National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Geography Level 1

This exemplar supports assessment against:

Achievement Standard 91932

Demonstrate understanding of the spatial distribution of a phenomenon and its impacts on place

An annotated exemplar is a sample of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade.

New Zealand Qualifications Authority

To support internal assessment

Grade: Achieved
For Achieved, the student needs to demonstrate understanding of the spatial distribution of a phenomenon and its impacts on place. The spatial distribution of New Zealand earthquakes has been described. This is evident in the response, where a linear pattern has been described along the Australian and Pacific plates and includes "*the Hikurangi subduction zone and the Alpine Fault ranges from North Island to South Island*". Further distribution characteristics such as clustered (e.g. at the top of the North Island) and dispersed (e.g. Eastern Coast of the South Island) are also described. The description includes relevant evidence such as the parameters of the distribution and geographic terminology. The student has explicitly linked contributing factors/processes to the described spatial distribution. For example, a linear pattern is linked to both subduction and transform plate boundary movements. The impacts of the phenomenon (earthquakes) on place (New Zealand) have been described, supported by evidence to exemplify the impact. Economic, environmental, and social impacts were described, using evidence from the Christchurch and Kaikoura earthquakes. Inclusion of evidence from North Island earthquakes, such as Napier or Wellington, would more accurately reflect coverage of the selected New Zealand geographic area. For Merit, the student needs to explain the contributing factors/processes and the impacts of the phenomenon. The description of the spatial distribution may be more complex and continue to be developed throughout the response. The explanations should include specific links between the contributing factors/processes and the spatial distribution, and the evidence and geographic terminology should support the explanations.

Achieved

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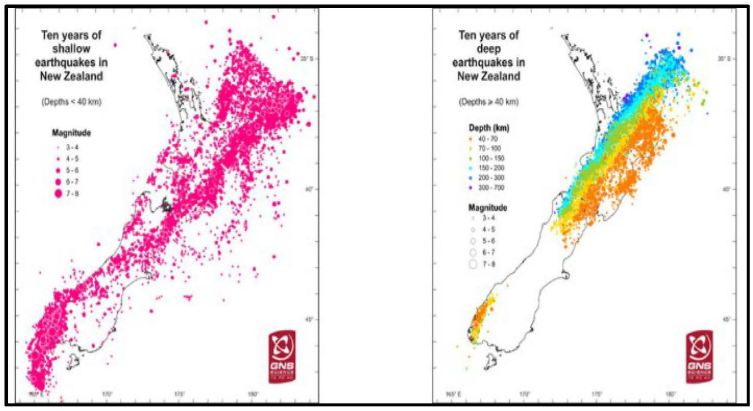
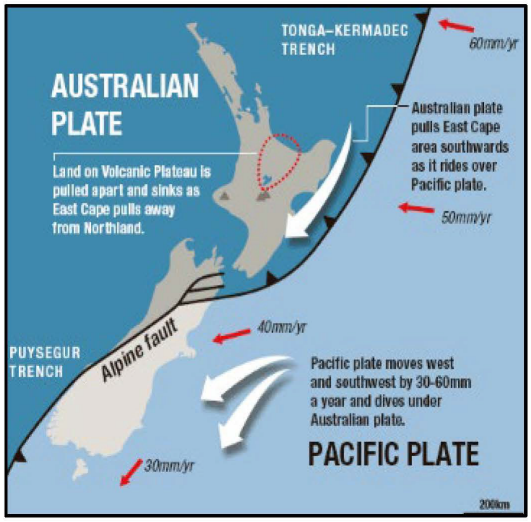


The spatial distribution refers to how things are arranged or spread out across a given area. In New Zealand, earthquakes follow a specific linear pattern along the boundaries of the Australian and Pacific plates. These boundaries, like subduction zones and transform boundaries, accumulate stress over time, leading to seismic activity. Notable areas include the Hikurangi subduction zone and the Alpine Fault rangers from North Island to South Island. Source of image AF8 (Alpine Fault Magnitude 8)

The geographical location of New Zealand is a primary natural factor influencing the linear, clustered, and occasionally dispersed arrangement of earthquakes. Situated within the Pacific Ring of Fire, New Zealand rests on a region with fault lines, primarily contributing to this seismic activity.

In the picture on the left, helps identify another type of spatial distribution which is a clustered and dispersed pattern. Clustered earthquakes occur when the strongest is concentrated around specific regions, such as the top of the North Island like Tonga-Kermadec Trench, or the southern tip of the South Island in the Puysegur Trench, specifically Milford Sound. Dispersed earthquakes in New Zealand are seen on the eastern coast of the South Island like Dunedin and the western coast of the North Island like New Plymouth. These are some of the few that experience fewer earthquakes in New Zealand.



It shows a visual representation of the tectonic processes and features contributing to the spatial distribution, particularly the linear pattern of the earthquakes in New Zealand. The presence of the Australian and Pacific plates, shown with arrows indicating their movement, highlights the fundamental tectonic setting of the region. The Alpine Fault, clearly outlined on the diagram, is a major fault line where the Transform plate, which is two plates, slides past each other horizontally, contributing significantly to the linear pattern of seismic activity observed in New Zealand. The black triangle on the Alpine fault represents the rate of movement, with the top first red arrow indicating 60mm per year. Additionally, arrows pointing to Christchurch and past Invercargill illustrate the direction and rate of movement along the fault, with 40mm per year and 30mm per year. Furthermore, the Tonga-Kermadec Trench and the Puysegur Trench indicated in the image, represent subduction zones where one tectonic plate is forced beneath another, generating powerful earthquakes. These geological features and tectonic processes collectively shape the spatial distribution of earthquakes, creating the distinct linear pattern observed across New Zealand.

Source of the image above: Structure geology

This image refers, further North, the Alpine Fault breaks up into a series of faults, which are named the Hope Fault, Kekerengu Fault, Clarence Fault, Wairau Fault, and Awatere Fault which are all known as the Marlborough Fault system.

Lateral and vertical movements are key in understanding geological events such as earthquakes. Sideways shifts from tectonic plate motion and vertical movements of the Earth's crust affect seismic activity. Al convergent boundaries, plate colliding may increase earthquake risk. These movements occur in the lithosphere, interacting with the upper mantle.

Source of image: Wikipedia

Earthquakes have profound long-term and short-term impacts on the environment, people (social), and the economy.

The Christchurch 2011 and Kaikoura 2016 earthquakes had significant economic impacts, causing widespread damage like disruption of businesses, and infrastructure, affecting tourism and trade in the affected regions.
The 2011 Christchurch earthquake had a big economic impact. II caused about $28 billion in damage and led to job losses. Repairing homes and businesses cost around NZ$13 billion. International aid of $6-7 million was given to help with recovery. Economists predicted ii could take up to 100 years for the economy to fully bounce back.
The 2016 Kaikoura earthquake had also caused about NZ$2 billion in damage. It disrupted vital infrastructure like State Highway 1, affecting industries such as tourism and fishing. The closure of the highway alone resulted in a loss of NZ$1.3 billion in economic activity. Overall, the earthquake had significant economic consequences for the region.

The earthquakes in Christchurch in 2011 and Kaikoura in 2016 earthquakes had big environmental impacts, including damage to ecosystems, water contamination, and changes in land levels.
The 2011 Christchurch earthquake resulted in environmental damage, including broken water and sewage pipes, leading to water contamination. Liquefaction, in areas like the Avon River, caused riverbank collapse, altering flow and damaging surrounding vegetation and ecosystems. This instability also led to lateral spread near waterways, and changes in land levels affecting drainage. Additionally, the earthquake triggered numerous rockfalls and landslides and impacted air and water quality with increased dust and pollutants.
The 2016 Kaikoura earthquake had a significant environmental impact, particularly on marine ecosystems. It caused a disturbance in coastal areas, leading to the loss of important marine species like brown and red algae, paua, and grazing snails. The earthquake also uplifted coastal platforms by around 1-6m. Additionally, there was a prolonged bloom of green algae (sea lettuce) along the coastline from Omihi to Cape Campbell, highlighting the vulnerability of marine ecosystems to seismic events. Continued efforts to address these impacts are essential for preserving coastal biodiversity.

The Christchurch 2011 and Kaikoura 2016 earthquakes had profound social impacts, including loss of life, injuries, displacement, and population shifts. The 2011 Christchurch earthquake, which caused 3,129 fatalities and left 6,800 with minor injuries, had a profound societal impact. 2,200 individuals had to find temporary housing, and nearly a quarter of the city's residents relocated afterward. These figures illustrate the extensive destruction, displacements, and population shifts resulting from the earthquake. It significantly damaged infrastructure, retail, and office buildings in the central business district, leading to financial difficulties for many.

The most significant social impact of the 2016 Kaikoura earthquake was the disruption of vital services, home, and temporary isolation, showcasing infrastructure vulnerability to natural hazards. Evidence reveals communities grappling with limited access to essential services and displacement due to damaged infrastructure, underlining the pressing need for resilient systems to withstand such disasters. Additionally, people weren't able to access their essential needs because of the road blockages.


State Highway 1 experienced significant liquefaction during the 7.8 magnitude earthquake in Kaikoura, New Zealand in November 14, 2016.
A collapsed building debris envelops a bus in downtown Christchurch on February 22nd 2011.
The landslide in the 2016 Kaikoura hit near Kaikoura town on New Zealand's South Island, damaging State Highway 1.
Collapsed buildings and damaged infrastructure mark the city's devastation. People navigate debris post a 6.3 magnitude earthquake in Christchurch, New Zealand, on February 22, 2011.

Grade: Merit
For Merit, the student needs to explain the spatial distribution of a phenomenon and its impacts on place. The spatial distribution of tourist attractions in Rotorua has been described using geographic terminology such as cluster, linear, uneven, scattered, outlier, and concentration. The described distribution reflects the parameters of the selected geographic area. Contributing factors/processes have been explicitly linked to the spatial distribution and explained. For example, a range of ideas have been used to explain the spatial distribution such as accessibility, natural features (Mt. Ngongotaha and geothermal sites), tourist infrastructure, and historical sites. Understanding of the impacts of the phenomenon (tourism) is demonstrated through explanation of social, economic, and environmental impacts, including positive and negative implications. The explanation is supported with relevant case study evidence. For Excellence, the student could examine the contributing factors/processes to the spatial distribution. In the subject glossary, the word ‘examine’ is defined as “to look at in detail”. An examination of the contributing processes could include further detail and explanation about the factor of relief to the cluster at the base of Mount Ngongotaha, with reference to the gondola, mountain biking, and the Zorb. An Excellence response would make judgements about the significance of the impacts of the phenomenon on place. While the most significant is identified as the employment and income generated, the student could include why these are long term impacts. The social and environmental impacts and why they are not the most important could also be discussed for a higher grade.

Merit

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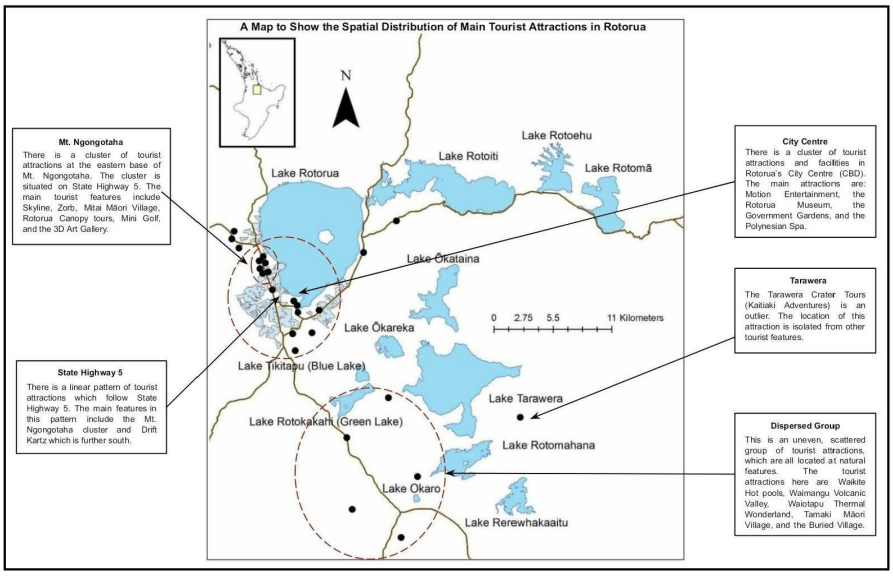

Map showing the Spatial Distribution of Main Tourist Attractions in Rotorua

There is a concentration of tourist attractions in and around the City Centre of Rotorua, and tourist attractions dispersed around the wider region of Rotorua. There is a cluster of tourist attractions at the base of Mount Ngongotaha. This cluster also connects to the linear pattern along State Highway 5. Most of the tourist attractions in Rotorua are located at natural features to utilise the resources they grant and/or the beauty they possess. Some natural features which provide use to the tourism industry are Lake Rotorua, Mount Ngongotaha, Mount Tarawera, and the other surrounding lakes. Due to Rotorua's unique location in a volcanic plateau, there are also many tourist attractions which rely on the rare geothermal features.

<u>The Spatial Distribution of the Tourist Activities in Rotorua</u>

Rotorua is a major tourist hot-spot in New Zealand. The cluster of tourist attractions at the base of Mt. Ngongotaha is because of the relief of the mountain, and how accessible and convenient the area is to tourists. State Highway 5 runs through this cluster, providing accessibility. Convenience also comes from the amount of tourist attractions in the area. Skyline (Luge, Gondolas, Skyswing), Zorb, and 4WD Offroading rely on the hilly terrain and steep slope of Mt. Ngongotaha (the summit is at 757m).

There is a linear pattern of tourist attractions along State Highway 5. This is because of its constant usage by both locals and tourists: State Highway 5 goes through many heavily developed areas in Rotorua, it is used by locals everyday and by people driving to other main cities in New Zealand such as Auckland, Tauranga, and Taupō. Tourist attractions located on this road have a higher likelihood of getting noticed by potential tourists driving past them.

The cluster of tourist attractions in the city centre derives mainly from the first tourist infrastructure built at the lakefront to establish Rotorua's tourism industry in the late 1800s: the Government Gardens and the former Bath House. That and newly built tourist attractions that have made use of the pre-existing tourist hot-spot. There is also an abundance of tourist-based infrastructure built in the city centre making the area easily accessible for tourists.

Many tourist attractions around Rotorua are located randomly. This is mainly because they are located at natural features. Due to Rotorua being part of the Taupo Volcanic Zone, there's a great number of lakes, mountains, and geothermal activity. Most of these natural features are used to attract tourists: the lakes are used by Duck Boat Tours and other tourist activities, Mount Tarawera is used by Kaitiaki Adventures and Volcanic Air which provide tours to the Tarawera craters, and the geothermal activity is used for spas and sightseeing, e.g. Waikite Hot Pools, Waimangu Volcanic Valley, Wai-Ariki Hot Springs, and Hell's Gate.

Impacts ofTourism in Rotorua

The most important impacts of tourist attractions in Rotorua are the employment opportunities and the money generated, as they are both long-term impacts and essential to Rotorua's economy. The social and environmental impacts are not the most important as some effects of the impacts may only be short-term, or do not hold large value to the economy.

Tourist attractions in the Rotorua District contributed $260.4m towards GDP in Rotorua in 2023, 5.9% of Rotorua's economic output. For example: around $34.9 million profit was generated from Skyline in 2022. This money directly contributes towards the development of Rotorua: infrastructure, road management, public services, local events etc. Without the money generated from tourist attractions, there would be a significant amount of pressure put on other sectors in Rotorua to produce more money. Rotorua's economy relies heavily on tourism; which may be negative if the tourism industry in Rotorua was to collapse. During the nationwide lockdown, New Zealand's economy suffered losses due to tourists not visiting New Zealand, in the first year over 72,000 employed in tourism lost their jobs, and there was a 91.5% decline in international visitor spend.

Nearly 3,500 people were directly employed in the tourism sector in Rotorua in 2023, 9.5% of Rotorua's total employment. This does not take into account those employed in Retail Trade (3248), and Accomodation and Food Services (3452), which also benefit from tourists. The Duck Tours directly employs 10 people. This impact is long-term as it directly aids those employed in these tourism attractions, and contributes tax to the economy.

There is an abundance of tourism attractions which provide entertaining and informative experiences about Maori culture (e.g. Te Pa Tu, Mitai Maori Village, Te Puia). Tourists experiencing/learning about the culture keeps it alive, and spreads knowledge of the Maori culture world-wide. It also allows Maori to actively connect with their cultural identity. Te Puia attracts around 500,000 visitors annually. This has a social impact. Another social impact is that locals in Rotorua get to interact with people from all over the world and learn about different cultures from overseas. 86% of Rotorua residents say they have experienced benefits from tourism in Rotorua.

The tourism industry contributes damage to the natural environment (waste, pollution, land erosion) and to the urban environment (traffic, congestion). During Crankworx, the congestion around the Mount Ngongotaha cluster of tourist attractions massively increases. 38% of Rotorua residents believe that there is more litter and waste generation because of the tourism industry. Though there is no data to prove this, it is not unlikely that there is a large quantity of tourists who litter, or disrespect the environment when doing outdoor tourist attractions. Some tourism based companies actively combat this issue. For example: Rotorua Canopy Tours are major contributors to improving the environment, they do this through pest management, increasing biodiversity in the forests they use, and are the major financial supporters of the Canopy Conservation Trust. Another example is the Duck Boat Tours, their vehicles cause pollution and so to combat this they take care of the environment through educating tourists, preventing the spread of aquatic pests, and planting trees to improve their carbon footprint.

Grade: Excellence
For Excellence, the student needs to analyse the spatial distribution of a phenomenon and its impacts on place. The spatial distribution of New Zealand earthquakes has been described using geographic terminology such as linear and cluster, and the specific examples used strengthen the description. Characteristics of the linear pattern, like noting variations in the width of the line and where clusters occur, contribute to a complex description and demonstrate understanding. The spatial distribution is frequently referred to throughout the examination of contributing factors or processes, clearly showing understanding of the relationship. Evidence of the progression from explanation to examination is shown when the subduction process is linked to faulting, and this in turn linked to the width of the linear pattern. An extensive range of impacts of earthquakes on place are explained, and judgements about their significance provided. Case study evidence has been integrated in a way that clearly exemplifies and supports the ideas being discussed and the national scale/geographic area. For example, the explanation of the impacts on plants and animals used evidence from the Christchurch, Napier/Hawkes Bay, and Kaikoura earthquakes. Judgements have been made about the significance of impacts, using evidence and geographic terminology to develop the explanation. For example, categorisation of impacts (social and economic), significance (short term and long term), and severity *(“large impact”, “fewer deaths”, “equally as devastating”).*

Excellence

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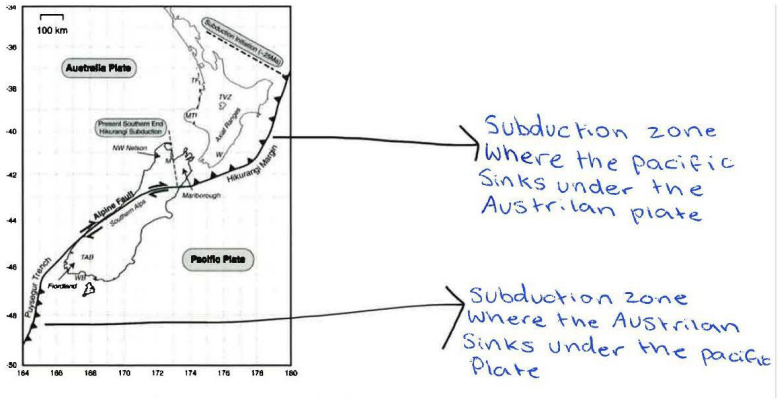
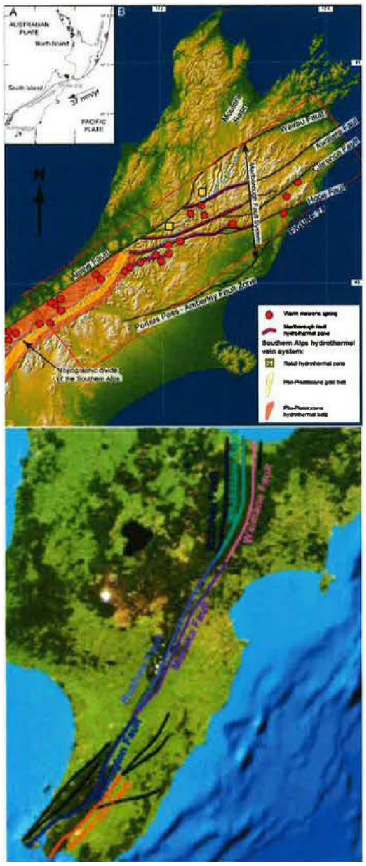
Aotearoa is located between two tectonic plates, the Pacific plate and Australian plate. The spatial pattern that the earthquakes follow is a linear pattern from the southwest of the South Island at Fiordland to East Cape in a Northeast direction in the North Island.

The pattern begins offshore in the Puysegur trench in a subduction zone near Fiordland. (as seen in diagram 1). The linear pattern carries on in a Northeast direction along the Southern Alps where the Alpine Fault is located, then continues into the Marlborough fault system. These form a shallow earthquakes cluster. Continuing Northeast, the plate boundary goes into the Hikurangi trench which is a subduction zone where deep earthquakes occur and the Pacific plate sinks under the Australian plate (diagram 1).

The width of the linear pattern of earthquakes is less in the South Island than the North Island. This is because of the different plate movements at these places. The wider linear pattern stretches across the North Island from the Mt Taranaki to the Hawkes Bay and Coromandel Peninsular, all the way to the coast. The pattern of deeper earthquakes to the Northwest in the North Island is because of the slope of the boundary where subduction occurs between the 2 plates.



An important factor that contributes to the distribution of earthquakes are fault lines. Fault lines are fractures in the earth's crust created by the pressure from the tectonic plates. In Aotearoa fault lines are caused by the pressure of the Australian and Pacific plate colliding together and subducting beneath each other. There are many main fault lines in Aotearoa that contribute to the distribution of earthquakes like Alpine, Marlborough fault system, Wellington, Wairarapa, Hope, Kekerengu, Clarance, Awatere, Wairau faults and they all make up the linear pattern with a general Northeast to Southwest trend. (labelled faults in diagram 2 and 3).



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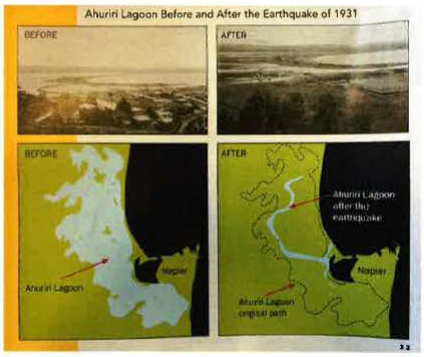
We see a linear pattern of distribution of earthquakes throughout Aotearoa mainly following the Alpine Fault in the South Island where the 2 tectonic plates meet alongside, there are usually shallow and focus earthquakes. Movements along fault lines occur in different direction where the rocks in the crust get caught and pressure builds up until the rocks break and allow the tectonic plates to move past each other. The pressure is then released as seismic waves (earthquakes). Some examples are Kekerengu fault line 15km deep magnitude 7.8 Nov 14 2016, Wairarapa fault line 33km deep magnitude 7.8 Jan 23 1855, Port Hills fault line 3-5km deep 22 Feb 2011 magnitude 6.3. There are more faults in the Marlborough system and in the southern North Island showing a wider linear pattern of earthquakes. This is likely due to the pressure from the Hikurangi trench off the east coast crushing the land.

Another important factor to the linear pattern of distribution of earthquakes throughout Aotearoa is location. Aotearoa is located on top of a tectonic plate boundary where the Pacific and Australian plate collided. At the narrow part of the linear pattern near the Southern Alps the Australian plate slides to the North and Pacific plate pushes the alps up causing earthquakes along this line. Nearly 95% of earthquakes occur along the tectonic plate boundaries. Parts of Aotearoa are also located in subduction zones where deep earthquakes occur (more than 300km below the surface). Aotearoa's subduction zones are located the Southwest of the South Island (Puysegur trench Fiordland) and under the North Island stretching from the Hikurangi trench. This subduction zone causes a wide linear pattern through south and central N.Z. Aotearoa is located in the Southwest section of the Ring of Fire where 90% of the world's earthquakes happen (ring of fire diagram 4 and 5).

Plants and animals were affected by the impacts from uplifted land, rockfalls and the pollution in rivers which occurred in each of these major earthquakes. Silt from the liquefaction all around Christchurch was washed into rivers (Avon). The sediment from silt covered up the aquatic life many animals were affected (eels, white bait). In the 1931 Hawkes Bay earthquake there was a long term and significant impact because the earthquake caused Ahuriri Lagoon to rise 3 meters. The rise of the land drained all the water changing the habitat for the aquatic life causing thousands of plants and animals to die. In the Kaikoura earthquake 2016 they also experienced "shocking damage". The tectonic forces caused 110km of the coast to be uplifted killing off species, the uplifted land caused the reef to be underwater for only 4 hours a day leaving the marine species to dry up.



→ Befor and after of the Hawkes Bay earthquake causing the lagoon to rise and become land. (turned into air port.)

The effects of the aquatic ecosystem in Christchurch was short term as the rivers were restored. They began in 2013 in the Avon River, where the river was dredged and new aquatic plants were planted in the river bed. The new water entering the Avon was then treated. In Kaikoura and Hawkes Bay the effects were long term because of the change in land and the amount of animal life killed.

Overall, earthquakes in New Zealand, such as those in Christchurch, Kaikoura, and Hawke's Bay, have had profound impacts and significance. The loss of life and destruction of property are significant, leading to human suffering and the need for costly rebuilds. Psychological impacts are severe, with increased rates of PTSD and trauma. Environmental damage, including rockfalls, landslides, and coastal uplift, impacts ecosystems and changes landscapes. Coastal uplift, seen in the 2016 Kaikoura earthquake and the 1931 Hawke's Bay earthquake, raises land from below sea level, affecting marine habitats and biodiversity. The overall significance of these impacts is in the extensive human, economic, and environmental costs as a result of earthquakes, however the human impacts were the worst. These case studies highlight the huge social impacts earthquakes can have, including immediate loss of life, injury, and educational impacts, as well as lasting psychological and economic strains.