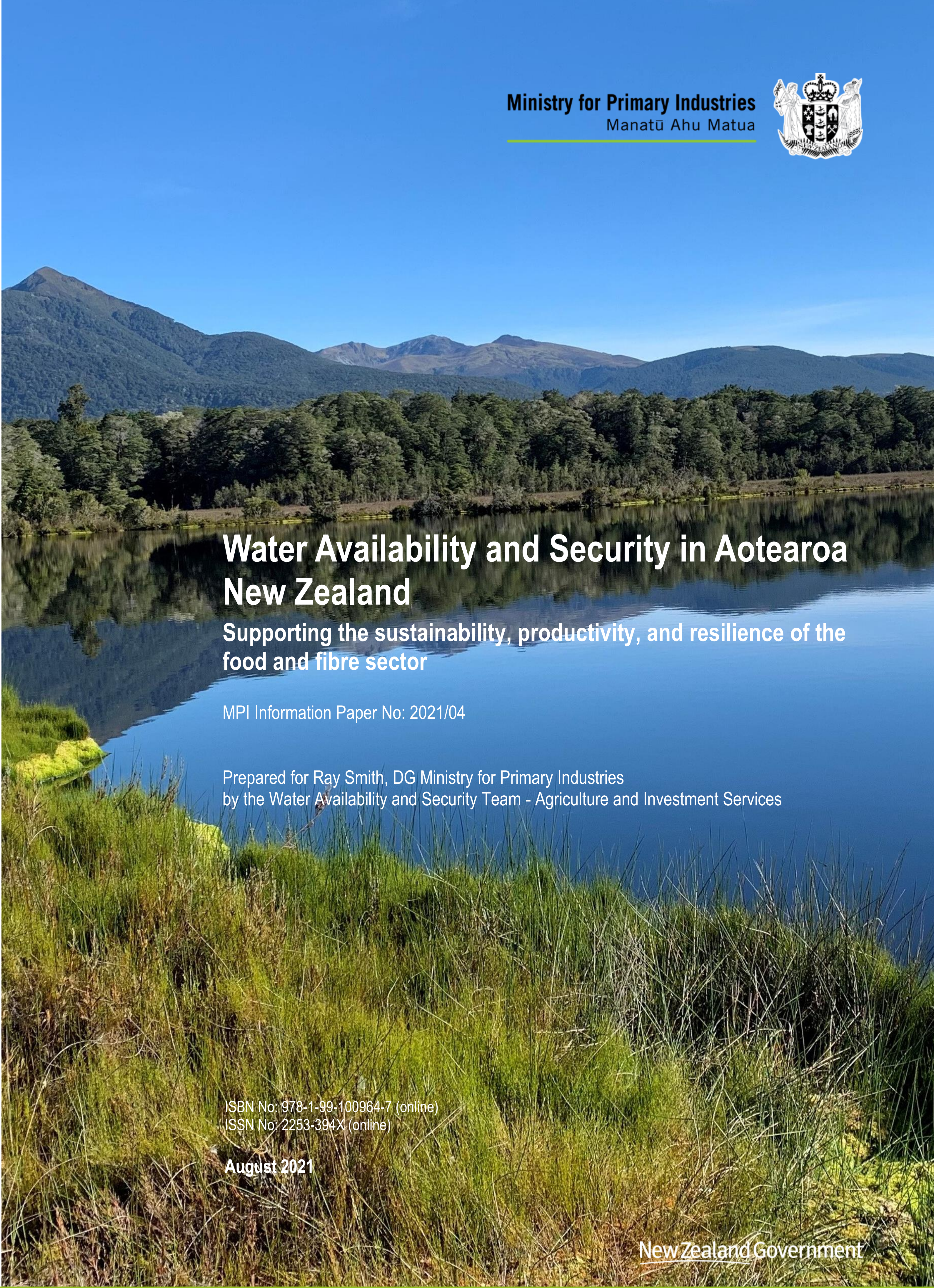

Ministry for Primary Industries
Manatū Ahu Matua

Water Availability and Security in Aotearoa New Zealand

Supporting the sustainability, productivity, and resilience of the food and fibre sector

MPI Information Paper No: 2021/04

Prepared for Ray Smith, DG Ministry for Primary Industries
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Front cover photo: Spirit Lake - Fiordland - Credit Mike Jebson - February 2021

Contents

Page

Glossary	Definition
Adaptation	The process of adjusting to current or expected 'climate change' and its effects.
Adoption	The process of adopting new technologies or practices.
Alliance Group	A New Zealand farmer co-operative company that processes and exports lamb, beef, venison, and co-products.
Aqualinc Research Ltd	An independent New Zealand-based provider of research and consulting services for water and land management.
Aquifer	A body or strata of rock and/or sediment that holds groundwater.
Arable and horticultural crops	Arable crops include wheat, barley, oats etc, and horticultural crops include fruits, vegetables, and ornamental plants.
Beef + Lamb NZ	A farmer-owned, industry good organisation representing New Zealand sheep and beef farmers.
Central Plains Water Limited	An irrigation company in Canterbury which owns and operates the Central Plains water enhancement scheme.
Climate Change - National Adaptation Plan	An Adaptation Plan (NAP) under the Climate Change Response (Zero Carbon) Amendment Act 2019.
Climate Change - National Adaptation Strategy	A strategy to address the impacts of a changing climate and respond to national and international policies and agreements related to climate change.
Co-innovation	When an enterprise or entity works directly with its customers and/or partners to solve problems and develop new solutions.
Community resilience	The ability of communities to withstand, adapt to, and recover from shocks and adverse events.
COVID	Refers to the coronavirus COVID-19 pandemic impacting the world from late 2019.
Dairy NZ	The industry good organisation representing New Zealand dairy farmers.
Deep South Science Challenge	The National Science Challenge (involving Crown Research Institutes and universities) focusing on research to enable New Zealanders to adapt, manage risk and thrive in a changing climate.
Default minimum environmental flow	Interim limits from the proposed National Environmental Standard on ecological flows and water levels – 2008. These proposed default limits are: for rivers and streams with mean flows less than or equal to 5 m^3/s: • A minimum flow of 90% of the mean annual low flow (MALF) • An allocation limit of 30% of MALF. for rivers and streams with mean flows greater than 5 m^3/s: • A minimum flow of 80% of the mean annual low flow (MALF) • An allocation limit of 50% of MALF.
Dynamic adaptation pathway planning (DAPP)	An assessment tool for developing adaptation options. It helps decision-makers consider the conditions under which policies will fail to reduce risks, and provides stress-test options using plausible socioeconomic scenarios of the future

Demand responses	Responses to manage the demand for, and use of, fresh water (including market based and regulatory mechanisms and promotion of practice change).
Desalination	The process of removing salt from water to produce fresh water
Department of Internal Affairs (DIA)	A New Zealand government agency - Department of Internal Affairs Te Tari Taiwhenua
Department of Conservation (DOC)	A New Zealand government agency - Department of Conservation – Te Papa Atawhai
Efficiency	A reduction in the amount of wasted resources that are used to produce a given number of goods or services (outputs). Economic efficiency results from the optimisation of resource-use to best serve an economy and its people.
Environmental footprint	The effect that a person, company, activity, or product has on the environment, for example the amount of natural resources (e.g. water, land etc) that they use and the amount of harmful effects (greenhouse gases, or pollutants) that they produce.
Environmental Protection Agency (EPA)	A New Zealand government agency - Environmental Protection Agency - Te Mana Rauhī Taiao. Responsible for regulating activities that affect New Zealand's environment.
Essential Freshwater	A Government programme lead by the Ministry for the Environment to restore and protect the health of waterways.
Fit for a Better World - Accelerating our Economic Potential	A roadmap developed by MPI in July 2020 that identifies opportunities the Government considers will accelerate the productivity, sustainability, and inclusiveness of the food and fibre sector, to deliver more value for all New Zealanders.
Flexible membranes	An impermeable lining for a water storage pond, reservoir, dam, or water race.
Food and fibre production and processing enterprises	Enterprises that produce food and/or fibre (farmers, horticulturalists, vegetable growers, viticulturalists, foresters) and/or process agricultural, horticultural, forestry, and fisheries products (meat, wool, milk, fruit, grapes, fish, wood etc.).
Food and fibre sector	Enterprises that produce food and fibre (farmers, horticulturalists, foresters etc.) and/or process products (meat, wool, fruit, fish, wood etc.)
Freshwater management unit	A water body, multiple water bodies, or any part of a water body determined by a regional council as the appropriate spatial scale for setting fresh water objectives and limits, and for fresh water accounting and management purposes (usually a water catchment or sub-catchment).
Royal Forest and Bird Protection Society	A non-government membership-based conservation organisation dedicated to the protection of the New Zealand and global environment.
Greater Wellington Regional Council (GWRC)	The council responsible for the Wellington region's quality of life by ensuring its environment is protected while meeting the economic, cultural, and social needs of the community.

Greenhouse gases	A gas that contributes to the greenhouse effect by absorbing infrared radiation. Carbon dioxide, nitrous oxide and methane are examples of common greenhouse gases.
Ground water (aquifer)	Water that occurs below the Earth's surface, where it occupies all or part of the void spaces in soils, or geologic strata such as aquifers. An aquifer is a body of rock and/or sediment that holds groundwater.
Headroom	Additional water that can be allocated from a water source within environmental limits to meet additional demand for fresh water.
Heinz Wattie's	Heinz Wattie's Ltd is a US-owned food producer of frozen and packaged fruit, vegetables, sauces, baby food, cooking sauces, dressings, and pet foods that operates in the New Zealand market.
Horticulture New Zealand	The industry good organisation representing New Zealand's 6,000 commercial fruit and vegetable growers.
Irrigation	The artificial application of water to land or crops to assist with pasture or crop growth and/or frost protection.
Irrigation New Zealand	The industry body representing New Zealand irrigators, irrigation schemes, user groups and the irrigation service industry.
Iwi/hapū	Iwi (tribe) – the largest political grouping in Māori society. Usually consisted of several related hapū (clans or descent groups).
Kānoa – Regional Economic Development & Investment Unit (Kānoa – REDIU)	Formerly known as the Provincial Development Unit, Kānoa is the regional economic development and investment business unit of the Ministry of Business, Innovation and Employment (MBIE), responsible for administering, the Regional Strategic Partnership Fund (launched in May 2021) and monitoring, and reporting on grants and loans made under the Provincial Growth Fund and other funds.
Mahinga kai / Mahika kai	Māori phrase that means 'to work the food' and relates to the traditional value of food resources and their ecosystems, as well as the practices involved in producing, procuring, and protecting these resources.
Managed ground water (aquifer) recharge	Storing water for future use by pumping surface water into an aquifer, or by creating of infiltration zones/basins so surface water percolates into ground water.
Manuherekia	Refers to the Manuherekia River and surrounding catchment in central Otago.
Māori owned land	Held in common ownership under Te Ture Whenua Māori Act 1953 and land held under fee simple ownership by Māori Trusts and incorporations and individuals of Māori descent.
Tikanga Māori	A Māori concept incorporating practices and values from mātauranga Māori (Māori knowledge). This can include culture, custom, ethic, etiquette, fashion, formality, lore, manner, meaning, mechanisms, method, protocol, style, and customary law.
Mātuaranga	Māori word for knowledge and encompasses traditional concepts of knowledge and knowing that Māori ancestors brought with them to Aotearoa New Zealand.

Mauri	A Māori concept that includes life force, vital essence, life principle, special nature, a material symbol of a life principle, source of emotions - the essential quality and vitality of a being, entity, object, collective, or ecosystem.
Merchandise export revenue	The earnings of a country that are generated through the export of goods or services
Mezzanine financing	A hybrid of debt and equity financing that gives the lender the right to convert to an equity interest in the company in case of default, generally, after venture capital companies and other senior lenders are paid
Ministry for the Environment (MfE)	A New Zealand government agency - Ministry for the Environment – Manatū Mō Te Taiao. The primary advisor to the New Zealand Government regarding environmental matters.
Minimum environmental flows	The minimum flow and allocation limits for water bodies (rivers and streams) required to sustain the health and mauri of fresh water and ecosystems.
Multi-benefit infrastructure	Infrastructure designed to serve multiple benefits (e.g. water storage infrastructure that provides water to supplement environmental flows, provide community drinking water, and water for industrial use, irrigation, firefighting, recreation, and hydroelectricity generation).
National Disaster Resilience Strategy	Prepared by the National Emergency Management Agency the National Disaster Resilience Strategy outlines the vision and long-term goals for civil defence emergency management (CDEM) in New Zealand, and the objectives to be pursued to meet those goals.
National Emergency Management Agency (NEMA)	A New Zealand agency under the Department of Prime Minister and Cabinet, NEMA is the Government lead coordinator for emergency management.
National environmental standards for sources of human drinking water (NES DW)	Regulations under the Resource Management Act (RMA) that set requirements for protecting sources of human drinking water from contamination. First enacted in 2008, these regulations are currently subject to review as part of the Three Waters Review.
National Institute of Water and Atmospheric Research (NIWA)	A New Zealand Crown Research Institute established in 1992 that conducts leading environmental science to enable the sustainable management of natural resources for New Zealand and the planet.
National Policy Statement (NPS)	A government statement to direct and prescribe objectives and policies for matters of national significance that are relevant to achieving the sustainable management purpose of the Resource Management Act. Matters of national significance may include matters outside the matters of national importance listed in section 6 of the RMA.
NZ Fish and Game (NZF&G)	A New Zealand statutory entity responsible for managing, maintaining, and enhancing sports fish and game birds and their habitats in the best interests of anglers and hunters.
NZ Institute of Economic Research (NZIER)	A specialist consulting firm established in 1958 that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia.

Pastoral agriculture	The farming of livestock based on pasture systems (e.g. dairy, sheep and beef, deer and goat production).
PED - Potential evapotranspiration deficit -	Represents the amount of water required by irrigation, or that needs to be replenished by rainfall, to maintain soil moisture levels to ensure optimal plant growth. As such, PED estimates provide a robust measure of drought intensity and duration.
Provincial Development Unit (PDU)	See Kānoa above
Radiative forcing of GHG	Is the change in energy flux (capture of the sun’s radiant energy) in the earth’s atmosphere by greenhouse gases such as carbon dioxide, methane and nitrous oxide.
Real Options Analysis	An analysis under uncertainty to determine the likely net present value of making or else abandoning some future choices often concerning business projects or investment opportunities.
Reallocation	To apportion or redistribute the allocation of resources such as water in a new or different way or to a new party.
Reserve Bank of NZ	New Zealand’s central bank, wholly owned by the Government of New Zealand.
Run of River	Taking (withdrawal) of fresh water directly from a river or stream or lake with no significant attempt to store water or regulate flow.
Silver Fern Farms Ltd	A New Zealand multinational meat company owned by New Zealand farmers and Shanghai Maling Aquarius Ltd. The company is New Zealand's largest livestock processing and marketing company.
Special purpose vehicles (SPVs)	A new funding model created under the Infrastructure Funding and Finance Act 2020 used to fund and construct infrastructure to support housing and urban development. SPVs will repay any finance raised by charging a levy to those who benefit from the infrastructure (for example, homeowners in the area serviced by the new infrastructure).
Stats NZ	A government department – Statistics New Zealand – Tatauranga Aotearoa responsible for New Zealand's official data and statistics.
TANK	The Tūtaekurī, Ahuriri, Ngaruroro and Karamū catchments of central Hawke’s Bay.
Taonga/ taoka	A Māori word that refers to a treasured thing, whether tangible or intangible.
Tasmanian Irrigation Partnership Ltd	A Tasmanian state-owned company responsible for the development and operation of publicly subsidised irrigation schemes in Tasmania, Australia.
Taumata Arowai	A New Zealand Crown agency dedicated to the regulation of three waters (drinking water, stormwater, and wastewater).
Te Arawhiti (the Office for Māori Crown relations)	A New Zealand Crown agency dedicated to fostering strong, ongoing, and effective relationships with Māori across Government.

Te Mana o Te Wai (TMoTW)	As expressed in the National Policy Statement – Freshwater Management 2020 - TMoTW is a concept that recognises the vital importance and mana of freshwater and its role in protecting the health and well-being of the wider environment. It encompasses six principles relating to the roles of tangata whenua and other New Zealanders in the management of freshwater: 1. Mana whakahaere: the power, authority, and obligations of tangata whenua to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater 2. Kaitiakitanga: the obligation of tangata whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations 3. Manaakitanga: the process by which tangata whenua show respect, generosity, and care for freshwater and for others 4. Governance: the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and well-being of freshwater now and into the future 5. Stewardship: the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations 6. Care and respect: the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation.
Te taiao	The natural world (our environment).
Te Taiao meter (Te Taiao Tohu)	A verification framework for measuring the environmental and cultural progress of food and fibre producers on a te Taiao pathway including the verification of indicators and measures to assess wellbeing outcomes in and across the four pou (pillars): 1. Āhuarangi (climate), 2. Whenua (land), 3. Koiora (living beings) and 4. Wai (Water).
Te Puni Kōkiri (TPK)	The New Zealand Government's principal policy advisor on Māori wellbeing and development.
Variable-rate irrigation (VRI)	The ability to spatially vary water applications across a crop or pasture using technology to control the rate of application of irrigation water to address specific soil, crop, and/or other conditions.
Water availability	Encompassing the biophysical supply of water, the demand for water, and access to water for productive and other uses.
Water Efficiency Standards	Standards for reducing water wastage by measuring the amount of water required for a particular purpose and the amount used or delivered. Water efficiency differs from water conservation in that it focuses on reducing waste, not restricting use.
Water Industry Commission of Scotland (WICS)	The economic regulator of the water and sewerage industry in Scotland. It is an executive non-departmental public body of the Scottish Government with statutory responsibilities.
Water infrastructure	A broad term for systems of water supply, treatment, storage, flood prevention and hydro-electricity storage.
Water pricing	The price assigned to water supplied by a public utility or irrigation company for a specific or general use.
Water security	The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, and for preserving ecosystems.

1 Executive Summary

Ko te wai te oranga o ngā mea katoa

Water is the life giver of all things

Water is a precious taonga, essential to our people and the world we live in. The quality, availability and security of fresh water is critical to food and fibre production and processing, community resilience, our identity as New Zealanders (Māori and non-Māori), and the health of te taiao - the natural world on which we all depend.

The *'Fit for a Better World - Accelerating our Economic Potential'* (FFBW) roadmap recognises access to reliable sources of water provides transformational opportunities to diversify and unlock the potential of our land and processing industries so that our food and fibre sector, and the communities they support, are more sustainable, resilient, and successful in a world experiencing significant change.

While Aotearoa New Zealand is traditionally viewed as a green and water rich country, current climate change trends show a country getting warmer and drier (with some regional variations), and more prone to climate extremes (floods and droughts). The frequency of these events is increasing rapidly. The declining natural availability of water, combined with the need to halt further degradation of our natural waterbodies and operate within environmental limits, pose significant challenges for the availability and security of water for the food and fibre sector and rural communities.

The responses of the past will not be sufficient for the future challenges and uncertainties we face. Aotearoa New Zealand will need a strategic focus and serious investment to better manage this increasing challenge and to capture the transformational opportunities, so the food and fibre sector continues to lead the recovery in a post-COVID world.

This discussion paper marks the end of the exploratory phase of the Ministry for Primary Industries (MPI) Water Availability and Security (WAS) initiative. It sets out to:

i) acknowledge the complex and dynamic systems we are working within;
ii) highlight the direction of change based on what we currently know; and
iii) provide a compelling argument for the recommendation to act strategically – and to act now.

A transition towards land uses that have a higher economic and lower environmental footprint, and improved community resilience, will require increased water security. This will require a strategic response that addresses and integrates approaches that consider the current and future supply, demand, and priorities for the use and protection of freshwater and the resources dependent on it.

As part of both demand and supply management there needs to be a better integration of practices and technologies to monitor, measure, and manage water to improve efficiency and climate proof water availability and security. Where demand responses are not sufficient to ensure water security there is a need to consider the role of supply solutions such as investment in water storage, ground water recharge and water distribution to supplement natural sources of freshwater.

In the context of Te Mana o Te Wai[1] (TMoTW), where new, repurposed, or updated water infrastructure (e.g. storage including ground water recharge and distribution) is being considered to address water availability and security challenges there is:

- a need for multi-benefit infrastructure that supports a range of needs such as ecosystem health and drinking water while also enabling a sustainable food and fibre sector
- a need for dynamic adaptation pathway planning, flexible investment and governance structures and new investment models around multi-purpose storage as water needs and priorities of use vary over time.

[1] as expressed in the National-Policy-Statement-for-Freshwater-Management-2020

Based on a technical assessment of water allocation, availability, security, and financial viability[2] - Northland, Waikato, Bay of Plenty, Gisborne, Hawke's Bay, Otago, Greater Wellington, Tasman and Manawatū-Whanganui have been identified as having the greatest potential to grow the food and fibre sector by improving water availability and security. However, this growth needs to be carefully considered and placed within the context of Te Mana o te Wai (TMoTW) to incorporate wider community needs and expectations.

For this to occur we recommend:

i) MPI establishes a Water Availability and Security Partnership comprised of central and local government, iwi/Māori, food and fibre sector organisations, science providers, and community interest groups.

ii) The Water Availability and Security Partnership develops an action plan and business case for the design and implementation of a national water availability and security strategic approach that will work within the framework of TMoTW.

iii) The action plan needs to be supportive of the food and fibre sector, guide practice change, and future science and technology (e.g. improving or developing technology and new systems related to efficiency, recycling, etc. and incorporating mātauranga Māori), and coordinate investment in water infrastructure (distribution and/or storage).

iv) Any further investment in water availability and security made by government should use Te Mana o Te Wai as the guiding framework and focus on the use of multiple purpose/multiple benefits models.

[2] Water Availability and Security: National Scale Assessment – MPI Technical Paper No. 2021/18 - Aqualinc Research Ltd - July 2021

2 Introduction

2.1 Background

Water has its own mauri (lifeforce). It underpins the living world. Our rivers, lakes and wetlands, their waters and how we care for and utilise them, are a fundamental part of who we are as New Zealanders (Māori and non-Māori). We respect the mana of our freshwater – Te Mana o Te Wai.

Water is critical to our ecosystem health and biodiversity, the wellbeing of our people and our industries. Food and fibre production and processing enterprises rely on access to secure and reliable water to contribute to our merchandise export revenue (NZ$48 billion in 2020[3]) accounting for 11% of New Zealand's Gross Domestic Product[4] (GDP).

The 'Fit for a Better World - Accelerating our Economic Potential' (FFBW)[5] roadmap recognises water availability and security as a key transformational opportunity for the food and fibre sector and supporting communities. The roadmap sets out to enable food and fibre production and processing to optimise existing land uses, identify opportunities to diversify, increase product value, and adapt to climate events such as drought alongside more gradual climate change impacts.

Secure and reliable access to water is a necessary precondition for the integrity and resilience of rural and urban communities, and future investments in land use, land use change, and high value processing. It is also a key enabler for the transition to a lower emissions future. We want to ensure all people including Māori have appropriate access to water both now and in the future.

Compared with many other countries, New Zealand is considered a green and water rich country. But this perceived abundance hides a much more complex reality where water availability varies from year to year, region to region, and month to month. This variability results in many areas having either too much water (floods) and/or too little (droughts) at different times. These seasonal patterns of plenty and scarcity are also changing due to climate change.

At the same time, there is a growing understanding that water is a limited resource and we all need to look after this precious taonga and use it efficiently and wisely to support the wellbeing of our environment, economy, people, and animals. Capturing water in an area of abundance and shifting it long distances to where it is needed, is rarely an option for a range of reasons including impracticality, and expense and tikanga Māori not supporting the mixing of waters between different catchments.

Water is central to many complex systems dealing with increased uncertainty at a time of decreasing tolerance for the depletion of natural, social, and human resources, for the sake of financial benefit. Attempts to simplify 'water problems' or to 'solve' them in isolation will undoubtedly come up against barriers and/or result in unintended negative consequences.

2.2 Process to date

The initial exploratory phase of the Water Availability and Security (WAS) initiative focused on exploring some of the complexities, dynamics, and system interrelationships. We learned from past policy settings and initiatives within the context of Crown-Māori relationships and the work currently being led by the Ministry for the Environment (MfE) focused on Treaty rights and interests.

We funded technical work to explore the availability and demand for surface and ground water across mainland New Zealand to identify challenges and opportunities within and across regions. We also worked with an external Water Availability and Security Advisory Group (members listed in Appendix 2) to test our thinking and findings.

We held discussions with agencies involved in related work, including the Ministry for the Environment (MfE), Ministry of Business, Innovation and Employment (MBIE), Department of Internal Affairs (DIA), Taumata Arowai, Treasury, Te Arawhiti, Te Puni Kōkiri (TPK) and Department of Conservation (DOC). We also spoke with several regional councils, science providers, and other sector organisations and community groups.

[3] Situation and Outlook for Primary Industries - MPI 2020
[4] Producing-the-goods-the-changing-face-of-the-economy - Stats NZ, 2020
[5] *Fit For a better world accelerating our economic potential - MPI 2020*

Our conversations consistently highlighted the importance of a more strategic and integrated approach which would require a collaborative working partnership with iwi/Māori, key central and local government agencies, science providers, the food and fibre sector, and community groups.

This discussion paper marks the end of the exploratory phase of the WAS initiative. It sets out to:

i) acknowledge the complex and dynamic systems we are working within;
ii) highlight the direction of change based on what we currently know; and
iii) provide a compelling argument for the recommendation to act strategically – and to act now.

3 Context

3.1 Climate change and fresh water availability and security

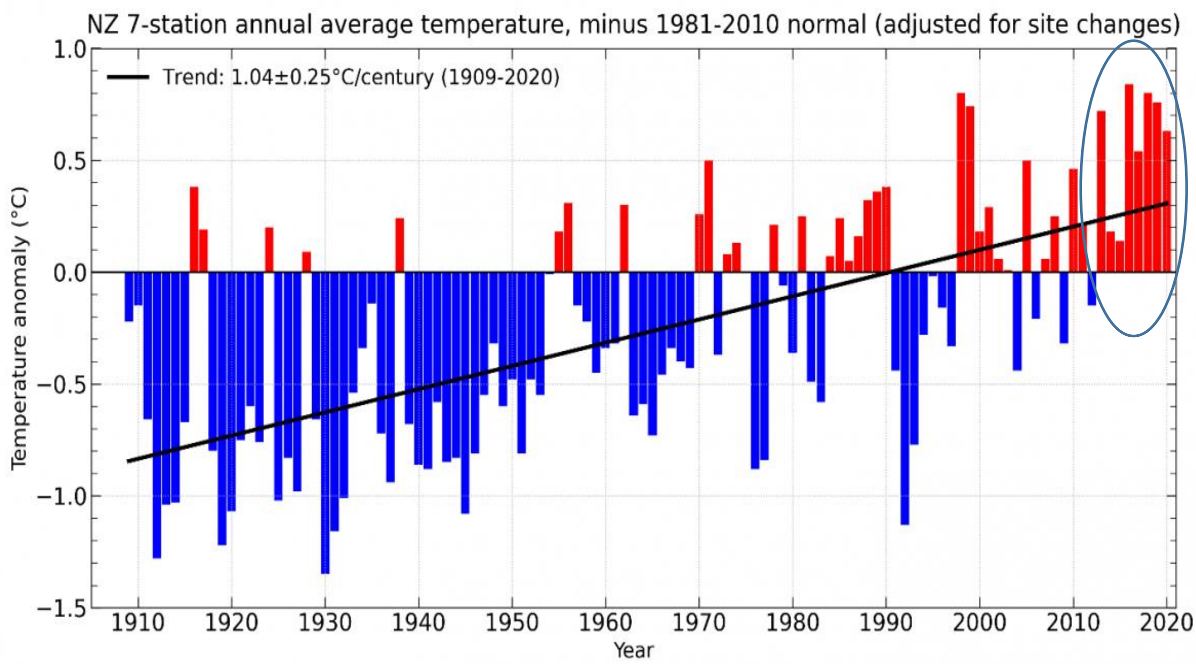
New Zealand's climate, rainfall, and water availability patterns are changing. This is already impacting the availability, security, and demand for fresh water for the food and fibre sector and surrounding communities and is driving changes in land use practices. While climate extremes (floods and droughts) have always been a challenge for the sector, the potentially profound long-term impacts of climate change threaten the sector and the communities upon which they depend as these impacts become more intense and widespread.

Most of these changes are attributed to rising global concentrations of greenhouse gases in our atmosphere and the resultant increases in air and sea temperatures that impact our weather systems.

3.1.1 Aotearoa New Zealand is getting warmer

Over the last century the National Institute of Water and Atmospheric Research Ltd (NIWA) has recorded a trend of about 1°C increase in average temperature across New Zealand. Of the eight warmest years on record, six have occurred since 2013.[6] (see Figure 1 below)

Figure 1: Average Annual Temperature in New Zealand over the last 110 years (source NIWA)



3.1.2 Aotearoa New Zealand is getting drier

Climate change is already impacting the availability and reliability of freshwater. These changes reflect a global pattern of increasing air and sea temperatures and shifting rainfall patterns. Stats NZ's 'water accounts' from 1995 to 2020[7] show a clear trend over the last quarter century of Aotearoa

[6] NIWA - Annual Climate Summary 2020
[7] Stats NZ water-physical-stocks-year-ended-june-1995-2020 prepared by NIWA and GNS

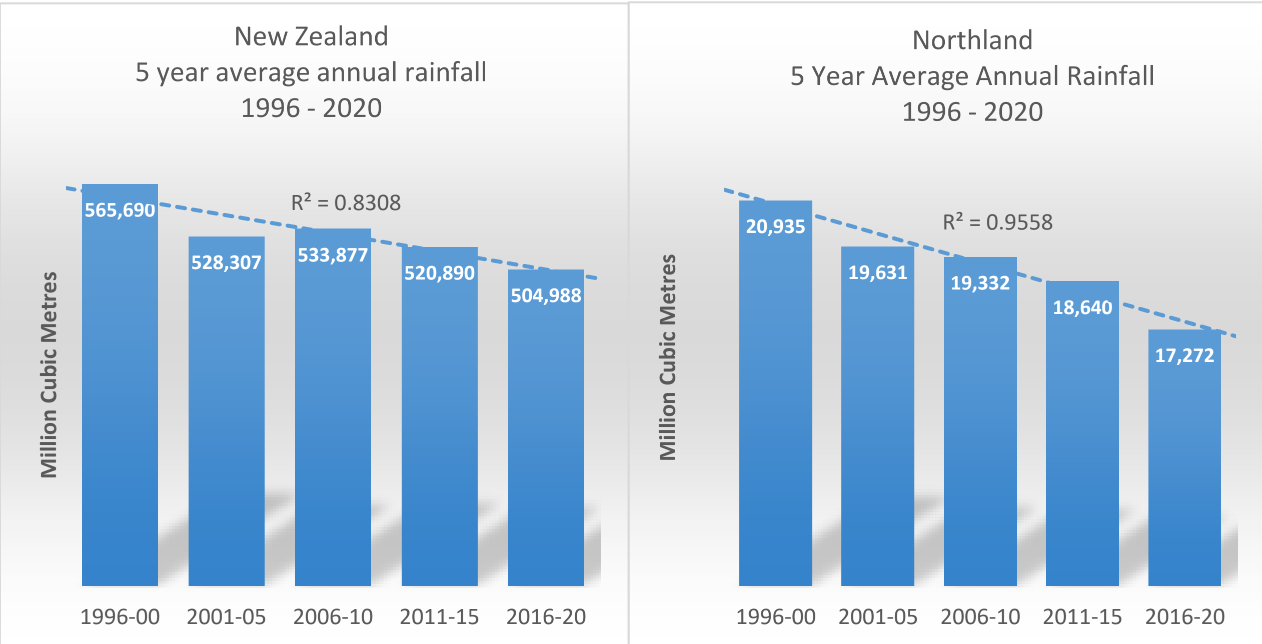
New Zealand that is getting drier on average despite considerable year to year and region to region variability (Figure 2 below). Stores of water locked up in ice are also shrinking. As at June 2019, the volume of ice in New Zealand has decreased 35% over the last quarter century. The rate of ice loss has also been increasing since 2007. The snowline is also rising, reducing winter storage of fresh water as snow, impacting snowmelt, and the seasonal release of fresh water.

Over the same period there has also been significant growth of the food and fibre sector across the country. The area of irrigated land has almost tripled (0.38 to 0.90[8] million ha) in the last two decades. *Food and fibre production (mainly irrigation) uses around 74%[9] of water allocated from rivers, streams, lakes, and groundwater*. Irrigated land comprises 8.5% of farm land used for food production[10], although its proportion of total agricultural production (by both production and value) is much higher than this.

Water availability is becoming more variable, and water security much less reliable, while demand for production and processing continues to increase. There has also been growing concern about the effects of some more intensive land uses on the freshwater environment.

Average annual rainfall[11] across New Zealand for the five years to 2020 was 3.1% below the previous five-year average and 10.7% below the five-year average starting in 1996. (see rainfall trend Figure 2 below).

Figure 2: Average Rainfall 1996-2020 (source Statistics NZ)



In the Northland region (Figure 2) the drying trend is even more severe. For example, Northland's average rainfall for the five years 2016 to 2020 was down 17.5% when compared with the five-year average from 1996 to 2000. For a single year in 2019, rainfall in Northland was 41% lower than the five-year average 1996-2000.

In the five years to June 2020, the decrease in average rainfall was most apparent in North Island regions. The average annual rainfall was 6.0 % lower than for the previous five-year period compared with a decrease of 1.5 % for the South Island over the same period. However, all seven South Island regions experienced a decrease in average rainfall (over 2016 to 2020) compared with the average rainfall from 1996 to 2000. In 2020 the West Coast received more rainfall than all the North Island and 30% of Aotearoa New Zealand's total rainfall.

See Appendix 1 for graphs for all regions showing rainfall trends over the last quarter century.

[8] Water Availability and Security in Aotearoa New Zealand: National Scale Assessment - Aqualinc Research Ltd - July 2021
[9] Water Availability and Security in Aotearoa New Zealand: National Scale Assessment - Aqualinc Research Ltd - July 2021
[10] Farmland for food production includes grazed tussock lands, crop land, horticultural land and other land but excludes plantation forest and native forest and native scrub lands.
[11] Rainfall includes all sources of precipitation (rain, hail, sleet, and snow) Stats NZ water-physical-stocks-1995-2020

3.1.3 Increasing frequency of droughts

Most of New Zealand has experienced widespread drought[12] conditions in four of the last 10 years (the highest frequency of drought conditions[13] in a ten-year period since records began 80 years ago).

In 2019, seven out of the nine North Island regions experienced drought-like conditions, with their lowest rainfall over the last quarter century since this time series began in 1995. With warmer, drier conditions the soil moisture deficit associated with drought conditions (measured as potential evapotranspiration deficit - PED) increases. Relative PED estimates provide a robust measure of drought intensity and duration.

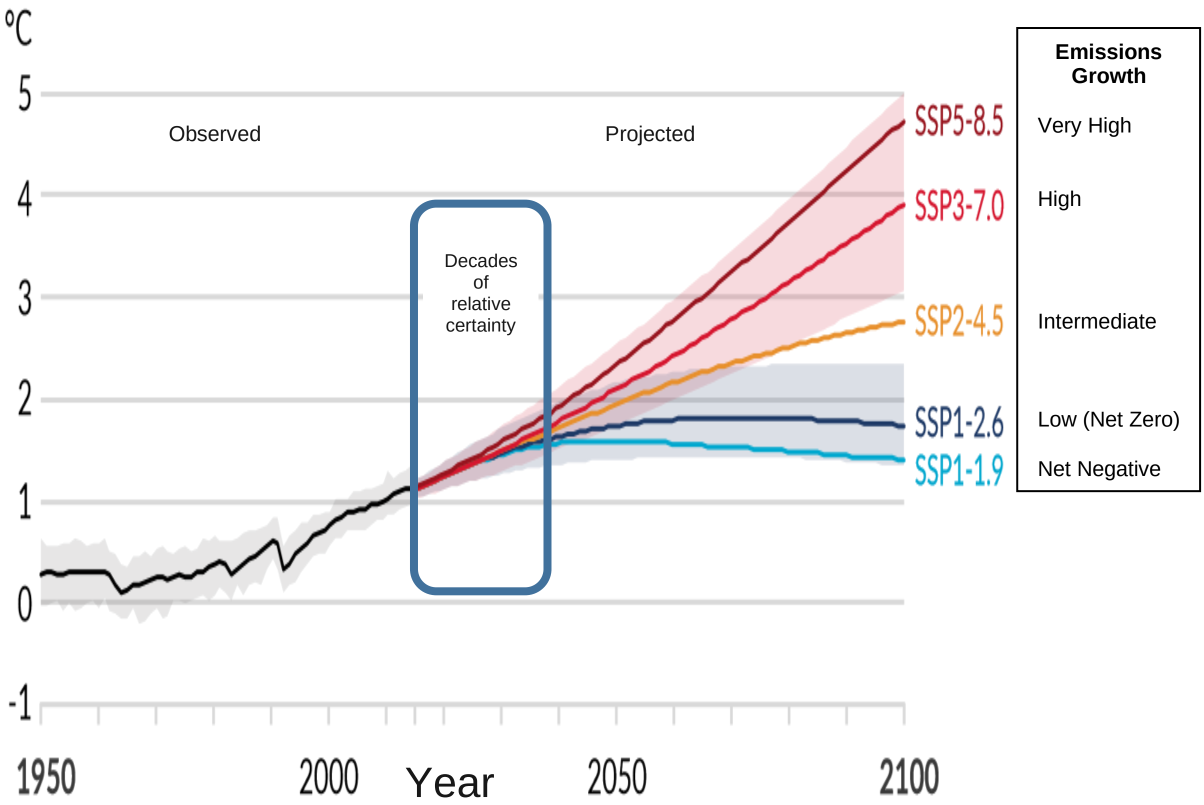
3.1.4 Further changes to the climate are predicted

Rising temperatures

The scientific consensus is that further temperature rises (driven by greenhouse gas emissions to-date) are certain[14]. Compared with the period 1986 to 2005, New Zealand's average annual temperature is projected to increase by a further 0.5°C to 1.0°C by mid-century (2040) under all emission scenarios (even with major emission reductions including the International Panel on Climate Change (IPCC-6) scenario - SSP1-1.9 of a net removal of greenhouse gases from the atmosphere (see Figures 3 below and 4 next page).

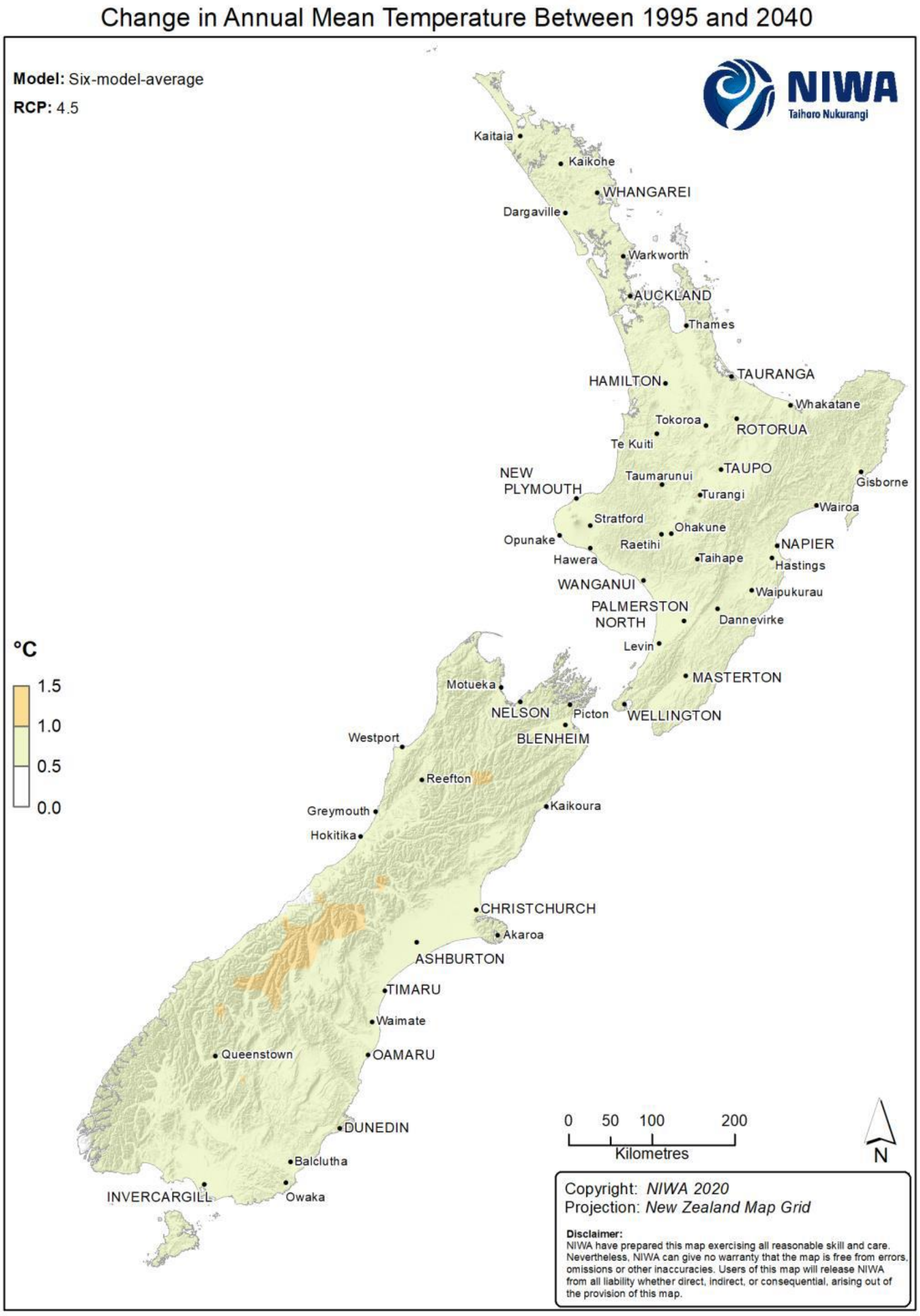
Beyond 2040 there is less certainty about whether global temperatures will continue to rise, or stabilise at or around 1.5°C to 2.0°C[14] above pre-industrial levels, as this will depend on how successful all countries, including Aotearoa New Zealand, are at achieving substantial emissions reductions over comings decades and other natural factors (see Figure 3 below).

Figure 3: Global surface temperature change relative to 1850-1900[14] based on 5 illustrative greenhouse gas emissions scenarios



[12] NIWA climate information and resources – drought charts 2021
[13] Drought conditions are considered to be accumulated annual PED of greater than 300 mm -a NIWA rule of thumb guide Pers.Commun. Dr Andrew Tait - NIWA Chief Scientist Climate, Atmosphere and Hazards.
[14] International Panel on Climate Change - Sixth Assessment Report – August 2021 – The Physical Science Basis

Figure 4: Projected changes in Mean Annual Temperature by 2040 (source NIWA)



Increasing droughts

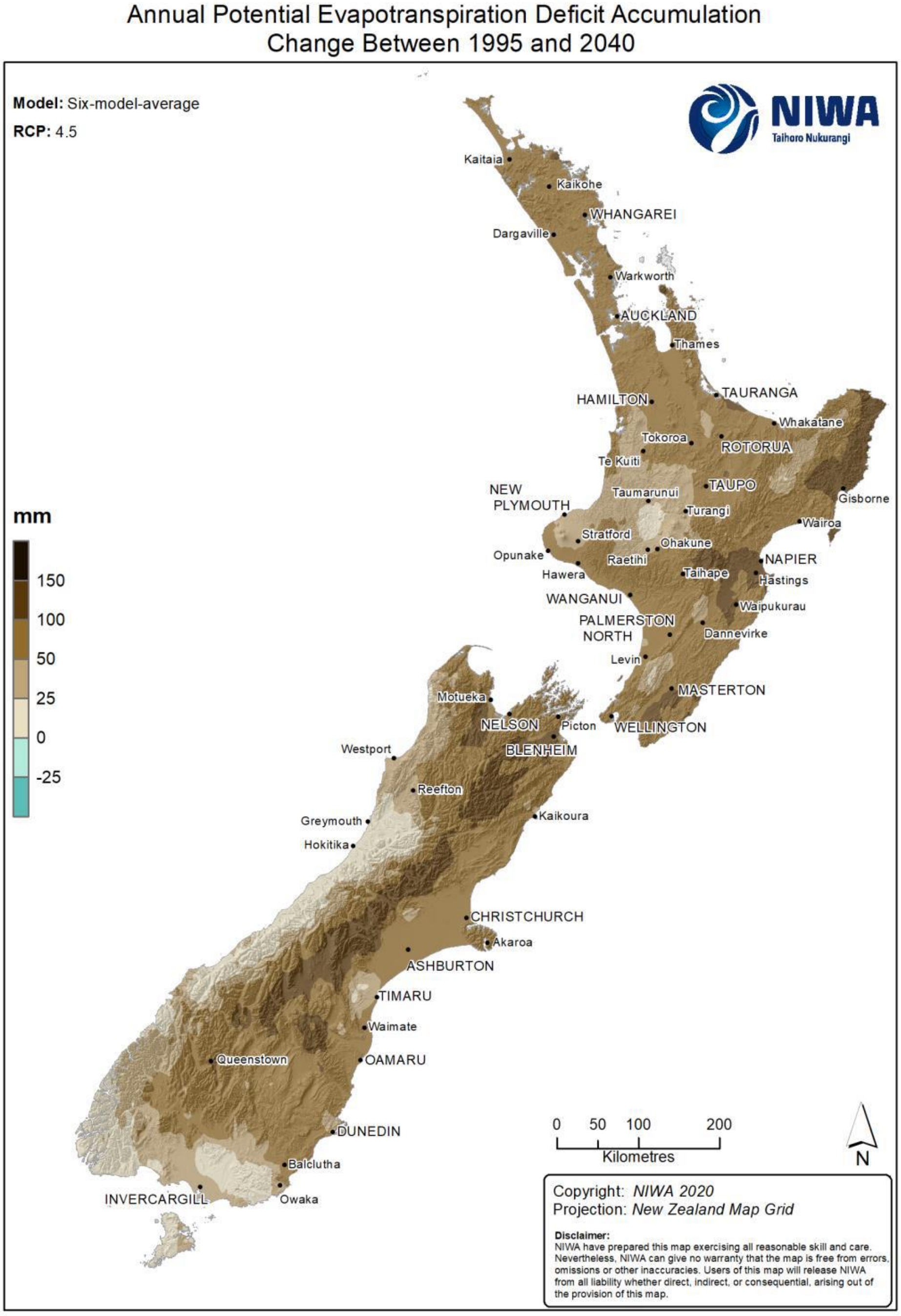
The frequency and intensity of droughts is also projected to increase, particularly in the north and the east of both main islands. Increases of PED by 2040 of an additional 50-100mm are projected for most of the country based on a middle-to-low GHG concentration pathway (see Figure 5 next page).

The frequency of dry days is expected to increase for most of the North Island and for inland regions of the South Island. Relative humidity is expected to decrease for the whole country but especially in the South Island in spring and summer.

When it does rain there is likely to be a higher frequency of extreme rainfall events (potentially causing floods) for most of the country, and a reduction in moderate intensity rainfall events necessary to recharge ground water and replenish soil moisture.

Increasing temperatures and lower relative humidity will increase the rate of soil moisture loss, and this in turn will increase the PED (need for rainfall and/or irrigation) (see Figure 5 below) required to maintain the necessary growing conditions for pasture and crop production and ensure access for food and fibre processing during dry periods.

Figure 5 Projected changes in annual accumulated PED (indicator of drought intensity and duration) by 2040 (source NIWA)



3.1.5 Need for adaptation

These changes to our climate are likely to have substantial impacts on the seasonal and long-term availability, reliability, and demand for fresh water for food and fibre producers, processors, and rural communities. Adaptation to these changes will be vital to reduce the severity of these impacts.

These changes are likely to be particularly acute for eastern and northern regions of the North and South Island including areas such as Wairarapa and Northland. (See cases studies Table 1 – next page).

Table 1 - Regional case studies

Wairarapa[15]- mid and late century climate change projections (all emissions scenarios)	Northland-[16]- mid and late century climate change projections (all emissions scenarios)
• Up to 52 hot days (>25°C) per year at Masterton by 2040 and up to 101 hot days per year by 2090 compared with 31 hot days per year currently • A clear trend towards longer dry spells and shorter wet spells is projected for both Wellington and Masterton. • Soils are generally projected to be drier in the Wairarapa plains, which may further impact pasture and crop growth and increase the need for irrigation. • On average, 15% more water will be required by 2040 and 30% more by 2090 to maintain soil moisture levels assuming current land uses due to rising temperatures and increasing potential evapotranspiration deficit (PED). • Drought conditions (indicated by annual PED exceeding 300 mm) are projected to increase for all lowland parts of the region. There is an annual probability of 80-100% of PED greater than 300 mm in the future for the area around Martinborough (up from 40-60% in the historic period). • River flows are likely to decline in the Wairarapa, with reduced flow reliability (the time where river water takes are prohibited are projected to increase to maintain environmental flows)	• Up to 46 hot days (>25°C) per year by 2040 and up to 99 hot days per year by 2090 compared with 25 hot days per year currently • Spring rainfall is expected to decrease by up to 17% in Whangarei and 12% in Kaitaia under RCP 8.5[17] by 2090 but with major year-to-year variations, increasing frequency of droughts and with likely fewer but more intense rain events. • Percentage of time spent in drought is expected to increase from 5% now to 12% for mid-century (2030-2050) and 15% for late century (2070-2090) • Due to projected increases in potential evapotranspiration deficit (PED), the soil moisture conditions necessary to allow drainage of water below the root zone to the underlying ground water will become less frequent, leading to less groundwater recharge. • Fires are likely to become a larger issue for northern New Zealand with projected increasing temperatures and decreasing rainfall

3.1.6 The economic and other costs of droughts

To give an indication of the likely costs of the effects of increasing frequency of droughts a report by Butcher Partners Ltd in 2009 for the then Ministry of Agriculture estimated the regional and national impacts of the 2007-2009 drought at a loss of $2.8 billion over two years, of which $1.9 billion was on-farm loss and $900 million was off-farm loss.

A report[18] for the Reserve Bank on the 2013 drought affecting much of the North Island and parts of the South Island estimated the costs of that drought at around 0.6% of GDP ($1.3 billion). Treasury estimated the costs associated with the same 2013 drought at $1.5 billion.[19] These impacts could have been worse but for a rise in world dairy prices that year, which partially offset the loss in farm production.

A recent report by NZIER[20] on the economic impacts of the 2019 drought that affected eastern and northern areas of the North Island and some parts of the South Island has estimated real GDP impact of between $596m and $760m depending on the recovery time expected to return to full production.

These costs do not include the very real social and mental health impacts of droughts on farmers, growers, and rural communities.

[15] Wellington Region Climate Change Extremes & Implications 2019 & Climate Change & Variability Wellington Region 2017
[16] NIWA – Climate Change Projections and Implications for Northland 2016
[17] Business as usual emissions growth scenario - GHG representative concentration pathways IPCC - 5
[18] Drying out: Investigating the economic effects of drought in New Zealand - Reserve Bank 2013
[19] Climate Change attribution and the economic costs of extreme weather events. Frame et al. Springer 2020
[20] Economic Impacts of the 2019 Drought – NZIER 2020 for MPI - Unpublished

3.2 Regulatory context for water availability and security

3.2.1 'Essential Freshwater' reforms and 'Te Mana o Te Wai'

The policy

The National Policy Statement for Freshwater Management 2020[21] (NPS-FM 2020) provides councils[22] with policy direction on how they should manage freshwater under the Resource Management Act 1991 (RMA). The NPS-FM 2020 is the fourth iteration of an NPS-FM in the last decade. It was first introduced in 2011, updated and replaced in 2014 with the introduction of the concept of Te Mana o Te Wai (TMoTW), amended in 2017, and further strengthened in 2020.

The first NPS-FM 2011 was released 20 years after the RMA came into law. Prior to 2011, councils created regional plans as they saw fit, without the benefit of national direction on water management.

The 'Essential Freshwater'[23] reforms including the NPS-FM 2020 and its companion regulations (National Environmental Standards for Freshwater - NES-FW 2020) provide direction to address the decline in the quality of New Zealand's fresh water resources and health of freshwater systems. These reforms have introduced new objectives, policies, rules, and regulations intended to:

- stop further degradation of New Zealand's freshwater resources and improve water quality
- reverse past damage and bring New Zealand's freshwater resources, waterways, and ecosystems to a healthy state within a generation.

Still to come as part of these and wider reforms is further direction (consultation planned over 2021 and 2022) to:

- address water allocation issues, by working to achieve efficient and fair allocation of freshwater resources, having regard to all interests including Māori, and existing and potential new users and
- reform of resource management legislation by repealing the Resource Management Act 1991 and replacing it with three acts:
  - Natural and Built Environment Act
  - Strategic Planning Act and
  - Climate Adaptation Act.

The key objective (Policy 1 of 15) of the NPS-FM 2020 is the requirement of those managing freshwater to give effect to Te Mana o Te Wai (TMoTW) as stated in the latest version of the NPS.

This national framework informs current and future decisions about freshwater management and has significant implications for the way in which fresh water will be available for use by the community and sectors. Regional and district councils and others are required to give effect to TMoTW by:

- involving tangata whenua in decision-making and planning
- working with tangata whenua and communities to set out long-term vision for the management of freshwater through a hierarchy of obligations.

The TMoTW - hierarchy of obligations for the management of freshwater (as introduced in the NPS-FW 2020) in order of priority are:

- first, the health and wellbeing of water bodies and freshwater ecosystems
- second, the health needs of people (such as by provision of safe drinking water)
- third, the ability of people and communities to provide for their social, economic, and cultural wellbeing, now and in the future.

Current discussions of the hierarchy of obligations indicates that the use of fresh water for food and fibre production and by processing enterprises is most likely a third-tier priority and will be competing with first and second tier uses. This view is currently subject to Judicial Review in the High Court and Environment Court on the basis that production of certain foods (e.g. vegetables) for the domestic market should be considered important for the health needs of people and hence a second order priority under TMoTW. This argument is due to be considered by the High Court in October 2021.

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[21] National Policy Statement for Freshwater Management 2020 – Ministry for the Environment
[22] Regional, City and District Councils and Unitary Authorities
[23] Essential Freshwater - new rules and regulations - Ministry for the Environment - 2020

How the policy is being implemented

Regional councils (in partnership with iwi/hapū) are required in their next generation of resource management plans to ensure that plan provisions, and other actions relating to freshwater management, give effect to the NPS-FM 2020 including TMoTW and its hierarchy of obligations as expressed above.

All councils are required to notify amended plans to give effect to the NPS-FM 2020 by the end of 2024 and decide on these plans within two years of notification (no later than December 2026). This requires councils to work with iwi/hapū and their communities to apply the hierarchy of obligations to local circumstances.

These requirements are resulting in regional councils progressively reviewing (among other things) the rules around the availability (allocation), harvesting, and/or extraction of water (from rivers, streams, lakes, and groundwater) for productive uses. The updated rules are required to include provision for fish passage and screening, and mahinga kai.

Revised rules are also likely to include flow sharing regimes, new or revised water take limits, and provision for variable (flushing) flows. When water takes should reduce or stop to protect/maintain minimum environmental flows in rivers and streams, or levels in lakes and groundwater, or to avoid saltwater intrusion into groundwater, are also being reviewed.

In setting minimum flows and limits to achieve environmental outcomes, regional councils must have regard to the *'foreseeable impacts of climate change'* and are required to prioritise the health of water ways above uses of water such as for food and fibre production, processing, and for stock water.

Some of these regulatory changes have already been adopted in some regions in response to earlier versions of the NPS-FM. Councils may amend and potentially further restrict these matters as well as introducing new requirements through the review of plans by the end of 2024.

3.2.2 Implications of NPS-FM 2020 for food and fibre sector

As the biggest user of fresh water by volume (75% of all water withdrawal consents[23]), the food and fibre sector will be the most impacted by these changes.

From a series of case studies and other information we have reviewed from some regions across the country, it is apparent that plan changes designed to achieve water quality objectives are likely to also have widespread impacts on the food and fibre sector (particularly in already water-short areas).

Changes are likely to result in a significant drop in both the security and availability of fresh water currently allocated to and used by food and fibre enterprises for both food production (via irrigation) and processing.

In many cases the revised plans could drive changes to land use, particularly where activities are contributing to degradation of freshwater ecosystems or where increases in minimum environmental flows and reductions in allocation volumes will affect the reliability of current water takes and uses.

This shift has the potential for significant economic impacts. New Zealand currently irrigates around 900,000[24] ha of land (approximately 8.5% of farmland[25] currently used for food production). A comparatively high proportion of this irrigation is dependent on run-of-river water when compared with other countries.

Globally[26] irrigated land produces 40% of food production off 20% of cultivated land and the pattern of much higher production of irrigated land compared with rainfed land, will be similar in New Zealand.

Most major processors of food and fibre including meat, milk, horticultural, and wood processors are also heavily reliant on secure sources of fresh water to operate their processing facilities.

[24] Water Availability and Security in Aotearoa New Zealand: National Scale Assessment - Aqualinc Research Ltd - July 2021
[25] Statistics New Zealand 2020 – Farmland used for food production includes grazed tussock lands, crop land, horticultural land, and other land, but excludes plantation forest and native forest and native scrub lands.
[26] Fact 24: Irrigated land | United Nations Educational, Scientific and Cultural Organization (unesco.org)

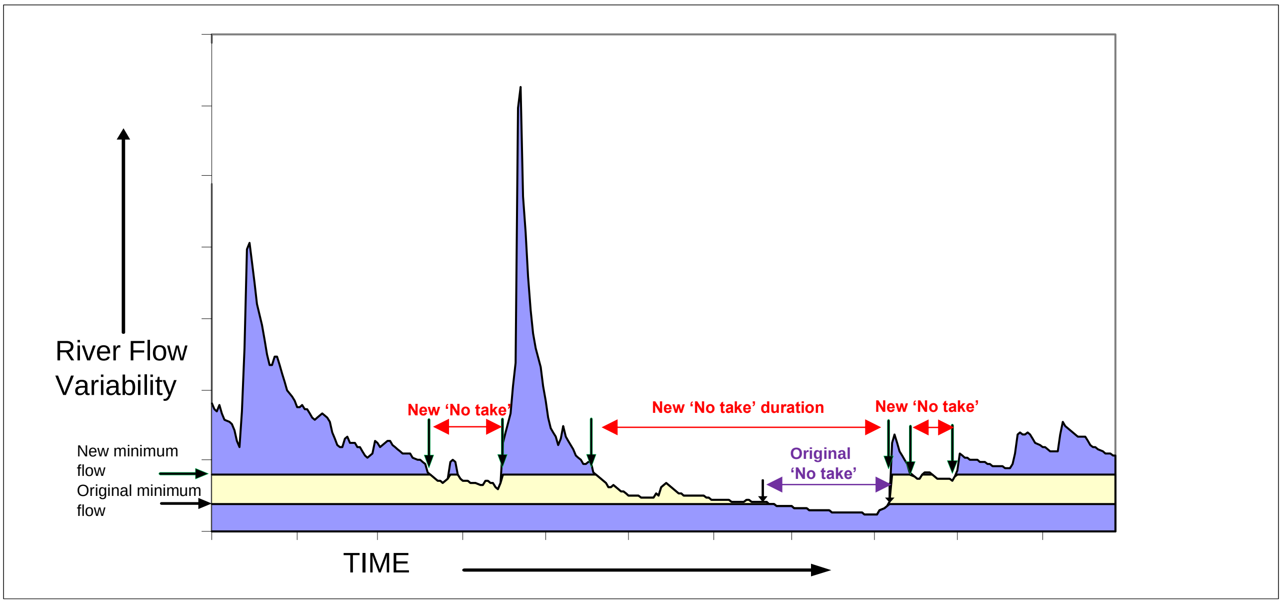
Rules that aim to introduce or significantly increase minimum environmental flow rates (river flows where water takes must cease) are likely to also increase substantially, the length of time when water cannot be harvested during seasonal low flows in normal and dry seasons from run-of-river systems for productive uses (see Figure 6 below). This will affect what is generally considered the most reliable water and will have a disproportionate effect on the reliability of supply for those that rely on that water.

While irrigated pasture-based production systems (dairy / sheep & beef) can cope to some extent with lower levels of irrigation reliability, (by substituting pasture production with stock feed or relocating or selling stock off farm), horticultural and other crop-based systems will be at a much greater risk of crop failure, and processing plants may have reduced operations or have to close down entirely for extended periods until water levels rise above minimum environmental flow levels.

These regulatory changes are likely to put some current production and processing at significant risk unless other approaches can be implemented, such as practice change or new storage to reduce demand and/or boost the supply of water during dry periods without compromising freshwater ecosystems.

This will be significant to the future development of underutilised / unproductive Māori land and the associated supply chain requirements. This could also be a barrier to recognising the potential of horticultural development of Māori and other land.[27]

Figure 6 Impact of lifting minimum flow[28] on availability/security of water (simplified)



The changes are also likely to significantly reduce any allocation 'headroom' available for new users (including iwi/Māori) to access sources of fresh water from run of river systems. It could also curtail opportunities for diversification to alternative lower emissions land uses (e.g. sheep/beef or dairy to horticulture and plant proteins), and investment in new or upgraded food and/or fibre processing facilities that need high levels of water security.

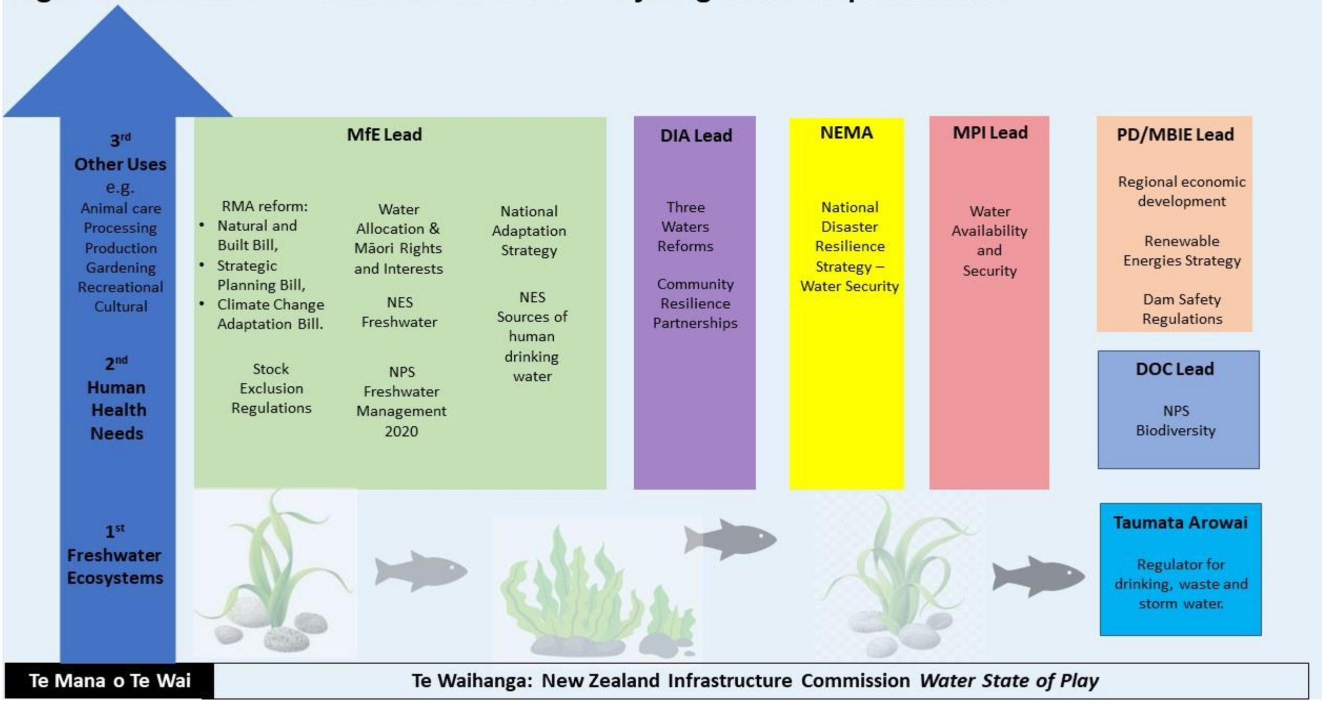
[27] Māori-in-horticulture-2020-research-report - TPK 2020
[28] Simplified representation of one aspect of environmental flows (minimum flows)

Table 2 -Regional case studies
a. Wairarapa – Greater Wellington Regional Council (GWRC) GWRC is updating its Natural Resources plan to meet NPS FM (2014 & 2020) requirements. The GWRC Ruamahanga Whaitua implementation plan[29] has proposed to progressively introduce tighter regional restrictions on water takes for key rivers from 2024 to 2029. These proposed restrictions include increasing minimum environmental flows and working towards reducing or capping the consented allocation for key rivers. In average and dry years this is likely to result in water being unavailable for use by current producers and processors for extended periods, assuming other changes are not made to boost the availability and security of water (by for example enterprise-scale or community-scale water storage). Without other actions to mitigate these impacts, this likely future reduction in security and access to fresh water during periods of low flow could lead to a range of region-wide impacts. These impacts may include: ➢ reduced local and export food production, ➢ risks to the viability of a major timber processor that supplies framing timber to the domestic housing market, and ➢ curtailed appetite for investment in land use change from pasture systems (dairy and sheep & beef) to high value crops that could have a lower environmental impact with higher employment opportunities.
b. Manuherekia – Otago Regional Council (ORC) ORC has recently commenced consultation with its community over introducing regulated minimum flow rates for the 300,000 ha Manuherekia catchment in response to the NPS-FM 2020.[30] Currently 27,000 ha of this catchment is irrigated with river water supplemented by water stored in three irrigation dams (Falls, Manor Burn, and Pool Burn Dams) owned and operated by the irrigators. The region is also affected by the change in water regime arising from the demise of Otago-specific deemed mining permits after a 30-year transition from 1991. The status quo is a voluntary minimum environmental flow limit for the Manuherekia river of 900 l/s at the bottom of the catchment near Alexandra. Current irrigation scheme reliability is greater than 95% based on this voluntary limit. There is no current head room for new irrigation in this catchment as the river is considered fully or over allocated. ORC has consulted on five possible options to establish a regulated environmental minimum flow limit at this location. These range between Option 1 - a minimum environmental flow limit of 1,200 l/s (33% increase on status quo) and Option 5 - a minimum environmental flow of 3,000 l/s (333% increase on status quo). Depending upon the option adopted, current irrigation reliability has been modelled to reduce from the status quo 95% to 91% (Option 1) to as low as 73% (Option 5). With the higher minimum flow rate options, most of the water stored in the privately owned irrigation dams in this catchment is likely to be reallocated from irrigation uses back to the river to supplement environmental flows. Increases from a voluntary environmental flow limit to a higher regulated limit has an overall effect of reducing water availability and security for irrigation, drinking water supply, and stock water uses. ORC has modelled the impact on earnings before interest and tax (EBIT) for all options. For example, for Option 5 the impacts for farmers in the district is assessed as very significant with high volatility. In the absence of mitigation such as new water storage or land use change, enterprise viability and land values will be severely stressed by this option. Protection of instream values, Mahika kai, recreational uses, and the freshwater ecosystem of the river is best achieved by the adoption of higher environmental flow limit options such as option 5.

29 Ruamahanga Whaitua Implementation Plan – Greater Wellington Regional Council
30 Manuherekia Scenarios - Otago Regional Council May 2021

3.3 Other government programmes related to freshwater

Figure 7: Central Government workstreams - synergies and dependencies



As indicated in Figure 7 above, central government have several water-related workstreams in progress. The above work is over and above activities being undertaken by local government in response to earlier and current government direction related to freshwater management (summarised in sections 3.2.1 and 3.2.2 above).

Government programmes likely to have an impact on water availability and security includes the Department of Internal Affair's (DIA) Three Waters Reform programme reforming water services delivery, Ministry for the Environment's (MFE) proposed update to the National Environmental Standard for Sources of Human Drinking Water, its proposed National Policy Statements for Highly Productive Land and for Indigenous Biodiversity, and the new safety regulations currently in development by the Ministry of Business, Innovation and Employment (MBIE) to protect people, property, and the environment from potential dam failures.

3.3.1 Implications

As discussed earlier, the NPS-FM 2020 has significant implications for water availability and security for the food and fibre sector. Other MFE programmes will also have impacts as will the other agency work programmes listed in Figure 7 above.

For example, the Resource Management (RM) reform process currently underway, recommends moving away from the Priority Rule for freshwater permits under the 'first-in-first-served' approach. A new set of principles including sustainability, equity, and efficiency have been proposed to guide freshwater allocation in resolving competing interests. The RM reform is being undertaken alongside ongoing programmes on allocation and Māori rights and interests in freshwater. Collectively these programmes are likely to have considerable influence on the future allocation and potential reallocation of freshwater for food and fibre enterprises and the role of iwi/Māori. They are likely to affect both future demand and supply, and the practices associated with the use of water.

The Climate Change - National Adaptation Strategy responds to New Zealand's most significant risks from climate change as identified in the National Climate Change Risk Assessment. An all-of-government action plan is in development that will set out the approach to managing these risks over time. The plan will need to consider how best to manage the emerging risks to water availability and security within a TMoTW framework. It will need to have regard to ensuring secure and reliable water resources for community needs alongside production and processing of food and fibre, including provision of stock water.

From 2021 onwards Kānoa - Regional Economic Development & Investment Unit's[31] $200m Regional Strategic Partnership Fund will include a focus on resilience and Māori, alongside productive, sustainable, and inclusive regional development. Water will be a key enabler to most of the investments, as current climate trends and regulatory changes could severely limit investments in regions due to uncertainty over access to reliable freshwater. In response Kānoa is currently funding GNS Science to undertake in-depth physical investigation work (known as Aqua Intel Aotearoa) to identify water availability and storage options for four regions (Northland, Tairāwhiti, Otago and Southland). This work is complementary to the MPI funded National Assessment of water availability and security.

New Zealand has a target of reaching 100% renewable electricity by 2035. While the main focus on new renewable electricity sources is likely to be on wind, geothermal, and solar energy, there could be opportunities to integrate small and medium scale hydro-generation as part of new water storage infrastructure, that could improve water availability and security, help diversify land use, and contribute to achieving the 100% renewables target.

Some of the Government's past investments in hydro-electric dam storage have integrated complementary uses, such as provision for irrigation, and boosting both the seasonal availability and reliability of freshwater. This could serve as a model for the future. For example, while most hydro-schemes are managed primarily for electricity production, there are a few examples where existing hydro-storage access has at a later date been negotiated to fill gaps in the reliability of water for other purposes such as irrigation, doing away with the need to build new storage (e.g. Central Plain Water Limited – case study). There may also be opportunities to integrate future mini and micro hydro-electric production with water stored and transported for other purposes.

The Department of Internal Affairs' Three Waters Reform programme, including the proposal to create four new water entities covering the 'three waters' for the country, is one of the most significant proposed changes in the delivery of water services in New Zealand. Because of the potential scale and proposed role of these entities (future investment in the order of $120 billion to $185 billion over the next 30 or 40 years), improved governance, access to capital markets and increased economies of scale, these reforms may bring opportunities to leverage these future investments in three waters infrastructure to improve water security and reliability for a wider range of benefits, including for food and fibre enterprises and community resilience. These reforms are required to give effect to TMoTW.

Finally, the National Emergency Management Agency (NEMA) work programme has implications for both flood and drought management, and broader community and infrastructure resilience to adverse climate events. It also paves the way to collaborate on storage and/or distribution infrastructure where needed, for multiple benefits, including flood attenuation and fire protection in high risk areas.

The changing role of council related to 'Three Waters' management, and the new processes around regional council consenting activity (as per TMoTW), will affect food and fibre enterprises. Drawing from Kirk et al (2020)[32], we acknowledge that:

> "*recent reviews of the implementation of national policy has highlighted that on the ground changes are not occurring as quickly or consistently as intended by central government, and while initial versions of the NPS FM set an implementation deadline of 2030 (MfE 2011[33]), this deadline has now been brought forward to 2024 (MfE 2020[34])".*

This shift in deadline is likely to impact significantly on all freshwater management interests, particularly food and fibre producers and processors, as the largest out-of-stream users (75%)[35] of fresh water. The scale of change needed is significant and comes at a cost, both in capital and operational changes.

Farmers, growers, and processors have less time to investigate and test options for practice change and/or transition to lower footprint land uses to adapt to the new regulatory framework. In many cases landowners will be required to reduce negative impacts on water quality while also needing to respond to the challenge of reduced water availability and security.

[31] Formally known as the Provincial Development Unit (PDU)
[32] Nicholas Kirk, Melissa Robson-Williams, Andrew Fenemor & Nathan Heath (2020): Exploring the barriers to freshwater policy implementation in New Zealand. Australasian Journal of water Resources.
[33] National Policy Statement for Freshwater Management – Ministry for the Environment 2011
[34] National Policy Statement for Freshwater Management – Ministry for the Environment 2020
[35] Water Availability and Security in Aotearoa New Zealand: National Scale Assessment - Aqualinc Research Ltd - July 2021

4 Current drivers

The issue of availability and security of fresh water spans across fresh water ecosystems, our communities, and the food and fibre sector from the domestic supply chain to the global marketplace. Effective management of the freshwater resource in Aotearoa New Zealand means ensuring the health and wellbeing of the water is first protected and human health needs are provided for before enabling other uses of water. Giving effect to this hierarchy will require a holistic approach that integrates all demands on the resource in a way that avoids adverse impacts (including cumulative effects) on the health and wellbeing of the freshwater environments. In many cases this will also mean taking steps to address past damage.

4.1 Demand from the food and fibre sector

Food and fibre producers and processers are by far the biggest out-of-stream users of freshwater in Aotearoa New Zealand accounting for 75%[36] of water withdrawal consents. As the largest contributor to our merchandise export revenue (NZ$48 billion in 2020[37]), a key challenge facing our food and fibre sector is to generate the same or more economic activity in a world with less access to water, and in a way that avoids adverse effects on freshwater environments. This will mean diversifying and adjusting traditional land use practices and adopting technology where relevant in a way that collectively achieves these objectives.

These changes may also better satisfy the increasing environmental sustainability expectations of food and fibre customers, as measured through a verification framework such as the Te Taiao meter that identifies food and fibre products in local and global markets with the Te Taiao Tohu - Mark of Practice.[38]

Fit for a Better World[39] (FFBW) recognises that water availability and security will be critical to enabling a shift to higher productivity activities and business and community resilience. Secure and reliable access to water is a necessary precondition for most future investments in land use change, high value processing, and for reducing exposure to drought and climate-related events. Access to secure freshwater will also be critical to improving the utilisation of Māori owned land (transitions of some areas from pasture and forestry to horticulture and other higher value uses).

Such shifts require reasonable investment certainty. Elevated risk/uncertainty impacts the ability to access capital and is a barrier to change and the positive gains (economic, environmental, and social) change may achieve. Uncertainty and risk (including market risks) associated with on-farm change is often significant even without considering the risks around water access. Regulatory uncertainty over future changes to availability and security further compounds these risks.

Enabling higher productivity from the use of water in New Zealand will mean that supply will come closer to meeting demand to supplement rainfed production. Seasonal demand for water for food and fibre production peaks when natural water supply is typically at its most scarce and insecure - during the mid-to-late summer months. Taking steps to improve the availability and security of fresh water during these periods can lead to less concentrated (just in case) use of water and has the potential to reduce overall demand.

4.2 Freshwater environments

Many of New Zealand's freshwater environments are under pressure from: reduced rainfall patterns; the taking and use of fresh water; modification for hydro-electric use and flood protection; the discharge of nutrients, waste, and stormwater; and changes to land use such as large-scale tree planting affecting the water yield from those catchments.

This pressure is impacting the ability of water bodies to provide for current and future social, economic, and cultural wellbeing. As discussed in section 3.2, regional councils, communities, and tangata whenua are required to determine how TMoTW will be applied to the management of water bodies in each region in a way that delivers on the hierarchy of obligations. This will involve establishing a long-term vision that captures the needs and aspirations of the community and tangata whenua. It will be based on the history of, and current pressures on, local waterbodies and catchments. It will be implemented through an integrated catchment approach and spatial planning.

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[36] Water Availability and Security in Aotearoa New Zealand: National Scale Assessment - Aqualinc Research Ltd - July 2021
[37] Situation and Outlook for Primary Industries - MPI - 2020
[38] Te Taiao – the new way forward for Aotearoa/New Zealand food and fibre sector - Primary Sector Council - 2020
[39] *Fit For a better world accelerating our economic potential – MPI -2020*

Protecting the health and wellbeing of the resource will mean different things in different water bodies and for different communities. For instance, raising minimum flow to reduce drought impacts is unlikely to achieve this goal in isolation from other actions addressing water temperature, nutrient loss, sediment loads, or stormwater discharges. Other initiatives are likely to be required such as: reducing wastewater discharges; restricting some land uses; providing shading by planting riparian areas; restoring natural wetlands and flora and fauna including mahinga kai; and improving the health of waterways.

4.3 Community resilience

Recent droughts in Northland and Tairāwhiti have demonstrated their impact, especially where necessary community infrastructure is lacking for reliable water provision for households, livestock needs, or for fire protection. Drinking water poverty is becoming increasingly real and pressing in some of these communities during periods of prolonged drought.

In 2020, a major drought in Northland required alternative emergency water supplies to be provided for both the Kaitaia and Kaikohe communities, and for tanker supplies to individual properties in remote areas where water shortages had become extreme. The cost of these short-term measures was almost $3.5 million[40], enabled by a $2 million grant from the then Provincial Growth Fund. A year later, Budget 2021 committed a further $8 million for up to 1,000 water tanks at vulnerable Far North homes as a means of improving resilience to water shortages in some of these areas.

Further analysis of the impacts of this event showed that in the case of the Kaikohe and Rawene communities, daily water demand is greater than the residual flow of the water source in a one-in-five-year drought[41] (even with water shortage directives in effect). This indicates that a more permanent solution is urgently required for these communities.

These situations may hint towards future scenarios for community water supplies elsewhere in Aotearoa New Zealand. A recent study completed as part of the Deep South Science Challenge[42] sought to understand the risk in relation to drinking water that communities would be exposed to under 'as yet unexperienced droughts'. It found that under most climate change scenarios there is likely to be decreased water available for municipal drinking water supply schemes in Northland, Taranaki, Tairāwhiti, Manawatū-Whanganui, Wairarapa and Tasman.

Climate change also presents an increased risk of fire across many parts of Aotearoa New Zealand. Extended dry periods have led to an increasing trend of very high and extreme fire danger days over the past decade in some areas.[43] This poses a heightened risk to remote communities that are undergoing land use change to carbon forestry. Many of these communities lack sufficient access to freshwater or water infrastructure to adequately prevent and fight fires.

Significant investment in community water supplies will be needed to improve community resilience to the effects of climate change. The food and fibre sector depends on local communities for resources and skills, and in many cases on community water supplies for primary processing of food and fibre products and for fire protection. A recent study by the Water Industry Commission of Scotland on behalf of the New Zealand Department of Internal Affairs (DIA) highlighted the huge investment (at least $120 billion) required over the next 30 years to ensure that New Zealanders have access to safe drinking water, and that the wastewater and stormwater networks achieve good environmental outcomes. However, this estimate does not take account of additional factors associated with water network requirements for such things as seismic resilience, climate change, or other changing societal standards.

The recent situation in Northland also highlighted other immediate risks to food and fibre sector from community water shortages. One of the two emergency Kaitaia supplies provided in 2020 came from an existing consented farm user's bore, with compensation agreed for substantiated farm losses of up to the value of $700,000 due to reduced water availability for that farm business. This type of situation is likely to become more common where existing consented water takes for food and fibre production are requisitioned to address acute community water shortages under emergency provisions.

[40] Matawii_Project Appendix_J_Economics - EPA
[41] Matawii_Project Appendix_J_Economics - EPA
[42] Water-availability-under-climate-change-Final-Report Deep South challenge 2020
[43] Stats NZ - Wildfire risk

4.4 Producers

Pastoral agriculture is the predominant land use in most parts of Aotearoa New Zealand, except for pockets where arable and horticultural crops are specifically suited. Pastoral agriculture requires a secure supply of water for livestock water and milking shed washdown purposes. Irrigated pastoral agriculture (around 8.5% percent of farmland used for food production) is a major water user, with water often applied over a 17 to 22-week-plus irrigation season. Pastoral agriculture can cope with lower reliability of supply due to the ability of pasture to withstand soil moisture deficits for a period. Additional feed supplements can also be supplied to animals through either importing feed, or by moving animals off farm when pasture growth is compromised by water being unavailable for a period.

Arable and horticultural crops generally require less water overall than pasture, but if water is not provided at optimal times, impacts on crop productivity and survival can be severe. Tunnel houses for example rely on daily applications of water, and if water is unavailable for more than a day this can result in total crop loss.[44] Some annual crops require significant volumes of irrigated water over short periods (6-8 weeks) whereas permanent crops such as grapes and kiwifruit may require smaller incremental amounts of water over a 15 to 20-week irrigation season.[45] Many of these producers also require a secure water supply for on-site packhouses and for livestock welfare but this requirement can vary depending on the crops involved.

Successfully moving to more diversified and highly productive land use with a low environmental footprint requires a wide range of factors to align. These include climate, soil type, topography, and access to processing facilities and labour. In many parts of New Zealand better security of supply of water than current rainfall patterns can typically provide will also be a necessity. Therefore, additional factors such as land suitability for irrigation, likely water requirements and any negative environmental impacts, will also need consideration.

Implementing land use change that requires increased levels of water security will be a difficult prospect in many parts of New Zealand due to the combination of climate and regulatory change. Without intervention, the impacts of climate and regulation on seasonal and long-term availability, reliability, and demand for fresh water will limit land use options beyond traditional pastoral agriculture. Furthermore, existing users of water are also likely to need to deal with reductions in water availability and security, potentially leading to production impacts or a move to lower value land uses.

4.5 Processors

Processors of agricultural products are significant water users and tend to be located near to key land production areas. In most cases primary processing of food and fibre products is time sensitive. Product must be processed quickly after leaving the farm or orchard to stabilise shelf-life, ensure product reaches the market fresh, or to avoid negative impacts on animal welfare. In many cases agricultural product processing facilities are significant employers within communities and are significant users of local municipal water supplies.

In Dargaville, Silver Fern Farms processes approximately 100,000 cattle per year from the Northland region. The plant uses approximately 200,000 m^3[(46)] of water annually which equates to approximately 25% of the Dargaville municipal water supply. The water demand is seasonal, ranging between 15,000m^3 and 25,000m^3 per month between November and August. During drought conditions meat processors are required to increase production to manage destocking activities of nearby farmers. This can place additional pressure on an already stressed water supply. In this case, livestock from Northland need to be transferred to other processing sites as water availability declines, potentially impacting the welfare of the animals concerned.

A similar situation was experienced in Dannevirke in 2020 where Alliance Group reduced operations at its plant to four days a week due to drought restrictions on its municipal supply. This was despite increased demand for livestock processing from nearby drought-affected farmers.

In Hawke's Bay, Heinz Watties post-harvest processing facilities employ about 600 people across two sites (Hastings and Tomoana). It purchases approximately $20 million of fruit and vegetables from Hawke's Bay growers annually, to be processed into finished goods. The company is the single

[44] Pers. Commun. Neil Deans
[45] Wairau Plain Land Use and Crop Water Trends - Neal Murray - Marlborough District Council 2004
[46] Scoping of irrigation scheme options in Northland Report 2017

largest private water user in Hawke's Bay and has consents to use 8.9 million m^3[47] of fresh water per year across five bores in the Heretaunga Plains.

Hearing of submissions for proposed changes to the Hawke's Bay Regional Resource Management Plan, known as the Proposed Plan Change 9 (PPC9) – Tutaekuri, Ahuriri, Ngaruroro, and Karamu (TANK) catchments, was underway during May-June 2021. The overall goal of PPC9 is to better manage water quality and quantity in the TANK catchments as required by the NPS-FM 2020. One of the proposed changes involves setting new and amended allocation limits that in effect mean that no further water can be allocated from most of the water bodies in the TANK catchments. In some catchments, including the Heretaunga Plains groundwater, water allocation is to be reduced. The goal of these changes is to phase out over-allocation and to drive water use efficiency. Heinz-Watties has concerns that the new interim allocation limits may not achieve the 95 percent reliability standard required for many irrigated crops in the region to be successful.[48]

Successful transition to a TMoTW framework will drive change in the use of fresh water across the entire supply chain. Further diversifying land use and increasing productivity will likely require additional processing capacity within rural communities. Initiatives to enhance water use efficiency can assist in minimising additional demand on water resources, but in many cases supply side interventions are also likely to be needed to address the gap between supply and demand (see section 7.1).

4.6 Māori agribusiness

The drivers identified above are occurring at a time where Māori land is undergoing significant change. As of August 2018, 73 Treaty settlements have passed into law. A further 50 groups (as at December 2020) are currently in the negotiation process.

With each settlement, Treaty partners progress along a development pathway to reversing the effects of past Treaty breaches. Investment in and by iwi authorities and Māori land trusts is enabling these land assets, the 1.47 million hectares of Māori freehold (80% of which is thought to be underused or underdeveloped[49]), and further general land owned by Māori, to develop. A significant proportion of this land is operating in the food and fibre sector or has food and fibre potential.

In 2018 the Reserve Bank of New Zealand valued the assets underpinning Te Ōhanga Māori (Māori economy) at $68.7 billion (up from $42.6 billion in 2013). Of this total, nearly $21 billion resides within Māori trusts, incorporations, and entities, with the majority ($14 billion) in the natural resource-based sectors. Sheep and beef farming is the dominant land use in the agriculture sector Te Ōhanga Māori[50], but horticulture is growing in significance. Water availability and security is critical to enable the development of these food and fibre businesses, and, where businesses are currently operating, to enable gains in productivity or transition to higher value land uses.

Due to the nature of the current allocation method for freshwater ('first-in-first-served' until all available water is allocated and statutory bias for renewal of existing water consents), and the historical injustice Māori have experienced, Māori food and fibre businesses have disproportionately missed out on the allocation of freshwater in regions that are now close to fully or over-allocated, resulting in inequitable and systemic barriers to economic development by Māori[51]. This is in addition to other barriers including collective ownership, access to information, access to finance, access to land, governance/management issues, and rating of whenua Māori.

5 The role of science and technology

In response to recent pressures on freshwater, science and technology have already improved our understanding of such things as: climate change projections; surface and groundwater hydrology; and land use impacts on water quality. Developments in science and technology including greater use of mātauranga Māori, have also resulted in a range of more sustainable practices and technologies available for use across the food and fibre sector, along with a better understanding of what is needed to support practice change.

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47 Heinz Watties Submission 193 to Plan Change 9 Hawke's Bay Resource Management Plan 2020
48 Evidence-Compiled-Plan Change 9 Hawkes Bay Resource Management Plan 2021
49 Māori Agribusiness in New Zealand: A study of the Māori freehold land resource – MAF - 2011.
50 Te Ōhanga Māori – The Māori Economy - Berl - Reserve Bank 2018
51 Wai2358 - National Freshwater and Geothermal Resources Inquiry Stage 2 report

5.1 Water data and efficiency

As water becomes more scarce and more valuable, it will become increasingly necessary to transfer water quantity and use data out of consenting databases and onto online digital platforms, preferably in real time. This will be important as we potentially enter an era of making value judgments and difficult trade-offs for water allocation. Where water trading and/or water pricing is being considered as a demand-side intervention there will be a need for a secure and verifiable source of truth for water quantity stocks and flows.

Evidence based management decisions on when and where to use water to support plant growth and reduce run-off relies on robust data. The advances in real time data monitoring of input and output quantity and quality is enabling a greater focus on effective and efficient water use than ever before. Producers and processors also have an increasingly sophisticated range of data capture, transmission, and mapping tools to monitor, evaluate and reduce the environmental impact of their water use and discharges.

Efficiency technologies have to date been primarily focused on supporting change at two levels:

i) improving practices on existing land uses, and

ii) transitioning from low to high value land uses.

Adoption of technology to enable needed change has often been slow. There a range of tools available such as irrigation scheduling tools (utilising real-time soil moisture monitoring and local weather insights) that could be much more widely adopted by all irrigation users to increase efficiency of use, pasture and crop production, and reduce nutrient leaching. This would support a change in practice from ‘just in case’ to ‘justified’ irrigation practices[52]. A 2015 Doctoral thesis[53] has suggested for example that in Canterbury 47% to 64% of irrigation applications were unnecessary and could have been avoided had appropriate irrigation scheduling practices been in place.

There are also more sophisticated tools available that could significantly decrease irrigation water use. For instance, a study of irrigation water use in Canterbury estimated that if all irrigated farms adopt variable-rate irrigation (VRI) technology as a standard practice, this will save over 250Mm^3 of water seasonally[54]. To put the potential saving in context, this volume of water is more than the mid-range[55] estimate of 182Mm^3 for the volume of water stored in storage ponds and dams for irrigation across all of Aotearoa New Zealand.

Over the last two decades, the size of irrigated agriculture has increased in Aotearoa New Zealand by 137%, from 0.38 to 0.90 million ha, largely enabled by newer application methods. However, current estimates[56] indicate that less than one-fifth of irrigators are fitted with water-saving technologies such as VRI.

Therefore, while these technologies have enabled individual practices to be more resource (water as well as time) efficient, due to the lack of widespread adoption they may not have delivered on wider community aspirations for the management of fresh water. Where there has been a reduction in water used per hectare, the saved water has largely been used to irrigate more land to increase production, benefiting the producer and the economy. The increase in water use efficiency has not resulted in widespread land-use change or been used to enhance ecosystem health.

5.2 Supporting practice change

As outlined in the MPI extension framework[57] the inappropriate use of a ‘tech transfer’ approaches can be a significant barrier to technology adoption and practice change. Often technologies are developed in isolation with little input from end-users or impacted parties, or focus on environmental impact, making them less responsive to on-the-ground realities. The last decade has seen a push towards proactive approaches that seek and embed end-user capacities and capabilities and consider a wider socio-cultural and environmental context when developing technologies.[58]

Successful uptake of such technologies requires an understanding of the different type of support required to enable adoption, adaptation, or co-innovation. The key lesson from such approaches is

[52] Just-in-case to justified irrigation: improving water use efficiencies in irrigated Dairy farms - MS Srinivasan et al. NIWA 2017
[53] *Modelling the temporal and spatial variation of evapotranspiration from irrigated pastures in Canterbury Van Housen, J. 2015. Doctoral Thesis, Lincoln University*
[54] Aotearoa Agritech Unleashed - Driving Productivity, Sustainability and Economic Growth - Agritech New Zealand - 2020
[55] Water Availability and Security in Aotearoa New Zealand: National Scale Assessment - Aqualinc Research Ltd - July 2021.
[56] Pers. Commum. Denis Gavin, Lindsay NZ
[57] Over the Fence -Designing extension programmes to bring about practice change - MPI - 2015
[58] Lessons on transdisciplinary research in a co-innovation programme in the New Zealand agricultural sector. Outlook on Agriculture 43(3), 219-223

that technology development and dissemination processes need to take account of human attitudes and values. In the case of best-practice standards and VRI, an adoption approach rather than a technology transfer approach is required, and a combination of push-and-pull drivers should be used to support successful adoption and practice change.

For example, the push could come from regulations, price signals and reducing availability of water. The pull could come from attitude changes recognising water as a taonga, incentives for embedding sustainable practices, and recognition of energy and cost savings from reduced pumping costs and improved nutrient retention in the soils to aid pasture and crop production.

In contrast, transitioning to high-value low-impact land uses will require a co-innovation approach, and will rely on a combination of drivers across the production and supply chains. These range from resource access (e.g. availability of water at the right times, in the right place, in the right amounts and for the right purposes) to consumer demand for sustainably produced products. Improved water security is one of the key enablers to land use diversification.

This is a change from past practice. For example, a field study[59] of farmers' attitudes towards land use change and diversification in a large irrigation scheme in mid-Canterbury in the mid-2010s indicated that farm financial performance was the most important driver of practice change with skills and knowledge also being a barrier.

5.3 Water recycling

Chemical and biological treatments of by-product water from manufacturing processes and grey water from cleaning are also reducing freshwater use. Technology developed by Ravensdown Cooperative has opened the possibility of treating and reusing on-farm grey water, with the potential to save as much as 4.2 Mm^3 of freshwater across Aotearoa New Zealand dairy farms[60]. A recent international review[61] estimated that 10 percent of global irrigation relies on untreated or partially treated waste water. When treated according to the needs of end users, wastewater has proved to be a realistic option for non-conventional sources of water overseas.

In response to serious issues with wastewater operations due to wet weather, Fonterra has introduced water recycling technology to its Paihiatua plant. The Paihiatua processing plant processes up to 4000m^3 of milk per day and employs around 250 people in the local community. Waste water is stored and applied via irrigation across four farms. After recent expansion, the plant was found to produce more wastewater than could practically be applied to the farms given the relatively wet climate of the area, and restrictions on nitrogen discharges when soils are saturated.

Addressing this issue led the company to investigate recycling a portion of its wastewater. The solution was to treat condensed water from the milk drying process using reverse osmosis technology and reuse the treated water in plant processes. This initiative has enabled the reuse of up to 500m^3 of water per day recovered from milk, thereby reducing the water take for the plant and better managing nutrient loads from wastewater discharges.

There is considerable potential to widen the uptake of these types of approaches to reduce the demand on the use of freshwater, but to date there has been limited incentive to drive their widespread adoption.

5.4 Desalination

Desalination is an artificial process by which saltwater is converted to fresh water. The most common desalination processes are distillation and reverse osmosis. This could provide a potential future source of fresh water for both producers and processors in water short regions but has yet to be fully consulted on in Aotearoa New Zealand. Globally, there are about 16,000 desalination plants, producing about 100 million m3 /day.

The main obstacle to desalination has always been the cost. Its application in agriculture internationally[62] has been limited to a small number of areas, for certain high-value crops, and has involved government subsidies for capital costs.

[59] Challenges and Opportunities for Land Use Transformation: Insights from the Central Plains Water Scheme in New Zealand Sustainability 2019
[60] ClearTech®: A new technology to improve effluent management - Massey 2019
[61] The State of Food and Agriculture – Overcoming water challenges in agriculture FAO-UN Rome 2020
[62] The State of Food and Agriculture – Overcoming water challenges in agriculture FAO-UN Rome 2020

Over the last decades, however, desalination has become much more efficient and cost-effective internationally thanks to rising demand, technology improvements, reductions in costs and energy use, increase in plant size to large and mega capacity sizes, and more competitive project delivery. A recent international study[60] estimates that the cost of desalinated water currently varies between NZ$0.70 - NZ$2.12/m^3. Membranes and renewable technologies such as solar power have made desalination more feasible, especially for high-value cash crops such as greenhouse vegetables.

Desalination work to date in New Zealand has been largely focused on drinking water for Auckland. A 2020 desalination scheme concept report from the Environmental Protection Authority[63] explored a desalination plant as an option for alternative water resources that could be available to meet the future demand for Auckland's drinking water supply. In that report several issues were raised including the energy cost and potential impact on emissions, and the need for extensive conversations with iwi/Māori. However, with technologies improving all the time there may be potential to explore desalination in high-priority areas in future to support food and fibre processing, and thus reduce the sector's reliance on natural freshwater sources.

5.5 Water Storage

Several science investigations in Aotearoa New Zealand and elsewhere, have identified storage as a key climate change adaptation option to tackle water scarcity. Historically, the storage discussion has been embedded in water supply-demand cycles, geotechnical possibilities, environmental constraints, and engineering practices and technologies.

There have been significant advances in storage infrastructure including the introduction of flexible membranes to line storage areas that can withstand significant seismic activity. This now allows storage ponds and reservoirs to be built in a wider number of locations and ground conditions without significant loss to ground water.

More recent socio-hydrology studies[64] emphasise that the development of storage infrastructure must consider social, cultural, economic, and environmental factors, alongside hydrological, geotechnical, and structural engineering matters. This complexity is clear in a series of case studies undertaken by MPI including Wairarapa Water and Te Tai Tokerau water storage initiatives.

Over the last decade, groundwater scientists have been working closely with regional councils, industry, and irrigation schemes to explore ways of increasing ground water storage via managed groundwater (aquifer) recharge. This requires the diversion of surface water to suitable areas so that the water will either infiltrate through the ground or be pumped into the aquifers below.

Pilot studies are already underway in catchments and regions of the country where the current levels of groundwater allocation are deemed unsustainable and where significant clawbacks on allocations are required. While the pilots in Canterbury and Gisborne have shown the potential of managed aquifer recharge, questions around the environmental and cultural acceptability of such practices still need to be considered.

5.6 Flood protection / mitigation

Given the projected increase in frequency of flood events under climate change, the role of water storage infrastructure to also provide flood management benefits, by reducing flood peaks or capturing flood events, also needs to be considered.

There are already examples of New Zealand hydroelectric dams that provide this benefit. For example, the Mahinerangi (Waipori Power Scheme)[65] operates to fully capture up to a 50-year flood event reducing flooding on the Tairei Plains. This has supported higher value land uses (including the Dunedin airport) at least in part given this flood protection.

Matahina hydroelectric power scheme and dam on the Rangitaiki River in the central North Island provides a level of additional flood protection complementing other flood management infrastructure (e.g. stop-banks) downstream. Both schemes operate as hydroelectric dams. Matahina also has a local water supply. Potential exists at both these dams to also provide irrigation support in future.

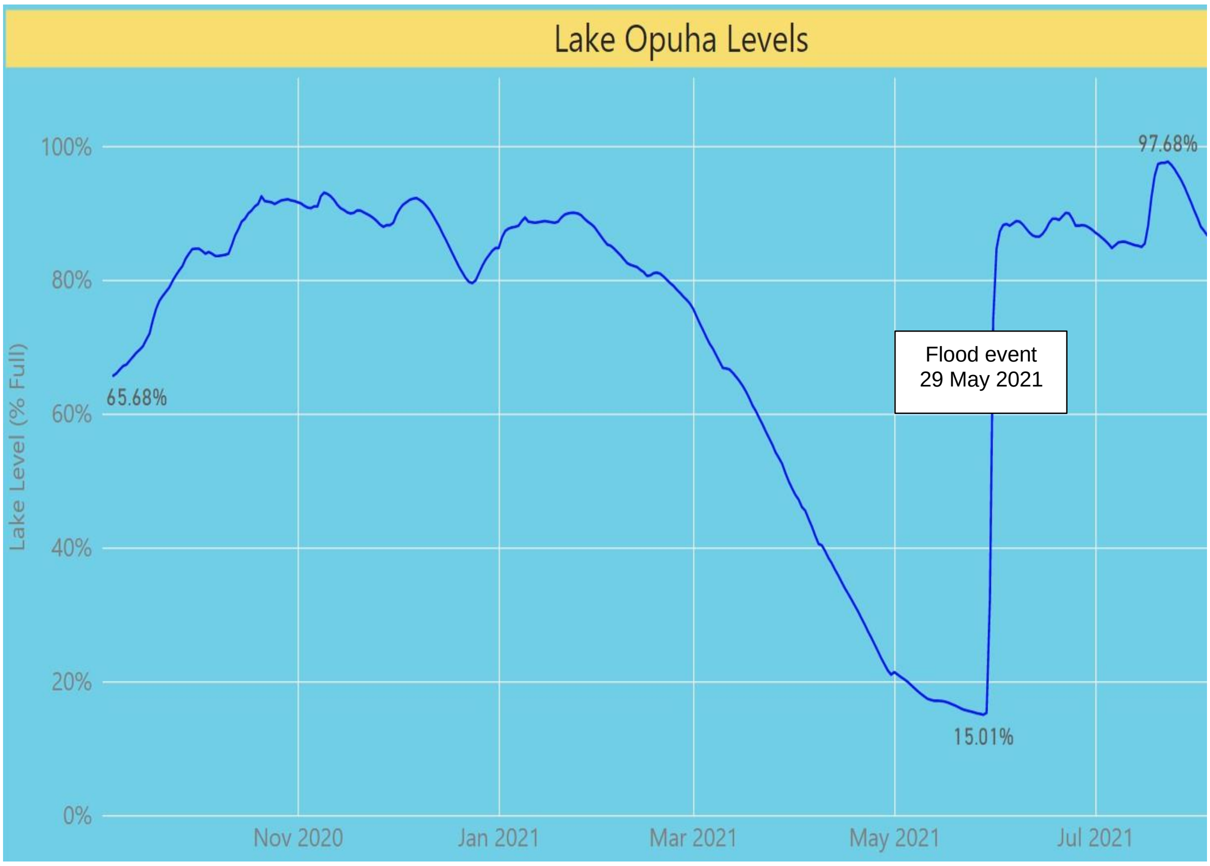
[63] Water Source Options Assessment for the Metropolitan Supply - Desalination Scheme Concept Report - Beca 2020
[64] Jevons' Paradox and Efficient Irrigation Technology – Sustainability 2018
[65] Pers. Commun. - Peter Lilley – Managing Director Riley Consultants 2021

Case Study – the benefits of water storage for flood protection

The benefits of water storage[66] for flood attenuation was demonstrated by Lake Opuha during the major May 2021 flood event in Canterbury. On 28 May MetService issued a red alert forecasting 200-300 mm rain in the Canterbury High Country over the following two days. In some inland areas of Canterbury, the rainfall and subsequent flooding was so extreme that it might only be expected to happen every 200 years[67]. This was the largest rainfall event recorded at Canterbury foothill rain gauges, including at Lake Opuha which reported 230mm of rainfall over a 36 hour period.

Over the course of this flood event the Opuha dam was reported to have held back 450 m^3 per second of high flow in the Opuha river and captured and stored in the order of 40 million m^3 of water, increasing the lake level from 15% to 88.4% full over the course of 36 hours (see figure 8 below).

Figure 8: Opuha lake level during the South Canterbury flood event 29 May 2021



The capture of water behind the Opuha Dam will have reduced the peak flows in the Opuha, Opihi and Temuka river downstream, which may have otherwise flooded Temuka[66]. While high flows in the Temuka and lower Opihi Rivers put significant pressure on the stop-banks protecting the southern end of Temuka township and the Levels Plains/Opihi River Hut communities, the stop banks held despite being close to capacity.

This was not the case further north where damage to Environment Canterbury-owned flood infrastructure included 20 breaches in stop-banks, significant stop-bank scour and weakening, erosion to river banks and large sections of flood protection vegetation (which play a critical role of slowing down floodwater), was lost. There was also significant deposition of shingle on private property and throughout rivers in the Ashburton/Hakatere area and further north in Canterbury.

[66] Lake Opuha dam saves Timaru District from full potential impact of flooding | Stuff.co.nz 31 May 2021
[67] Ecan Regional Council - Canterbury flood event - 29 May 2021

6 National scale assessment - water availability and security

MPI commissioned Aqualinc Research Limited to undertake a national-scale assessment[68] (the assessment) of water availability and security - based on current council surface water and ground water allocation rules and modelled hydrology for all freshwater management units[69] across mainland New Zealand.

A key focus of the assessment was on identifying districts and regions where opportunities (headroom) existed to expand irrigation and enable land use mixes that aid sustainable growth of the food and fibre sector and associated rural communities. This was based on availability of potentially irrigable land that could be supplied by available water, or by new water storage.

6.1 Methodology

Current allocation data was compiled from a national database of council resource consents. Supply 'headroom' was estimated after accounting for current allocation rules (and default limits[70] where catchment specific allocation rules were not available or specified) including current minimum environmental flow limits on water withdrawals. The supply headroom was matched against potentially irrigable areas and a suite of land use mixes selected (kiwifruit, vegetables, citrus, sheep & beef etc.) based on soils, climate and existing market or supply chain infrastructure within that region.

The potentially irrigable areas were identified based on land slope (land slopes up to 20°) and elevation (between sea level and 800m elevation) and excluded areas already under irrigation as well as protected[71] and urban land (see table 3 below).

Table 3: Summary of existing irrigated area by region as at 2020

Region	2020 Mapped irrigated area (ha)	% of total mapped area	Estimated Uncertainty (± ha)	% Uncertainty
Auckland	9,938	1.1%	1,587	16%
Bay of Plenty	13,072	1.4%	1,605	12%
Canterbury	546,205	60.5%	21,583	4%
Gisborne	9,667	1.1%	987	10%
Greater Wellington	21,487	2.4%	2,014	9%
Hawke's Bay	43,473	4.8%	3,592	8%
Manawatū-Whanganui	27,480	3.0%	2,475	9%
Marlborough	35,351	3.9%	1,808	5%
Northland	12,337	1.4%	1,761	14%
Otago	111,082	12.3%	5,771	5%
Southland	22,254	2.5%	2,145	10%
Taranaki	4,567	0.5%	655	14%
Tasman	15,808	1.7%	2,015	13%
Waikato	26,307	2.9%	3,943	15%
West Coast	4,437	0.5%	647	15%
Total (ha)	**903,465**	**100%**	**52,590**	**6%**

The assessment identified 903,465 ha of currently irrigated land as at 2020 with the majority in Canterbury (60.5%), Otago (12.3%), Hawke's Bay (4.8%), and Marlborough (3.9%). Based only on topographic criteria the assessment identified a further 5.7 million ha of land that would be straight forward to irrigate if water was available and a further 1.5 million ha with some potential to irrigate. Of this area 277,000 ha is Māori owned land.

[68] Water Availability and Security: National Scale Assessment – MPI Technical Paper No. 2021/18 - Aqualinc Research Ltd - July 2021
[69] Generally, a single catchment or sub-catchment – see glossary
[70] Interim limits from the proposed NES on Ecological Flows and Water Levels - MFE 2008
[71] excludes conservation and QEII covenanted land, riverbeds and lakes, and wetlands.

The land use mixes considered in the technical review were limited by an assessment of current market structures such as demand, regional supply chains, industry support, and the technical and skills base. This meant that already dominant land uses within a region also became the most dominant potential new land use. It was assumed that all the land use mixes considered for this assessment would require at least 95% irrigation water supply reliability to be viable. This is the minimum reliability considered necessary to support land uses other than pastoral land uses.

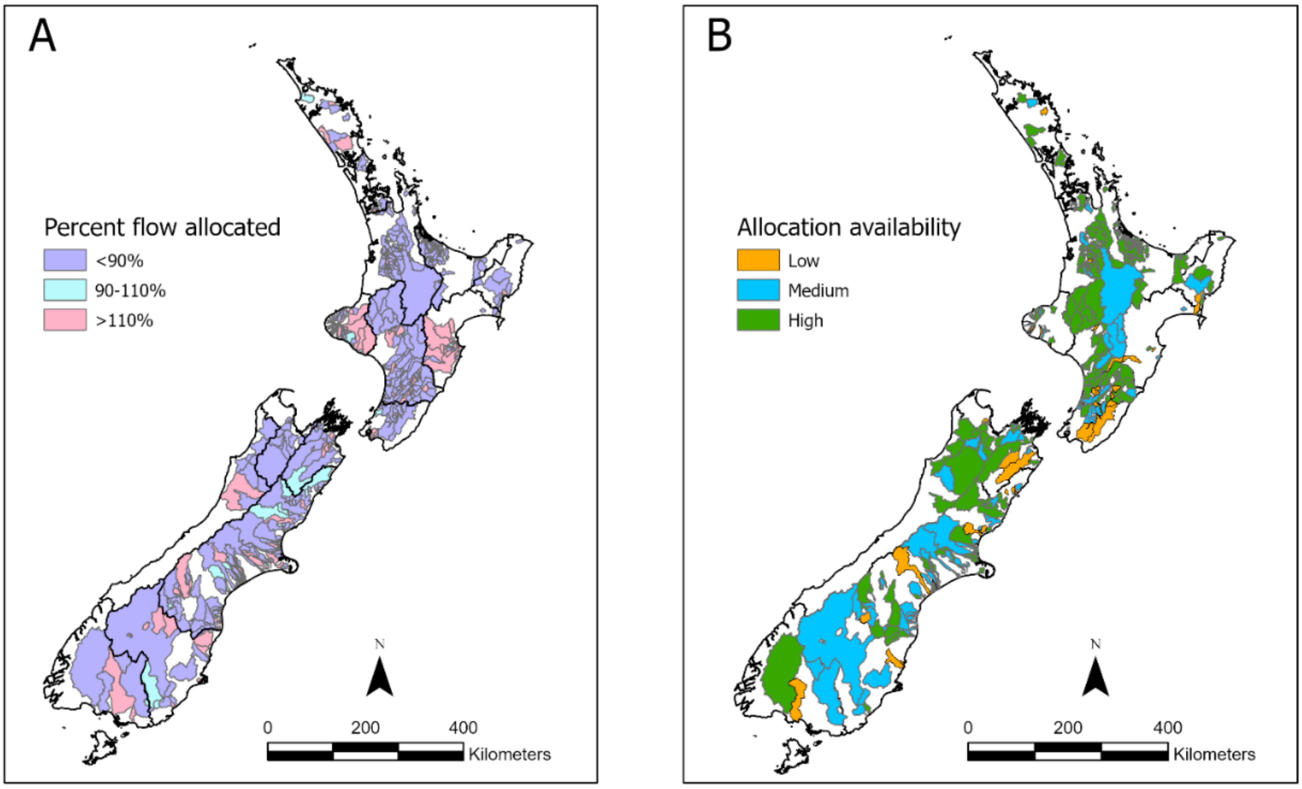
The assessment looked specifically at opportunities for community scale storage and infrastructure investment to enable irrigation expansion. While groundwater is a significant potential source of supply, owing to its localised nature, it is more suitable for individual entities than for community size schemes. No inter-catchment transfer of water was considered.

The assessment was based on current council rules and did not consider any future regional plan change processes driven by the NPS-FW 2020 or RMA reform, or future modelled climate change impacts on water availability and security. As such this assessment represents a static analysis based on the rules and modelled hydrology as they currently apply to provide a national scale assessment. While the analysis used allows further filtering and identification of options on a finer spatial scale, it is not suitable for use in design or investment decision-making, without further detailed analysis and ground truthing and sensitivity analysis of the likely impact of rule changes and climate projections.

In catchments where substantial surface water allocations are currently still available (see Figure 9 B below), these factors are expected to substantially alter the availability of water. For instance, in Otago, the Clutha catchment has been identified, based on the current operative rules, to have significant supply headroom from rivers such as the Clutha, but an ongoing current plan change process could alter significantly the future availability of water from the Clutha river.

Subject to funding availability this additional sensitivity analysis will be desirable to understand how these processes may impact the future availability and security of freshwater.

Figure 9 Percent of surface water allocated and allocation availability – all regions



Allocation is based on current plan rules, or a default rule where catchment-specific allocation rules have not been set.

Allocation availability is presented for those catchments with 90% or less surface flow allocated as shown in Figure 1A. The available allocations are based on current plan rules or a default rule where catchment-specific allocation rules have not been set.

Results

The national scale assessment of surface water allocations indicated that a significant percentage of catchments across the country are either close to or fully allocated (see Figure 9A above). The assessment also found that in catchments with available supply headroom, storage of water is likely to be necessary to achieve 95% or greater water security in many areas. Figure 9. A - previous page - shows a spatial distribution of surface water catchments that are either under, fully, or over-allocated based on current allocations and plan rules (or default rules where no existing plan rules are in place).

Figure 9. B – previous page - identifies areas where there is some availability (headroom) of surface water for allocation. Availability is assigned in three categories: low (orange less than 33% of river and stream flows unallocated), medium (blue 33-67% unallocated) and high (green more than 67% unallocated). In some cases, the available water will need significant storage to convert it into a viable supply. Based on the availability of flow allocation (Figure 9B), a suite of land mixes was considered. The land use mixes are located on 'potentially irrigable' areas (Figure 10 next page) that were filtered based on topography (less than 20 degree land slope), elevation (below 800 m elevation), and hydrology (availability of allocation within the catchment).

Apart from soil suitability and climate, the land use mixes considered were the dominant land use type in the region, as that would enable access to existing markets and supply chain infrastructure. For example, access to market meant that most of the potential arable lands were limited to Canterbury. Generally, the horticultural land uses were found to be more profitable if a water security of 95% or greater is feasible. Most regions of the North Island, and Otago and Southland in the South Island showed the greatest potential for the expansion of horticultural crops.

While considering land use mixes and matching them against available supply headroom were considered at a catchment scale, the spatial placement of those land use mixes within the catchment was not considered. The land uses were generally assigned to the catchment and not to specific parts of the catchments. Similarly, when storage volumes to achieve 95% or greater reliability were estimated, all land use mixes identified within a catchment were assumed to occur. This influenced the demand for water and the size of storage.

6.2 Assessment findings

Given the current level of water supply headroom, the national scale assessment found that storage is essential in all catchments considered to achieve the land use mixes shown in Figure 10 (next page) at 95% or greater level of water security. However, where a partial implementation of potential land use mixes is considered, the level of storage needed would be less than what's identified in Figure 11. The storage volume estimations in Figure 11 are presented at two levels – a storage up to 1,000 m^3 per ha per year (about a third of seasonal storage demand) was assumed to represent small-scale (farm) storage and anything greater than 1,000 m^3 per ha per year was assigned as medium to large community level storage. Small storages are designed for specific farm use and thus may not have the capacity to serve wider community needs. Also, investment in small storage is primarily done by individual private interests (farmers/growers). Medium and large storages are of special interest to this work as they can provide for multiple uses (environmental flows, drinking water, flood protection etc.) for private as well as public benefits.

Based on the national scale assessment, Canterbury, Hawke's Bay, Tasman, and southern Manawatū were identified as regions that would need medium to large storage infrastructures to enable a water security of 95% or greater. However, we predict the storage requirements will vary as flow availability and allocations vary in the short and medium term (plan changes, RMA reforms, TMoTW) and long (climate change) time scales. For example, a large proportion of unallocated water in the Clutha catchment meant little to no storage was considered necessary although the upcoming plan changes could change the outlook substantially.

Based on the combination of land use mixes (Figure 10) and new storage requirements (Figure 11), a desktop analysis of farm-scale financial viability to pay for secure water availability was conducted. This included paying for storage and associated distribution infrastructure. Parts of Northland, Hawke's Bay, Bay of Plenty, Gisborne, southwest Manawatū, Otago, Tasman, Waikato, Wellington, and the West Coast of South Island were identified to have moderate to greatest financial viability to expand (Figure 12). A simple multiplier-based estimation of potential community benefits indicated that the development of these land use mixes, and allied processing industries have significant off-farm benefits such as increased employment and improved social and cultural cohesion.

Table 4 summarises the assessment by applying the topographic, hydrological, and financial viability filters, and likely water quality constraints, to land that potentially can be irrigated in different regions, and indicates the likely land uses that would benefit. This provides a basis for prioritising regions for further investigation and engagement.

Figure 10. Potential land use mixes on newly identified irrigable areas. Land mixes were chosen based on soil type, climate, and market availability

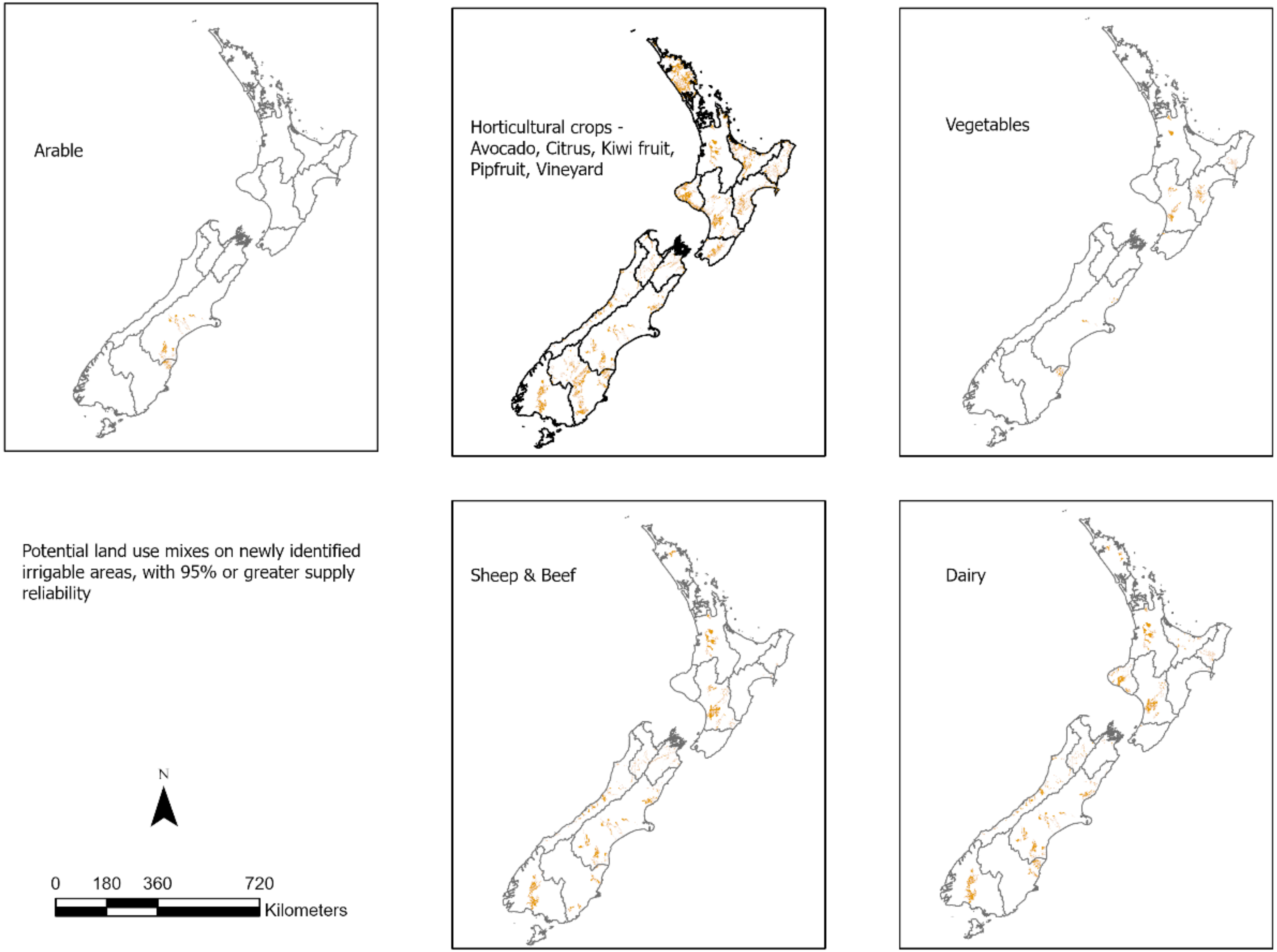


Figure 11. Storage requirements to achieve 95% or greater water security (for land use mixes shown in Figure 9).

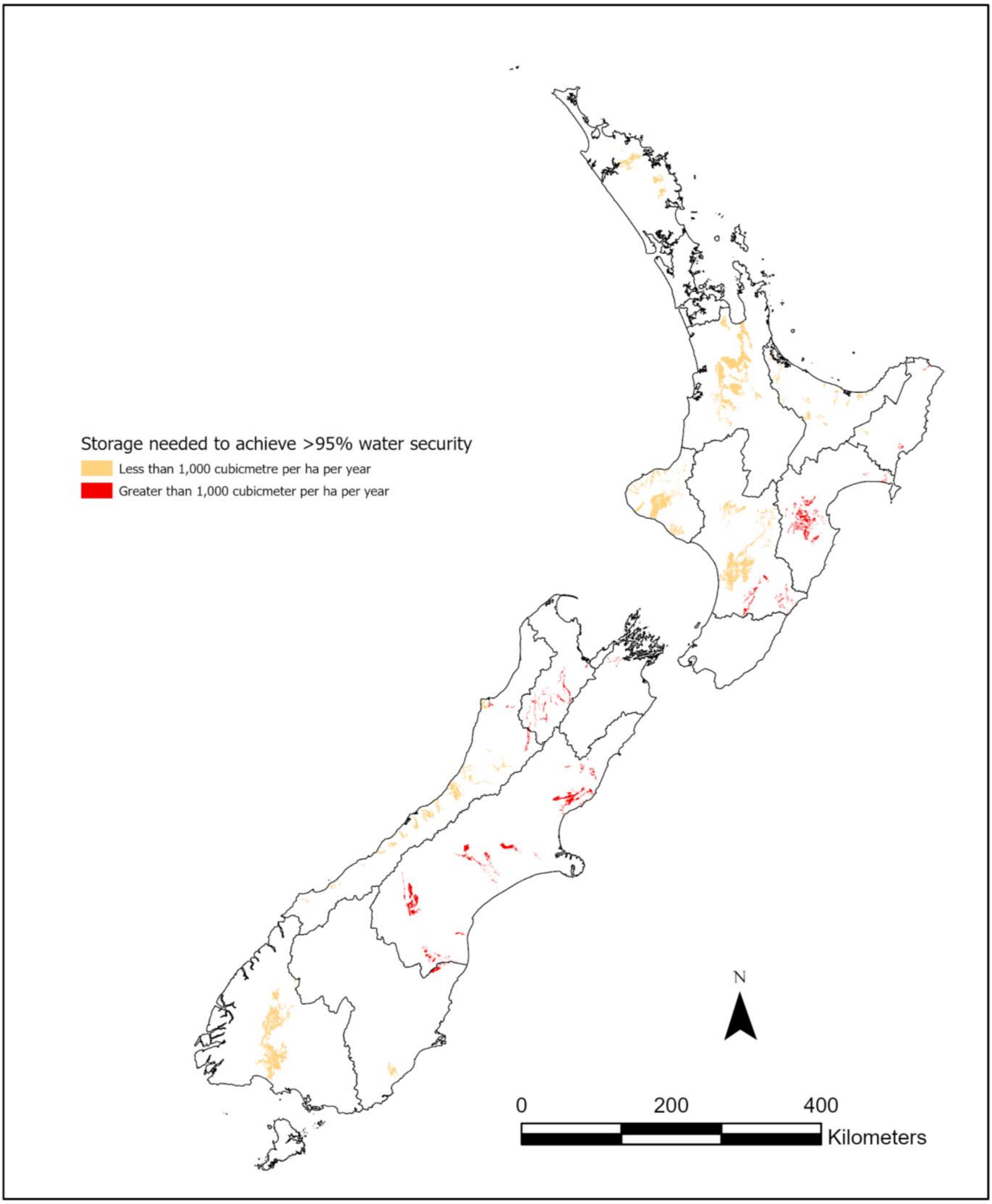
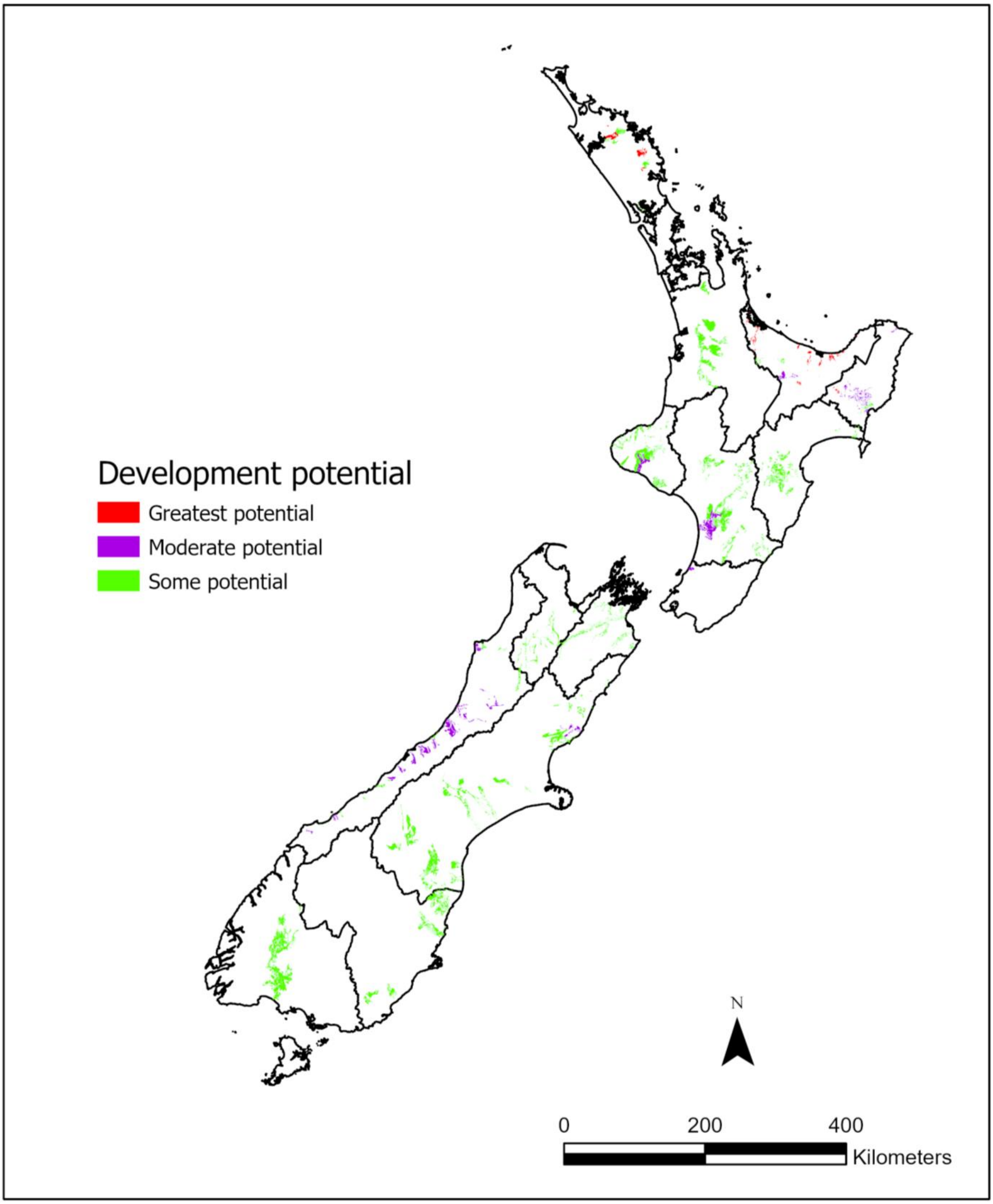


Figure 12. Areas with the potential to grow the food and fibre sector based on water availability



Development potential Figure 12 was estimated based on the financial capacity of the chosen land use mixes to pay for secure water (with reliability of supply of 95% or greater), including storage and distribution infrastructure.

Table 4 Regions with potential to expand and diversify food and fibre production (with storage)												
Region	**Current area[1]**	**Topographic filter**			**Hydrological Filter**	**Financial viability filter**						
	2020 Mapped irrigated area (ha)	**Straight forward potential area (ha)**	**Possible potential area (ha)**	**Total potential area (ha)**	**New irrigable area based on hydrology (ha)**	**Area of greatest potential (ha)**	**Ranking Greatest potential**	**Area with some potential (ha)**	**Total Land with good or some potential (weighted)**	**Ranking Greatest & Some potential (weighted)**	**Future land-uses in viable areas**	**Likely water quality constraints**
Auckland	9,938	143,609	62,110	205,719	1,572	0		1,464	483		Vegetables	High
Bay of Plenty	13,072	234,244	58,708	292,952	133,970	104,231	2	22,708	111,725	2	Kiwifruit, Dairy, Avocado	Low
Canterbury	546,205	1,374,812	173,100	1,547,912	316,365	0		6,043	1,994		Sheep and Beef, Dairy, Vegetables	High
Gisborne	9,667	79,854	50,525	130,379	81,150	0		45,336	14,961	7	Dairy, Kiwifruit, Citrus, Vegetables	Medium
Greater Wellington	21,487	144,564	31,405	175,969	36,961	2,035	8	5,600	3,883	9	Dairy, Sheep and Beef, Vegetables	Medium
Hawkes Bay	43,473	210,863	78,379	289,242	36,697	2,286	7	0	2,286	10	Fruit, Vegetables, Vineyard	High
Manawatū-Whanganui	27,480	402,570	94,895	497,465	221,455	3,421	6	87,562	32,316	5	Dairy, Vegetables, Kiwifruit	Medium
Marlborough	35,351	85,058	9,423	94,481	41,299	0		0	0		-	-
Nelson		956	129	1,085	569	0		0	0		-	-
Northland	12,337	348,335	211,313	559,648	74,267	22,004	3	9,941	25,285	6	Dairy, Avocado, Kiwifruit	Low
Otago	111,082	739,352	258,727	998,079	342,721	239,715	1	0	239,715	1	Sheep and Beef, Vineyard, Fruit	Low
Southland	22,254	679,727	129,657	809,384	81,015	0		0	0		-	-
Taranaki	4,567	208,673	49,357	258,030	17,425	0		13,810	4,557	9	Dairy	Medium
Tasman	15,808	83,769	18,616	102,385	36,045	8,291	5	13,549	12,762	8	Fruit trees, Vegetables, Vineyard, Kiwifruit	Medium
Waikato	26,307	733,317	240,168	973,485	358,284	10,895	4	155,428	62,186	3	Dairy, Kiwifruit, Sheep and Beef	High
West Coast	4,437	222,863	5,090	227,953	156,357	1,249	9	98,174	33,646	4	Dairy, Sheep and Beef	Medium
Total:	**903,465**	**5,692,568**	**1,471,601**	**7,164,169**	**1,936,152**	**394,127**		**459,615**	545,800			

7 Future approaches

7.1 Demand and supply side approaches

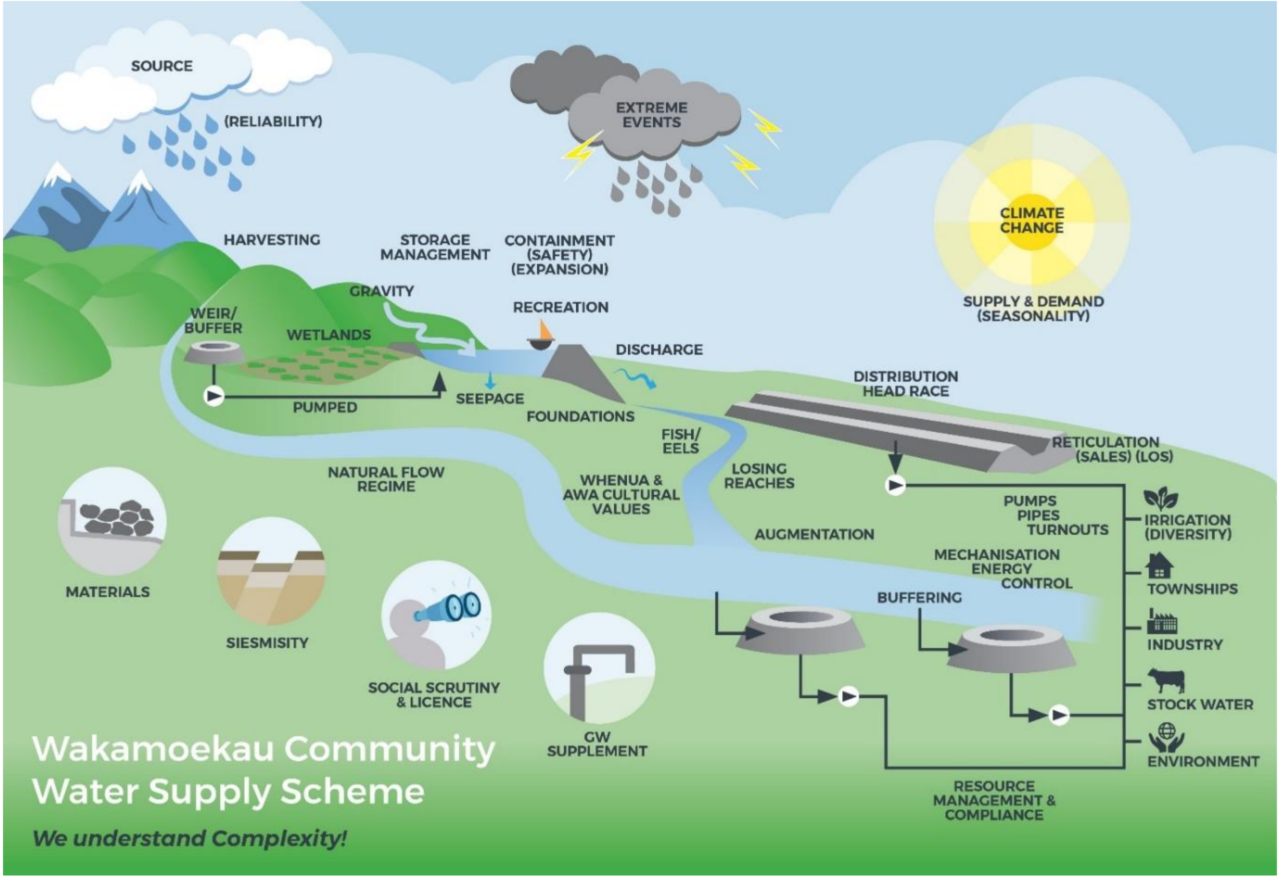
In a world operating under a Te Mana o Te Wai (TMoTW) framework, it will be critical to use available water as efficiently as possible, so that all uses under the hierarchy of obligations can meet their fullest potential. In a world with increasing water scarcity, this is a significant challenge. Water uses will need to be prioritised (and potentially reallocated from low priority to higher priority uses) to achieve the best outcomes for the sectors, community, and iwi/Māori.

Addressing demand side issues will be a prerequisite before focusing on supply side solutions. This is because getting the demands settings right can mean reducing the volume of water needed to be stored, and hence the size of additional infrastructure investment needed, to meet water security needs. Supply side solutions are usually expensive, complicated; and involve long lead in times especially investments in new infrastructure.

To increase the availability and security of water there will be a need to store and move water during times of plenty. This will enable it to be released back into the system to supplement environmental flows, and fill gaps in water availability required by communities, producers, and processors during times of scarcity.

Depending upon the scope and scale of integrated storage and distribution requirements, solutions that are designed to deliver both public and private benefits will require public/private funding models that are attractive to investors and achieve ecosystem and community-wide benefits through multi-purpose solutions.

Figure 13 – Supply Complexity



Source WSP

Given the complexity of water systems (as shown in Figure 13 above) solutions may need to consider a range of approaches to manage both supply and demand, including administrative merit and market-based approaches.

Options that need to be considered, include but are not limited to the following demand and supply options for fresh water management:

Demand management options

- Support for the uptake of technical and practice change solutions to improve water use efficiency and reliability, and to encourage the reuse/recycling of freshwater
- Water pricing /auctioning – through its National Water Initiative (NWI), Australia has taken a shared commitment approach to driving more efficiency in its water use, leading to increased certainty for investment and productivity for rural and urban communities. It has pricing principles for recovering capital expenditure, setting water tariffs, recovering costs for planning and management of water, and for recycled/stormwater reuse. In a New Zealand setting options needing to be explored including water pricing to encourage efficiency of use based on different tiers of reliability, practice, use, and ability to pay (to address equity/fairness concerns).
- Water transfers and trading – while this is undertaken more formally in other countries, e.g. the US and Australia, the success of a water market depends on features like:
  - pressure for change such as increasing scarcity or where an overseas market is providing a driver for industry to adapt.
  - system connectivity. Water trading / markets often struggle to operate without storage. Direct user to user real time trading can be very complex as it presumes the relative need (one high/one low) coincides. To be more effective water trades are best for stored water so there is flexibility in the timing between the seller and buyer.
  - increasing demand for water over time, and diverse demands - as a range of different uses are unlikely to have the same pattern of requirement.
  - in considering water trading there will be a need to ensure a well-designed and appropriately regulated market to avoid the development of water monopolies, price gouging, community disenfranchisement or other detrimental socio-economic effects.
- Water efficiency standards – which build on incorporating more real time data, as well setting the benchmarks for collection and use of information.
- Water use regulations – which offer more sophistication at a catchment scale and go beyond a typical cap/and or trade model.

Supply side options

- Water reallocation – including, where possible, freeing up lower value uses, managing coincident peaks in demand, and reprioritising to higher value uses within current systems, or via investment in ancillary infrastructure. In considering the reallocation of water it is important that the complexity and magnitude of this task from both a regulatory, political and community perspective is not underestimated.
- Water infrastructure - involving integrated new or upgraded community scale or regional scale water storage and distribution schemes, on-farm/enterprise storage, and managed groundwater (aquifer) recharge, including the repurposing of existing infrastructure.
- Water data - incorporating more real-time data into on-farm management and planning to get a more comprehensive appreciation of water availability and security.

7.2 Funding models

While previous government and private sector investment models achieved the water infrastructure New Zealand currently relies on, future models are going to need to be more innovative to achieve multiple purposes and benefits.

Security of a return on investment and unlocking the potential uptake across the system are key enablers that will drive new funding models. Financing and procurement of such models will bring in different types of partners and stakeholders for investment at different phases of the scheme. Interventions such as a government underwrites, or guarantees are still very relevant tools that will be needed at certain stages to incentivise uptake.

There remains a clear role for central and local government to co-invest where there is both public and private benefits from new infrastructure and regulatory and climate change uncertainty impacting the willingness for the private sector to invest.

There is likely to be a difference in the attractiveness to the private sector in investing in water storage to maintain access and security of water that keeps existing irrigation and processors whole in the face of the potential for regulatory clawbacks and climate change, and the attractiveness to invest in storage for 'growth water' to support new land uses and processing plants.

As a rule of thumb[72] the capital cost of building community or regional scale water storage (active storage volumes of more than 1 million m^3) is in the order of $5/$m^3$ delivered to the farm gate, compared to small enterprise scale storage which is usually a lot more expensive (storage of less than 1 million m^3 costing in the order of $15/ m^3). This is because of the economies of scale larger community scale storage can achieve.

Growth water requires economies of scale to drive the cost of water down, whereas 'security water' operates more like an insurance product that can command a higher premium, particularly where irrigation is used for high value horticulture and significant on farm/orchard investment has already been made and is at risk.

The use of special purpose vehicles (SPVs) such as an infrastructure levy model through the Infrastructure Funding and Financing Act 2020 is an example of an off-balance sheet model for funding of local infrastructure. Although the main intent of SPVs is currently to finance major infrastructure ($100m or greater) for high growth councils (including significant 'three waters' type assets), there is potential to test this in a multi-purpose water availability and security setting.

7.2.1 A role for Government investment due to market failures

There are several current market failures hampering private sector investment in necessary infrastructure to address supply side constrains for water availability and security. Among other factors, successfully attracting private sector investment in water infrastructure requires:

- regulatory certainty,
- sufficient access to water to be able to optimise the infrastructure investment and to be commercially attractive.

Market failures in these areas are driving a need for both local and central Government investment and other interventions to address community and regional scale water availability and security issues.

Regulatory uncertainty

Most community and regional scale water infrastructure investments require a long lead time through an investment pipeline as shown in Figure 14 - next page. Often many options are considered and discarded before a preferred solution is found that satisfies environmental, social, cultural, and economic requirements.

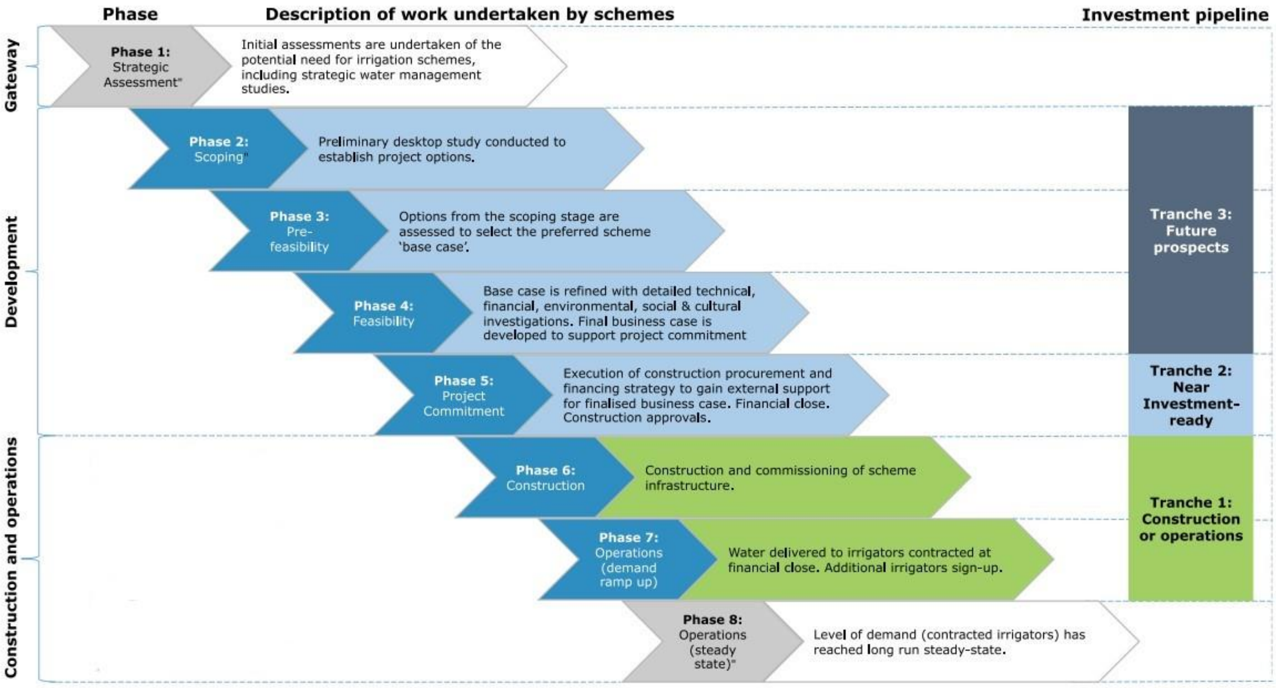
For example, in the case of the Wakamoekau Community Water Storage Scheme (WCWSS)[73] proposal to address water security concerns for the town of Masterton, and the water needs of local producers and processors in the Wairarapa, the initial assessments of options started over 20 years ago. Investigations of 243 potential water storage sites across Wairarapa were undertaken before settling on a preferred site at Wakamoekau using multi-criteria analysis.

Given the large risks and uncertainty in the gateway and development stages of the investment pipeline there is little incentive for the private sector to invest. Most of the early stage investment in recent infrastructure proposals over the last two decades has instead relied on funding from central government (Sustainable Farming Fund, Community Irrigation Fund, Irrigation Acceleration Fund, Crown Irrigation Investments Ltd and most recently the MBIE Provincial Growth Fund) with matched funding from regional or district councils. Without this early stage investment, these projects would not have proceeded.

Some delays to moving through the investment stages have been driven by regulatory uncertainty and the need to rescope storage and distribution options based on shifting regulatory requirements. In the case of the Wakamoekau Community Water Storage Scheme proposal, the scheme proponents have had to rescope the project several times due to the enactment of four versions of the NPS-FW over the course of the last decade and revised climate modelling.

[72] Water Availability and Security in Aotearoa New Zealand: National Scale Assessment - Aqualinc Research Ltd - July 2021
[73] MPI - Wairarapa Water Case Study 2021 (unpublished)

Figure 14 -Investment Pipeline for community scale or regional scale water infrastructure



End users, including producers and processors, are also having to consider how regulatory changes, such as the introduction of new environmental standards for freshwater, and mitigation of greenhouse gas emissions will impact business planning to maximise the benefits of access to water. In many cases the changes required represent uncharted territory for business, lenders, and the community regarding relative profitability of different crops and livestock types, and associated supply chain requirements such as inputs, skills, and processing. This uncertainty delays decisions to invest in potential infrastructure projects.

Other regulatory driven uncertainties currently in play that are also likely to impact private sector investment in new infrastructure include:

- potential for new water allocation and pricing models and uncertainty over the length of future water consents
- future decisions around water rights and interests and rangatiratanga and the shape and structure of the joint management and governance decision making.

Water availability constraints

Potential new water users may not to be able to access sufficient water to optimise use of new infrastructure. The most reliable (available most often) water has generally been fully allocated to existing users through a ‘first-come, first-served’ allocation system. Notwithstanding likely regulatory intervention, there is less appetite to invest in storing water where the remaining allocatable water from natural sources is typically less reliable (periodically unavailable), potentially impacting the ability to fill and optimise the storage.

Commercial viability

Another factor contributing to stalled investment in water availability and security infrastructure is the relatively unattractive commercial terms of the investment. Few investment proposals reflect opportunities to create value and generate commercial returns on infrastructure investment. For instance, irrigation schemes have been largely developed around the premise of end-user affordability ensuring water is delivered at cost to the end user.[74] This structure favours investment by end users who will use the water to create value in their own businesses and are therefore less interested in creating value for the infrastructure itself. This rules out a wide range of potential infrastructure investors.

[74] MAF – Business Case for Irrigation Infrastructure Price Waterhouse Cooper & Aqualinc - 2010

Where there has been slow investment uptake by end users (e.g. due to regulatory uncertainty), infrastructure proposals have either stalled or failed because they have not been suitably structured to be attractive to a wide range of investors. Where infrastructure projects have proceeded, the success has generally only been realised where there was a fundamental non-financial rationale for involvement – such as by local or central government based on public benefit.

7.2.2 Real options analysis

Given the inherent uncertainty in planning or adapting to climate change there is also more interest in approaches that can try and address uncertainty better. One such example is the real options analysis for water infrastructure[75], which combines climate change modelling with discount rates and decision points to offer a phased and cost-effective approach to investing into various elements of water infrastructure. This includes staging and building at the pace of demand, smaller distributed storage built to a masterplan to allow 'ready-now' activities plus time for the land use to change and adapt in the longer term alongside upscaling of investment in processing and the supply chain. The work encompasses reliability of supply, and key factors include uncertainty of outcomes, severity, size, or amount of restriction; frequency, how often the restrictions occur; duration, how long the restrictions last; and timing when restrictions occur.

7.2.3 International Case Study – Innovative Funding Models

Operating under the umbrella of Australia's NWI, the Tasmanian Irrigation Partnership Ltd. (TI) was formed in 2008 with the primary aim of growing the wealth of Tasmania through enhancing the productivity of its agricultural industries.

It works between the public and private sectors to understand what water is required, and then sets up partnerships to share the cost of establishment. Private equity input is through the purchase of tradeable water entitlements, whereas operating/asset renewal costs are provided for by annual charges levied on water entitlement holders.

All TI schemes developed have the following features

- a 100-year life
- delivery of water with 95% reliability; and
- the backing of TI towards the project, financial and technical management of the scheme from end to end.

In an Aotearoa New Zealand setting, TI sits as a form of hybrid between private irrigation schemes and a vehicle similar to Crown Irrigation Investments Limited. With further exploration and tailoring, a TI type scheme could offer a suitable type of vehicle for future co-ordination, and co-governance of investment in water infrastructure. This could address some of the more complex multi-purpose water availability and security scenarios facing communities across New Zealand.

7.3 Multi-purpose for multi-benefits

Using Te Mana O Te Wai (TMoTW) as a framework to deliver solutions to water quality, availability and security issues will require a holistic climate-proofed approach that provides multiple benefits over long time periods. Giving effect to TMoTW requires regional councils, communities, and tangata whenua to determine how water bodies are to be managed using a long-term vision that captures the needs and aspirations of the community and tangata whenua.

When capturing new opportunities or dealing with issues of degradation, equity of access, or managing climate change, water management initiatives should provide for the entire hierarchy of obligations within TMoTW in an appropriately prioritised manner. For these initiatives to be resilient they must allow time for robust discussion, engagement, and partnership formation. They should also provide flexibility (e.g. to change allocations of different parties, re-route allocation, stop certain water takes, incorporate additional users, or uses, and allow for future changes to governance and funding streams). This is especially important where long lived community scale water infrastructure investment is being considered.

This approach represents a departure from historic initiatives born from singular policy objectives focused on the economic opportunities that water provides. Most have later expanded to provide for additional benefits identified beyond the primary objective, including protecting the health and wellbeing of the water body itself.

[75] Robust adaptation decision-making under uncertainty: Real Options Analysis for water storage - Deep South Challenge

However, outcomes from many of these initiatives remain sub-optimal when measured against a wider range of community expectations.

Table 5 Regional Case Studies

Canterbury
Earlier Canterbury irrigation schemes providing water to the farm gate have enabled the key policy objective at the time of increased land production and drought resilience and led to substantial regional economic growth. However, the schemes have also enabled inefficient water use practices, and led to inequitable access, negative impacts on freshwater ecosystems, and community opposition to water use for irrigation.

In Canterbury, solutions to these issues have had to be retrofitted by taking a catchment and region-wide strategic approach to management of the water resource via the Canterbury Water Management Strategy. The emphasis on freshwater ecological health and other social and cultural values that emerged has meant that land users have needed to adjust their water use by altering practices to better provide for these multiple outcomes. However, more progress is needed to address the impacts of land use practices on the freshwater ecosystems in these catchments and better provide for community expectations.

Northland
More recent water management strategies have sought to address a wider range of policy objectives. The Te Tai Tokerau Water scheme under development in Northland has evolved from a single objective to a broader range of objectives due to community engagement over several years prior to committing to solutions.

Beginning with an objective of economic development through land irrigation, the scheme has evolved into targeted solutions that deliver multiple benefits for (and as identified by), the communities involved and the region. This scheme sought to do this through repeated canvassing of the range of needs and opportunities within the community and region at each stage of the development. The result is a series of integrated solutions that collectively can provide much-needed wealth creation and resilience to the most deprived and vulnerable communities in Northland.

The water scheme, alongside expansion of local electricity generation, will enable integration of high value land use, supply chain development, and municipal water and energy supplies to meet and manage community demand in a changing climate. Importantly the solutions will also relieve demand pressure on treasured, sensitive, and vulnerable natural water bodies, thereby maintaining ecological health.

It will be critical for this scheme to remain connected with and focused on, the community objectives and aspirations now that solutions have been committed to. Doing this well will mean building in flexibility to respond to future challenges and opportunities, including changes to community expectations and land use.

Providing a water management system that allows for changes over time is vitally important but also enormously challenging. Enabling this will require innovative approaches to funding and governance models that can provide for such flexibility. Past initiatives have provided solutions without influencing how water is used. Future models need to go beyond the farm, town, or factory gate and support investment in practice and land-use change and play a deliberate role in providing for the mana of the water.

8 Roles and responsibilities

8.1 How MPI and Government can play the best role

As the Ministry responsible for agriculture, fisheries, biosecurity, food safety, forestry and rural communities, MPI has a key responsibility on behalf of Government and all New Zealanders to: strengthen the social environmental and cultural fabric of New Zealand; keep our sectors moving forward; help them to adapt to a changing climate; and to a changing regulatory environment and market requirements.

Our food and fibre sector performed well through the initial part of the COVID-19 global pandemic and has been at the front and centre of Aotearoa/New Zealand’s economic recovery to date. For this to continue and gather speed, MPI, working across government and with key strategic partners including Māori, will need to address the emerging challenge of water availability and security in a way that meets the needs of the food and fibre sector, while satisfying the aspirations of iwi/Māori and non-Māori to restore the health of our waterways.

This will require integrated strategies to improve where practical the availability and security of freshwater across:

- horticultural and arable crops and pasture production.
- food and fibre processors (packhouses, wood processing, meat works, food and milk processing, breweries, wineries etc.)
- rural community drinking water needs
- Māori land development
- recreational and environmental uses
- flood protection, and
- emergency water requirements for firefighting and to maintain the root stock survival of key horticultural crops and the welfare of stock during drought.

For this to happen New Zealand needs a coherent and integrated strategy to address the emerging challenges of water availability and security alongside the current challenges of the need to improve water quality and adapt to climate change. This will require a focus on addressing both demand and supply issues including water allocation - within a TMoTW framework.

Water availability and security is clearly a complex issue and one which cuts across a range of policy, regulatory, Treaty partner, and stakeholder interests. MPI has direct and indirect roles in many of the programmes and interventions that are likely to be needed to enable the transition to a sustainable food and fibre sector, support the resilience of rural communities, aid the adaptation to climate change, and protect the welfare of animals.

A wide range of central and local government work programmes are being undertaken simultaneously and without the guidance of a co-designed integrated national strategic approach. While the freshwater reforms have some objectives and the hierarchy within TMoTW sets a clear framework, these don't collectively provide a strategy for water management. Climate change is also adding to this uncertainty. However, this time of change also provides an opportunity to begin longer-term discussions to improve collaboration and enable a more strategic approach to water management.

Work undertaken in the food and fibre sector under the *FFBW* roadmap and Te Taiao[76] is already responding to this opportunity. For example, water is one of the four pou of Te Taiao and the principles are:

- The natural world must be able to thrive without overuse.
- Any use is a privilege, not a right.
- If something is not healthy or well, we must fix it.

These principles focus on attitudes and behaviours that resonate with those inherent in TMoTW.

Therefore, MPI is well placed to be a part of a 'Water Availability and Security' Partnership that focuses on ways to work strategically to support the enactment of TMoTW and other policy directions, while also enabling food and fibre enterprises to thrive through investment in multi-purpose and multi-benefit water practices and infrastructure. This acknowledges the key importance of equity of water access and ensuring water is provided to Māori land and enterprises to unlock potential, and to transition the food and fibre sector as a whole to more environmentally, socially, and economically sustainable practices, land uses, and supply chains.

A greater focus on collaboration was a key recommendation provided by Kirk et al. (2020) to help identify what 'on-the-ground' practice change needs to be achieved prior to the development of future policy development. This will in turn enable iwi/hapū, local communities and local government help define outcomes and the achievement and monitoring of these outcomes within a national water management strategy.

[76] Te Taiao – the new way forward for Aotearoa New Zealand's food and fibre sector – Primary Sector Council 2020

MPI is well placed to provide leadership in a Water Availability and Security Partnership by:

- feeding back views from within the food and fibre sector (and all relevant stakeholder groups)
- ensure appropriate prioritisation within the 'productive use' hierarchy that allows for the continuation of the food and fibre sector and contributes to New Zealand's economic and socio-cultural wellbeing
- identify areas of priority for investment in practice change and infrastructure that support a sustainable and high value food and fibre sector, alongside ecosystem and human health and
- support the food and fibre sector to adapt to a changing climate.

8.2 The role of others and how to attract them

8.2.1 Water Availability and Security Partnership

Central and local government

As discussed above, MPI could lead the establishment and delivery of a Water Availability and Security Partnership. Other central government agencies key to an effective working partnership are MfE, TPK, MBIE, DIA, DOC, Taumata Arowai, and NEMA. Regional councils are also key to this partnership as they are fundamental to the successful implementation of National Policy Statements. The four proposed water services entities[77], if/when established, are also likely to be key players.

Working together in a Water Availability and Security Partnership should be welcomed by the above agencies and regional councils given the overlaps and synergies between their respective work streams.

Māori – As treaty partners/iwi/hapū/whānau

We consider the interests of iwi/Māori in water availability and security to be considerable due to both water's significance as a taonga and its importance to Māori economic development. This, in conjunction with Waitangi Tribunal findings, suggests this initiative could serve as an opportunity for MPI to advance the Crown-Māori relationship and give effect to article 21(2) of the United Nations Declaration of Rights of Indigenous Peoples[78].

For example, future work could prioritise the economic development and increased productivity of Māori-owned land to not exacerbate existing inequality by fortifying the water use rights of existing users. Priority investment could also be given to catchments where MPI holds Treaty settlement obligations for the purpose of economic development namely: the social and economic revitalisation strategy under clauses 5.57-5.59 of 'The Iwi and Hapū of Te Rohe o Te Wairoa Deed of Settlement.

For this opportunity to be realised it is critical that Māori are foundational members of a partnership network to support future work. To attract Māori to this partnership, government will need to take a genuine partnership approach, with joint governance and decision making, and Māori leadership accepted in areas as required. We could work with already established groups such as Te Kahui Wai Māori [79] and the Māori Primary Sector Forum to ensure appropriate people are in the partnership. Where specific localities are targeted, the partnership will need to extend to iwi/hapū l (i.e. mana whenua) to achieve this purpose.

Food and fibre sector organisations and community interest groups

Industry organisations with a clear role in water management should also be a part of the Partnership. For example: Science Providers, Private investors, Irrigation New Zealand, Federation of Māori Authorities, Horticulture New Zealand, Beef + Lamb NZ, Dairy NZ, Meat Industry Association, Dairy Companies Association of New Zealand, New Zealand Wine Growers, and the Food and Grocery Council. Community interest groups such as the Royal Forest and Bird Protection Society, and NZ Fish and Game. These organisations are already aware of the issues around water availability and security and are at various stages of developing their own strategic approach, including a call from some for government to establish a national level water management strategy. Working together in a Water Availability and Security Partnership should therefore be welcomed by these organisations and groups.

[77] https://www.beehive.govt.nz/release/government-water-reforms-build-economic-resilience-and-save-ratepayers-money /
[78] United Nations Declaration of Rights of Indigenous Peoples
79 Kāhui Wai Māori/the Māori Freshwater Forum works collaboratively with the Cross-government Water Taskforce on the development and analysis of policy options

8.2.2 Additional groups, stakeholders

Additional people and groups that the Water Availability and Security Partnership would likely engage with on a regular basis to access expertise, opinions and support would include:

- Māori experts (mātauranga, engagement, co-governance & co-design)
- water infrastructure owners/providers, end users, rural communities, and other groups and organisations (e.g. NGOs) with an interest and/or potential benefit (as separate from private investors)
- local government, economic development agencies, etc
- technology, services, and research organisations
- meat, milk, food and wood processors, fruit and vegetable marketers and exporters
- energy water users (hydro-electricity generators, geothermal, hydrogen production)
- private investors including Impact and Green investors (enablers, but not necessarily end users)

9 What next

9.1 Recommendations

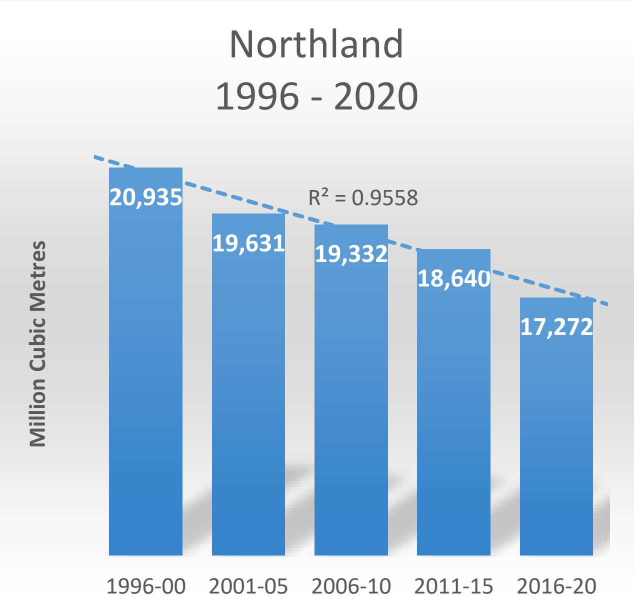
Based on the above report we provide the following recommendations:

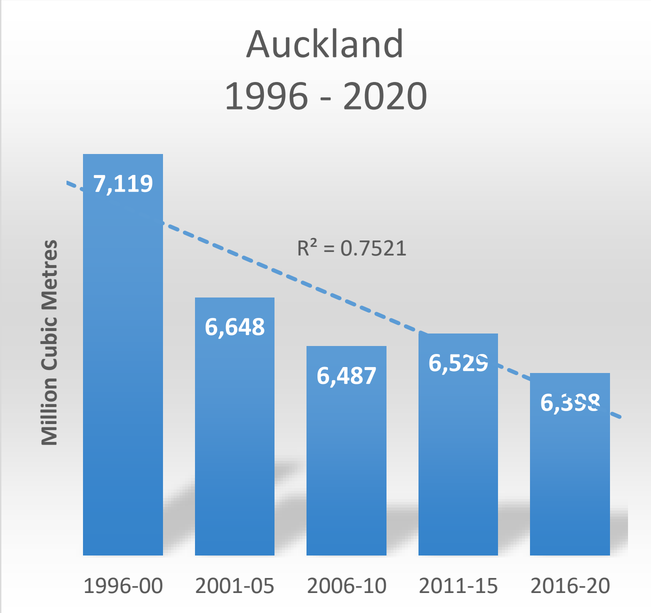
1. MPI establishes a Water Availability and Security Partnership comprising central and local government, Iwi/Māori, food and fibre sector organisations and community interest groups.

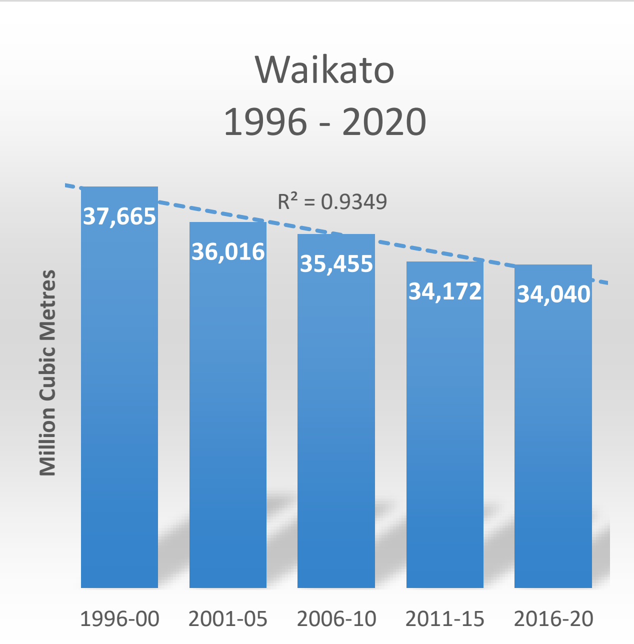
2. The Water Availability and Security Partnership develops an action plan and business case for the design and implementation of a national water availability and security strategic approach that will work within the framework of TMoTW and regional water strategies, be supportive of the food and fibre sector and other water users, guide practice change, and future science and technology (e.g. improving or developing technology and new systems related to efficiency, recycling, etc.), and coordinate investment in water infrastructure (distribution and/or storage).

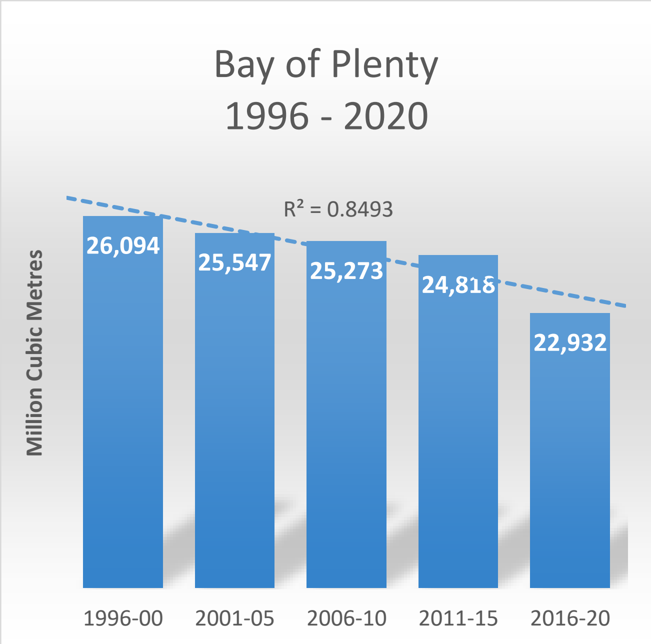
3. Until the development of the action plan, any further investment in water availability and security made by government should use TMoTW as the guiding framework and focus on the use of multiple purpose/multiple benefits models.

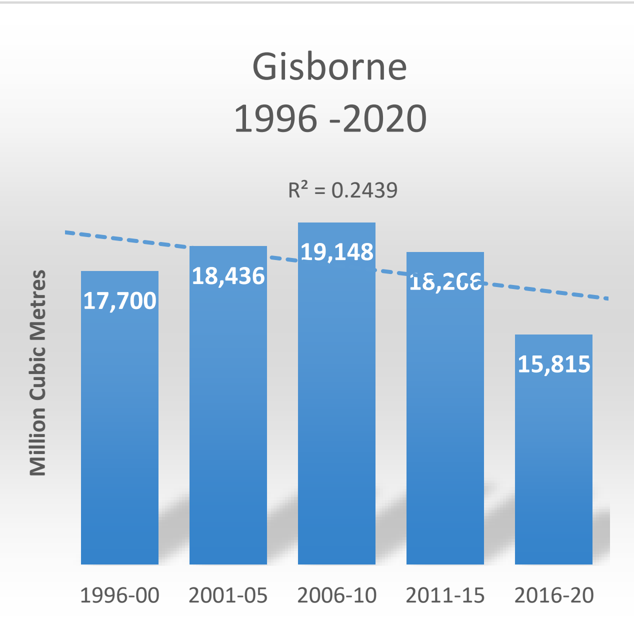
Appendix 1 – Rainfall change by regions 5 yearly average 1996-2020

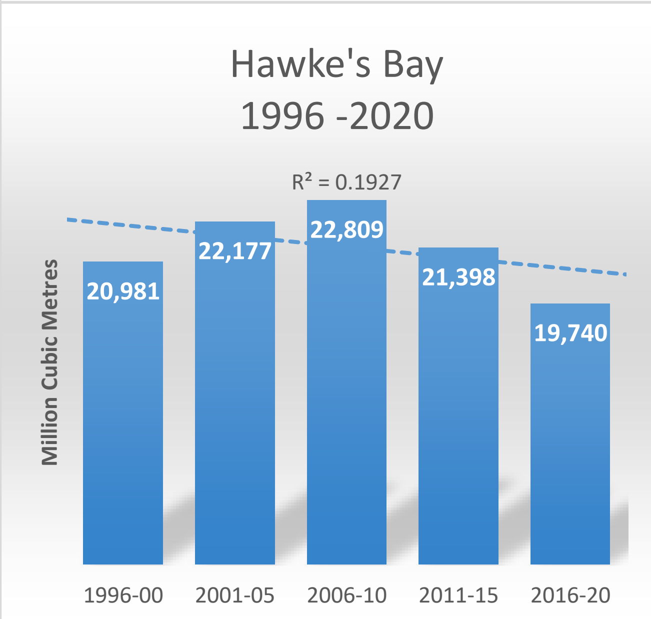


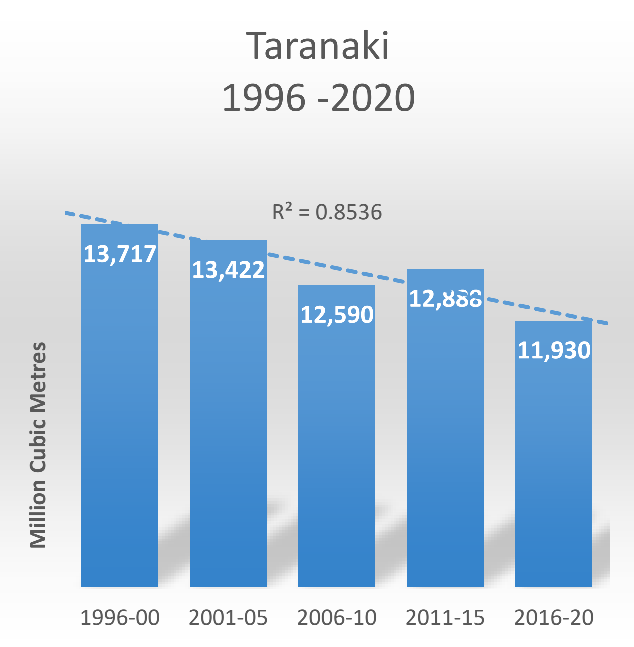


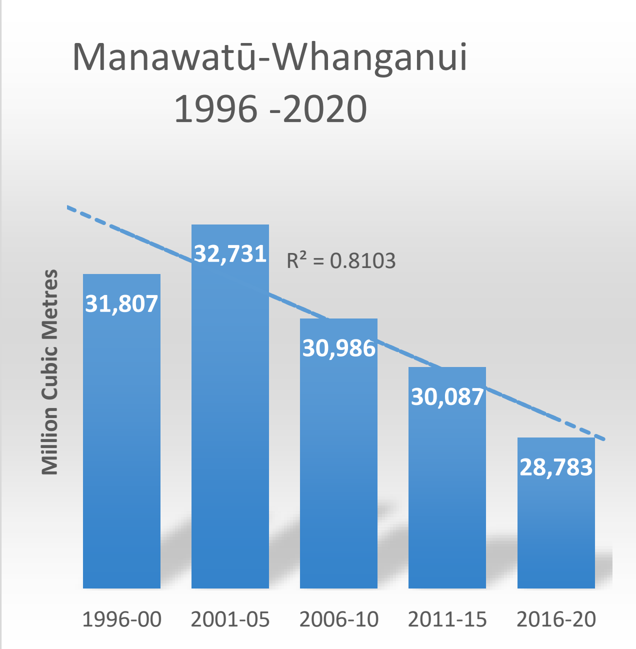


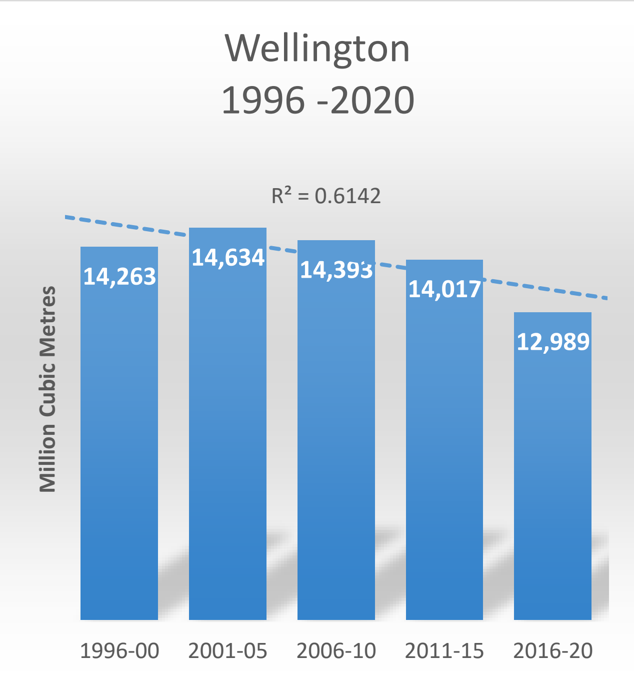


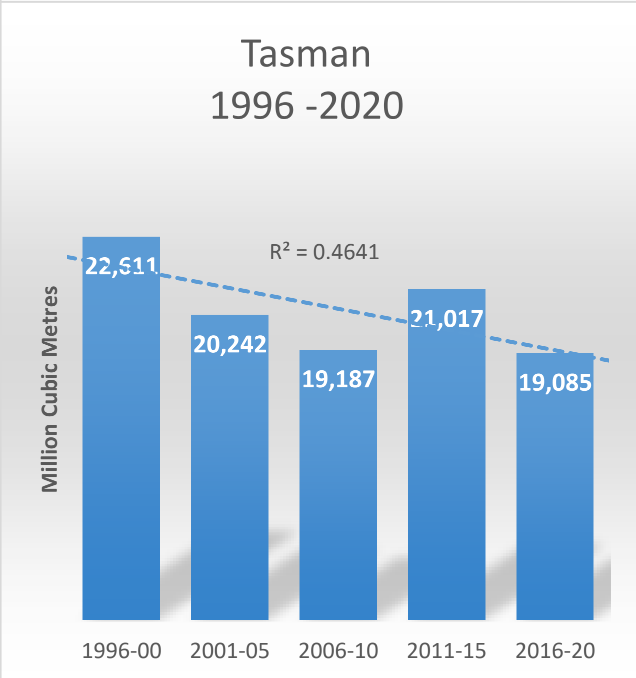


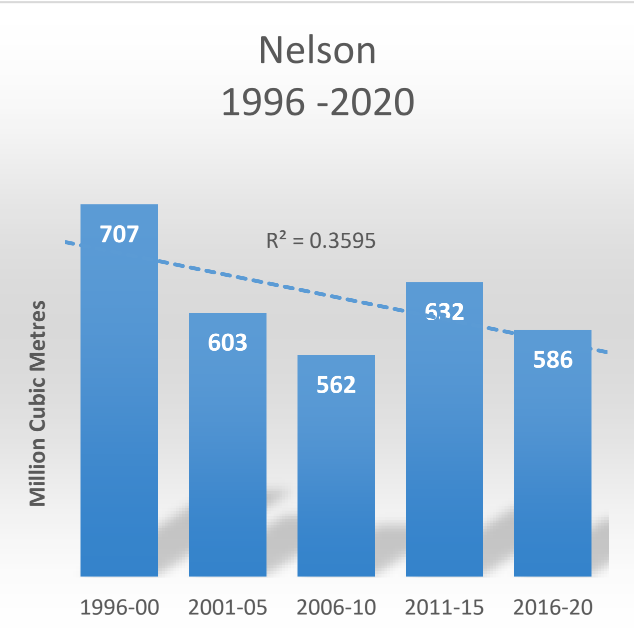


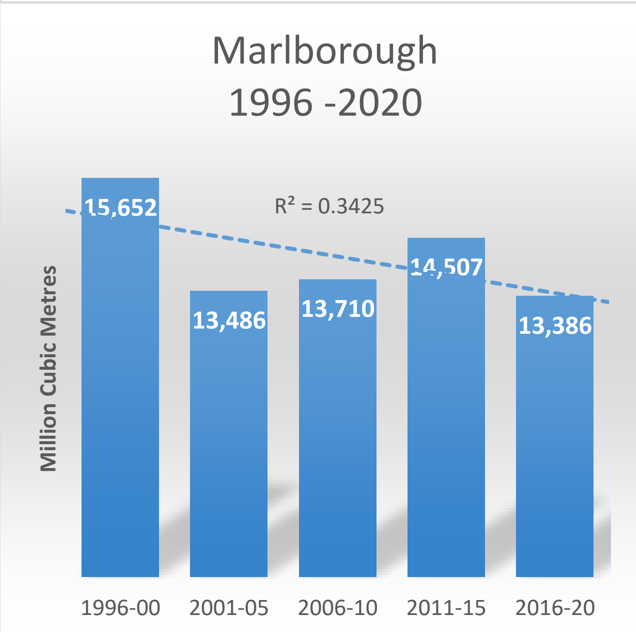

Taranaki
1996 -2020
R² = 0.8536
Million Cubic Metres
13,717
13,422
12,590
12,888
11,930
1996-00
2001-05
2006-10
2011-15
2016-20

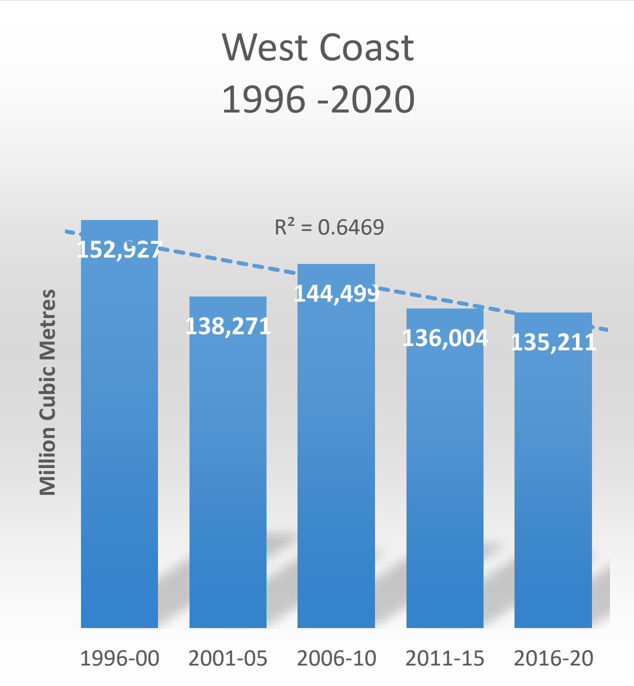

Manawatū-Whanganui
1996 -2020
R² = 0.8103
Million Cubic Metres
31,807
32,731
30,986
30,087
28,783
1996-00
2001-05
2006-10
2011-15
2016-20

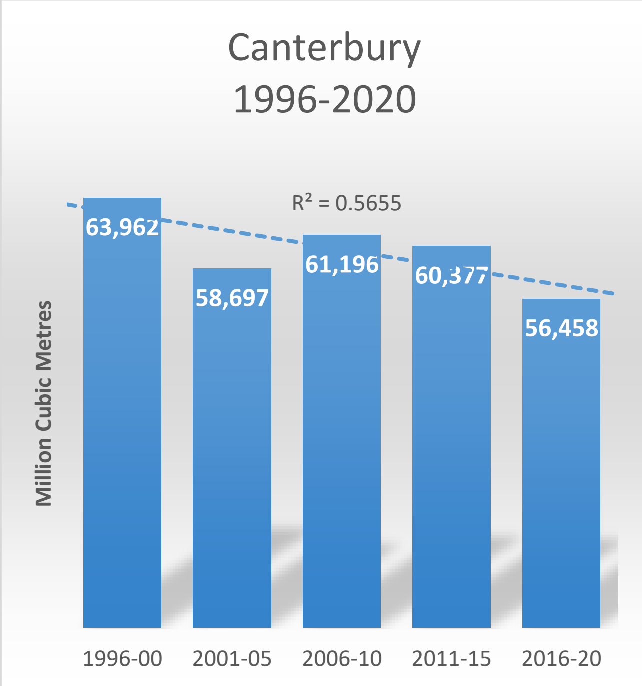

Wellington
1996 -2020
R² = 0.6142
Million Cubic Metres
14,263
14,634
14,393
14,017
12,989
1996-00
2001-05
2006-10
2011-15
2016-20

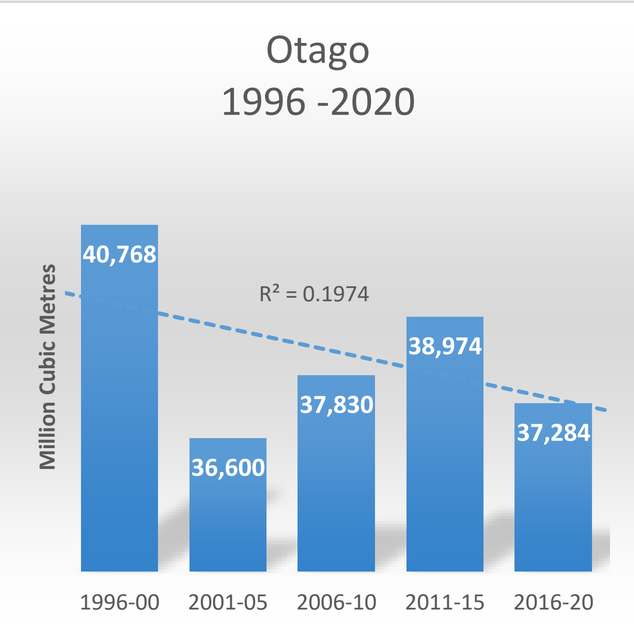

Tasman
1996 -2020
R² = 0.4641
Million Cubic Metres
22,611
20,242
19,187
21,017
19,085
1996-00
2001-05
2006-10
2011-15
2016-20

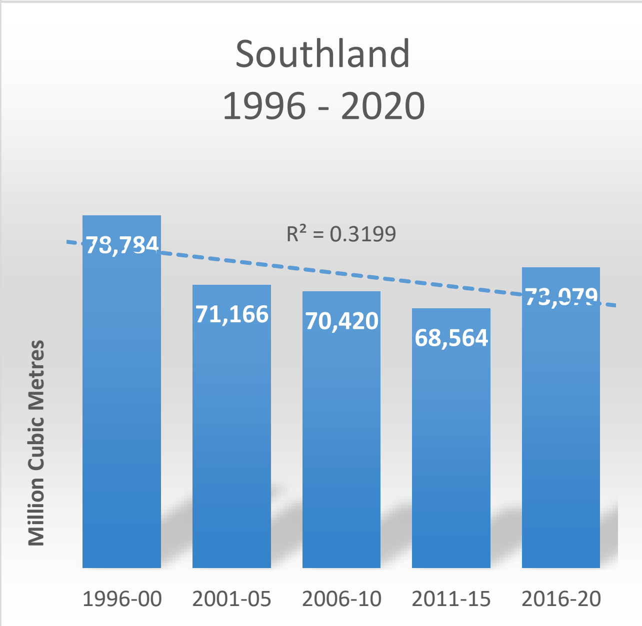

Nelson
1996 -2020
R² = 0.3595
Million Cubic Metres
707
603
562
632
586
1996-00
2001-05
2006-10
2011-15
2016-20

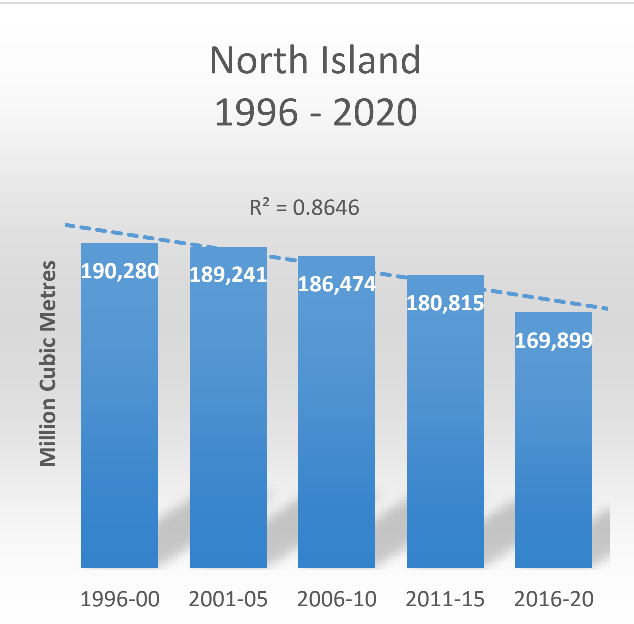

Marlborough
1996 -2020
R² = 0.3425
Million Cubic Metres
15,652
13,486
13,710
14,507
13,386
1996-00
2001-05
2006-10
2011-15
2016-20

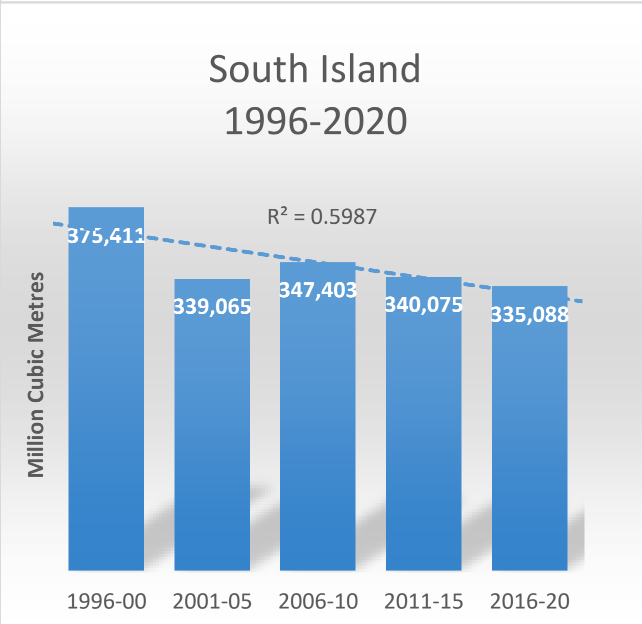

West Coast
1996 -2020
Million Cubic Metres
R² = 0.6469
152,927
138,271
144,499
136,004
135,211
1996-00
2001-05
2006-10
2011-15
2016-20


Canterbury
1996-2020
Million Cubic Metres
R² = 0.5655
63,962
58,697
61,196
60,377
56,458
1996-00
2001-05
2006-10
2011-15
2016-20


Otago
1996 -2020
Million Cubic Metres
R² = 0.1974
40,768
36,600
37,830
38,974
37,284
1996-00
2001-05
2006-10
2011-15
2016-20


Southland
1996 - 2020
Million Cubic Metres
R² = 0.3199
73,784
71,166
70,420
68,564
73,079
1996-00
2001-05
2006-10
2011-15
2016-20


North Island
1996 - 2020
Million Cubic Metres
R² = 0.8646
190,280
189,241
186,474
180,815
169,899
1996-00
2001-05
2006-10
2011-15
2016-20


South Island
1996-2020
Million Cubic Metres
R² = 0.5987
375,411
339,065
347,403
340,075
335,088
1996-00
2001-05
2006-10
2011-15
2016-20

Appendix 2 - Water Availability and Security Advisory Group

and WAS initiative Project Team

WASAG Members
Lyn Harrison
Kevin Steel (Chair)
Lionel Hume
Christina Robb
Chris Koroheke
Peter Lilley
Stephen McNally
Michelle Sands
Nigel Paragreen

MPI Project Team
Mike Jebson (Project Lead)
Courtney Stone
Vickie Compton
George Strachan
Jane Davidson
Mathirimangalam Srinivasan (MS)