

Health and climate change: adaptation policy in Aotearoa New Zealand



Famaz Pourzand,^a Annette Bolton,^b Claire Salter,^b Simon Hales,^{a,*} and Alistair Woodward^c

^aUniversity of Otago, Wellington, New Zealand

^bInstitute of Environmental Sciences and Research (ESR), Christchurch, New Zealand

^cUniversity of Auckland, Auckland, New Zealand



Summary

Recent extreme weather events attributable to climate change have major implications for policy. Here we summarize and evaluate the current state of climate change adaptation policy, from a health perspective, for Aotearoa New Zealand, based on government sources. Legislation relating to both environmental management and health are currently subject to major reforms. At present, adaptation policy emphasises protection of health care facilities from climate extremes; there is insufficient attention paid to broader determinants of health. We argue for greater health input into adaptation planning. Without intersectoral collaboration, contributions from diverse communities, and better support of indigenous solutions, climate change policy is unlikely to achieve effective health outcomes and there is a risk that climate change will exacerbate inequities. We recommend that the Climate Change Commission engage formally and directly with health bodies to strengthen the Commission's advice on the implications of climate change, and of national climate change policies, on health and equity. Climate resilient development does not occur without better public health. For this reason, the health sector has a critical role in the development and implementation of adaptation policy.

The Lancet Regional Health - Western Pacific 2023;40: 100954

Published Online 15 November 2023

<https://doi.org/10.1016/j.lanwpc.2023.100954>

Copyright © 2023 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Keywords: Climate change; Human health; Policy; Adaptation; Transformation

Background

“[Aotearoa New Zealand] faces an extremely challenging future. Reducing climate-related health risks would require significant and rapid global emission reductions to limit temperatures to 1.5 °C–2.0 °C, as well as robust and timely adaptation. The projected warming under current global emissions reduction policies would leave many of the region's human and natural systems at very high risk and beyond adaptation limits.¹”

Climate change mitigation is an urgent global priority. The health damaging effects in Aotearoa New Zealand were demonstrated by floods and storms that affected northern parts of the country in early 2023.² Climate change affects human health directly, via extreme meteorological events; (deaths and injuries from storms, floods, heatwaves and fires); indirectly, due to changes to the environment and ecosystems; (increases in temperature and/or changes in rainfall patterns affecting food production, food availability, diets and nutrition; altered transmission of communicable diseases) and due to social and economic changes. All of the above impacts will have important effects on

livelihoods, household costs and the distribution of income. In turn, these changes have important health impacts.³

In this paper, we summarise, in turn, key climate risk drivers; potential climate-sensitive health risks; relevant climate change policy, legislation and activities, in Aotearoa New Zealand. Finally, we summarize and evaluate the current state of climate adaptation policy, from a health perspective, in Aotearoa in mid-2023. We end with some recommendations.

Key climate risks under current and projected climate

Aotearoa New Zealand is currently experiencing rising average temperatures, more extreme temperatures, changing rainfall patterns and sea level rise. The national average temperature has risen by 1.2 °C over the past century, at an average rate of 0.10 °C per decade.⁴ Climate models project that average temperatures will continue to increase by a further 0.6 °C–1.32 °C by mid-century, and between 1.03 °C and 2.26 °C by the end of the century (relative to 1995–2014). Temperature increases are expected to be larger in summer, and be greater in northern and eastern areas, and at higher altitudes.⁵

Changes in weather extremes are likely to have more severe effects than changes in mean conditions, in the

*Corresponding author.

E-mail address: simon.hales@otago.ac.nz (S. Hales).

short term at least. Regional modelling projects more hot and fewer cold nights. In a high emission scenario, the frequency of days with temperatures exceeding 25 °C is anticipated to rise by 50–100% by 2040 and by 130–350% by 2090. Under a low emission scenario, it is expected that the number of days surpassing 25 °C will increase by 20–60% by 2040 and by 20–60% by 2090.⁶

Climate change is anticipated to intensify the hydrological cycle. This increases the frequency and intensity of extreme hydrological events, such as heavy rainfall, atmospheric rivers,⁷ storm surges, droughts, and floods in many regions. Projections of these impacts are less certain than those of temperature. The intensity of heavy rainfall is projected to increase in most areas. Increases in winter and spring rainfall are projected in the west as a result of increased westerly winds. Increases in summer rainfall are projected in the east. As a result of reduced rainfall and higher temperatures, drought frequency may increase in the north.¹

There is high confidence that fluvial and pluvial flooding and coastal flooding from sea level rise will increase due to changes in climate. This will affect communities on floodplains and in low-lying coastal areas.⁸ The expected increase in river flooding is 5–10% by 2050 in many parts of the country.⁵ In addition, land-use change, rapid urbanization, and existing and increasing urban development of flood plains and coastal areas contribute to flood risk.⁹ Flood hazards cause crops and livestock losses, damage to buildings, homes/kāinga, infrastructure and cultural sites such as urupā (burial grounds).

Climate change is also an important contributing factor to sea level rise in Aotearoa New Zealand. Similar to the rate of global average sea level rise, the local sea level has risen, on average, by 1.81 (±0.05) millimetres per year on average. Future climate change projections reveal that sea levels will continue to rise, caused by the melting of glaciers and ice sheets combined with thermal expansion of sea water and vertical land movement. By 2050, it is expected local sea levels may rise by approximately 23 cm (RCP2.6) or 28 cm (RCP8.5). By 2090, climate change projections indicate a rise of about 42 cm (RCP2.6) or 67 cm (RCP8.5). Rising sea levels and storm surges will have increasingly severe impacts on infrastructure, coastal communities, coastal habitats, and biodiversity.⁸

Consequently, all of these changes pose significant direct and indirect threats to human health and livelihoods in various ways with immediate to long-term consequences.

Potential climate-sensitive health risks

Direct risks to health

The direct health risks associated with climate change include injuries and fatalities, resulting from changes in the intensity and frequency of natural hazards like heat waves, flooding, droughts, and fires.

Rising temperatures can increase the risk of heat-related illnesses such as heat exhaustion, heatstroke, and dehydration. For instance, it was estimated that 14 deaths related to heat occur per year in Auckland and Christchurch. The projected numbers of deaths per year were 28, 51, and 88 for average global warming of 1, 2, and 3 °C above the current temperature levels, respectively.¹⁰

Old and young populations, occupational groups such as outdoor workers, and people with mental health conditions are especially vulnerable to high temperatures. Furthermore, high temperatures have been associated with aggressive behaviour, violence, and suicide.^{11–13}

Empirical studies of short-term associations between weather variables and health impacts in Aotearoa have demonstrated direct effects of heat on mortality in Christchurch¹⁴ and of cold weather and hospital admissions for respiratory diseases in Auckland.¹⁵

Indirect risks to health

Changes in rainfall patterns and extreme weather events can impact water quality and increase the risk of waterborne diseases. Flooding interacts with agricultural run-off, potentially influencing the occurrence of diseases transmitted through contaminated drinking and recreational water, leading to outbreaks of diarrheal diseases, as was seen with the *Campylobacter* outbreak in Havelock North, Hawke's Bay region in August 2016.¹⁶ Contamination of recreational water sites can impact customary practices such as mahinga kai (gathering of wild food). Extreme precipitation events increase the risks of wastewater treatment facility failure or combined sewer overflow (wastewater overflows),^{17,18} leading to contamination of community water supplies or private groundwater wells, along with other untreated or minimally treated drinking water sources. Notifications of salmonella¹⁹ cryptosporidium and giardia^{20,21} were associated with weather variables, while heavy rainfall has been linked to hospital admissions for enteric diseases in children.²² Seasonal patterns of mortality²³ and enteric diseases,²⁴ are consistent with the short-term associations described above.

Local transmission of mosquito-borne diseases has not been recorded in Aotearoa New Zealand. Modelling of the potential for transmission of vector borne diseases in Aotearoa suggests that risks are likely to remain low for both dengue and malaria, even under high emissions scenarios, up to the end of the century.^{25,26} Arboviruses present in Australia, including Ross River virus and Barmah Forest virus are already a risk under current climate conditions in Aotearoa, should suitable vectors become established here.²⁷

Social and economic impacts of extreme events

Droughts and floods are the most damaging and costly natural hazards. Between 2007 and 2017, extreme rainfall-attributed insured losses cost \$NZ140 million, and the financial damages associated with the two most

significant summer droughts were estimated at \$NZ800 million according to the Insurance Council of New Zealand's data.²⁸

Extreme events, such as the severe 2023 January floods and February Cyclone Gabrielle hit northern and eastern regions of the North Island. A total of 15 individuals lost their lives, while over 10,500 people were displaced, with many facing the unfortunate reality of permanent displacement from their devastated homes. The affected region includes many disadvantaged communities and the storms and floods will increase health inequities. There are likely to be major long term health impacts as a result of loss and damage to housing, displacement and disruption to livelihoods.² According to the Treasury the economic losses are expected to exceed the \$2bn–\$4bn of losses of the 2016 Kaikōura earthquake.²⁹

Droughts and floods can often reduce agricultural productivity, leading to crop failures, food shortages, and ultimately increased food prices.³⁰ These factors contribute to food insecurity, malnutrition, and inadequate access to nutritious food, which can have long-term consequences on population health and development.

Drought can cause economic hardships, particularly in agricultural-dependent regions. Loss of income and livelihoods, increased unemployment, financial stress, limited educational opportunities, and loss of cultural traditions³¹ can have indirect health impacts, including mental health issues such as suicide^{32,33} and reduced access to healthcare.³⁴ In addition, conflict over limited water resources, increased social tensions, and disrupted community dynamics can impact overall well-being and mental health.^{35,36}

However, identifying the distributional consequences of the impacts is crucial because, indirectly, certain sectors or groups may derive benefits from drought events. For example, drought-induced increases in prices can lead to competition between farmers in unaffected areas and those affected by drought, resulting in potential benefits for farmers in unaffected regions.³⁰ Drought events in some regions of Aotearoa have the potential to boost the revenue and profits of dairy farms in other regions, given that Aotearoa holds a significant position as a market maker in the global milk powder market. This occurs when drought-induced factors contribute to an increase in global prices.^{37,38}

In recent years, Aotearoa has experienced larger wildfires occurring earlier in the year, which can be attributed to the significant role played by climate change in intensifying the severity and duration of fire seasons.³⁹ Between July 1, 2020 and June 27, 2021, there were 4586 fires reported, resulting in the burning of approximately 13,348 ha of land. This represents a considerable increase compared to the previous season and exceeds both the 5-year and 10-year averages. Notably, two-thirds of the country's wildfires occurred in

the North Island, while the South Island (Mid-South Canterbury and Otago districts) accounted for 88% of the total burned area.⁴⁰ Regardless of climate mitigation efforts, on average, there will be an increase in fire risk, including the length of fire weather conditions during the season and the intensity of fires that could occur, until at least mid-century. Areas that are prone to seasonal drought and arid conditions have been identified as having the highest levels of fire danger.³⁹ Wildfires pose a range of direct and indirect health risks such as presentations to emergency departments with respiratory and cardiovascular conditions, mental distress, contamination of water supplies, loss of livelihoods, loss of biodiversity and indigenous species.

Climate change can result in forced migration, displacement and changing population demographics. Displaced populations often face challenges in accessing adequate healthcare, sanitation, and clean water, increasing the risk of infectious diseases, household crowding and mental health issues. Increased stress, anxiety, depression, post-traumatic stress disorder and other mental health issues can arise due to the trauma and disruption caused. Furthermore loss of connection to land (whenua) or water (wai) can affect iwi/hapu Māori access to ancestral knowledge sense of belonging and can poses risks to mental and spiritual health.⁴¹

Vulnerable population groups

The vulnerability of individuals to climate change is influenced by their level of exposure to change in climate, their sensitivity to the impacts of climate change, and their ability to effectively prepare for, respond to, cope with, and adapt to these changes.

Rural communities are expected to face the consequences of climate change earlier and more severely than urban populations. Reasons for this include primary industry livelihoods (such as agriculture, fishing, and forestry) at risk due to climate change; remote coastal communities facing high vulnerability to storm surges; coastal erosion and rising seas; low-income rural communities with lower quality housing; and critical infrastructure vulnerabilities such as dependence on untreated drinking water sources.^{42–44}

Many rural populations include a higher proportion of Māori (Indigenous people of Aotearoa New Zealand) than urban areas.⁴⁵ In general, Māori are expected to face higher vulnerability to the impacts of climate change due to their increased exposure to environmental risks.⁴⁶ For instance, many Māori reside in areas, particularly in the north and east, where temperatures are projected to rise most quickly. The Māori economy relies heavily on climate-sensitive primary industries, such as forestry and fisheries.⁴⁷ Anthropogenic climate change has been described as an intensification of the process of colonization, which caused loss of Māori land and other assets, and entrenched disadvantage.^{48,49} The IPCC acknowledges that loss and separation and

enduring harms due to colonization increase vulnerability to climate change.⁵⁰ One example is the unjust and disproportionate burden of chronic disease borne by Māori.⁵¹⁻⁵³ Other groups at greater risk of adverse health impacts from climate change include older people, disabled people and children.³

Climate change and health legislation

Legislative and policy frameworks relevant to climate change and health at international, regional, national, and local levels are summarized in Table 1. There is an emphasis on the interconnectedness of disaster risk resilience and climate related mitigation and adaptation and how that supports health outcomes, climate environmental health, community well-being, and sustainable development. Early adaptation and a comprehensive approach can provide health benefits in addition to preventing adverse climate change effects. For example, improving climate resilience and thermal performance of buildings will protect against health impacts of seasonal changes in weather, as well as the

increased frequency of extreme events attributable to future climate change. Indigenous knowledge, perspectives and principles can inform climate change adaptation strategies to promote equitable and culturally appropriate health outcomes. This requires understanding our collective responsibilities of environmental stewardship (kaitiakitanga) and upholding Te Tiriti o Waitangi, an agreement made in 1840 between Māori and the Crown. According to Te Tiriti, the health system bears the responsibility of:

- whanaungatanga - working in partnership and relationship with Māori,
- kāwanatanga - governance and stewardship of the health and disability system to deliver equitable outcomes,
- tino rangatiratanga - enabling Māori self-determination and authority,
- ōritetanga - delivering equitable health outcomes, and
- wairuatanga - respecting Ritenga Māori (Māori customary rituals)⁵⁴

International commitments	Regional commitments	National commitments	Local government commitments
<p>Sustainable Development Goals (SDGs) The SDGs emphasize the interconnectedness of economic, social, and environmental dimensions of sustainable development. SDG-related efforts contribute to health improvement, as seen in SDG-specific goals that intersect with health. Climate change is intrinsically linked to health outcomes, making these international goals significant for addressing climate-related health challenges. https://sdgs.un.org/goals</p> <p>United Nations Framework Convention on Climate Change (UNFCCC) The UNFCCC focuses on preventing anthropogenic interference with the climate system. This includes encouraging national adaptation plans (NAPs) to address climate risks. NAPs must integrate with greenhouse gas reduction efforts, reflecting the importance of climate adaptation for health. https://unfccc.int/topics/adaptation-and-resilience/workstreams/national-adaptation-plans</p> <p>Paris Agreement This agreement aims to limit global warming to 1.5 °C and reduce emissions. Aotearoa's commitment to reduce emissions by 30% by 2030 is significant for mitigating climate-related health impacts. It also emphasises adaptation through risk assessments, policies, and monitoring. https://unfccc.int/process-and-meetings/the-paris-agreement</p>	<p>The Sendai Framework This framework recognizes the importance of shared responsibility, including with local government, to reduce disaster risks. Addressing health risks resulting from climate change falls within its scope, aligning with its goal to protect health and well-being during environmental changes and disasters. https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030</p> <p>Western Pacific Regional Framework This framework advocates cross-sectoral measures to protect health from climate change, emphasizing the importance of adapting to climate-related health risks. https://www.who.int/publications/i/item/9789290618164</p> <p>Regional Climate Adaptation Regional adaptation strategies are vital for protecting health in changing climates. Aotearoa New Zealand, as a regional leader, can play a pivotal role in facilitating collaboration and supporting adaptation efforts among Pacific Island nations in the Western Pacific region to address its health-related impacts.</p>	<p>Resource Management Act (RMA) The reform of the RMA includes planning for natural hazards and climate change, and the creation of a Climate Change Adaptation Act. https://environment.govt.nz/assets/publications/RM-system-2023/New-resource-management-system-August-2023.pdf</p> <p>Climate Change Response (Zero Carbon) Amendment Act This legislation sets the framework for a low-emission, climate-resilient economy and recognizes the need to assess the health effects of climate change. https://environment.govt.nz/acts-and-regulations/acts/climate-change-response-amendment-act-2019/</p> <p>Climate Adaptation Act Under this act, health is one of the key considerations, recognising the broad health implications of climate change. This act is intended to address the complex and distinctive issues associated with managed retreat such as funding, compensation, land acquisition, liability and insurance https://environment.govt.nz/assets/publications/Adapt-and-Thrive-consultation-document.pdf https://www.legislation.govt.nz/act/public/2019/0017/latest/LMS30991.html.</p>	<p>Local government play's a critical role in managing climate change effects on health through land use controls and adaptation strategies. Their actions must align with national policies and consider health and well-being in their communities.</p> <p>Natural Hazards Management Local governments have responsibilities to mitigate natural hazards, including those related to climate change, and protect community health, aligning with national policies.</p> <p>Local Well-Being Approach Local governments' role in promoting social, economic, environmental, and cultural well-being aligns with the holistic health and well-being approach needed to address climate-related health challenges.</p>
Addressing climate-related health risks requires collaboration and alignment across all levels of governance.			
Table 1: Legislation relevant to climate change and health.			

Aotearoa New Zealand's health and disability system is undergoing reform in response to an ongoing Waitangi Tribunal Inquiry, the Health Services and Outcomes Kaupapa Inquiry, and the Health and Disability System Review.^{55,56} This inquiry highlighted the importance of establishing an independent Māori Health Authority and ensuring that Māori are actively involved in decision making regarding design and delivery of primary health services.

The health reforms are legislated via the Pae Ora (Healthy Futures) Act 2022 and include the following entities: —Manatū Hauora—Ministry of Health (which includes the Public Health Agency), Te Whatu Ora—Health New Zealand (which include the National Public Health Service), Te Aka Whai Ora—Māori Health Authority and Whaikaha—Ministry of Disabled People. The new legislation also recognises the role of Iwi-Māori Partnership Boards.⁵⁵ The health system reform is an opportunity to improve health equity by articulating Te Tiriti o Waitangi in legislation and the establishment of Te Aka Whai Ora (a crown entity) and Iwi-Māori Partnership Boards. Greater power sharing by the Crown in the health system is required to give full effect to Te Tiriti o Waitangi.^{46,57,58}

The Pae Ora Act and Te Pae Tata state that the health system should take action on climate change and highlight the need for intersectoral collaboration to address the wider determinants of health. However, Te Pae Tata is light on detail regarding levers that can be used to foster intersectoral collaboration beyond relationship building. The Health and Disability Review report remarks climate change provides both opportunities and pressure for Aotearoa New Zealand's population and wellbeing⁵⁵ but the advantages of early adaptation to benefit health are not mentioned.

Guidance on adaptation to climate change for local government is available, based on a risk assessment framework,⁵⁹ national climate change risk assessment,⁶⁰ and national adaptation plan.⁶¹ The national adaptation plan recommends the development of a Health National Adaptation Plan, and regional climate health action plans. The Health National Adaptation Plan is currently (October 2023) behind schedule, but under development.

Other health and sector specific plans may require refinement. For example, heatwaves are not identified as a potential hazard of national significance in the National Civil Defence Emergency Management Plan, but the National Health Emergency Plan does identify extreme weather as a hazard at local to regional scales. Consistency and periodic updates of plans are crucial to ensure that they effectively address emerging climate related challenges and potential evolving health risks, allowing for proactive and comprehensive responses to safeguard communities and enhance resilience.

Climate change and health adaptation activities

A summary of climate and health related adaptation activities in Aotearoa is shown in [Table S1](#). We derived documents in the table from: government documents or webpages that had climate change as the overarching focus and included reference to addressing human health adaptation initiatives; adaptation plans, national reports, adaptation assessments, vulnerability or risk assessment or changes to legislation.

We used a framework developed by Austin et al.,⁶² in which climate and health related adaptation activities were categorised into: Capacity building; Management, Planning and Policy; Information; Warning or Observation systems; Practice and Behaviour and Accountability. We also refer to these categories in the discussion. This list is not intended to be exhaustive, and it is recognised that some activities may be underway but not yet completed. Relevant agencies were contacted to verify the information in the table. Responses were received from Ministry of Health Manatū Hauora, Ministry for the Environment, National Public Health Service, Te Whatu Ora—Health New Zealand and Te Aka Whai Ora—Māori Health Authority.

National climate change risk assessment

The National Climate Change Risk Assessment identified priority risks across five domains: human, natural environment, economy, built environment and governance. Risks were assessed qualitatively, based on evidence and expert judgement, as: *insignificant*, *minor*, *moderate*, *major*, or *extreme*. The ten most significant risks included two from each domain; of these, the following were assessed to be extreme.⁶⁰

- Risks to social cohesion and community wellbeing from displacement of individuals, families and communities due to climate change impacts.
- Risks of exacerbating existing inequities and creating new and additional inequities due to differential distribution of climate change impacts.
- Risks to governments from economic costs associated with lost productivity, disaster relief expenditure and unfunded contingent liabilities due to extreme events and ongoing, gradual changes.
- Risks to potable water supplies (availability and quality) due to changes in rainfall, temperature, drought, extreme weather events and ongoing sea-level rise.
- Risks to buildings due to extreme weather events, drought, increased fire weather and ongoing sea-level rise.
- Risk of maladaptation across all domains due to practices, processes and tools that do not account for uncertainty and change over long timeframes.
- Risk that climate change impacts across all domains will be exacerbated because current institutional

arrangements are not fit for adaptation. Institutional arrangements include legislative and decision-making frameworks, coordination within and across levels of government, and funding mechanisms.

There are major implications for human health, but there has been no attempt to quantify the potential health impacts, beyond broad categories of risk. The National Climate Change Risk Assessment recognised that Māori are particularly vulnerable to climate change risks. Risks to mental health of Māori were assessed as “major”.⁶⁰ Risks to health from extreme climate events, vector-borne and zoonotic diseases, water availability and resource quality and accessibility were considered minor at present but increasing to moderate by 2050 and major by 2100.

National Adaptation Plan

The National Adaptation Plan recognises the interconnected nature of climate change risks across the domains, as well as the need to consider relationships and feedback between climate change mitigation and adaptation policies.¹ Although there are actions for improving the welfare system, community resilience and social cohesion, housing, transport, supporting Māori land owners, water security and biosecurity, there is little apparent recognition of the importance of intersectoral policy for health in the National Adaptation Plan.

The specific objective relevant to health in the National Adaptation Plan is that “The health sector is prepared and can support vulnerable communities affected by climate change”.⁶¹ The specific action proposed is to “assess healthcare service resilience” with the intention that:

“By 2024, guidance material is provided for the sector and a set of recommendations produced for Health New Zealand ... From 2023, regional assessments are completed as part of the next phase of health adaptation planning.”

The National Adaptation Plan includes a comprehensive range of actions to address the most significant climate change risks. The Ministry of Health is identified as the lead agency for reform of the health and disability system and development of the Health National Adaptation Plan, but is not explicitly considered as a relevant lead agency under any other adaptation responses.⁶¹

Recommendations

We now make recommendations on climate health adaptation policy in Aotearoa New Zealand. The proposed Health National Adaptation Plan will set out activities to be taken forward to address health resilience to climate change. However, at present, national policy

is limited to the climate resilience of health care facilities. This may reflect a narrow “biomedical” view of the determinants of health in the development of climate policy.

The Health National Adaptation Plan could consider the required responses to all major pathways by which climate change affects health outcomes. This includes more direct pathways, such as mortality from heatwaves, mental health impacts, availability of safe freshwater supplies and disruption to health care facilities. However, this alone will be insufficient: a focus beyond the health sector is needed to respond to indirect effects of climate change via disruption of social and economic systems. Climate resilience of health care facilities is important, but primary prevention of disease and the potential health co-benefits of climate change mitigation have not received sufficient attention.^{63,64} While health risks related to climate change have been estimated based on expert judgement, opportunities exist to quantify observed and projected health risks more accurately, to inform detailed policy recommendations.⁶⁵ Next, we consider the findings based on categories described by Austin et al.^{5,8}

Capacity building

There is an opportunity to co-ordinate and improve knowledge around the impacts of climate change and health, from an educational and capacity building perspective. This can include indigenous perspectives of climate change adaptation and an improved evidence base to support capacity building, policy development and adaptation activities.

Management, planning and policy

A range of policy levers may be applied to climate health adaptation. The Climate Change Response (Zero Carbon) Amendment Act 2019 sets out the framework to transition to a low emissions and climate resilient economy.⁵⁹ The Act directs that the National Adaptation Plan considers economic, social, health, environmental, ecological, and cultural effects of climate change, including effects on hapū, iwi and whānau Māori.

Co-ordinated effort is required to achieve adaptation that influences positively the broad determinants of health. Public Health England and now the United Kingdom Health Security Agency provide good examples. Their actions include scientific evidence on the health impacts of climate extreme events and a Single Adverse Weather and Health Plan which replaces the Heatwave and Cold Weather Plans for England, and provides guidance on cold and hot weather, drought and flooding.⁶⁶

Practice and behaviour and information

Health professionals will be needed to carry out important public health messaging and education with a focus on prevention, mitigation and adaptation. This may require the development of new educational

Search strategy and selection criteria

We derived documents in [Table S1](#) from: government documents or webpages that had climate change as the overarching focus and included reference to addressing human health adaptation initiatives; adaptation plans, national reports, adaptation assessments, vulnerability or risk assessment or changes to legislation.

material as potentially new risks emerge. Public health professionals will need to be well connected to researchers, who in turn need to be well resourced to detect emerging direct and indirect health impacts and determine those most at risk.

Warning or observing systems

Existing and potentially new climate related health risks should be monitored so that alerts and responses can be prepared for. Health surveillance and weather forecasts are key components of these systems. More focus is needed to understand the relationship between weather and health impacts, particularly in terms of environmental shifts (e.g. increased rainfall and enteric diseases).

Accountability

To date, the Climate Change Commission has focussed mainly on mitigation policy. By August 2024, the Commission intends to complete a progress report on implementation of the National Adaptation Plan. Including health professionals in its review process would enable it to account more effectively for the implications of climate change, and of national climate change policies, on health and equity. To date, several climate health adaptation plans and policies at both regional and national levels are taking shape ([Table S1](#)). However, it is unclear how many of these plans have been implemented or evaluated. This highlights the importance of developing accountability mechanisms for action on climate health and clarifying roles and responsibilities regionally and nationally.

To date, there has been relatively little meaningful input from a health perspective into the relevant intersectoral policy on climate change and health in Aotearoa New Zealand. Without greater intersectoral collaboration, including with diverse communities, and supporting indigenous solutions, climate change policy is unlikely to achieve effective health outcomes and there is a risk that climate change will exacerbate inequities.^{5,8} We recommend that the Climate Change Commission engage with health professionals to account for the implications of climate change, and of national climate change policies, on health and equity.

The most vulnerable communities can be the first to benefit from policies for climate resilience,

including improvements to physical infrastructure (affordable and accessible housing, water supplies, energy, transportation) and social systems (education, livelihoods, economic security and insurance). We recommend that policies reflect low carbon physical infrastructure, that has a wellbeing focus. For example, improving the sustainability and resilience of building and communities to increase affordability, health and reduce environmental impacts of new and existing houses. The ability to adapt to climate change depends on strong mitigation of greenhouse gas emissions globally. Aotearoa must also lead in emissions reductions. Although national emissions are small in the global context, decarbonising the economy, and especially energy systems will, if thoughtfully carried out, have profound co-benefits for health and equity. But win-win outcomes are not guaranteed: poorly done, mitigation may cause substantial social harm. Synergies between adaptation and mitigation are therefore key to achieving climate resilient development.^{1,8,67}

Transformation of energy systems to achieve net zero emissions should not disadvantage communities that are already struggling with financial pressures, but successful mitigation requires rapid and wide-ranging interventions. Equally, there are opportunities for achieving health co-benefits from mitigation policies in buildings, transportation and agriculture but potential gains have seldom been achieved as competing interests have prevailed and policy changes have been muted.^{68,69}

Conclusions

The health system has an important role to play in achieving climate resilient development, and a just transition towards sustainable societies. Social transformation will be needed to avoid severe climate change impacts, reduce social inequities and improve long term health outcomes. The health system can support the required social transformation by taking a broad public health approach to climate change policy.

Further research is needed to assess the indirect, long-term, health impacts of climate events via social and economic systems. This highlights the need for integrated environmental and health data and intersectoral collaboration on data and monitoring. However, from first principles, the required policy direction is clear. Provision of the basic requirements for health include: promoting equity; a just transition to net zero carbon emissions; safe, affordable, accessible and culturally appropriate water, food, energy, housing, education, and transport systems; approaches that uphold Te Tiriti o Waitangi, respect indigenous knowledge and empower but not burden indigenous leadership; maximizing the health co-benefits of climate mitigation whilst producing equitable health outcomes.

Contributors

Conceptualisation, FP, AB, CS, SH, AW; data curation, FP; investigation, FP, AB, CS, SH, AW; methodology, FP, AB, CS, SH, AW; project administration, SH; supervision, SH; AB writing—original draft, FP, AB, CS, SH; writing—review & editing FP, AB, CS, SH, AW.

Declaration of interests

We declare no competing interests.

Acknowledgements

FP was supported by the Health Research Council of New Zealand, ref. 19/104; AB, SH and AW were supported by the Health Research Council of New Zealand, ref. 22/377.

The funder had no role in paper design, data collection, analysis, interpretation, or writing of the paper.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.lanwpc.2023.100954>.

References

- IPCC. The IPCC sixth assessment report on climate change impacts. *Popul Dev Rev.* 2022;48(2):629–633.
- Jones R, Macmillan A, Woodward A. Superheated storms: climate drivers, health effects and responses. *N Z Med J.* 2023;136(1573):8–11.
- Royal Society Te Apārangi. *Human health impacts of climate change for New Zealand.* 2017.
- IPCC. AR6 synthesis report: climate change 2023; 2023 [cited 2023 Jun 29]. Available from: <https://www.ipcc.ch/report/ar6/syr/>.
- Bodeker G, Cullen N, Katurji M, et al. Aotearoa New Zealand climate change projections guidance: interpreting the latest IPCC WG1 report findings; 2022. Available from: <https://apo.org.au/node/317740>.
- Ministry for the Environment. *Climate change projections for New Zealand: atmospheric projections based on simulations undertaken for the IPCC fifth assessment. Prepared by A.B. Mullan, A. Sood, and S. Stuart.* 2nd ed. Wellington: Ministry for the Environment; 2018.
- Shu J, Shamseldin AY, Weller E. The impact of atmospheric rivers on rainfall in New Zealand. *Sci Rep.* 2021;11(1):5869.
- Lawrence J, Wreford A, Allan S. Adapting to avoidable and unavoidable climate change: what must Aotearoa New Zealand do? *Policy Q.* 2022;18(2):51–60.
- Ministry for the Environment. *Meeting the challenges of future flooding in New Zealand.* Ministry for the Environment; 2008 [cited 2023 Feb 24]. Available from: <https://environment.govt.nz/publications/meeting-the-challenges-of-future-flooding-in-new-zealand/>.
- Hennessy K, Fitzharris B, Harvey N, et al. *Australia and New Zealand: climate change 2007: impacts, adaptation and vulnerability: contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change.* Parry M.L. Cambridge, UK: Cambridge University Press; 2007 [cited 2023 May 11]. Available from: <https://www.ipcc.ch/report/ar4/wg2/>.
- Bouchama A, Dehbi M, Mohamed G, Matthies F, Shoukri M, Menne B. Prognostic factors in heat wave related deaths: a meta-analysis. *Arch Intern Med.* 2007;167(20):2170–2176.
- Page LA, Hajat S, Kovats RS, Howard LM. Temperature-related deaths in people with psychosis, dementia and substance misuse. *Br J Psychiatry.* 2012;200(6):485–490.
- Ranson M. Crime, weather, and climate change. *J Environ Econ Manage.* 2014;67(3):274–302.
- Hales S, Salmond C, Town GI, Kjellstrom T, Woodward A. Daily mortality in relation to weather and air pollution in Christchurch, New Zealand. *Aust N Z J Public Health.* 2000;24(1):89–91.
- Gosai A, Salinger J, Dirks K. Climate and respiratory disease in Auckland, New Zealand. *Aust N Z J Public Health.* 2009;33(6):521–526.
- Gilpin BJ, Walker T, Paine S, et al. A large scale waterborne Campylobacteriosis outbreak, Havelock North, New Zealand. *J Infect.* 2020;81(3):390–395.
- Hughes J, Cowper-Heays K, Olesson E, Bell R, Stroombergen A. Impacts and implications of climate change on wastewater systems: a New Zealand perspective. *Clim Risk Manag.* 2021;31:100262.
- White I, Storey B, Owen S, et al. *Climate change & stormwater and wastewater systems;* 2017. Available from: <https://motu.nz/our-work/environment-and-resources/climate-change-impacts/climate-change-and-stormwater-and-wastewater-systems/>.
- Britton E, Hales S, Venugopal K, Baker MG. The impact of climate variability and change on cryptosporidiosis and giardiasis rates in New Zealand. *J Water Health.* 2010;8(3):561–571.
- Britton E, Hales S, Venugopal K, Baker MG. Positive association between ambient temperature and salmonellosis notifications in New Zealand, 1965–2006. *Aust N Z J Public Health.* 2010;34(2):126–129.
- Lal A, Baker MG, Hales S, French NP. Potential effects of global environmental changes on cryptosporidiosis and giardiasis transmission. *Trends Parasitol.* 2013;29(2):83–90.
- Lai H, Hales S, Woodward A, et al. Effects of heavy rainfall on waterborne disease hospitalizations among young children in wet and dry areas of New Zealand. *Environ Int.* 2020;145:106136.
- Davie GS, Baker MG, Hales S, Carlin JB. Trends and determinants of excess winter mortality in New Zealand: 1980 to 2000. *BMC Public Health.* 2007;7:1–9.
- Lal A, Hales S, French N, Baker MG. Seasonality in human zoonotic enteric diseases: a systematic review. *PLoS One.* 2012;7(4):e31883.
- Colón-González FJ, Sewe MO, Tompkins AM, et al. Projecting the risk of mosquito-borne diseases in a warmer and more populated world: a multi-model, multi-scenario intercomparison modelling study. *Lancet Planet Health.* 2021;5(7):e404–e414.
- Messina JP, Brady OJ, Golding N, et al. The current and future global distribution and population at risk of dengue. *Nat Microbiol.* 2019;4(9):1508–1515.
- Hime NJ, Wickens M, Doggett SL, et al. Weather extremes associated with increased Ross River virus and Barmah Forest virus notifications in NSW: learnings for public health response. *Aust N Z J Public Health.* 2022;46(6):842–849.
- Frame DJ, Rosier SM, Noy I, et al. Climate change attribution and the economic costs of extreme weather events: a study on damages from extreme rainfall and drought. *Clim Change.* 2020;162(2):781–797.
- New Zealand Ministry of Foreign Affairs and trade. *Cyclone Gabrielle's impact on the New Zealand economy and exports - March 2023.* New Zealand Ministry of Foreign Affairs and Trade; 2023 [cited 2023 May 10]. Available from: <https://www.mfat.govt.nz/en/trade/mfat-market-reports/cyclone-gabrielles-impact-on-the-new-zealand-economy-and-exports-march-2023/>.
- Pourzand F, Noy I. *Catastrophic droughts and their economic consequences.* Oxford University Press; 2022. Available from: <https://oxfordre.com/environmentalscience/view/10.1093/acrefore/9780199389414.001.0001/acrefore-9780199389414-e-689>.
- Finucane ML, Center EW, Peterson J. *Human dimensions of drought in Hawaii*. Explor Study Of; 2010.
- Horton G, Hanna L, Kelly B. Drought, drying and climate change: emerging health issues for ageing Australians in rural areas. *Australas J Ageing.* 2010;29(1):2–7.
- Luong TT, Handley T, Austin EK, Kiem AS, Rich JL, Kelly B. New Insights into the relationship between drought and mental health emerging from the Australian rural mental health study [cited 2023 May 12]. *Front Psychiatry.* 2021;12. Available from: <https://www.frontiersin.org/articles/10.3389/fpsyg.2021.719786>.
- Keshavarz M, Karami E, Vanclay F. The social experience of drought in rural Iran. *Land Use Policy.* 2013;30(1):120–129.
- Cianconi P, Betrò S, Janiri L. The impact of climate change on mental health: a systematic descriptive review. *Front Psychiatry.* 2020;11:74.
- Cooper S, Hutchings P, Butterworth J, et al. Environmental associated emotional distress and the dangers of climate change for pastoralist mental health. *Glob Environ Change.* 2019;59:101994.
- Pourzand F. Regional differences in the effects of drought events on farm profitability in New Zealand. *Environ Hazards.* 2022;0(0):1–24.
- Pourzand F, Noy I, Sağlam Y. Droughts and farms' financial performance: a farm-level study in New Zealand. *Aust J Agric Resour Econ.* 2020;64(3):818–844.
- Langer EL, Wegner S, Pearce G, Melia N, Luff N, Palmer D. *Adapting and mitigating wildfire risk due to climate change: extending knowledge and best practice.* 2021.
- Scion NZ. *Wildfire season summary 2020/2021 wildfire season update;* 2021 [cited 2023 May 29]. Available from: <https://www.ruralfireresearch.co.nz/tools/nz-wildfire-season-summary>.
- Awatere S, King DN, Reid J, et al. *He huringa āhuarangi, he huringa ao: a changing climate, a changing world* 2021.

- 42 Glavinovic K, Eggleton K, Davis R, Gosman K, Macmillan A. Understanding and experience of climate change in rural general practice in Aotearoa—New Zealand. *Fam Pract*. 2022;cmac107.
- 43 Pomeroy AA. *Rural community resilience and climate change*. New Zealand. Dunedin, New Zealand: University of Otago: Ministry of Agriculture and Forestry; 2011.
- 44 New Zealand National Advisory Committee on Health. *Rural health: challenges of distance, opportunities for innovation*. Ministry of Health; 2010 [cited 2023 May 12]. Available from: <https://thehub.swa.govt.nz/resources/rural-health-challenges-of-distance-opportunities-for-innovation/>.
- 45 EHINZ. *Urban—rural profile*; 2018 [cited 2023 Jun 29]. Available from: <https://www.ehinz.ac.nz/indicators/population-vulnerability/urbanrural-profile/>.
- 46 Awatere S, King DN, Reid J, et al. *He huringa āhuarangi, he huringa ao: a changing climate, a changing world* 2021.
- 47 Te Puni Kōkiri. *A time for change in Māori economic development*. Wellington: Te Puni Kōkiri.; 2007.
- 48 Jones R. Climate change and indigenous health promotion. *Glob Health Promot*. 2019;26(3_suppl):73–81.
- 49 Whyte K. Indigenous climate change studies: Indigenizing futures, decolonizing the anthropocene. *Engl Lang Notes*. 2017;55(1–2):153–162.
- 50 IPCC. Summary for policymakers. In: Pörtner H-O, Roberts DC, Tignor M, et al., eds. *Climate change 2022: impacts, adaptation and vulnerability. Contribution of working group II to the sixth assessment report of the intergovernmental panel on climate change*. Cambridge, UK and New York, NY, USA: Cambridge University Press; 2022:3–33. <https://doi.org/10.1017/9781009325844.001>.
- 51 Bennett H, Jones R, Keating G, Woodward A, Hales S, Metcalfe S. Health and equity impacts of climate change in Aotearoa-New Zealand, and health gains from climate action. *N Z Med J*. 2014;127(1406):16–31.
- 52 Crengle S, Davie G, Whitehead J, de Graaf B, Lawrenson R, Nixon G. Mortality outcomes and inequities experienced by rural Māori in Aotearoa New Zealand. *Lancet Reg Health West Pac*. 2022;28. [cited 2023 Jul 10] Available from: [https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065\(22\)00185-7/fulltext](https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065(22)00185-7/fulltext).
- 53 Gurney J, Stanley J, Sarfati D. The inequity of morbidity: disparities in the prevalence of morbidity between ethnic groups in New Zealand. *J Comorbidity*. 2020;10:2235042X20971168.
- 54 Ministry of Health. *Te Tiriti o Waitangi*. Ministry of Health NZ; 2020 [cited 2023 Jun 29]. Available from: <https://www.health.govt.nz/our-work/populations/maori-health/te-tiriti-o-waitangi>.
- 55 Health and disability system. *Health and disability system review—final report—Pūrongo Whakamutunga*. Wellington: HDSR. Ministry of Health NZ; 2020 [cited 2023 May 26]. Available from: <https://www.health.govt.nz/new-zealand-health-system/new-health-and-disability-system>.
- 56 New Zealand Waitangi Tribunal. *Hauora: report on stage one of the health services and outcomes Kaupapa inquiry/Waitangi Tribunal*. Hauora: report on stage one of the H... | Items | National Library of New Zealand | National Library of New Zealand. Lower Hutt: Legislation Direct, 2019; 2019 [cited 2023 Sep 18]. Available from: <https://natlib.govt.nz/records/42632626>.
- 57 Rae N, Came H, Baker M, McCreanor T. A critical tiriti analysis of the pae ora (Healthy futures) bill. *N Z Med J*. 2022;135(1551):106–111.
- 58 Rae N, Came H, Bain L, McCambridge A. A critical Tiriti analysis of Te pae Tata: the Interim New Zealand health plan. *N Z Med J*. 2023;136(1573):88–93.
- 59 Ministry for the Environment. *Arotakenga huringa āhuarangi: a framework for the national climate change risk assessment for Aotearoa New Zealand*. Ministry for the Environment; 2019 [cited 2023 May 26]. Available from: <https://environment.govt.nz/publications/arotakenga-huringa-ahuarangi-a-framework-for-the-national-climate-change-risk-assessment-for-aotearoa-new-zealand/>.
- 60 Ministry for the Environment. *National climate change risk assessment for New Zealand - main report*. Ministry for the Environment; 2020 [cited 2023 May 26]. Available from: <https://environment.govt.nz/publications/national-climate-change-risk-assessment-for-new-zealand-main-report/>.
- 61 Ministry for the Environment. *Adapt and thrive: building a climate-resilient Aotearoa New Zealand - Ministry for the environment - Citizen space*; 2022 [cited 2023 May 26]. Available from: <https://consult.environment.govt.nz/climate/national-adaptation-plan/>.
- 62 Austin SE, Biesbroek R, Berrang-Ford L, Ford JD, Parker S, Fleury MD. Public health adaptation to climate change in OECD countries. *Int J Environ Res Public Health*. 2016;13(9):889.
- 63 Bolton A, Hepi M, Khatri K, Billings C. *Considerations for developing a health national adaptation plan for New Zealand*. The Institute of Environmental Science and Research; 2019.
- 64 Horton R, Beaglehole R, Bonita R, Raeburn J, McKee M, Wall S. From public to planetary health: a manifesto. *Lancet Lond Engl*. 2014;383(9920):847.
- 65 Ebi KL. Methods for quantifying, projecting, and managing the health risks of climate change. *NEJM Evid*. 2022;1(8):EVIDra2200002.
- 66 NHS England. *Third health and care adaptation report*; 2021. Available from: <https://www.england.nhs.uk/wp-content/uploads/2021/12/NHS-third-health-and-care-adaptation-report-2021.pdf>.
- 67 Lawrence J, Wreford A, Blackett P, et al. Climate change adaptation through an integrative lens in Aotearoa New Zealand. *J R Soc N Z*. 2023;0(0):1–32.
- 68 Macmillan A, Rioli KC, Wild K. Stuck with the car and all its harms? A public health approach to the political economy of the status Quo. *Act Travel Stud*. 2021;1(1). [cited 2023 Sep 18] Available from: <https://activetravelstudies.org/article/id/1084/>.
- 69 Woodward A. Climate change: disruption, risk and opportunity. *Glob Transit*. 2019;1:44–49.