.maritimenz.govt.nz**
- Ministry of Transport – **www.transport.govt.nz**
- Civil Aviation Authority – **www.aviation.govt.nz**
- New Zealand Transport Agency – **www.nzta.govt.nz**
- Transport Accident Investigation Commission – **www.taic.org.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz**
- National Emergency Management Agency New Zealand – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Contamination

Air / Land / Water / Food

What is contamination?

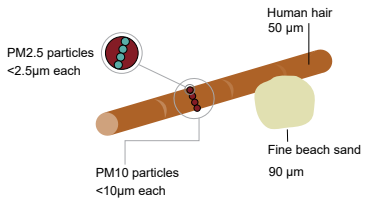
Contamination refers to the presence of harmful substances in the environment — such as chemicals, biological agents, or pollutants—that pose risks to human health, ecosystems, and property. Common contaminants include heavy metals, pesticides, hydrocarbons, and pathogens.

Air quality and contamination

Elevated levels of certain contaminants may be present in specific areas which could impact human health and the environment. Air pollutants can settle out of the air onto land and water bodies. From the land they can wash into and concentrate in waterways or be taken up by plants and animals.

On average a person inhales around 14,000 litres of air every day. When the air we breathe is of poor quality it can affect our health. Particulate matter (PM) is a collective term for solid and liquid particles suspended in the air that are small enough to be inhaled. PM varies greatly in structure and chemical composition depending on where it comes from. PM comes from human activities and natural sources. It is often classified according to its size because size determines how PM interacts with the environment and human body. These are classified as:

- PM10 – particles with a diameter of 10 micrometres or less
- PM2.5 – particles with a diameter of 2.5 micrometres or less
- TSP total suspended particulate



Relative size of particulate matter.

When we breathe in, the hairs in our nose and air passages generally remove particles larger than 10 micrometres in size. Particles smaller than 10 micrometres can penetrate the lungs and affect our health.

Air contamination in New Zealand is a significant environmental and public health concern, particularly in urban and industrial regions. Anthropogenic air pollution sources include vehicle emissions - Traffic congestion and heavy diesel vehicles are particularly problematic; dusty industrial activities and sites; and industrial discharges from factories, refineries, and ports; domestic heating (wood and coal), and agricultural activities (through the release of methane (CH_4) from livestock and ammonia (NH_4) from fertilisers).

Land and contamination

The land sustains every aspect of our lives, providing fundamental life-support systems and the foundation of our economy and society. Land ecosystems are central to the maintenance of fundamental life-support systems for the planet: the air we breathe, temperatures we can endure, water we can drink, soils that support the plants we use, and the creatures we co-exist with. Land is also the foundation of New Zealand's economic activity.

Land is considered to be contaminated when hazardous substances are at concentrations above their normal background concentrations and are likely to have a negative effect on human health and/or the environment. Land contamination in New Zealand arises from various sources, including industrial activity from manufacturing plants, oil refineries, and timber treatment facilities; agriculture particularly the use of fertilisers and pesticides; landfills and improper disposal of hazardous substances; and historic pollution from mining and forestry.

Fresh water environment and contamination

New Zealand's freshwater environment is an interconnected system and is affected by many pressures from human activities. Land-based activities in catchments have detrimental effects on freshwater through excess sediment, nutrient, and contaminant pollution, and these pressures have been amplified by the intensification and expansion of agriculture and urbanisation. Increases in greenhouse gas emissions are raising sea levels at our coasts and increasing the magnitude and frequency of extreme rainfall and drought, which puts further pressure on the freshwater environment.

Water contamination is a significant environmental issue in New Zealand, affecting both freshwater and coastal ecosystems. The primary sources of water contamination include agricultural runoff, particularly from intensive dairy farming; urban waste through stormwater runoff that picks up pollutants like oils, heavy metals, and chemicals; industrial discharge from mining, paper mills and chemical processing plants; and natural pollutants particularly where there is geothermal activity.

Food contamination

A food safety incident is a serious and uncontrolled foodborne risk to public health domestically or internationally that requires urgent action, as identified by a competent authority. Major food safety incidents have the potential to result in death or serious illness, or a widespread foodborne illness outbreak nation-wide or in an export market .

Food contamination can lead to foodborne illness outbreaks, ranging from mild gastrointestinal symptoms to severe, life-threatening conditions. Incidents of food contamination in New Zealand include:

- **2016 Havelock North Water Contamination:** Although primarily a water contamination event, this outbreak of Campylobacter affected thousands of residents in the Hawke's Bay region and highlighted the importance of water quality in food safety, as waterborne pathogens can enter food through improper washing or cooking.
- **2013 Milk Powder Contamination:** The botulism scare in New Zealand's dairy sector led to large-scale recalls of infant formula. While no cases of illness were reported, the event significantly impacted consumer confidence in food safety and led to stricter regulations in dairy processing.

Our story
Bay of Plenty context

Air quality in the Bay of Plenty is generally good, but the Mount Maunganui industrial area experiences issues with particulate matter and other contaminants. Rotorua city also experiences problems with particulate matter. Particle matter includes burner emissions. In Rotorua this occurs primarily over winter due to smoke from solid-fuel burners used for home heating. Air quality is an issue in the Mount Maunganui industrial area all year round but primarily over summer when the wind picks up.

Air monitoring. Source: Bay of Plenty Regional Council

Bay of Plenty Regional Council manages more than 1300 consents to take and use water from ground and surface water sources. Approximately 1.94 million cubic metres of water per day is allocated to these consents. Domestic demand is estimated to more than double from 2005-2055 and significant potential for increases in irrigated horticultural and agricultural land is predicted. A range of industrial plants, including pulp and paper and dairy, use water from the region's rivers, streams and groundwater aquifers. Water use is for irrigation of crops and pasture, stock watering and community water supply.

Contamination incidents in the Bay of Plenty have been largely associated with issues like agricultural runoff, wastewater treatment failures, and industrial discharge.

2021 Whakatāne Mill discharge

In 2021 the Whakatāne Mill discharged contaminants (namely plastic) over two periods (May and August-September) into the Whakatāne River. The Bay of Plenty Regional Council prosecuted the Mill leading to a conviction and a fine of $35,625.

Plastic retrieved from discharge in the Whakatāne River. Source: NZ Herald

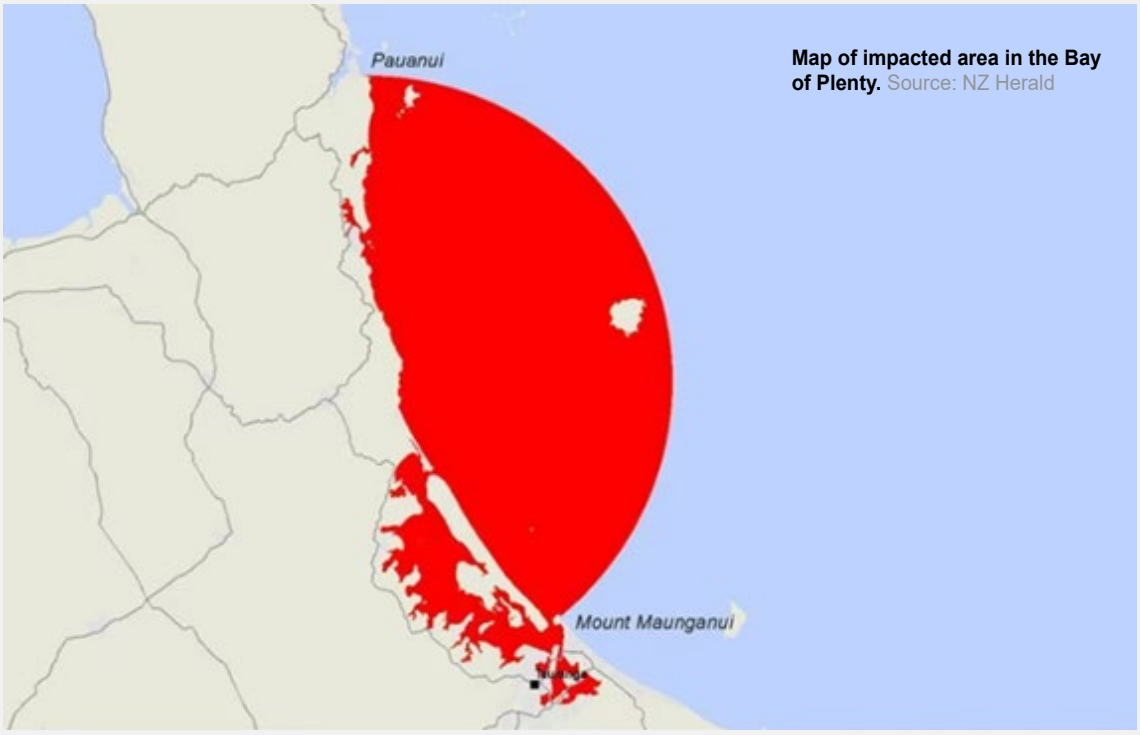
2022 Contaminated Waitahanui Stream

Sediment-laden water discharging from a hole in a sediment retention pond and flowing over land at a kiwifruit development property in 2022. Source: Newstalk ZB

Between 12 July and 02 August 2022, a significant contamination event occurred in the Bay of Plenty region involving sediment-laden water being discharged into the Waitahanui Stream due to earthworks at a kiwifruit orchard development in Ōtamarākau. The discharge, caused by a failure in a sediment retention pond, resulted in a high level of contamination in the stream, with serious ecological impacts on freshwater ecosystems. The Bay of Plenty Regional Council prosecuted the companies involved, as sediment runoff is a major environmental concern, particularly in the agricultural sector.

Shellfish biotoxin warning

In November 2024, New Zealand Food Safety (NZFS) advised the public not to collect or consume shellfish gathered from an area of the Bay of Plenty due to the presence of paralytic shellfish toxins. Routine tests on tuatua from Waihi Beach showed levels of paralytic shellfish toxins more than double the safe limit. Shellfish types impacted include mussels, oysters, tuatua, pipi, and others. Kina, paua, crab, and crayfish remain safe to eat if prepared correctly (removing guts for crustaceans). This contamination poses significant health risks if shellfish from the affected areas are consumed. A warning was put in place from Pauanui south to the Tauranga Harbour, by Mount Maunganui.



Map of impacted area in the Bay of Plenty. Source: NZ Herald

Hazard impacts

Air

Health: Air pollution, particularly from vehicle emissions, industrial activities (including smoke from industrial fires), and wood burning for home heating, can contribute to respiratory and cardiovascular diseases. Fine particulate matter (PM2.5) is a key concern, as it can penetrate deep into the lungs and bloodstream, causing issues like asthma, bronchitis, and other long-term health problems.

Industrial and Agricultural Emissions: The Bay of Plenty is home to significant agricultural and industrial activity, both of which can be sources of air contamination. Ammonia emissions from livestock farming, as well as emissions from the Port of Tauranga, contribute to localised air pollution. Additionally, emissions from processing plants and packhouses, such as those involved in the kiwifruit and timber industries; the production of asphalt, fertiliser and dusty industries, can affect the quality of air in surrounding communities.

Vehicle Emissions: The growing population and traffic congestion in Tauranga contribute to air quality issues, particularly during peak traffic hours. Nitrogen oxides (NOx) and carbon monoxide (CO) from vehicles are harmful to human health and the environment. These pollutants can cause respiratory issues.

Ecosystems: Rotorua's geothermal regions, where air quality can sometimes be impacted by sulphur emissions, there can be an effect on the environment.

Land

Across the Bay of Plenty thousands of sites have been identified as having the potential to be contaminated or have been contaminated from hazardous substances. Land contamination in the Bay of Plenty region can result from a variety of sources, leading to environmental degradation, public health concerns, and economic impacts.

Agricultural: Agricultural practices, including intensive dairy farming and horticulture, have led to significant land contamination in the Bay of Plenty. The use of fertilisers, pesticides, and herbicides can seep into the soil and water systems, contributing to nutrient pollution and soil degradation.

Industrial: The region has also experienced industrial contamination. One of the key sources is the Port of Tauranga and its surrounding industrial zones. Past activities, such as chemical storage or spillages, have left residues in the land. These contaminants can affect soil quality, harm local vegetation, and pose risks to human health.

Water

Water contamination in the Bay of Plenty has significant ecological, environmental, economic, and public health impacts.

Agricultural: Agricultural practices contribute significantly to water contamination. Nutrient runoff, including fertilizers and animal waste, has led to elevated levels of nitrogen and phosphorus in local rivers and lakes. This type of pollution can lead to eutrophication, which causes harmful algal blooms, depletes oxygen levels in water, and damages aquatic ecosystems.

Industrial: The region has experienced several industrial contamination events causing impact to the environment (List of incidents: Bay of Plenty Regional Council |Environmental Enforcement)

Sewage Overflows: Heavy rainfall events can overwhelm wastewater systems, resulting in sewage overflows that discharge untreated sewage into rivers and streams. This kind of contamination poses immediate health risks to local communities, as well as longer-term ecological damage.

Sediment: The 2024 incident of sediment-laden water being discharged into the Waitahanui Stream during earthworks at a kiwifruit orchard development in the Ōtamarākau area caused a spike in water turbidity, which affects aquatic habitats and disrupts ecosystems.

Food

Food contamination in the Bay of Plenty could occur due to a range of factors including agricultural runoff, industrial discharges, or mishandling of food products. Impacts on food contamination in this region are particularly significant due to the area's reliance on horticulture, aquaculture, and tourism.

Economic: Contaminated food incidents can disrupt the local agricultural economy, leading to losses for growers, suppliers, and exporters.

Health: Foodborne illnesses, such as those caused by bacteria (e.g., Salmonella or E. coli) or chemical contamination, can pose risks to public health. Contaminated seafood, often linked to algal blooms or pollution, can lead to severe food poisoning.

Environmental: Contamination from pesticides or fertilizers can affect soil and water quality, indirectly impacting food safety. Heavy rainfall or flooding events could increase these risks by spreading contaminants into agricultural zones and waterways.

Hazard management – what to do and what this means for you

What to do in a contamination incident

- **Call 111 in an emergency.**
- Report pollution incidents in the Bay of Plenty: Pollution Hotline 0800 884 883
- Make a food complaint to the Ministry for Primary Industries:
  - Foreign objects in food: 0800 00 83 33 or Online New Zealand Food Safety
  - Food sold past its use-by date: Report to your local Council (if the business is registered with that Council – See Public Register)

Make a food complaint:

Public register:

To prepare

- **Ministry of Primary Industries** – www.mpi.govt.nz
  - Food Safety at Home
  - Preparing and storing food safely at home
- **Bay of Plenty Regional Council** – www.boprc.govt.nz
  Request Land Use Register for information on contaminated land.
- **Emergency Management Bay of Plenty** – www.bopcivildefence.govt.nz > Get Ready

In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

Other information

- **Ministry of Primary Industries** – www.mpi.govt.nz > Food Safety and Food recall
- **Bay of Plenty Regional Council** – www.boprc.govt.nz
  - Water Ecology
  - Air Pollution
  - Air Quality
  - Air Monitoring
  - Mount Maunganui Industrial Air Quality
  - Rotorua Air Quality
  - Pollution
  - Environmental Enforcement
  - Air Quality
  - Contaminated Land

To help with identifying potentially contaminated land, the Ministry of the Environment has compiled a list of activities and industries commonly associated with contaminated land.
environment.govt.nz > Hazardous Activities and Industries List (HAIL).

Source: Bay of Plenty Regional Council

Acknowledgements and references

We would like to acknowledge the Ministry for Primary Industries and Te Whatu Ora | Public Health on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Bay of Plenty Regional Council – **www.boprc.govt.nz**
- Te Whatu Ora | Toi Te Ora Public Health Bay of Plenty – **toiteora.govt.nz**
- Ministry for the Environment – **environment.govt.nz**
  - Ministry of the Environment / Stats NZ: Our Freshwater 2023 Report, April 2023
  - Ministry for the Environment / Ministry of Health: Health and air pollution in New Zealand 2016, March 2022
- Land Air Water Aotearoa (LAWA) – **www.lawa.org.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Terrorism / Civil unrest

Terrorism

Terrorism is broadly defined as the unlawful use or threat of violence, often against civilians, to instil fear and achieve political, ideological, or religious objectives. Terrorism aims to influence governments, societies, or groups by creating a climate of fear and uncertainty.

Terrorism is a form of extremist behaviour. The scales of extremism are detailed as:

- **Extremism:** views on the fringe extreme ideologies can be based on faith, social or political beliefs that exist on the fringes of society, outside the more broadly accepted views and beliefs of most people. Extremists may seek to radically change the nature of government, religion or society, or to create a community based on their ideology.
- **Violent extremism:** the belief in violence Violent extremists take these ideologies further and justify using violence to achieve radical changes. Violent extremists often target the groups that they see as threatening their success or survival, or undermining their worldview. The two most high-profile forms of violent extremism are faith motivated (of any kind, but exemplified over the last decade by individuals associated with the Islamic State in Iraq and the Levant, ISIL) – and identity motivated, particularly adherents to a White Identity Extremism.
- **Terrorism:** Terrorism refers to acting on that belief in violence. Violent extremism would only become terrorism when a terrorist act is carried out. Under New Zealand law, a terrorist act is defined as an ideologically, politically, or religiously-motivated act that is intended to intimidate a population, or to coerce or force the government to do or not to do certain things. A terrorist act could include acts causing death or serious bodily injury, but isn't necessarily limited to this.

Terrorism in New Zealand

Violent extremist narratives in New Zealand are influenced by international trends and can be adapted to the New Zealand context. For example, the 2019 Christchurch terrorist attack, grievances associated with the COVID-19 pandemic, international political and social tensions and conflicts, and extremist content on the internet, have all influenced the New Zealand terrorism threat environment.

There have, however, been a number of incidents that might be seen as terrorist. Most involved the actions of individuals rather than organised groups, and lacked clear political motives. In some cases, the actions were clearly aimed at property rather than people.

New Zealand undertakes regular assessment of national security threats to New Zealand. Recent assessment concluded that:

- New Zealand's unique place and role in the Pacific can make us vulnerable to the activities of other states striving for influence and position throughout the region.
- A small number of foreign states conduct interference and espionage in and against New Zealand and New Zealanders. These states seek to disrupt the rights of New Zealanders, including their right to freedom of expression.
- There are consequences for New Zealand's national security from intentional or unintentional harm caused by people in positions of trust in public or private organisations. The harm could come through acts of espionage, unauthorised disclosure of information, the loss or degradation of a resource or capability, or in extreme cases acts of terrorism.
- The most likely terrorist attack scenario in New Zealand is a lone actor, acting with little to no intelligence forewarning.
- There are a small number of people who subscribe to a range of known violent extremist ideologies. Increasingly, we also see individuals whom we assess to support violence from a mixed, unstable, or unclear ideological outlook.

Civil unrest

Civil unrest is defined as significant and persistent unlawful mass disorder/activity arising from an event or mass act of civil disobedience (such as a riot) in which participants may become violent and hostile towards authority and/or their actions impact the functioning of key institutions and infrastructure.

Civil unrest today often focuses on climate action, indigenous rights, and responses to governmental policies and international circumstances.

Key features of civil unrest can be:

- **Peaceful Protests:** Demonstrations or marches advocating for change without violence.
- **Violent Riots:** Acts of aggression that may involve property damage, looting, or clashes with law enforcement.
- **Strikes or Work Stoppages:** Organised actions disrupting industries or essential services to pressure authorities.

New Zealand context

2019 – Christchurch mosque shootings

The terror attack on the Al Noor Mosque and the Linwood Islamic Centre in Christchurch on 15th March 2019 was unprecedented in New Zealand. 51 people died, many were injured, and Muslim communities were deeply impacted. The two consecutive mass shootings took place in Christchurch. They were committed by a single perpetrator during Friday prayer, first at the Al Noor Mosque in Riccarton and second at the Linwood Islamic Centre. The attacks were mainly motivated by white nationalism, anti-immigrant sentiment, and white supremacist beliefs.

Al Noor Mosque in Christchurch. Source: RNZ

Politicians and world leaders condemned it, and then-Prime Minister of New Zealand Jacinda Ardern described it as “one of New Zealand’s darkest days”. The government established a royal commission into its security agencies in the wake of the shootings, which were the deadliest in modern New Zealand history and the worst ever committed by an Australian national. The 2019 Christchurch mosque shootings, in which 51 people were killed, made it clear that New Zealand is not immune to terrorist attack.

The psychological impact

In relation to the Christchurch Mosque terrorist attacks the psychological impacts to people were from affected family/ whānau; survivors who suffered physical injuries as a result of the terrorist attack, including from trying to escape; and witnesses. Most survivors could not return to work immediately, and some had to change vocation because of their injuries. While many survivors reported that their employers were supportive, giving them ample time off to recover, some people lost their jobs because they could no longer perform their tasks. A few survivors lost their businesses. Many affected whānau, survivors and witnesses we spoke to have difficulty sleeping for reasons that include fears of the dreams they might have or of being vulnerable while they sleep.

Civil unrest

New Zealand has generally experienced low levels of civil unrest, with incidents often linked to protests and demonstrations over political, social, and environmental issues.

2022 – Parliament grounds occupation

The 2022 Parliament grounds occupation in Wellington was a significant event marked by protests primarily against COVID-19 vaccine mandates and other government pandemic policies. Protesters gathered outside the Parliament from 6th February until 2nd March 2022, inspired in part by global movements like Canada's "Freedom Convoy." The protest drew a mix of groups, including anti-mandate activists, conspiracy theorists, and various fringe organisations.

During the occupation, tensions escalated between protesters, the government, and law enforcement. The protest disrupted central Wellington, with blocked roads and an eventual escalation to clashes. On 2nd March police moved in to dismantle the encampment, leading to chaotic scenes as fires were set, and demonstrators resisted. The event concluded with over 100 arrests and significant cleanup efforts for the damage caused to Parliament grounds.

Protesters encamped at Wellington's parliament grounds in February 2022. Source: The Spinoff

A rioter throws a desk on to a fire by the parliamentary playground at the end of the parliament occupation, March 2, 2022. Source: The Spinoff

Hazard impacts

The impacts to terrorism drastically vary depending on the attack/ incident. Whilst New Zealand has been immune to the realities of global terrorism, New Zealanders see the impacts of terrorism most days through the TV's in their living rooms.

The impacts of civil unrest will be dependent on circumstances causing civil unrest activities; and the response to the unrest from government agencies and law enforcement.

Infrastructure

The most immediate and measurable impact of terrorism is physical destruction. Terrorists destroy existing buildings, machines, transportation systems, workers, and other economic resources. On smaller scales, acts of terrorism may blow up cafes, churches, or roads. Acts of civil unrest can cause damage to building and infrastructure; and cause disruption to transport services. Large-scale protests can result in clashes with law enforcement, temporary closures of public spaces, and strain on emergency services.

Human and Psychological

Casualties are what put the "terror" in terrorism. At the same time, very little has been done to assess the human consequences of terrorism beyond counts of the number of deaths and, perhaps, injuries. Terrorism is intended to provoke collective fear and uncertainty. This fear can spread rapidly and is not limited to those experiencing the event directly—others that are affected include family members of victims and survivors, and people who are exposed through broadcast images. Psychological suffering is usually more prevalent than the physical injuries from a terrorism event. Civil unrest can polarise communities, increase stress and anxiety, and challenge public confidence in the Government of the day.

Economic

The impact of terrorism and war is negative for the economy, and physical destruction is a large reason why. There are two obvious industries especially vulnerable to the effects of terrorism: insurance and tourism. Not all insurance policies pay out in the event of international terrorism or foreign wars, so the impact is likely less than first expected. Strikes and industrial actions can disrupt critical supply chains and economic activity for months.

Hazard management – what to do and what this means for you

How to know the signs of terrorism

All New Zealanders are responsible for helping to detect and prevent terrorist attacks. We also have a role in preventing and countering violent extremism. The people closest to vulnerable individuals tend to be whānau, friends and community members. These are the people who are most likely to identify concerning behaviours. Leaders in the broader community also have a role, from civil society organisations and groups online to iwi leaders, faith communities and interfaith groups. Everyone can have a positive, constructive role in preventing violent extremism and keeping New Zealanders safe.

Know the signs | Guidance for identifying signs of violent extremism provides an explanation of the kinds of behaviours or activities that are a concern; and what to do if you see the signs:

- **In an emergency, phone 111 immediately.** Also phone 111 immediately if the information is time-critical, such as if an attack is likely to happen very soon.
- If the information is not time critical, you can report suspicious behaviour in one of the following ways:
  - **Tell the New Zealand Security Intelligence Service** – Complete an online Public Contribution form confidentially on their website: www.nzsis.govt.nz
  - **Tell the Police** – you can either: Complete an online report at **105.police.govt.nz**, or call their non-emergency number 105.
  - **Tell Crimestoppers** – phone Crimestoppers anonymously on 0800 555 111, or submit an online report at www.crimestoppers-nz.org

Terrorism threat levels

Terrorism threat levels are a statement about the likelihood of a terrorist attack occurring. The New Zealand national terrorism threat level is set by the Director-General of Security on advice from the Combined Threat assessment Group (CTAG).

New Zealand's current national terrorism threat level and information about counterterrorism and wider national security can be sourced through the Department of the Prime Minister and Cabinet (DPMC) | Count-Terrorism.

What to do in the event of terrorist attack or incident

New Zealand is a safe country but we are still at risk from terrorist attacks or similar incidents from lone individuals or organised groups.

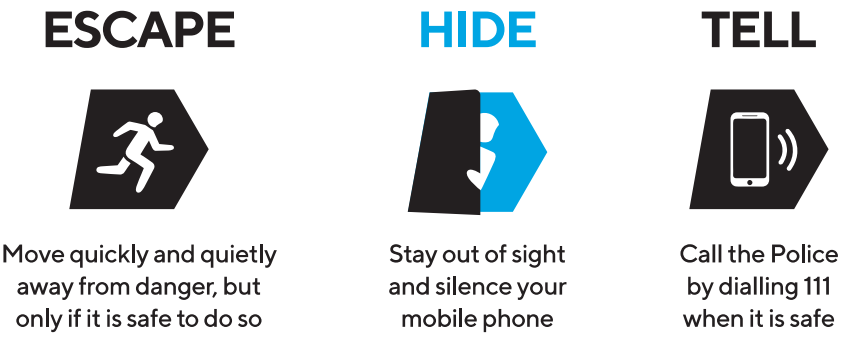
All situations are different. You will need to make quick decisions during an event and be prepared to change your plan if necessary.

- **New Zealand Police – Know what to do**
  - **ESCAPE** - Move quickly and quietly away from danger, but only if it is safe to do so.

    If you see a safe way out leave the area immediately. Move quickly and quietly away from danger if it is safe to do so. Take your mobile phone with you if you can, but do not go back to get it if it puts you in danger.
  - **HIDE** - Stay out of sight and silence your mobile phone.

    Secure your environment by locking doors and windows and barricading entries where possible. Stay away from doors and be as quiet and still as possible so you do not give away your hiding place.
  - **TELL** - Call 111 when it is safe.

    The more information you can give about your location, surroundings, the attackers and the events that have occurred, the better.



What to do in civil unrest?

- **Call 111 in an emergency when it is safe.**
- **Stay informed:** In many cases, large-scale demonstrations undergo planning days or weeks in advance. By keeping updated with the news, people can plan when to avoid certain areas or take extra precautions, especially if they think there may be a risk to their safety.
- **Making a plan:** In the event of an emergency, people may want to consider potential evacuation routes from their homes.
- **Staying alert:** Demonstrations may sometimes occur with little or no notice. In extreme cases, they may turn violent. If a person is suddenly surrounded by a crowd, they can minimize the risk of confrontation by keeping their head down and moving with the flow of people.

- **Sticking together:** If a person is with loved ones, they should hold hands or lock elbows. They should also pick up any children in their care, so there is no danger of them being trampled. If a person is alone, they can share their location with loved ones when it is safe.
- **Seeking an escape route:** While remaining calm and keeping a low profile, people can look for an opening to walk away from the crowd and avoid running.
- **Seeking shelter:** A person should look for a doorway, a side street, an alley, or a safe building in which to shelter. Ideally, people should find a safe, enclosed area, such as a building. They should stay away from windows and doors and try to find a sheltered room. Additionally, they should identify any exits if they need to leave in a hurry.
- **Leave the area:** When the crowd has passed, people should leave the area, moving in the opposite direction to the crowd. If they encounter police, they should try to keep their hands visible and empty.

Acknowledgements and references

We would like to acknowledge the New Zealand Police on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- New Zealand Police – **www.police.govt.nz**
- New Zealand Security Intelligence Service – **www.nzsis.govt.nz**
  - The New Zealand Security Threat Environment 2024
  - Know the signs | A guide for identifying signs of violent extremism
- New Zealand's first publicly released counterterrorism strategy - New Zealand Government | New Zealand's Countering Terrorism and Violent Extremism Strategy 2022
- Royal Commission of Inquiry into the Terrorist Attack on Christchurch Mosques on 15 March 2019 **christchurchattack.royalcommission.nz**
- United National Office for Disaster Risk Reduction | Civil Unrest – **www.undrr.org**
- National Highway Traffic Safety Administration Office of Emergency Medical Services (United States of America) Guidance | Civil Unrest Resources – **www.ems.gov**
- Risk Engineering Services | Riots and Civil Commotion Preparation Guide – **corporatesolutions.swissre.com**
- Te Ara – The Encyclopedia of New Zealand – **teara.govt.nz**
- National Emergency Management Agency New Zealand – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Cyber attack and cybercrime

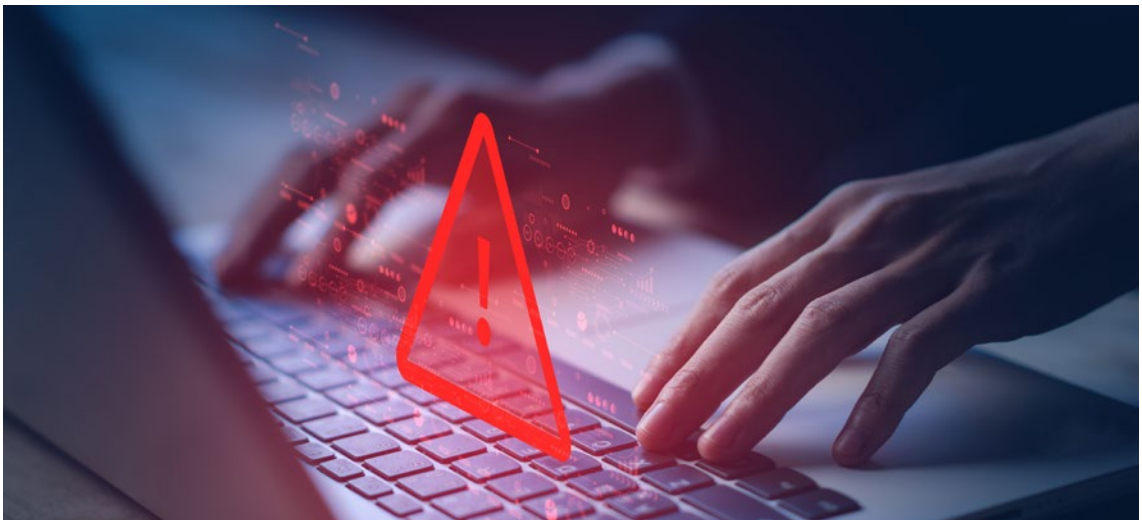
What is meant by a cyber attack?

A cyber attack is an attempt by hackers or malicious actors to damage, disrupt, or gain unauthorised access to computer systems, networks, or data. Cyber attacks can vary in form, including phishing scams, malware (such as viruses or ransomware), denial-of-service (DoS) attacks, and data breaches. These attacks can lead to significant impacts, such as compromised personal information, operational disruptions in essential services, and financial losses for individuals, businesses, and government agencies.

What is cybercrime?

Cybercrime, also known as technology enabled crime, electronic crime, e-crime or online crime, refers to criminal activity that involves the Internet, a computer, smartphone or other electronic devices.

Cybercrime covers a wide range of incidents, from pure cybercrime where computers are the target (for example computer intrusions), through to cyber-enabled crime where the technology is used to assist in committing a crime. Most crimes now have a technology component.



Warning alert, cyber security and cybercrime. Source: Adobe stock

Cyber attacks in New Zealand

The growing availability of effective malicious cyber tools, compromised credentials, and vulnerabilities in public-facing infrastructure has made it easier for malicious cyber actors to work at scale, and with the sophistication required to cause national-level harm. It is likely more politically or ideologically motivated groups and individuals have access to the cyber tools they require to cause real-world impacts, and they are further galvanised by domestic and global events. The effects of Russia's invasion of Ukraine in February 2022 continue to be felt in cyberspace, too. While the direct cyber threat to Aotearoa New Zealand has not changed as a result of the invasion, the number and frequency of destructive or disruptive malicious cyber incidents globally has likely increased.

New Zealand has faced significant cyber threats that highlight the vulnerabilities in both public and private sectors. Cybersecurity incidents, such as the 2021 ransomware attack on Waikato District Health Board, had far-reaching impacts, disrupting healthcare services, delaying treatments, and compromising patient data. The attack led to system outages, postponed surgeries, and revealed gaps in data protection within New Zealand's health infrastructure.

In 2022, a separate cyber incident affected sensitive coronial and health records nationwide, impacting data held by the Ministry of Justice and Te Whatu Ora, New Zealand's health authority. Access to 14,500 coronial files and about 4,000 postmortem reports from around the country have been affected. The attack included files from the Bay of Plenty and raised concerns about data security across multiple regions, leading to swift investigation and increased focus on digital infrastructure protection.

Our story
Bay of Plenty context

2022 Pinnacle Health

On 28 September 2022, malicious actors accessed a third-party IT server that Pinnacle Midlands Health Network (Pinnacle) uses. The attacker took health information ranging from approximately 2016 to 2022 and some of Pinnacle's corporate information. This incident affected the services of the Pinnacle group in the Waikato, Lakes, Taranaki and Tairāwhiti districts. It also includes Primary Health Care practices from across Taranaki, Rotorua, Taupō-Tūrangi, Thames-Coromandel, Waikato and the Bay of Plenty. The affected IT was immediately taken offline and contained.

Hazard impacts

Cyber attacks in New Zealand have had substantial impacts on government agencies, businesses, and individuals. These attacks have ranged from data breaches and financial fraud to ransomware incidents that disrupt essential services. The impacts include financial losses, operational interruptions, compromised personal data, and risks to national security.

National Security

Advanced persistent threats (APTs) targeting critical infrastructure and government networks pose risks to national security. The National Cyber Security Centre (NCSC) has reported cases of state-sponsored cyber attacks aiming to collect intelligence or disrupt essential services.

Economic

Cyber attacks have resulted in significant financial losses for New Zealand businesses, with small to medium enterprises (SMEs) often being the most vulnerable. In 2020 alone, cyber incidents led to over $16 million in direct financial losses, as reported by CERT NZ. Phishing and scams, in particular, are major contributors to these losses.

Operational disruption in public services

Cyber attacks on public services have led to major disruptions. For example, in 2021, the Waikato District Health Board suffered a ransomware attack that compromised patient data and disrupted healthcare services for several days, delaying surgeries and diagnostic services. This incident highlighted vulnerabilities within New Zealand's healthcare infrastructure.

Data breaches and privacy concerns

Personal and organisational data breaches have been increasing. These breaches expose sensitive information, leading to privacy violations, potential identity theft, and loss of public trust in affected organisations. For example, attacks on local councils have exposed residents' data, causing concerns over personal information security.

Social and psychological impacts

Cyber scams, phishing, and fraud can also have emotional impacts on victims, leading to stress, anxiety, and loss of confidence in digital transactions. Increased digital reliance during the COVID-19 pandemic has also highlighted the vulnerability of individuals who are new to online platforms.

Hazard management – what to do and what this means for you

What to do – cybercrime

- **Call 111 in an emergency.** Reporting cybercrime is just like reporting any other offence. For example, if you've received an electronic message with an immediate and believable threat such as "I'm coming around now and I'm going to kill you", that would be an emergency.
- For non-emergency incidents or crimes you can still report by phone using 105, online to 105 or in person.

- Report any online internet safety concerns and harmful digital communications issues to **Netsafe** – netsafe.org.nz
- Report any cyber security issues to **CERT NZ** – www.cert.govt.nz or by phoning 0800 CERT NZ
  (0800 2378 69) Only weekdays: Monday to Friday 7 am – 7pm.
- Report a cyber security incident of potential national significance through the **National Cyber Security Centre** – www.ncsc.govt.nz
  - Phone (04) 498 7654 for immediate support, or if the incident occurs outside business hours.
  - Email incidents@ncsc.govt.nz for non-urgent incidents.
- How to get help if you've been affected by an online scam of incident:
  Go to **CERT NZ Own Your Online**. www.ownyouronline.govt.nz
- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency. www.getready.govt.nz

To prepare

- **National Cyber Security Centre** – www.ncsc.govt.nz
  - Information Security Guidance
  - Cyber Resilience Guidance
- **NZ Police** – www.police.govt.nz > Internet Safety
- **Netsafe** – netsafe.org.nz > Social Media Safety
- **Emergency Management Bay of Plenty** – www.bopcivildefence.govt.nz > Get Ready

In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

Acknowledgements and references

We would like to acknowledge the New Zealand Police on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- NZ Police – **www.police.govt.nz**
  - Cybercrime.
- National Cyber Security Centre (a part of the Government Communications Security Bureau). **www.ncsc.govt.nz** – 2022-2023 Cyber Threat Report
- Netsafe – **netsafe.org.nz**
- CERT NZ – **www.cert.govt.nz**
- National Emergency Management Agency New Zealand – **www.getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Section 5: Fire and Hazardous Substances

In this section:

Hazard: Urban fire

What are urban fires?

Urban fires are fires that occur within cities, towns, or other populated areas and can impact homes, businesses, and infrastructure. They spread quickly in densely built environments and pose a risk to human life, property, and public services. Urban fires can also disrupt essential services like electricity, water supply, and transportation.

What are the major causes of urban fires?

Urban fires can be accidental (such as from cooking, electrical faults, or industrial incidents) or intentional (arson). Fires may also be the result of a natural cause such as earthquakes or lightning. The most common cause of fire in the home is cooking with 1 in 4 house fires starting in the kitchen.

Burnt house interior. Source: Adobe Stock

Our story
Bay of Plenty context

Residential fires occur regularly and can have severe consequences for communities, especially in densely populated areas. Industrial fires in Tauranga have underscored the need for fire safety in commercial and industrial zones. These incidents, though contained, have had implications for local businesses, infrastructure, and community health due to smoke and fire hazards.

The Mount Maunganui Industrial Zone, near the Port of Tauranga, faces significant fire risk concerns due to the nature of its industrial activities and storage of hazardous materials. The area includes facilities for chemical storage, fuel, and other flammable substances, which increase the risk of large fires that could impact both the environment and surrounding residential areas. Fire incidents in this zone could lead to severe consequences, such as toxic smoke emissions, explosions, and the spread of pollutants, endangering nearby communities and causing long-term environmental damage. All agencies in the Tauranga area including businesses, plan for the management of the fire risk in the Mount Maunganui Industrial Zone.

2022 Whakatāne Mill fire

A significant fire broke out at the Whakatāne Paper Mill in March 2022. The fire broke out at the Whakatāne Mill, a major paperboard manufacturing plant, known for producing paperboard used in various packaging materials. The fire caused extensive damage to the mill's machinery and production facilities. This fire prompted an emergency response from Fire and Emergency NZ, as well as local authorities, due to its potential impact on local air quality, nearby infrastructure, and community safety.

1881 Great Tauranga fire

One significant urban fire in the Bay of Plenty region's history occurred in 1881, known as the Great Tauranga Fire. This fire nearly destroying the entire northern end of the town of Tauranga at that time, burning down several significant buildings shops; the Tauranga Hotel (Menzie's) and the Bay of Plenty Times Office.

The Strand, Tauranga c. mid 1870s. Source: Te Ao Mārama - Tauranga City Libraries

Hazard impacts

Urban fires in the Bay of Plenty can have significant impacts on both community safety and infrastructure. The effects of these fires range from physical damage to health risks, economic consequences, and social disruptions.

Property and infrastructure

Urban fires, particularly in commercial and residential areas, can lead to severe structural damage. For example, fires in industrial zones like the Whakatāne Mill fire in 2022 caused extensive damage to buildings, equipment, and materials. Such fires can disrupt essential services, like electricity and water, affecting both homes and businesses in the vicinity. Damage to buildings, especially in densely populated areas, can result in displacement of residents or loss of business spaces, leading to temporary or permanent closures.

Health and safety

Urban fires release smoke and toxic fumes, posing respiratory health risks for nearby residents. People can be affected by poor air quality due to fires. Direct physical harm, including burns and injuries, can occur for individuals attempting to evacuate, as well as for the Emergency Services.

Economic

Businesses affected by urban fires, such as those in Tauranga and Whakatāne, face economic losses from damaged inventory, repair costs, and business interruptions. The Bay of Plenty, with its mix of industrial, commercial, and residential areas, is economically vulnerable to fire disruptions. The costs of rebuilding, lost income, and potential rise in insurance premiums can have long-term impacts on affected businesses and local economies.

Property damage and the need for rebuilding also affect insurance claims and premiums in the region, influencing costs for homeowners and business operators.

Community

Urban fires displace families, disrupt community services, and can strain emergency response resources. The emotional toll on residents, including trauma and loss of homes or personal belongings, has lasting social impacts. In smaller communities within Bay of Plenty, fires can be particularly disruptive, affecting schools, local businesses and healthcare facilities.

Environmental

Fires in urban areas can impact the environment through run off by contaminating nearby water sources and affecting air quality. The release of pollutants from burning structures and materials can harm local ecosystems, particularly if runoff reaches rivers or coastal areas.

Hazard management – what to do and what this means for you

Fire safety and prevention

From Fire and Emergency NZ – www.fireandemergency.nz

- Smoke Alarms.
- Know about the fire hazards in your home.
- Understand fire safety in your home.
- Fire safety home checklists. Is your home fire safe?
  Use our home fire safety checklists to quickly find anything that could put you at risk of fire.
- Guidance when cooking to prevent house fires.

From Bay of Plenty Regional Council – www.boprc.govt.nz

- Guidance on Indoor burning.
- Guidance on essential backyard burning.

In the event of a fire

- What to do if you see a fire: **When in doubt** **Call 111**
- What to do in a house fire: www.fireandemergency.nz > Home fire safety > In the event of a fire > What to do in a house fire

Always have an escape plan: Escape Plan. To build your escape plan, we will ask you to think about: Smoke alarms in your home, what are your best and alternative ways out, a safe place where everyone will meet.

- Follow instructions from official channels (Emergency Mobile Alert – EMA; official agency websites, media).

Other information

Air Pollution

- Bay of Plenty Regional Council – www.boprc.govt.nz > Air Pollution.

Wildfires

- Always check the local Fire Danger at **www.checkitsalright.nz**
- If the local fire Danger is High, Very High or Extreme, don't light.
- Wildfire readiness and prevention:
  - Protecting your property: www.checkitsalright.nz/reduce-your-risk/protecting-your-property
  - Low flammability plants: www.checkitsalright.nz/reduce-your-risk/low-flammability-plants
  - Pets and livestock: www.checkitsalright.nz/reduce-your-risk/pets-and-livestock

Acknowledgements and references

We would like to acknowledge Fire and Emergency NZ and Bay of Plenty Regional Council on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Fire and Emergency New Zealand – **www.fireandemergency.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz** > Air Pollution

Hazard: Wildfire

What is wildfire?

Wildfire is an unplanned, unwanted and uncontrolled fire which occurs within an area of combustible vegetation (can involve grass, forest and scrub). This is different from a planned fire or “controlled burn” that involves the use of fire to help with land management.

Wildfires are free-burning vegetation fires, often moving rapidly across the landscape causing destruction to life, property, and the environment. Although wildfires most commonly occur in rural areas, they also may originate from (in terms of cause) or spread into the urban environments.

Wildfire may be started maliciously, accidentally, or through natural means, which negatively influences social, economic, or environmental values. In New Zealand, most wildfires are started by people. Statistically, approx. 3% of wildfires cause 95% of the area burnt and 97% of wildfires are caused by people.

Firefighters work to put out the blaze on Matakana Island on 24 December, 2023.
Source: Fire and Emergency New Zealand

Climate change is increasing the risk of wildfires. Recent years have seen some of the warmest global temperatures on record, contributing to extreme fire behaviour not typically associated with New Zealand. Climate change will not by itself cause more wildfires, but it will increase the risk of wildfires starting and the way in which they behave. The future fires that happen in New Zealand could occur under more severe conditions, and as a result exhibit more extreme fire behaviour, including the propensity for larger fires and the increased frequency of fires. In addition, an increased duration of the fire season is likely, with fires occurring earlier and later than historical fire seasons.

There has been an increase in the frequency of significant wildfires in New Zealand over the last seven to eight years. Large wildfires like the 1999 Alexandra Fires, 2000 Boxing Day Fires in Blenheim, 2017 Port Hills Fires in Christchurch, 2019 Tasman Valley Fires near Nelson, 2020 Lake Ōhau Fire, and the 2021/2022 Waiharara Fire in Northland are occurring every 1-2 years, resulting in significant impact and losses. In addition, many of these significant wildfires are happening in the shoulder months rather than the typical summer period.

The main causes of wildfires are from: burn offs; rubbish fires; bonfires and fireworks; barbecues; electrical faults including faults from powerlines; and activities that produce sparks (welding, grinding, etc). In New Zealand, reported wildfire causes have been diverse with pile burns (pile burns are the burning of cut and stacked vegetation); and cigarettes, matches and candles highlighted as the causes of a higher percentage of wildfires.

Fire danger sign. Source: Bay of Plenty Regional Council

There are number of key factors contributing to the overall fire risk in New Zealand.

- **Climate** – includes drought and the obvious spectre of climate change, which in turn influences soil moisture deficiency, depletion of water storage, and the requirement for water restrictions. The frequency and duration of droughts will be a critical factor.
- **Weather** – includes the key components of temperature, relative humidity, wind and rainfall (or the lack of). Weather is the most powerful factor driving vegetation fire behaviour.
  - **Temperature** – Global average temperatures have increased by around 1 degree Celsius in the last century, likely caused by atmospheric greenhouse gases emitted from human activities. While this change may seem small, relatively small changes in our climate can have big effects on our environment. Climate models project we may experience more warm extremes in the future which can contribute to the fire risk.
  - **Rainfall** – The key fire risk with rainfall is the risk of an increasing drying trend overall.
  - **Relative Humidity** has a significant influence on the availability of fine fuels to ignite, as fine fuels are where most wildfires are initiated. Decreasing relative humidity is a significant risk for wildfire.
  - **High winds** – Extreme wind events can occur with frontal weather systems, around strong convective storms such as thunderstorms, and with ex-tropical cyclones and cyclones. Projections indicate climate change may alter the occurrence of extreme wind events, with the strength of extreme winds expected to increase across New Zealand.
- **Fuels** – categorised as forest, grassland and scrub, the condition and distribution of these is a key determinant of wildfire risk. These fuels are the ones that burn, with fires in grass and scrub the most common.
- **Topography/terrain** – The key factor of note is slope. Fires typically burn faster upslope, which increases the fire damage potential as well as make them more difficult to extinguish (until such time as the terrain changes or they run out of available fuel).

  Weather, Fuel and topography are the three primary components of the fire environment, where fire environment is: “The surrounding conditions, influences and modifying forces of topography, fuel and fire weather that determine fire behaviour”.

- **Climate** – El Niño Southern Oscillation (ENSO) is one of the recognised main climate drivers fro fire weather in New Zealand.

  El Niño Southern Oscillation (ENSO) - affects New Zealand’s weather through changes in air pressure, sea temperature, and wind direction. ENSO has three phases: neutral, El Niño, and La Niña. It influences rainfall, temperature, and wind patterns in New Zealand, and globally. In New Zealand an El Niño phase in summer typically brings increased westerly winds, more rain in the west, and dryness in the east. During a La Niña phase we may experience more north-easterly winds, wetter conditions in the north and east, and higher tides. We can also experience warmer than average air and sea temperatures. Wildfires can happen under any of these influences, although the areas at greatest risk varies.

  With warming global temperatures, especially sea-surface temperatures (SST), ENSO is becoming less relevant. There are also other climate drivers which are having an increasing influence on the NZ climate, such as the Indian Ocean Dipole (IOD), Southern Annular Mode (SAM), and Madden-Julian Oscillation (MJO).

Our story
Bay of Plenty context

The Bay of Plenty has a mix of forests, grasslands, and scrublands, which can provide ample fuel for fires. This vegetation, when combined with strong, dry winds that bring periods of elevated temperatures and lower relative humidity, along with sources of ignition, increases the wildfire risk.

In recent years there has been a decrease in the number of wildfires but an increase in area burnt in the Bay of Plenty. The Bay of Plenty, along with other regions in the North Island, has experienced very dry conditions throughout the wildfire season (approx. October-May), but noting that 2023 was very wet with a number of severe weather events (Auckland Anniversary Sever Weather and Tropical Cyclone Gabrielle). Conditions are drier east coast of the North Island which is due to New Zealand being in the westerly wind belt and having significant mountain barriers to the west.

While the number of wildfires and total area burnt in the Bay of Plenty has fluctuated over recent years, they have represented less than 10% of the total number of wildfires and <1% of the total area burnt nationally each year, with the total area burnt ranging between about 20-85 hectares for the period since July 2018.

There have been a number of notable wildfires in the Bay of Plenty:

- **Welcome Bay Fire, Tauranga** – January 1998 (70 ha of plantation).
- **Wairapukao** – December 1977 (432 ha).
- **Matakana** – December 2023 (52ha).
- **Western Bay** – November 2024 (350 ha).

An aerial view of the fire on Matakana Island. Source: Fire and Emergency New Zealand

2023 Matakana Island Forestry Fire

On 23 December 2023 a large forestry fire broke out on Matakana Island. This is not the first time that has happened with fires on the island – three years earlier in December 2020 there was also a large fire on the Island. On 13 December 2020, a fire was reported at 5 Hume Highway South, Matakana Island. The local Matakana Island Brigade deemed the fire too risky for a ground attack and requested helicopters for an aerial attack. This event took place over approximately 45 days over the Christmas and New Year period; and the fire burnt through 52 hectares.

The December 2023 fire burnt through more than 41 hectares of scrub and pine slash. In some areas the fire burnt underground in the roots of large trees. The response was a joint Fire and Emergency NZ- Forestry-landowners and the community response.

The challenge in the Matakana wildfire was Fire and Emergency being able to respond as it required deploying appliances and staff offshore to Matakana Island, along with the time of year creating logistical issues. Fire crews were very swift in tackling the blaze using boats regularly stopping off at the island to drop off firefighters. 18 brigades from across the Bay of Plenty, down to Lake Taupō and north to Paeroa, worked to bring the fire under control.

Once containment was achieved, fire crew strengthened control lines to make sure that there were no further break outs and there were no hidden hazards including unstable trees or ash pits.

The fire did not appear to pose a danger to settlements on the Island as the fire was closer to the side of the island facing the Pacific Ocean, whereas most residents live on the other side of the Island. Wildfire impacts are not just associated with communities in the immediate vicinity of the fire ground. Although there were no impacts to Matakana community, the fire was visible from the Tauranga mainland and its smoke could be smelled from as far as the Lakes, and rural Welcome Bay. Residents in Tauranga reported the impacts of the smoke and ash with people not being able to hang the washing on the line or had to shut all the windows. There were also some reports of respiratory conditions being impacted by the smoke.

Rural Firefighters Ryan Pryde and Juliska Coetzee from the Eastern Bay Volunteer Fire Brigade at work on Matakana Island. Source: Fire and Emergency New Zealand

Hazard impacts

Fire danger in many parts of New Zealand is expected to increase due to higher temperatures, stronger winds, and lower rainfall and humidity associated with climate change. On average, there are 3,000 to 4,000 wildfires in New Zealand each year Wildfires can lead to the loss of important cultural and biodiversity habitats, economic losses, issues with health and loss of life and property. The wildfire impacts can be direct, such as the destruction of homes, infrastructure and the environment, or indirect, such as health effects from smoke exposure.

Health

Health impacts affect both firefighters and the public. Direct impacts of fire include burns, smoke inhalation, heat exhaustion, and even death. Smoke from wildfires contains fine particles and toxic substances that can harm respiratory health, especially for firefighters and vulnerable groups like the elderly, young children, and those with pre-existing conditions such as asthma. Prolonged exposure can lead to respiratory distress, eye irritation, and cardiovascular issues.

The threat of wildfires, and the experience of evacuations or property loss, can lead to long-term mental health impacts, including anxiety, depression, and post-traumatic stress.

Property and infrastructure damage

Each year, wildfires affect thousands of hectares of land, resulting in considerable damage to infrastructure and public property. Wildfires can cause widespread damage to homes, outbuildings, power lines, and railway lines. In heavily impacted areas, infrastructure damage can lead to prolonged disruptions in electricity, water supply, and access, which makes recovery efforts challenging for affected residents.

Economic and the environment

The economic impact of wildfires in New Zealand is significant. In the Bay of Plenty there could be considerable impacts with commercial and private forestry losses (plantation), with flow-on effects to export markets and impacts to investors/shareholders/owners. The total cost often extends beyond the financial impact to include damage to rural and conservation land, future suppression efforts, insurance claims, potential loss of life, and ecosystem values and services, which are not easily captured or quantifiable.

Wildfires can destroy natural habitats, including native bushlands and reserves, with potentially significant impacts on biodiversity values. For Māori/iwi communities, fires that affect culturally significant sites or native species can lead to a profound sense of loss. In some areas, wildfires threaten taonga (treasured) species and landscapes.

Community

Wildfires in New Zealand can have a range of significant impacts on communities, particularly in regions with extensive vegetation, rural settlements and urban-uninhabited interfaces.

Wildfires present significant risks to communities. As temperatures rise, populations increase and development expands, it is expected that costs will increase further highlighting the urgency for people to be equipped with the knowledge and skills necessary to proactively mitigate and manage fire risks.

Hazard management – what to do and what this means for you

In the event of a fire:

- What to do if you see a fire: **When in doubt** **Call 111**

Always have an escape plan: Escape Plan. To build your escape plan, we will ask you to think about: Smoke alarms in your home, what are your best and alternative ways out, a safe place where everyone will meet.

- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

GET READY

getready.govt.nz

For regional information: What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from: Bay of Plenty Civil Defence Emergency Management Group www.bopcivildefence.govt.nz > get ready

Wildfire readiness and prevention

- **FireWeather – NIWA** – fireweather.niwa.co.nz
- **Reduce your risk** – How to prevent wildfires: www.checkitsalright.nz/reduce-your-risk
- **Protect your home:** www.fireandemergency.nz/outdoor-and-rural-fire-safety/protect-your-home-from-outdoor-fires/
- **Before you light, always check the Fire Season status** and the local Fire Danger at www.checkitsalright.nz
  - If the Fire Season is Restricted, you will need a permit for most fire types.
  - If the Fire Season is Prohibited, there is a total fire ban in place.
  - Also remember to check the local council rules, there are often total fire bans on beach areas.
  - Department of Conservation has year-round restrictions on the use of open fires.
  - Check local fire danger, along with current and forecast conditions.
  - If the local Fire Danger is High, Very High or Extreme, don't light.
  - Know the conditions before you consider operating machinery that may cause a spark of heating (i.e. chainsaw, cutting grass, welding or grinding).

- Understanding the Fire Weather Index System

Fire Weather Index System. Source: Fire and Emergency New Zealand

- **Wildfire readiness and prevention** – www.checkitsalright.nz
  - Protecting your property
  - Low flammability plants
  - Pets and livestock
- **Fire and Emergency Guides and Tools** – www.fireandemergency.nz
  - Wildfire Safer Housing Guide
  - Fire as a Land Management Tool

Acknowledgements and references

We would like to acknowledge Fire and Emergency New Zealand on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Fire and Emergency New Zealand – **www.fireandemergency.nz**
- National Emergency Management Agency New Zealand Get Ready – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Hazard: Hazardous substances

What is a hazardous substance?

A hazardous substance is defined as any substance that is one or more of the following:

- explosive.
- flammable.
- capable of oxidising.
- corrosive.
- toxic.
- ecotoxic.

It also includes substances that when combined, create another substance with one or more of the above properties on contact with air or water. A hazardous substance may also include any infectious or radioactive substance that may harm human, animal, or plant health.

Hazardous substances in New Zealand

About 150,000 workplaces throughout New Zealand use hazardous substances. These workplaces can be located in close proximity to communities. Chemicals, pollutants, heavy metals, and industrial byproducts, can present from workplaces storing and using hazardous substances.

In New Zealand, hazardous substances are regulated due to the risks they pose to health, safety, and the environment. Hazardous substances include chemicals that are flammable, toxic, corrosive, or explosive, and they are commonly found across industries such as manufacturing, agriculture, construction, and transport. Between 600 and 900 New Zealanders are estimated to die from work-related illness every year, many from exposure to hazardous substances. Exposure to different hazardous substances affects people in different ways.

Our story
Bay of Plenty context

Mount Maunganui Industrial Zone.
Source: Bay of Plenty Regional Council

In the Bay of Plenty, hazardous substances are found in various industries, such as manufacturing, agriculture, and transport. Industrial zones, like Mount Maunganui, have heightened risks due to their storage and handling of fuels, chemicals, and other potentially dangerous materials.

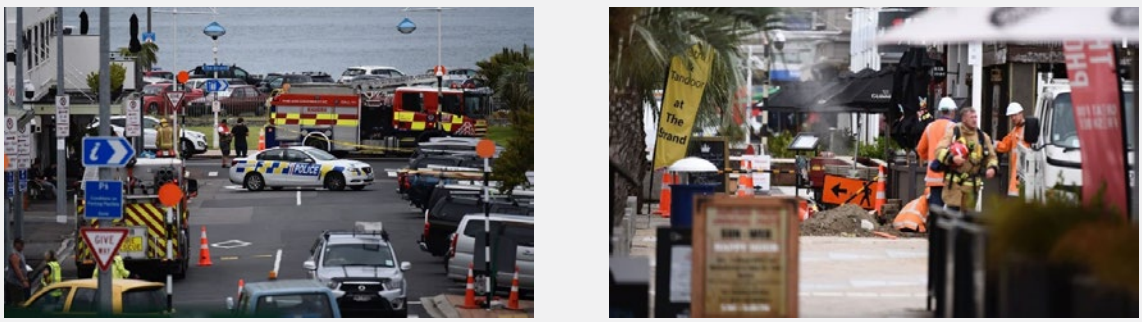
The Mount Maunganui Industrial Zone, near the Port of Tauranga, faces significant fire risk concerns due to the nature of its industrial activities and storage of hazardous materials. The area includes facilities for chemical storage, fuel, and other flammable substances, which increase the risk of large fires that could impact both the environment and surrounding residential areas. (See: Urban Fire). The area is home to a significant population base, including communities in the surrounding suburbs of Arataki, Omanu and Pāpāmoa, contributing to the overall population density of Tauranga, which exceeds 150,000 people.

2018 – Sulfuric acid spill Mount Maunganui Industrial Zone

In 2019, a sulfuric acid spill at the Mount Maunganui Industrial Zone, led to the release of hazardous materials, which required a quick containment and cleanup effort. The incident involved the spill of approximately 600 litres of sulfuric acid, which is highly corrosive and dangerous to both human health and the environment.

2019 – Methane gas leak in Tauranga

In January 2019, there was a methane gas leak in ‘The Strand’ in Tauranga’s CBD causing a shut down of part of central Tauranga causing businesses to evacuate, trains were unable to move through the area, and a nearby street became gridlocked with traffic. Methane, a highly flammable gas, posed a hazard to nearby properties and required evacuation and containment measures.



Fire and Emergency NZ and the Police cordoned off The Strand. Source: Bay of Plenty Times

Hazard impacts

Hazardous substances can have significant impacts on the Bay of Plenty region due to the area's industrial, agricultural, and commercial activities. The release of toxic chemicals, fuels, or industrial by-products can pose risks to both the environment and human health, affecting water quality, air quality, soil health, and ecosystems.

Air quality and health

Exposure to hazardous substances can have a range of adverse health impacts, depending on the type, concentration, and duration of exposure, as well as an individual's susceptibility. In industrial areas like Mount Maunganui, the use and storage of hazardous chemicals for petrochemical processing, port activities, and manufacturing have raised air quality concerns. Substances released during fires or accidental spills can lead to respiratory issues, irritate the eyes and skin, and worsen conditions like asthma. Persistent exposure to certain airborne pollutants can also have long-term health impacts, especially for populations in residential near industrial zones. Health effects are wide ranging can include personality changes, sleep disorders, memory loss, cancer, fertility problems and even death.

Water contamination

Hazardous substances from industrial runoff, agricultural pesticides, and waste disposal can seep into rivers and streams, potentially impacting water quality and harming aquatic life. In the event of a spill, pollutants can quickly spread through waterways, affecting fish, birds, and ecosystems and posing risks to human health if water sources are contaminated.

Agricultural

Chemicals such as pesticides and fertilizers used in agriculture, when over-applied or improperly managed, can accumulate in soils, leading to reduced soil health and potential crop contamination. The long-term impact on soil quality could reduce agricultural productivity and harm food safety.

Fire and explosion

Industrial areas handling large amounts of hazardous substances, such as petrochemical storage in Mount Maunganui, carry a heightened risk of fires and explosions, which can release toxic smoke and hazardous by-products into the air. The Whakatāne Mill fire in 2022 highlighted these risks, as it led to temporary environmental contamination and health concerns in the area.

Environmental

Spills or leaks of hazardous substances can disrupt local ecosystems, harming plants, animals, and marine life. Contaminants can affect fish and shellfish populations, which are important for both the environment and the local economy, as the Bay of Plenty has significant fisheries and aquaculture.

Hazard management – what to do and what this means for you

What to do if you are affected by hazardous substances?

- **When in doubt** **Call 111**
- What to do if you're affected? **fireandemergency.nz** > Hazardous Substances.
  In all situations where people have become affected by hazardous substances, seek medical advice immediately, **Call 111**.

Every year, dozens of New Zealanders are affected by exposure to hazardous substances. It's important you know what to do if someone is exposed to a hazardous substance, so you can act quickly and minimise harm.

- If someone has swallowed a hazardous substance: **Contact the National Poisons Centre for advice on 0800 Poison (0800 764 766).**
- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.
- Report an odour issue to Bay of Plenty Regional Council – www.boprc.govt.nz

To prepare

- In an emergency, make a plan to work out what you need to get through including water and food; and what you would take if you needed to evacuate. www.getready.govt.nz
- Emergency Management Bay of Plenty: Get Ready. www.bopcivildefence.govt.nz > get-ready

Other information

- **Fire and Emergency NZ** – www.fireandemergency.nz
  - Emergency response planning for organisations dealing with hazardous substances.
  - Hazardous Substances on farms
  - Fire and Emergency New Zealand's approach to dealing with hazardous substances Factsheet.
- **WorkSafe New Zealand** – www.worksafe.govt.nz
  - Hazardous Substances. Information about managing your hazardous substances safely, key regulations and how to become a certified handler.
  - Hazardous Substances Toolbox.
- **Bay of Plenty Regional Council** – www.boprc.govt.nz > Mount Maunganui Industrial Air Quality Network Newsletters.
- **Toi Te Ora Public Health** – toiteora.govt.nz Health Risk Assessment on the impacts of air pollution in Mount Maunganui.

Acknowledgements and references

We would like to acknowledge Fire and Emergency NZ and Bay of Plenty Regional Council on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Fire and Emergency New Zealand – **www.fireandemergency.nz**
- Worksafe New Zealand – **www.worksafe.govt.nz**
- Bay of Plenty Regional Council – **www.boprc.govt.nz** > Air Pollution.
- National Emergency Management Agency New Zealand – Get Ready – **www.getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

Section 6: Critical Infrastructure

In this section:

Critical infrastructure failure

Energy, Communications, Transport, Water

Dam failure

Road wash out. Source: Bay of Plenty Regional Council

Hazard: Critical infrastructure failure

Energy, Communications, Transport, Water

What is critical infrastructure?

Critical infrastructure provides a range of services that are essential to the functioning of our society (also known as lifeline utilities). There are a wide variety of entities across New Zealand that provide essential services, including the following sectors: energy, telecommunications, water services (for fresh, waste and storm water), food and grocery, financial services, digital services, transport and health. These kinds of entities, and the assets, systems, and networks that make them up are what we refer to as ‘critical infrastructure’.

Critical infrastructure can take many forms, including (but not limited to).
Sourced and adapted from: New Zealand Government

What is infrastructure failure?

Critical infrastructure failure considers the significant loss of nationally significant services due to the disruption or loss of infrastructure, across four core sectors, including water, energy, transport, and information and communications technology infrastructure sectors.

Such failures can result from natural disasters (e.g., earthquakes, storms), aging infrastructure, human error, or cyberattacks.

Critical infrastructure and infrastructure failure in New Zealand

Critical national infrastructure assets are often ‘pinch points’ in the supply chain which, if they failed, would cause a significant loss of service with major consequences. New Zealand’s geography nature and low population density makes the development of fully redundant (duplicated) networks challenging. This results in single points of failure in many networks, such as the Marsden-Wiri fuel pipeline, Maui gas line, single water supply sources to large urban populations (e.g., Hamilton, Invercargill), electricity transmission lines to areas such as Northland and Hawke’s Bay and many others.

Significant events causing critical infrastructure failure in New Zealand include:

- **2011 Christchurch Earthquakes:** Caused significant critical infrastructure failures including damage to 80% of the city’s water and sewerage networks; 75% of Christchurch lost power immediately after the quake; roads and bridges across the city were damaged by liquefaction, subsidence, and surface cracking; and telecommunication networks were disrupted due to power outages and physical damage to infrastructure.
- **2016 Kaikōura Earthquake:** Extensive damage to road and rail infrastructure, particularly State Highway 1 and the Main North Line railway.
- **2021 Westport Floods:** Widespread damage to water supply systems and roads on the West Coast.
- **2023 Auckland Anniversary Severe Weather:** Severe weather caused extensive road closures, landslips and flooding across Auckland and surrounding regions.
- **2023 Cyclone Gabrielle:** Caused extensive damage to critical infrastructure across New Zealand including damage to the roading network (State Highway and local roads); Wastewater treatment plants in regions such as Northland and Hawke’s Bay were overwhelmed causing system overflows; extensive power outages; and damage to telecommunications infrastructure.

Tropical Cyclone Gabrielle, Tairāwhiti Gisborne. Source: Local resident

Our story
Bay of Plenty context

Infrastructure failures in the Bay of Plenty region can significantly impact communities, businesses, and the environment. These incidents often involve disruptions to essential systems such as transportation, electricity, water supply, and telecommunications. Such failures may arise due to aging infrastructure, natural disasters, or unforeseen technical issues. Between 15% and 20% of all Lifeline Utility point assets (site, poles, cabinets, etc) are projected to be exposed to one or more of coastal erosion, coastal flooding and fluvial flooding by 2130. This equates to over 70,000 point assets, with over 43,000 of those within the water sector.

1987 – Edgecumbe earthquake

The 1987 Edgecumbe earthquake was a significant seismic event causing substantial damage to critical infrastructure in the Bay of Plenty region. Power lines and substations suffered extensive damage, leading to widespread power outages. Water mains were ruptured, disrupting the supply to homes and businesses; and in some areas, wastewater systems were compromised. Roads and bridges were severely impacted by ground deformation. Rail services were halted due to track damage.

Substation and railway damage from the Edgecumbe earthquake. Source: Archives New Zealand

2022 – SH35 collapse

In July 2022, a significant collapse occurred on State Highway 35 (SH35) near the Motu River Bridge, between Ōpōtiki and Te Kaha attributed to heavy rainfall, unstable geology, and persistent weather pressures, conditions that are typical in the region. This event caused a portion of the eastbound lane to fall into the river, leading to road closures and disruptions, isolating some coastal communities. These conditions made SH35 particularly vulnerable. Full restoration is focused on long-term safety and road stability.

A section of SH35 near Te Kaha has collapsed into Motu River. Source: NZ Herald

2023 – Auckland Anniversary severe weather

The bridge on No 4 Road washed out on 29 January 2023. Source: RNZ

In January 2023, significant infrastructure damage occurred in the Western Bay of Plenty due to severe weather events during the Auckland Anniversary Weekend Severe Weather. Key impacts included major slips across over 30 sites, and the complete washout of a bridge on No. 4 Road in Te Puke. This incident affected access to properties and caused logistical challenges, particularly for kiwifruit growers, as truck access was critical for the upcoming harvest. Temporary solutions, such as installing a Bailey bridge, were implemented to restore access, with costs for recovery estimated at $15 to $20 million. More than 30 sites were identified where major slips occurred. Roads damaged by slips included Wairoa Road, Oropi Gorge Road, Old Kaimai Road and Te Puna Station Road.

2023 – Rotorua District impacts due to lake water levels

Heavy rainfall significantly impacted communities around Lake Rotoiti, Lake Rotomā, and Lake Rotoehu in the Bay of Plenty. Rising water levels inundated properties, damaged infrastructure, and led to road closures, affecting residents' access and daily lives. State Highway 30 and several local roads suffered from slips, erosion, and flooding.

Jetty submerged in rising water levels at Lake Rotoma east of Rotorua. Source: GNS Science
Photographer: Margaret Low

Lake Rotomā flooded playgrounds and boat ramp. Source: NZ Herald

Hazard impacts

The impacts from infrastructure failure will vary depending on the hazard.

Energy

Power outages can have widespread and varied impacts on communities, businesses, and infrastructure, especially during extreme events such as earthquakes, storms, or floods. Power outages can impact thousands of households and businesses including disruption to essential services (healthcare and water); operational business shutdowns; disruption to telecommunications; and disruption to traffic signals and streetlights.

Damaged powerlines.
Source: National Emergency Management Agency

Damage to energy assets could include above ground conductors as these are usually the last connection from the line to homes; underground conductors if there are changes in soil moisture before, during and after high rainfalls; substations and overhead power lines with a range of hazards from volcanic ashfall to tsunami.

Telecommunications

Telecommunications outages can have significant impacts on communities and businesses. Disruptions to mobile networks and internet connectivity affect emergency communication and business continuity. These outages are often caused by extreme weather events, earthquakes, or other infrastructure failures. Vulnerabilities to telecommunications can include reliance on mains power; limited access to fuel during a prolonged power outage; and antenna or miss-alignment.

Telecommunications tower.
Source: Bay of Plenty Regional Council

Telecommunication infrastructure is susceptible to a range of impacts. Equipment in cabinets, pits and pedestals can trip-out when overheated and battery life can decrease in high temperatures. Antennas situated on poles that can be damaged by extreme winds. Damage to telecommunication assets can also be caused by volcanic ashfall with collapse and corrosion of equipment and increased loading on lines resulting in breakages; tsunami can cause structural collapse and assets being washed away; liquefaction damage to fibre cables, dishes and exchanges.

Transport

Vulnerabilities to the transport network include State highway/local roads and key bridge vulnerability due to flooding, tsunami, seismic activity and a lack of detour/ alternate routes; the rail network along the Matatā Straights, bridges in South Matatā and the Kaimai tunnel; and the Port of Tauranga through a range of hazards from tsunami and earthquake impacting containers, logs and Port infrastructure.

Damage to transport infrastructure in summary could include: roads; railway track lines; road and rail bridges; and the asphalt surfaces on the tarmac, apron and runway at airports. Bridges often carry lines (telecommunication, water, etc) so the loss/ impact to a bridge will also cause wider outages. Airport and runway operations can be impacted in high-winds leading to reduced landing capacity.

2010 Cantebury road rupture.
Source: National Emergency Management Agency

Water

Damage to water, wastewater, and stormwater systems in the Bay of Plenty has significant impacts on communities, particularly during natural disasters like earthquakes, floods, and severe storms. These essential systems are critical for public health, sanitation, and environmental protection. Contaminated water supplies due to infrastructure failures pose significant public health risks. Vulnerabilities with water, wastewater, and stormwater systems include wastewater systems in low lying areas; road access to assets; fuel capacity in generators for reservoirs; access to a power supply; reliance on electricity for bores; and limited back-up generator support water assets.

Damage to water assets covers the suite of water infrastructure reservoirs; pumps; wastewater treatment facilities; water intakes; and stormwater pipes. Additionally, pipes that are older or constructed from asbestos concrete or concrete have greater vulnerability. Power failures can impact water pumping and treatment facilities, increasing the risk of water contamination.

Chapel Street treatment plant. Source: Tauranga City Council

Hazard management – what to do and what this means for you

What to do in a lifeline disruption?

- **Call 111 in an emergency.**
- For regional information on lifelines disruption: What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from: Bay of Plenty Civil Defence Emergency Management Group | Utilities Disruption Page.
- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency.

To prepare

- Make a plan with your family/flatmates/friends to get through an emergency.
- Emergency Management Bay of Plenty – www.bopcivildefence.govt.nz > Get Ready

In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.

Damage to transport infrastructure - road washout caused by flooding, 2011. Source: Whakatāne District Council

Damage to transport infrastructure. Source: Whakatāne District Council

Acknowledgements and references

We would like to acknowledge all Councils in the Bay of Plenty and Lifeline Utilities on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- New Zealand Lifeline Council – **www.civildefence.govt.nz** > New Zealand Lifelines Council
- New Zealand Government | Strengthening the resilience of Aotearoa New Zealand's critical infrastructure system; Summary discussion document, June 2023
- New Zealand Lifelines Council | New Zealand Critical Lifelines Infrastructure National Vulnerability Assessment, 2023
- National Emergency Management Agency | Lifeline Utilities – **www.civildefence.govt.nz**
- National Emergency Management Agency New Zealand – Get Ready – **getready.govt.nz/**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**
- Bay of Plenty Lifeline Utilities Group
- Bay of Plenty Regional Energy Transition Accelerator – **www.eeca.govt.nz**

Hazard:
Dam failure

What is a dam?

A dam is defined as a barrier that is constructed or modified to divert, store or hold back water or other fluids. Flood control facilities, tailings dams, canals in fill, storage reservoirs and natural features modified to store water or other fluids fit this description.

What is meant by dam failure?

A dam failure occurs when a dam can no longer retain the water or material it was designed to hold back. This can happen suddenly or develop over time due to structural issues, natural events like earthquakes or extreme rainfall, or inadequate maintenance. When a dam fails, large volumes of water or materials (like silt or industrial waste) can be released quickly, leading to flash flooding, extensive property damage, environmental contamination, and risks to life in downstream communities.

Matahina Dam during Edgecumbe flood 2017. Source: Whakatāne District Council

Dam Failure in New Zealand

New Zealand has a relatively good record when it comes to dam safety, with no recent catastrophic failures. However, historical incidents and near-misses have highlighted the need for stringent safety measures, especially given the country's susceptibility to seismic activity. Here are a few notable cases and developments in dam safety:

- **Waikaremoana Dam (1948):** One of New Zealand's first significant dam failures was at Waikaremoana, where part of the diversion tunnel collapsed due to instability in the structure.
- **Lower Huia Dam (1970s):** During this period, concerns about seismic risks led to the reinforcement of Auckland's Lower Huia Dam. This dam had structural vulnerabilities that could have led to failure in the event of a large earthquake. The dam underwent strengthening to ensure its resilience.
- **Cromwell Gorge Dams:** The construction of dams in Cromwell Gorge in Central Otago, particularly the Clyde Dam, faced issues due to landslide risks in the area. Extensive engineering work and monitoring systems were implemented to stabilise the gorge and prevent potential failures due to geological instability.

The Clyde hydroelectric power dam spilling large amounts of excess water – Clyde, Otago. Source: Adobe Stock

Our story
Bay of Plenty context

There have been no major recorded incidents of dam failures in the Bay of Plenty region. The Bay of Plenty region has a number of large dams that are used for a variety of purposes including hydroelectric generation, water supply, flood control, irrigation, farm stock supply, recreation and flood control.

Matahina Dam

The Matahina Dam is a hydroelectric dam on the Rangitāiki River in the Bay of Plenty near Te Teko. Completed in 1967, it is one of New Zealand's significant hydroelectric power sources, supplying energy to the national grid. Managed by Trustpower, the dam has a generation capacity of approximately 80 megawatts, enough to power thousands of homes. The Matahina Dam experienced structural issues following the 1987 Edgecumbe Earthquake. This led to an extensive retrofit in the 1990s to improve the dam's resilience against seismic activity.

Matahina Dam in flood July 2004.
Source: Whakatāne District Council

Kaituna River

The Kaituna River in the Bay of Plenty region does not have large-scale hydroelectric dams but features smaller water control structures, such as weirs and sluice gates. These smaller structures help manage water levels and flows for various purposes, including irrigation, flood control, and environmental management. The Weirs and Sluice Gates are commonly used to control water levels along the river, benefiting local agriculture and helping to prevent flooding in low-lying areas. They play a key role in directing water flow into wetlands and other areas that need periodic flooding for ecological purposes. The Kaituna River Re-diversion Project through the Bay of Plenty Regional Council is a project to re-divert part of the Kaituna River's flow back into the Maketu Estuary, aiming to improve water quality and restore natural habitats. As part of this project, water control structures along the river help manage water diversion and maintain appropriate flow levels for both ecological and agricultural needs.

Lake Rotomahana Dam Failure – then and now

While not a “dam failure” in the conventional sense (involving human-made dams), this is a significant historical event that resulted in catastrophic consequences for the surrounding region, especially near Lake Rotomahana. On 10th June 1886, the eruption of Mount Tarawera devastated the Bay of Plenty, including the area surrounding Lake Rotomahana. During the eruption, a natural dam formed by the eruption of mud and debris blocked the lake’s outlet, creating a temporary reservoir. After the eruption, the natural dam that had formed at Lake Rotomahana gave way. This led to a massive release of water and silt into the surrounding valleys. The sudden flood devastated local settlements, including the Māori villages around the lake, and caused significant changes to the landscape.

Currently, the risk of a dam failure at Lake Rotomahana is low, as the lake does not have an artificial dam structure. Instead, the lake is held by natural formations created by volcanic activity, and the landscape is relatively stable. However, Lake Rotomahana sits within an active volcanic area, and any future volcanic or seismic events near Mount Tarawera could potentially destabilise these natural formations, posing flood or lahar risks to nearby communities.

Views of Lake Rotomahana. Source: GNS Science. Photographer: Bruce Hayward

Hazard impacts

Dam failures, though rare, can have significant consequences for communities, infrastructure and the environment.

Property and infrastructure damage

A dam failure can lead to sudden and catastrophic flooding downstream. Water stored in a dam can be released quickly, inundating nearby communities, agricultural land, infrastructure, and buildings. This may cause significant damage to property, roadways, and critical infrastructure like power lines, telecommunications, and water treatment plants.

Environmental

In the event of a dam failure, large volumes of water rushing downstream can alter natural ecosystems, destroy wildlife habitats, and negatively affect water quality. For example, rapid flooding can wash away fish populations and disturb aquatic plants, harming biodiversity. This can also lead to long-term consequences for industries like aquaculture and fishing, which depend on healthy river systems. Additionally, if the dam contains industrial or wastewater runoff, the release could result in contamination of soil, water, and coastal environments, further impacting ecosystems and agriculture.

Economic

Dam failure can result in significant economic losses. There would be costs associated with cleanup, recovery, and rebuilding; and there may also be disruptions to industries such as agriculture, forestry, and tourism. The Bay of Plenty's economy, which relies heavily on these sectors, could suffer from these long-term impacts. For example, irrigation systems for farms could be damaged, disrupting local food production.

Health

The immediate threat to human safety is perhaps the most concerning aspect of dam failure. In addition to the risk of drowning, the release of toxic materials from industrial dams could pose health risks to those living near the river or downstream. Cleanup operations following a dam failure can expose workers and residents to hazardous conditions. In severe cases, dam failure can lead to loss of life, particularly in communities located in low-lying areas near rivers.

Hazard management – what to do and what this means for you

What to do if you in a dam failure incident?

- **Call 111 in an emergency.**
- Follow the National Emergency Management Agency's guidance on how to make sure that you and your whānau will get through an emergency. **getready.govt.nz**

For regional information on lifelines disruption: What you need to know; How to prepare; What to do when it happens; After the event – go to guidance from: Bay of Plenty Civil Defence Emergency Management Group **www.bopcivildefence.govt.nz** > Utilities Disruption Page

To prepare

- In an emergency, you may be stuck at home for three days or more. Figure out what supplies you need and make a plan to work out what you need to get through including water and food.
- Emergency Management Bay of Plenty: **www.bopcivildefence.govt.nz** > Get Ready.

GET READY

getready.govt.nz

Other information

- **Bay of Plenty Regional Council** – www.boprc.govt.nz > Dangerous Dams.
- **Ministry of Business, Innovation & Employment** – www.mbie.govt.nz > Dam Safety Regulations.
- **New Zealand Society on Large Dams** – nzsold.org.nz > Dam Safety Guidelines.

Acknowledgements and references

We would like to acknowledge Bay of Plenty Regional Council on the development of information to inform this Hazard page.

Sources of information associated with this Hazard page are:

- Bay of Plenty Regional Council – **www.boprc.govt.nz** > Dangerous Dams.
- National Emergency Management Agency New Zealand – **getready.govt.nz**
- Bay of Plenty Civil Defence Emergency Management Group – **www.bopcivildefence.govt.nz**

BAY OF PLENTY
EMERGENCY MANAGEMENT
GROUP

bopcivildefence.govt.nz
facebook.com/bopcivildefence
twitter.com/bopcivildefence