FUTURE/CURIOUS

Climate Change: prepare today, live well tomorrow

Huringa Āhuarangi

WHAKARERI MAI KIA HAUMARU ĀPŌPŌ

MODULE FOUR

Responding to change, planning for action

Introduction

The term 'wicked problem' is used in science, planning and education to describe problems that are extremely complex in nature. Anthropogenic climate change is one such problem. Because there is no one-size-fits-all solution, no quick fix, climate change can be difficult to get your head around, let alone teach or respond to. This resource aims to help teachers/kaiako and their learners to understand the immediacy and complexity of this 'wicked problem'. It offers a range of practical and proactive strategies for responding to the challenges.

A collective and inclusive response is needed to mitigate and adapt to the predicted impacts of climate change. This response asks that we recognise the interconnectedness of all life on earth, as the impacts of climate change will be widely and diversely felt by all living things. Also essential to this response is the ability to communicate, listen to and respect varying perspectives and ideas. We are all in this together and can all be part of the solution.

'Huringa Āhuarangi: whakareri mai kia haumaru āpōpō | Climate Change: prepare today, live well tomorrow' is a science-based, integrated learning programme. It focuses on Earth's systems, the interconnectedness of the living world, and the impacts of anthropogenic climate change. It encourages learners to interpret, analyse and engage with science, and to understand that science knowledge changes over time.

There is opportunity to consider a mātauranga Māori perspective in the learning programme, particularly around the interconnectedness of life on earth as expressed through the relationship between Papatūānuku and Ranginui. Other indigenous knowledge bases will contribute to a broader understanding of the interconnectedness of life on earth and help to inform possible responses.

The programme builds understanding of climate change through an exploration of critical global, national, and local responses aimed at mitigating and adapting to predicted impacts. It is critical to consider indigenous responses, and – in particular for Aotearoa – to include those of whānau, hapū and iwi.

In exploring the challenges of climate change, ākonga are encouraged to develop and apply key competencies. They are prompted to think beyond themselves, to tautoko | support others, and to connect with the intergenerational community responding to the problem.

Most importantly, the resource supports and empowers all learners to have a voice, to take action, and to play their part in a larger, systematic response.

Teaching and learning modules

The modules can be applied in sequence or independently, depending on learners' existing awareness of climate change. For those who have limited prior learning it is suggested that the programme be followed in its entirety, and in the order suggested in the 'User guide'. This will encourage a sound understanding of climate change science and explore potential responses to the challenges of climate change, whilst also supporting wellbeing.

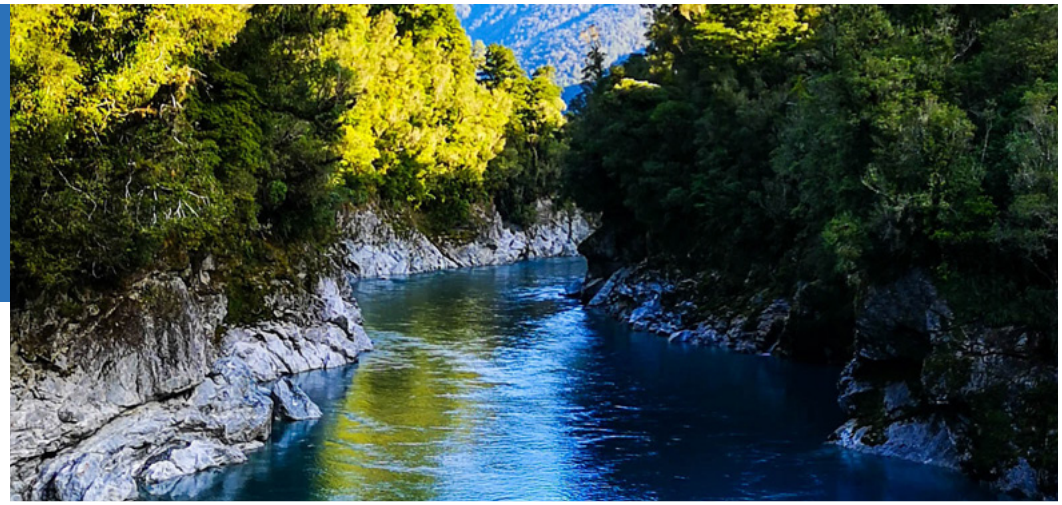
Climate change wellbeing guide

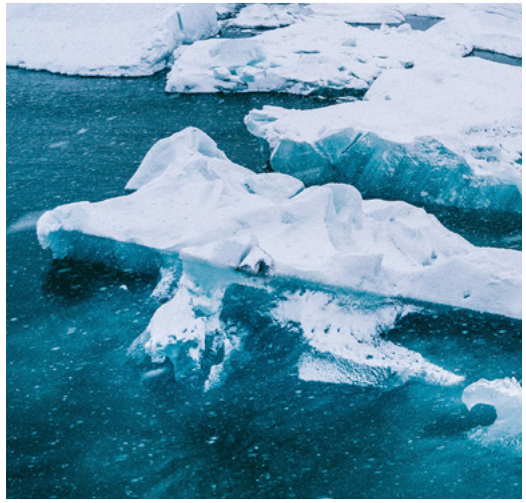
Teachers/kaiako and ākonga will have different reactions when learning about and responding to climate change, with some experiencing strong emotions. Background information and activities to support wellbeing are included. Look for to connect to the 'Climate Change Wellbeing Guide', a companion resource to the learning programme.


“Listen to yourself. Listen to what you have got to say.”
ZAK

MODULE FOUR

Responding to change, planning for action





Specific learning intentions

Learners will:

- learn how scientific knowledge about climate change can inform our behaviour, responses, and actions
- develop an understanding of the global, systematic response to climate change and explore how their own actions and ideas can add to the wider response
- learn about the potential impacts of climate change within the context of Aotearoa New Zealand and explore their growing knowledge using reflection, visual arts, and by connecting with nature through poetry
- investigate the processes causing ocean acidification, the impacts of those processes, and the relationship to climate change.

Success criteria

Learners will be able to:

- relate how science and indigenous knowledge systems help to inform behaviour, responses and actions to address climate change
- explore the global, systematic response to climate change and consider how their own actions and ideas can play a part
- explore and apply their knowledge regarding the potential impacts of climate change on Aotearoa New Zealand using reflection, visual arts, and by connecting with nature through poetry
- investigate the processes causing ocean acidification, the impacts of those processes, and the relationship with climate change.

Background information for teachers and kaiako

The time is now

Through science and indigenous knowledge systems such as mātauranga Māori, we know that the climate is changing at a rate never seen before. It is now widely agreed that the main driver of these changes is anthropogenic/human activity.

Every year it becomes harder to avoid the feelings that arise as we hear more about the impacts of climate change. The seasons are changing, species and habitat loss is inevitable, and for those living in low-lying areas – both here and around the world – homes and livelihoods are directly threatened. Understandably, climate change is now widely regarded as one of the biggest and most pressing problems facing the planet. It not only threatens the natural environment, but also our economic, social and cultural wellbeing. It's already impacting upon the agricultural sector, ecosystems, infrastructure, health and biosecurity. A number of countries – including Aotearoa New Zealand – have declared 'climate emergencies'.

The Intergovernmental Panel on Climate Change (IPCC, 2021) Sixth Assessment Report (Working group 1) reported unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach. To limit global warming, strong, rapid, and sustained reductions in CO_2, methane, and other greenhouse gases are necessary. They have also stated that global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades.

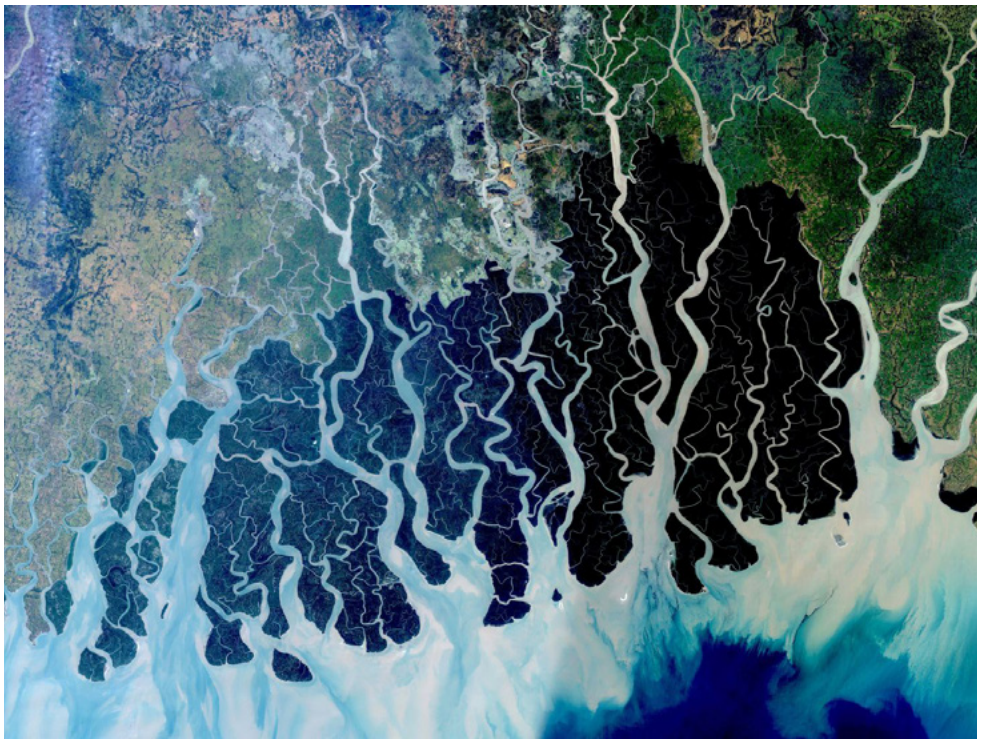
The response to climate change needs to be immediate and highly coordinated. It requires an intergenerational, global, national and local commitment focused on actions that will mitigate potential impacts on all living things. It will also require innovative adaptation planning aimed at addressing the short, medium, and long-term impacts already locked in.

A global response

The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC came into force in 1994. It enables countries to collectively consider how to mitigate climate change and cope with its impacts. It has near-universal membership with 197 Parties (countries) – including Aotearoa New Zealand – having ratified the Convention.

However, the international community has also recognised that urgent action is needed, with more powerful and legally binding measures than those required under the UNFCCC. Negotiations on a second agreement under the UNFCCC – known as the Kyoto Protocol – began in 1995 and came into force in 2005. 55 countries backed it, including those responsible for 55% of global emissions.



The Kyoto Protocol

The Kyoto Protocol committed developed countries to heat trapping gas emissions reduction targets for the first commitment period of the Kyoto Protocol (2008–2012). Only countries that ratified the Protocol are bound to it. Aotearoa New Zealand ratified the Kyoto Protocol in December 2002. Our obligations under the Kyoto Protocol included responsibility towards an emissions reduction target for the first commitment period (2008–2009) to reduce heat trapping gas emissions to their 1990 levels. We were also required to submit an annual inventory of heat trapping gas emissions to the UNFCCC. During November 2015, Aotearoa New Zealand accepted the Doha Amendment to the Kyoto Protocol. This meant supporting a second commitment period under the Kyoto Protocol, running from 2013 until 2020. However, the amendment will only come into force when 144 parties under the United Nations have accepted it. As of May 2018, 112 parties had accepted the Doha Amendment.

In 2018, the IPCC released a major special report (IPCC 1.5°C). The report focused on the impacts of global warming of 1.5°C above pre-industrial levels (pre 1720–1800; Hawkins, 2021) and related heat trapping gas emission pathways. This was in the context of efforts to reduce emissions, and the need to strengthen the global response to the threat of climate change.

The Paris Agreement

The Kyoto Agreement was replaced by the Paris Agreement, and adopted by Parties under the UNFCCC in December 2015. Its overarching purpose was to provide the framework for an integrated global response. This introduced a robust system of measures aimed at monitoring, reporting on, and reassessing national targets over time. These measures – Nationally Determined Contributions (NDCs) – enable measurement of progress towards achieving global outcomes. It committed all signatory countries to taking action on climate change and required each to announce their next round of targets every five years. Those commitments took effect from 2020.

The Paris Agreement set out to:

- keep the global average temperature well below 2°C above pre-industrial levels, while pursuing efforts to limit the temperature increase to 1.5°C
- strengthen the ability of countries to deal with the impacts of climate change
- support development of low-carbon and climate-resilient economies.

The influence of the agreement was considerably weakened when the USA, the world's second largest emitter of carbon dioxide (CO_2), announced its withdrawal in 2018. However, the USA rejoined in February 2021, at a time at which several countries announced ambitious new targets. However, there is still a lot to be done if the goals of the Paris Agreement are to be met. One analysis of national commitments so far shows that implementation would only limit warming to 2.7°C by the end of the century (New Climate Institute, 2020).

A local response

The Paris Agreement and the Climate Change Response Amendment Act 2019 (the Carbon Zero Act)

Aotearoa New Zealand ratified the Paris Agreement in 2016. Our first Nationally Determined Contribution (NDC) under the agreement applies from 2021 and commits Aotearoa New Zealand to reducing heat trapping gas emissions by 30% below 2005 levels by 2030. In 2019, the government enacted the Climate Change Response Amendment Act 2019 (the Carbon Zero Act), in part, to provide a framework within which Aotearoa New Zealand can develop and implement clear and stable climate change policies. It supports us to make our contribution to the global response to climate change under the Paris Agreement.

Other key parts of the legislation included new, more ambitious targets. These included reducing net emissions of all heat trapping gases – excluding methane (CH_4) from biological sources such as farm animals – to zero by 2050. Methane (CH_4) is to be reduced to 24–47% below 2017 levels by 2050. The Act also established the Climate Change Commission, a new independent body tasked with providing expert advice and monitoring progress to help keep the country on track to meet long-term goals.

Declaring a climate emergency

At the end of 2020, the government declared a climate change emergency, signalling the importance of the issue to all New Zealanders. It committed to a goal of avoiding a greater than 1.5°C increase in global warming. In declaring the emergency, Aotearoa New Zealand joined many other nations that had done the same. A number of district and regional councils across the country have made similar declarations.

He Pou a Rangi Climate Change Commission

At the end of May 2021, the Aotearoa New Zealand Climate Change Commission (CCC) released the final version of its first body of advice to the government on transitioning to a thriving, climate-resilient and low emissions Aotearoa. In it the Commission notes that current policies will leave the country well short of its targets, and that Aotearoa needs to be proactive and courageous as it tackles the challenges the country will face in the years ahead. It also raised concern that policies to reduce emissions should be fair and equitable, as well as being technically and economically feasible. The CCC has also prepared three emissions budgets setting out the progressive reductions required of heat trapping gases between now and 2035. Learn more on the Climate Change Commission website.

Health and wellbeing

The Royal Society of New Zealand Te Apārangi (2017) noted that many factors contributing to New Zealanders' health and wellbeing are threatened by climate change. These include effects such as increased exposure to heat waves, weather events and fires. They also pointed to indirect effects such as reduced water safety, increased exposure to microbial contamination and new diseases, disruption to health services, and challenges to our mental health. Social and economic factors identified included migration, housing and livelihood stresses, food security, socioeconomic deprivation and health inequality. Well designed policies will be needed if risks to health are to be reduced. Such policies would also have the potential to improve existing health and inequality issues.
Read the Royal Society of New Zealand report.

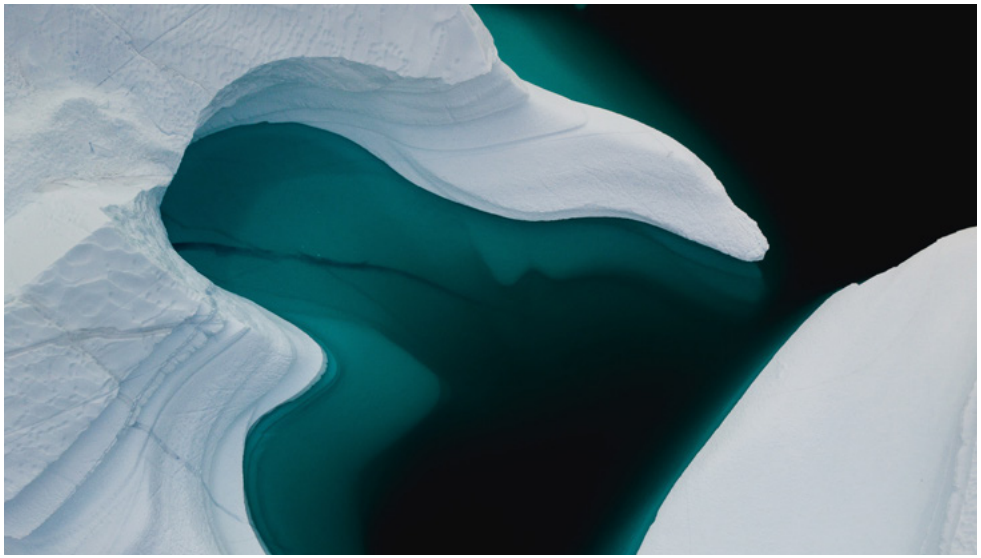
Biodiversity

Aotearoa New Zealand's terrestrial biodiversity will come under increasing pressure as a result of global climate change. Existing threats such as pests and human disturbance will likely worsen. The Department of Conservation (DOC) has suggested that the direct impacts of climate change on native biodiversity (e.g. changes to the range and altitudes at which species can live) will be felt over the long term. Indirect effects caused by human activity (such as land use changes) will be felt more immediately, as will biological threats (e.g. increased range and abundance of animal pests, new pathogens, and diseases). For more information, refer to 'Adapting to a changing climate – A proposed framework for the conservation of terrestrial native biodiversity in New Zealand' by Christie (2014). Read 'Adapting to a changing climate' (PDF) on the DOC website.

Opportunity knocks

There is some potential for Aotearoa New Zealand to experience benefits from a warming climate. For example, as our climate warms, high value horticultural crops may be grown in areas that were previously too cold and unsuitable for growth. Yields of other crops may increase for the same reason, although improved growing temperatures may be offset by altered rainfall patterns and increasing shortages of water for irrigation in some parts of the country. New landscapes formed by rising lake levels or retreating glaciers may provide new tourism opportunities. Increases of atmospheric carbon dioxide (CO_2) may provide a fertility benefit for the country's soils. For more information, refer to Wratt et al. (2008) 'Costs and benefits of climate change and adaptation to climate change in New Zealand agriculture: what do we know so far?' This report by EcoClimate Consortium was prepared for the Ministry of Agriculture and Forestry (now the Ministry for Primary Industries/MPI) in 2008.
Read the report on the Motu website.

However, the greatest benefits are likely to arise from changed behaviours and the way we use resources. Our understanding of climate change and our connection to the wider natural environment will influence the choices we make. These choices will have important implications for our health, our culture and our country's economy.



Planning for the unexpected

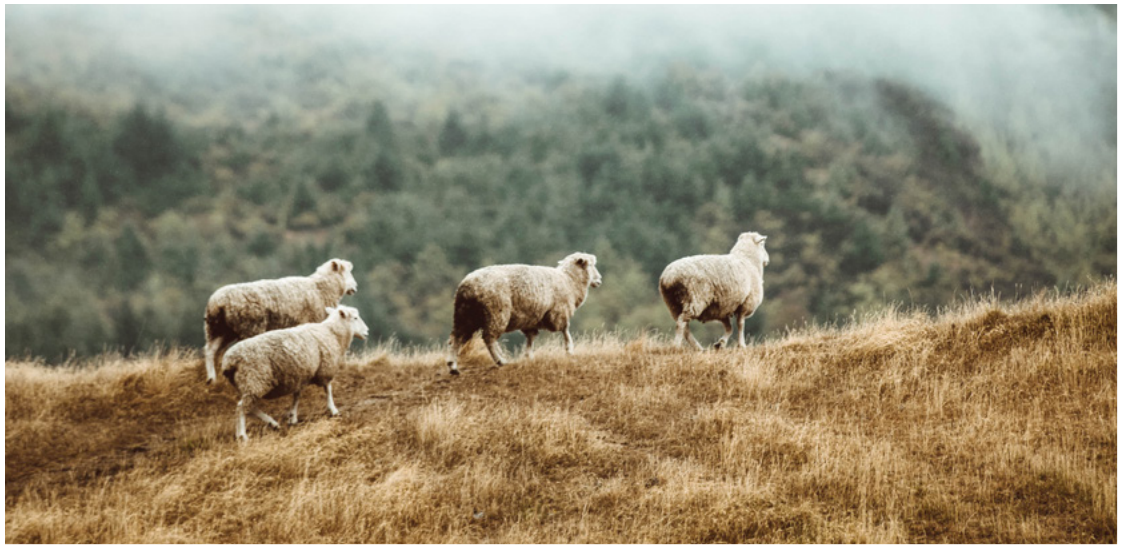
Globally, what could it look like?

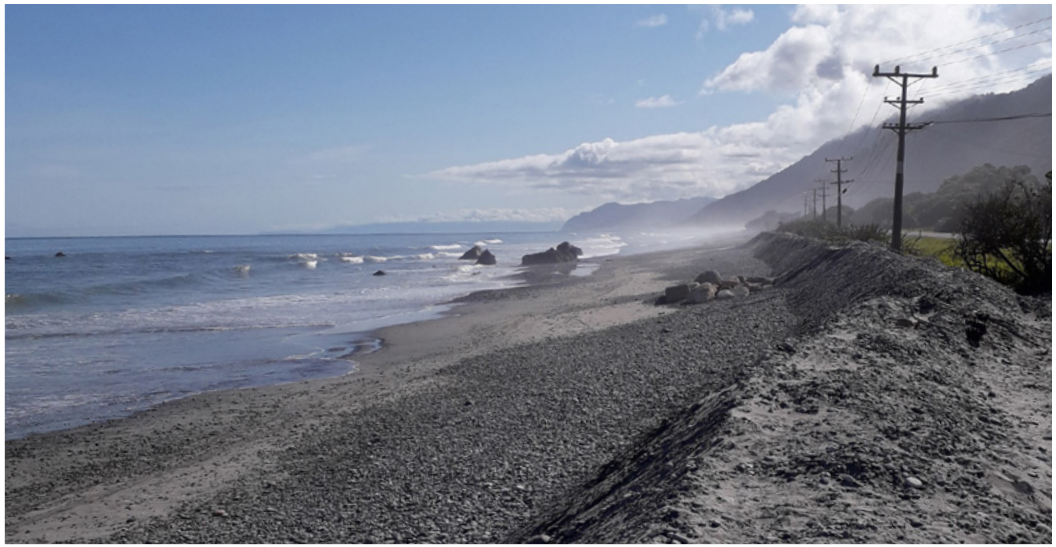
Since the late nineteenth century, the global average surface temperature has increased by more than 1.1°C – more in sensitive polar regions (NASA, 2017). Because of this, the effects of a warming climate are already obvious. The heat is melting glaciers and sea ice and shifting precipitation patterns. Rising temperatures have seen extreme weather events, shifting and declining wildlife populations and habitats, rising seas, and a range of other impacts. These changes are emerging as humans continue to add heat trapping gases to the atmosphere.

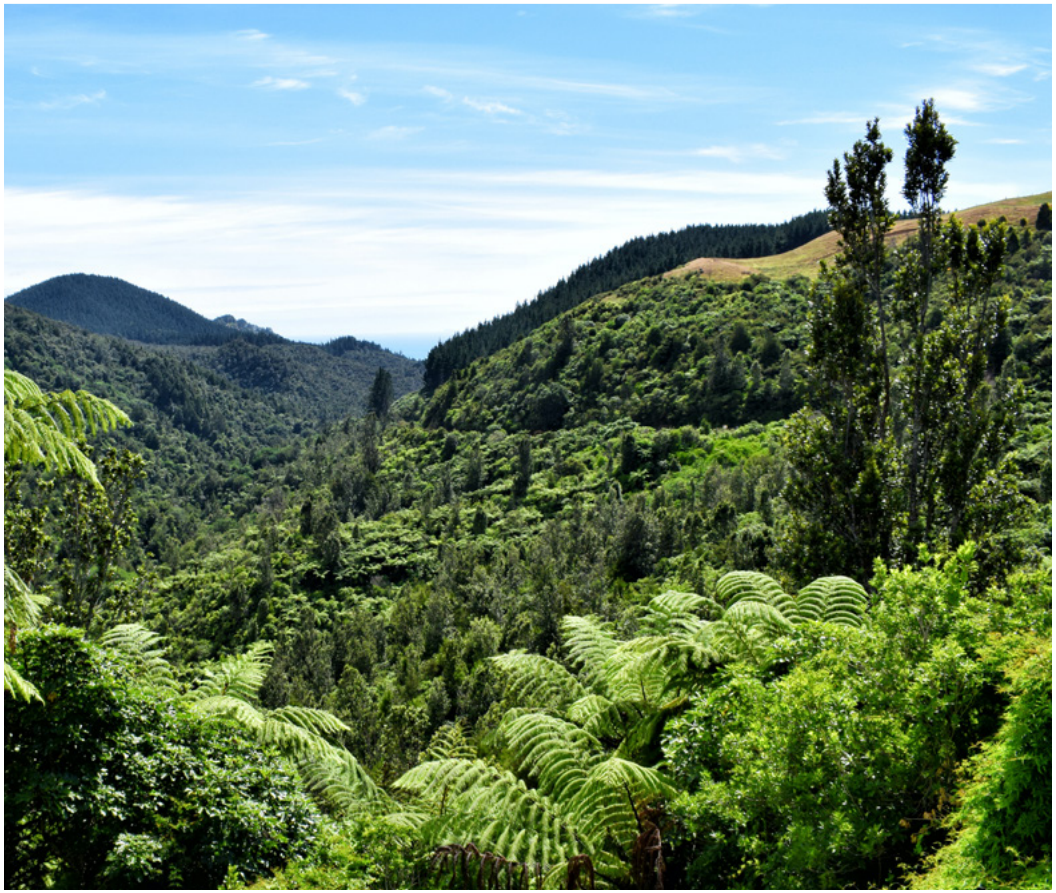
But what happens next? That will depend on the actions taken to mitigate the amount of harmful heat trapping gases released into the air – thus reducing the amount of warming that occurs. Climate change's impacts on individual countries and regions will vary over time, as will the ability to mitigate and adapt to change. The IPCC (2019) predicts that increases in global mean temperature of less than 1 to 3°C above 1990 levels will produce beneficial impacts in some regions and harmful ones in others. This includes social and economic factors and the way these play out between countries across different mitigation strategies and pathways.

However, it is widely agreed that if warming continues, the consequences that may arise later this century include:

- sea-level rise of between 0.6 and 1.1m by the end of the century (IPCC, 2019)
- increase in the regularity and severity of hurricanes and other storms as well as floods and droughts
- less availability of fresh water (as glaciers store about three-quarters of the world's freshwater)
- spread of diseases such as mosquito-borne malaria
- changing ecosystems causing species to move farther north or south depending on the hemisphere; some species (e.g. polar bear) won't be able to adapt and could become extinct (Pearson, 2006).







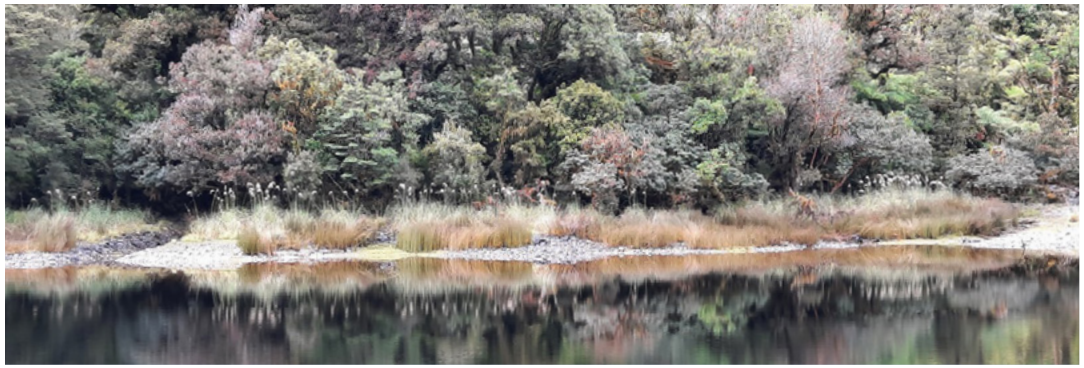
Our place: Aotearoa New Zealand

The impacts of climate change will be widely felt across Aotearoa New Zealand. The effects will depend on where you live and on your climate zone (see: 'Module one: Climate change – Systems, climate and weather'). What is known is that Aotearoa New Zealand is already experiencing higher land and sea temperatures. The sea rose 14 to 22 centimetres in the last century, the oceans are acidifying, there is more sunshine, and the country's glaciers have lost a quarter of their ice in the past 40 years. Some regions have drier soils, altered rainfall patterns, fewer frost days and more warm days. Extreme wind has also increased in some places. Studies suggest flood and drought events have worsened, and there is also a higher likelihood of these occurring. Many impacts, such as erosion from extreme rainfall, cannot be reversed. These effects are expected to intensify in the coming decades and all aspects of life in Aotearoa New Zealand will be affected. a. For more information, refer to 'Environment Aotearoa 2019', prepared by the Ministry for the Environment & Stats NZ (2019). The following table from the Ministry for the Environment provides an overview of the most likely short, medium, and long-term impacts of climate change on Aotearoa New Zealand. Some are positive, some less so. Many impacts will be like those experienced elsewhere around the world.

Impacts of climate change

Higher temperatures	• People are likely to enjoy the benefits of warmer winters with fewer frosts, but hotter summers will bring increased risks of heat stress and subtropical diseases • There may be a reduction in demand for winter heating meaning lower costs, reduced fossil fuel consumption, and reduced stress on those who cannot afford electricity • Both direct and indirect adverse effects on native biodiversity
Flooding	• More frequent intense winter rainfalls are expected to increase the likelihood of rivers flooding and flash flooding when urban drainage systems become overwhelmed (accompanied by increased risks to human health and safety, and to animal safety and welfare) • Loss of wildlife habitat
Water resources	• Water demand will be heightened during hot, dry summers • Risks to the supply of safe drinking water • Longer summers with higher temperatures and lower rainfall will reduce soil moisture and groundwater supplies • Drought intensity will likely increase over time; drier conditions in some areas are likely to be coupled with more frequent droughts • River flows are likely to be lower in summer and higher in winter • Loss of aquatic habitat – both quality and quantity • Increased stress on those directly dependent on secure water supplies, including irrigation and rainwater for crop growth • Lower river flows in summer will raise water temperatures and aggravate water quality problems (e.g., through increased algae growth) • Increased flows and lake levels on the west of the South Island
Sea-level rise	• Rising sea levels will increase the risk of erosion, inundation, and saltwater intrusion, increasing the need for coastal protection where possible • Dislocation of communities in some coastal areas, with attendant impacts on mental wellbeing
Health	• Higher levels of human loss of life related to summer heat are expected • Higher winter temperatures may lead to a reduction in winter related human mortality and illnesses such as colds and flu • Increased stress as people and communities are impacted by the climate crisis • Lifestyle adaptations could have significant health benefits including via changes to diet and modes of transport
Built environment	• Increased temperatures may reduce comfort of occupants in domestic, commercial, and public buildings and could lead to disruptions to business
Transport	• Hotter summers may damage elements of transport infrastructure causing buckled railway lines and damaged roads – with associated disruption and repair costs
Agriculture	• Agricultural productivity is expected to increase in some areas, with opportunities to improve yield and move to higher value crops • Risk of drought and spreading of pests and diseases • Financial costs associated with changing land-use activities to suit a new climate
Business and finance	• Households may find it more difficult to access adequate insurance cover in the face of increased flood risk • Fruit and vegetable growers may find it more expensive to insure against weather related damage (e.g., from hail) • The risk management of potential climate change impacts may provide significant opportunities for businesses

Please note: This table supports the activity Visual Arts – Climate change and possible impacts for Aotearoa New Zealand.



How will it affect wildlife?

Climate change is already affecting wildlife all over the world. For many species it adds another pressure to those that already threaten their survival, such as the destruction of habitats for human use and the encroachment of pests and introduced predators. Certain species are suffering more than others. Polar animals – whose icy natural habitat is melting in the warmer temperatures – are particularly at risk. Experts believe that Arctic sea ice is melting at an alarming rate – 13% per decade (NSIDC/NASA, 2021). Polar bears need sea ice for hunting prey, for raising young and for resting after long periods of swimming. Certain seal species, like ringed seals, make caves in the snow and ice to raise their pups, feed and mate. And it's not just polar animals that are in trouble. Apes, such as the orangutans that live in the rainforests of Indonesia, are under threat from habitat loss, and from the wildfires that occur as droughts become more frequent.

In Aotearoa New Zealand, all our native species and ecosystems will eventually be affected by climate change, either directly or indirectly. The following ecosystems and species will be especially vulnerable (Yale Environment 360, 2016):

- Alpine ecosystems are refuges for many of our bird, lizard and invertebrate species, and contain a great diversity of plant species. However, as temperatures rise, increased animal pest pressure (e.g. from hedgehogs, rats, wasps) is expected as the range of pest species expands to higher grounds. In the long-term, alpine zones will also experience increased woody growth as tree lines and scrub moves upslope, reducing the alpine habitat.
- Freshwater ecosystems will be particularly vulnerable as they are already subject to high levels of land-use pressure (e.g from human use and contamination). Native freshwater plants and animals will be impacted by climate change both directly (e.g. from increased flood frequency, lower water levels from drought), and indirectly (e.g. from increased water use and from encroachment by pests and weeds able to live in warmer water).
- Coastal ecosystems (estuaries, coastlines, and offshore island habitats) will be 'squeezed' against developed land by rising sea levels. Storm surge and increased sedimentation linked to increased flood frequency will also affect these ecosystems.
- Vulnerable native species may lack the ability to adapt to the impacts of a changing climate at the rate expected and may need us to specifically intervene.
- Land/forest damaged by wildfire. Not only are habitats destroyed, but the remaining land is left prone to erosion, land slumps, and sediment run-off that can cause further damage by polluting waterways. These predictions show just how important it is to recognise the interconnectedness of our global systems: the relationships between plants, animals, their environments and us (USEPA, 2017). The far-reaching consequences of excess heat trapping gas emissions will affect us all.

Impact on human mental wellbeing

Climate change will have direct and indirect impacts on psychological wellbeing. After climate related extreme weather events such as storms and fires, common human reactions include stress, anxiety, grief, social tension, feelings of displacement, relationship conflicts, cognitive decline and greater rates of mental health disorders such as post-traumatic stress disorder and depression. Learning and understanding about climate change also affects people. Confronting the reality of climate change – even without exposure to a direct event – may lead to anxiety, depression, despair, aggression, and a host of other emotional upheavals. In 2017 the Royal Society of New Zealand produced a report on the impact of climate change on New Zealanders' health. The report recognises many ways in which our health and wellbeing will be affected.

Learn more about impacts on human wellbeing (Royal Society website).

MODULE FOUR

Teaching and learning sessions

Referenced worksheets can be found at the end of the module.

Session one: A global response

Learning intentions

Ākonga will learn about the global, systematic response to climate change. They will develop an understanding of the ways in which their actions and ideas can add to this collective response.

Activity: Video – 'A brief history of climate change 2021'

What you need: Session two, Activity: Timeline – A changing climate: significant moments in history (Module two)

This short video takes ākonga on a journey to explore human activity and climate change. After watching the video, discuss and add to the timeline from 'Module two, Session two: A changing climate: Significant moments in history'.

Watch the video 'A brief history of climate change 2021'.

Session two: Connecting with nature

Learning intentions

Ākonga are encouraged to connect with nature as they learn about and respond to climate change. Building this connection helps learners to draw inspiration and hope from nature.

Activity: Poetry

Climate change can be complex to understand, to teach, and to respond to. Connecting with nature has a special capacity to calm, inspire and energise us. It reminds us that all living things are interconnected. The activity 'Create a poem inspired by nature' invites ākonga to listen carefully to nature and write their own poem. Learn more about the activity, including resources, by visiting the Department of Conservation (n.d.) website, 'Create a poem inspired by nature'.

Teacher/Kaiako reflection and wellbeing check.

Session three: The look and feel of climate change

Learning intentions

Ākonga learn about the potential impacts of climate change on Aotearoa New Zealand using reflection and visual arts.

What you need:

- digital devices
- art supplies.

Activity: Visual arts – Climate change and possible impacts for Aotearoa New Zealand

What you need: Worksheet 1: Impact of climate change

Teacher PLD: Before the lesson, learn more about climate change and art in 'What the warming world needs now is art, sweet art' by McKibben (2005).

The impacts of climate change on Aotearoa New Zealand are varied and far-reaching. It will touch every corner of our lives: people, species, ecosystems, economy and business. It will affect infrastructure and alter the places we visit and enjoy. However, climate change also presents new opportunities to do things better and smarter.

Using 'Worksheet 1: Impact of climate change', invite the ākonga to read, before choosing an area/s that interests them the most. Using the medium of visual arts, ask them to develop and refine visual ideas in response to their chosen area of interest. They may want to research their area more in order to develop and express their ideas fully. This may include exploring existing climate change artwork.

Activity: Videos

The following two videos highlight the direct impacts of climate change on Te Pātaka o Rakaihautū Banks Peninsula, Aotearoa New Zealand and the Pacific Islands.

What you need: Worksheet 2: Climate change – environmental, social, economic, and cultural impacts

Before watching the videos, share 'Worksheet 2: Climate change – environmental, social, economic, and cultural impacts' with the ākonga. Discuss how climate change is more than just an environmental issue. Its impacts are also felt socially, culturally and/or economically. At this stage, teachers/kaiako can offer one example of a consequence of climate change such as extreme flooding, before discussing the environmental, social, cultural and economic impacts of such an event.

Video 1: 'The Banks Peninsula Drought – Has Climate Change Arrived?'

Te Pātaka o Rakaihautū Banks Peninsula is situated not far from Ōtautahi Christchurch. The short video from the web series Frank – Changing South (2021) discusses the impact of the drought and its connection to climate change. "The dry" is a term normally associated with the arid landscape of Australia. Now, this terminology is being used through much of Aotearoa New Zealand's east coast. Data from the eastern bays of Te Pātaka o Rakaihautū Banks Peninsula recorded only 44 mm of rain between January and March. The average for this period is 148 mm.

Watch 'The Banks Peninsula Drought - Has Climate Change Arrived?' on YouTube.

As the ākonga watch the video, ask them to note on Worksheet 2 how the drought is affecting landowners and residents environmentally, economically, socially and culturally.

After watching the video, discuss with the ākonga their findings and feelings about the impact of the drought on the community.

Video 2: 'Youth on the Climate Front lines on the Pacific Islands'

Youth are leading the charge against climate change in Pacific island countries that are especially vulnerable to its damaging effects. In Fiji, Vanuatu and Tuvalu, the tropical environment faces cyclones and other threats. This short United Nations (2019) video shares the urgent call from Pacific Island youth for the world to act now.

Watch 'Youth on the Climate Front lines on the Pacific Islands' on YouTube.

Using Worksheet 2, ākonga watch the video 'Youth on the Climate Front lines on the Pacific Islands'. At the end of the video, invite them to research further impacts of climate change on the Pacific Islands, including positives (such as new technology and job opportunities), as well as negatives.

Session four: Understanding impacts: ocean acidification

Learning intentions

Ākonga investigate the processes causing ocean acidification, the impact of those changes, and the relationship to climate change.

Activity: Experiment – Ocean acidification

What you need:

- 3 eggs (Check that using food in an experiment is appropriate in your community. There might be local protocols that make it safe for you to do so.)
- 3 beakers, or clear glass jars with lids to avoid spills (container should have at least 300 ml capacity)
- 250 ml tap water
- 50 ml vinegar
- 50 ml household ammonia.

Note: The amount of liquid required may vary according to the size of container used.

Aotearoa New Zealand and our surrounding Pacific neighbours are experiencing ocean acidification. This is not caused by climate change but is a result of the same things that cause climate change, i.e. the increasing release of carbon dioxide (CO_2) due to the use of fossil fuels. Oceans and the atmosphere are constantly exchanging gases. About one third of the carbon dioxide (CO_2) released into the atmosphere is absorbed by our oceans. Without this process, the earth would be much hotter today than it is. However, as more carbon dioxide (CO_2) is produced it is absorbed by the oceans, causing them to become more acidic. In this experiment, ākonga observe how chicken eggs can be used to simulate the potential effects of increasing ocean acidity on marine animals. The calcium in the eggshells represents the calcium carbonate from shells or skeletons present in the ocean, e.g. bryozoans and cockles. For the full experiment background and method, visit the Science Learning Hub (2009) website.

Wellbeing check

Understanding our feelings about climate change, pages 5–6

Additional resources and activities to support all sessions

'Project Drawdown': (2017–2020) drawdown.org. The mission of Project' Drawdown' is to: "help the world reach 'drawdown' – the point in the future when levels of greenhouse gases in the atmosphere stop climbing and start to steadily decline, thereby stopping catastrophic climate change – as quickly, safely, and equitably as possible".

Impacts and tipping points: David Attenborough and Greta Thunberg's plea for the planet provides an overview of how science is leading our global response to climate change. It lays down a challenge: have the wisdom to find the solutions and the courage to back it. Watch the World Economic Forum video on YouTube.

'Glaciers Don't Lie' (NIWA): If you think New Zealand's Southern Alps are shielded from climate change, watch the video 'Glaciers Don't Lie' (NIWA).

'Forecast from the future: Weather 2050': This short video from NIWA shows what a weather forecast in Aotearoa New Zealand might look like in 2050. Watch 'Forecast from the future: Weather 2050' (NIWA) video.

'Thirst' by Paul Mason, *School Journal Level 3 August 2015*. In a realistic story set in the not-too-distant future, Paul Mason conveys a message that has increasing relevance today. The plot involves a family that cannot afford to buy water during a severe drought. The company with a monopoly on the supply of drinking water employs the parents in the story. When their neighbours receive a delivery of water, Ryder decides to take matters into his own hands. Read the story 'Thirst'.

WORKSHEET 1: Impacts of climate change

Higher temperatures	• People are likely to enjoy the benefits of warmer winters with fewer frosts, but hotter summers will bring increased risks of heat stress and subtropical diseases • There may be a reduction in demand for winter heating meaning lower costs, reduced fossil fuel consumption, and reduced stress on those who cannot afford electricity • Both direct and indirect adverse effects on native biodiversity
Flooding	• More frequent intense winter rainfalls are expected to increase the likelihood of rivers flooding and flash flooding when urban drainage systems become overwhelmed (accompanied by increased risks to human health and safety, and to animal safety and welfare) • Loss of wildlife habitat
Water resources	• Water demand will be heightened during hot, dry summers • Risks to the supply of safe drinking water • Longer summers with higher temperatures and lower rainfall will reduce soil moisture and groundwater supplies • Drought intensity will likely increase over time; drier conditions in some areas are likely to be coupled with more frequent droughts • River flows are likely to be lower in summer and higher in winter • Loss of aquatic habitat – both quality and quantity • Increased stress on those directly dependent on secure water supplies, including irrigation and rainwater for crop growth • Lower river flows in summer will raise water temperatures and aggravate water quality problems (e.g., through increased algae growth) • Increased flows and lake levels on the west of the South Island
Sea-level rise	• Rising sea levels will increase the risk of erosion, inundation, and saltwater intrusion, increasing the need for coastal protection where possible • Dislocation of communities in some coastal areas, with attendant impacts on mental wellbeing

Health	• Higher levels of human loss of life related to summer heat are expected • Higher winter temperatures may lead to a reduction in winter related human mortality and illnesses such as colds and flu • Increased stress as people and communities are impacted by the climate crisis • Lifestyle adaptations could have significant health benefits including via changes to diet and modes of transport
Built environment	• Increased temperatures may reduce comfort of occupants in domestic, commercial, and public buildings and could lead to disruptions to business
Transport	• Hotter summers may damage elements of transport infrastructure causing buckled railway lines and damaged roads – with associated disruption and repair costs
Agriculture	• Agricultural productivity is expected to increase in some areas, with opportunities to improve yield and move to higher value crops • Risk of drought and spreading of pests and diseases • Financial costs associated with changing land-use activities to suit a new climate
Business and finance	• Households may find it more difficult to access adequate insurance cover in the face of increased flood risk • Fruit and vegetable growers may find it more expensive to insure against weather related damage (e.g., from hail) • The risk management of potential climate change impacts may provide significant opportunities for businesses

WORKSHEET 2: Climate change – environmental, social, economic, and cultural impacts

Environmental	Social	Economic	Cultural

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