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IRRIGATION NEW ZEALAND

www.irrigationnz.co.nz

IrrigationNZ: out & about

SCHEME FORUM VISITS AMURI

In May, a scheme forum meeting was held at Culverden. The day included an opportunity to hear from Minister Damien O'Connor via Skype.

Minister O'Connor talked about the fact that irrigation schemes were taking action to address environmental impacts by requiring and supporting the development of Farm Environment Plans and facilitating training. He spoke about the importance of irrigators maintaining their social licence to operate in the future, and answered questions from forum members.

In the afternoon the group (pictured) visited Amuri Irrigation's Balmoral intake and proposed Hurunui scheme intake.

IRRIGATION INSIGHT WORKSHOP

In May, NIWA hosted a workshop in Rangiora for farmers and stakeholders as part of the Irrigation Insight project. The day was designed to look at how the tools developed as part of the project could be improved and shared more widely with other farmers to help them make better irrigation decisions. You can read more about the Irrigation Insight project and the science of weather forecasting on page 44. IrrigationNZ is one of a number of stakeholders supporting this project.

(Photo: NIWA)

ONLINE E-LEARNING MODULES IN DEVELOPMENT

IrrigationNZ is currently working to develop more modules of our online irrigation e-learning platform.

Steve Breneger of IrrigationNZ and Bayley Pearce of WaterForce (pictured) are filming a series of 'How To' videos for the e-learning platform. The new videos will cover bucket tests for all irrigation system types.

IrrigationNZ members can use our existing free e-learning resource on irrigation scheduling which explains how to decide when you should irrigate online at www.irrigation.co.nz (select the e-learning option).

Time for us all to look forward

As the irrigators are being packed up and systems winterised I encourage all farmers to consider what worked well over the irrigation season and what can we improve? The challenge of continuous improvement of our systems so that we can be confident we are only applying the water we need for optimal plant growth is not just important for driving productivity and profitability on farm but critical to ensuring we are being good stewards of the land, surrounding environment and our precious resource, water.

With the challenges of a very dry mid to late summer, and the reality of restrictions for many schemes and individual irrigators, using only what you require may seem a moot point when reliability of supply is still a huge challenge.

Improving both reliability and on farm irrigation systems comes at a significant cost. You as farmers have a proven track record of being committed in this space with $700 million being spent since 2011 to improve our systems. Our commitment to environmental stewardship, future technology opportunities and regulatory requirements will mean we need to continue to invest. The recent announcement by the Government that there will not be a water tax within this term is a short-term win and will allow farmers to continue to invest where it counts – in changes on farm. We know that it will be the actions of farmers on the ground that will have the biggest impact on reducing our environmental footprint, not a tax.

However, with an election only 15 months away we know that we need to keep communicating this message and not just to politicians and their advisors, but to the general public. Advocacy on this point (but also the wider value of irrigation and its place in producing high quality food within a sustainable system) is an absolute focus for IrrigationNZ and is one of the first key areas being prioritised by our Chief Executive Elizabeth Soal.

We are also aware of the large amount of data now being collected by irrigated farmers not just for irrigation but also land use. We are determined to develop a central information platform that brings together key irrigation information we need to better tell our story and to demonstrate improvements. "Not another system or form to fill out," I hear you groan – no, that is the last outcome we want. Instead we need to pull together the data you are already submitting to regional councils and information provided through your farm environment plans. This sounds simple but it will take some serious digital smarts and close workings with regional councils and our other primary sector organisations to achieve this. The government also sees a requirement to streamline farm information within the primary sector and we will continue to work with MPI to ensure our requirements are being met through their Integrated Farm Plan concept. Having this information will make advocacy messages stronger both nationally and regionally.

Farmers have invested heavily in modernising their irrigation systems in recent years.

As a sector you have continuously upskilled yourselves through a range of training provisions, with IrrigationNZ heavily involved in this space. The question we are asking our members now is, "What are your requirements going forward and what role would you like IrrigationNZ to play?" Having now trained over 3,000 irrigating farmers, and with the need for continuous upskilling, we still envisage training to be essential but we are increasingly seeing different ways in which we can provide or facilitate this. IrrigationNZ launched our online e-learning platform offering all members free access to work through modules on a range of irrigation topics – this allows farmers and employees to upskill in their own time and at their own pace. We see this as complementing the existing on-site training now being offered not only by IrrigationNZ but by the wider market. Thanks to those members who are giving us feedback in this space.

Our industry members are also committed to upskilling and training and we have an industry design qualification awards evening in Christchurch in a few weeks to celebrate the hard work of those who have gained qualifications. We encourage farmers to continue to ask for accredited designers, installers and service providers to ensure that we do not have a 'cowboy' approach taken to developing or maintaining very expensive systems.

As our growing season slows up I hope you enjoy the somewhat quieter winter months but also take the time to plan ahead for next season.

Nicky Hyslop,
Chair of IrrigationNZ

National's plan to support water storage

By Simon Bridges, National Party.

Water storage is an essential component of New Zealand's landscape and needs to be implemented appropriately to ensure our thriving primary sector continues to produce at such high levels. As a former Minister for Economic Development I know exactly how important the Primary Sector is to our economy and water storage is an important cog in the machine. It has the potential to add significantly to New Zealand's economy while also buffering primary production against the impacts of climate change with important drought mitigation. If designed holistically such schemes can also improve water quality and provide flood management benefits.

The benefits of water storage have been largely lost in the negative public discussion around water quality associated with intensification of land use over the last few years. The two issues need to be separated as water storage can be used to enhance water quality, improve food security for our growing population, provide a reliable source of water for towns and cities and support economic activity.

We're in a fortunate position of having world leading agri-technology in the water space at our disposal, as GPS tech can now confirm how much water should be applied on different soil types and lysimeters can help measure soil water levels. By utilising this technology we can ensure that we're making the most of our natural resources in a way that is not degrading to the environment and continues our strong production.

New Zealand is extremely fortunate to have a freshwater resource of 600 trillion litres per year of which only 10 trillion is extracted for agriculture, industry, and town water supplies. There are distinct areas where our water falls during summer, and with strategic, well designed and well managed infrastructure we can appropriately utilise this and support improved water quality and sustainable agriculture.

National were strong supporters of irrigation in Government and provided funding through Crown Irrigation Investments Limited. We were immensely disappointed to see the Coalition Government cave into the Greens demands and stopping funding for new projects, with no clear reason other than an ideological objection to irrigation.

National wants to see more water infrastructure developed.

International evidence shows that water storage requires long term investment partners and in most countries such schemes are supported by federal or state equity or sponsorship. Crown Irrigation is the most recent structure in New Zealand which provided both expertise and funding assistance through grants and loans. If we earn the right to govern again we would look to establish a new entity with the intention of providing funding for projects that meet a criteria.

National's philosophy is that for water storage to be considered for funding it needs to meet three key benchmarks:

1. Beneficial to the economy
2. Positive social impact through improved urban water supply
3. And progressive environmental improvements to their community.

As well as having some sort of funding organisation, the other thing that needs to be looked at by Government is smoothing the planning process and RMA reforms to ensure these projects can get off the ground.

Regional water storage schemes such as the Waimea Dam and Central Plains Water (CPW) highlight the benefits of water storage and should act as a case study for well implemented projects going forward. They're both helping the primary sector through increased food security, the local urban populations due to a more secure water supply and aiding their environment by recharging aquifers and increasing river flows. CPW actually leaves the equivalent of nearly two Lake Taupo's of water in the ground.

It's not just the regions that need water storage either. In Auckland, billions needs investing in properly separating and better managing stormwater and sewage to clean up streams and beaches. It's a big issue that is often not mentioned in the water quality debate.

Recently National released our discussion document focusing on the environment where we detailed some of our ideas surrounding water. One of the most exciting proposals is establishing a new Water Infrastructure Fund to assist city and rural councils in improving water quality, and supporting more sustainable agriculture and resilience to climate change through Government funded water projects. Alongside this we had a series of proposals around improving water quality and allocation. The discussion document can be found at **www.national.org.nz/ourenvironment** and we welcome any feedback.

Currently we are at a space where we need to be looking forward and planning for the future. This means creating the infrastructure now for water storage that is going to be lasting for the future. While the Coalition Government are content to let things slip and turn a blind eye to the clear benefits of water storage, National would not sit back and let the opportunities pass New Zealand by. We're committed to providing a pathway for adequate water storage in New Zealand that benefits the economy, improves urban water supplies and advances the environment.

IrrigationNZ will be inviting all major political parties to contribute columns to upcoming magazine editions.

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Assessing water quality in Alberta's irrigation districts

By Margo Jarvis Redelback, Executive Director, Alberta Irrigation Districts Association.

In the province of Alberta, 13 irrigation districts convey water through 8,000 kilometres of canals and pipelines and 52 storage reservoirs to serve 580,000 hectares of irrigated land. This area represents 82% of Alberta's irrigated land base. The main purpose of the irrigation infrastructure is to serve the agricultural land base, however, raw water conveyed through the infrastructure is also used by municipalities, and industry (including agri-food processing plants), for water-based recreation and to enhance wetlands and wildlife habitat.

District irrigation water originates from high quality snowpack in the Rocky Mountains. As such there was a belief water flowing through district infrastructure would be of good quality owing to its source. However, there was no large-scale data to inform this belief. With agricultural producers being increasingly questioned on the quality of water used for agricultural food production by agri-food processors and the general public, the need to comprehensively assess the quality of water flowing through district infrastructure became apparent.

An initial two-year project to assess the quality of water in irrigation districts was undertaken in 2006 and provided important data for irrigation district staff, agricultural producers and others. Consequently, the project transformed into the long-term Irrigation District Water Quality Project (IDWQ).

The main objective of the project is to assess the quality of irrigation water within irrigation districts examining the quality of water for irrigation, livestock watering, recreational use and the protection of aquatic life. In addition, the project seeks to understand the quality of water as it moves through irrigation infrastructure and observes differences in water quality between irrigation districts.

Since 2006, up to 90 different sites have been sampled monthly from May to August. Sample site types include source sites where water is diverted from rivers into headwaters reservoirs; primary sites where water enters into districts through main canals; secondary sites located mid-district where water branches into smaller lateral canals or just after mid-district off stream reservoirs and return sites where water is returned to the river system. Return sites include infrastructure returns where water flows back through constructed irrigation canals and watershed returns where natural creek, drains, or coulees return water.

The project examines over 190 parameters in several categories including salts, nutrients, bacteria, metals, pesticides, livestock pharmaceuticals as well as the physical condition of the water.

A water quality index is used to analyse and summarise the project data. This computer program uses irrigation water quality guidelines to assess how many, how often and by how much guidelines are exceeded. The water quality index is calculated for each sample site on an annual basis. Overall, these results indicate that Alberta's irrigation districts have excellent water quality. In general, it is observed that most sites have maintained or improved their water quality over the 10-year project period. There are a few sites which have deteriorating water quality and these are sites that warrant further investigation or the implementation of best management practices for improvement.

Over the years, several research studies and subsequent water quality projects evolved from the original project to assist irrigation districts in addressing sites that may have deteriorating water quality. Spin-off studies include nutrient correlation to algae growth; the relationship of water quality to land cover and land use which then progressed further to a bioreactor project to treat drainage water. Pathogen surveillance and source tracking of Escherichia. coli (*E. coli*) found in the water are also studies currently in progress. The source tracking study aims to identify whether the observed *E. coli* is associated with cattle, wildlife, humans or is present in the water from naturally occurring strains. This research will assist in understanding how many *E. coli* strains present are actually pathogenic to assist in the development of strategic best management practices to reduce those strains.

The entire suite of water quality data through the IDWQ project is now available on-line at www.idwq.ca. This tool was developed to make data easily accessible to irrigation districts, agricultural producers, agri-food processors or the general public. The hope is the tool will help promote irrigation district water quality and demonstrate assurance of the quality of the water for food production.

The Alberta irrigation sector is eager to continue the Irrigation District Water Quality Project. Future water quality concerns will continue to be addressed through additional research in combination with best management practices in order to maintain the excellent water quality flowing through district irrigation infrastructure.

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New video shares safety messages around rural water hazards

Ashburton irrigation schemes, Ashburton District Council, Water Safety New Zealand and local community members have come together to create a new safety video for rural communities highlighting the need to be vigilant to prevent drownings of young children.

The short video has only been live since March but is already making an impact. It's been viewed around 10,000 times on Facebook and YouTube, and was shared nearly 100 times on Facebook.

Two of the stars of the video are Mayfield pre-schoolers Angus (2) and George Dampney (4).

They live on a farm which has a water race close to their house, as well as duck ponds, irrigation and effluent ponds and an effluent wedge.

"We are around water all the time. Water safety is really important and the danger it can pose to children needs to be taken seriously," says their mother Hayley Dampney.

Hayley says that the other children at the boys' pre-school have seen the video and the boys have learnt a lot about being safe around water through being involved in the video production.

The idea to create the video came from local irrigation schemes.

"In January a tragic drowning of a child occurred in a stock water race near Ashburton. This followed the drowning in September of a small child in a stock water race in Rolleston in the nearby Selwyn district," says Melanie Brooks, the Chief Executive of MHV Water.

"As a cooperative, community safety is of the utmost importance. We have around 320km of water races in our scheme, effluent storage ponds, and many on-farm storage ponds across our district. Drowning is an ever-present hazard and we wanted to explore what we could do locally to help prevent further toddler drownings."

Hayley Dampney with children Angus (front) and George (back) in an image from the video.

MHV contacted Water Safety New Zealand and the Ashburton District Council, which manages a large network of open water races. The organisations brainstormed options and brought two other irrigation schemes – Ashburton Lyndhurst Irrigation and Barrhill Chertsey Irrigation – into discussions.

"We all wanted to create a video which shared some key safety messages for parents to help keep kids safe around waterways and water races," Mel says.

The overall numbers of preventable drownings in New Zealand fell significantly in 2018, from 92 in 2017 to 68 in 2018. However the number of drownings of young children to date in 2019 is already at five – higher than the total of three for the whole of 2018. In addition to the two drownings in Canterbury, pre-schoolers drowned in a wastewater treatment pond in Gore, and in a pool in Riverhead,

Two-year-old Angus Dampney in the water safety video.

"It is not realistic to expect every waterway in rural areas to be fenced. With so many potential drowning hazards around, it is vital that everyone is keeping a vigilant eye on their young ones at all times. The Council is proud to be working in partnership with local irrigation companies and Water Safety NZ to help reinforce this crucial message."

north west of Auckland. A potential drowning is also being investigated near Whakatāne.

"To parents and caregivers in our rural communities the most important message is to actively supervise your children at all times around water or where potential water hazards are present. Babies and toddlers need to be kept within arms-reach," says Water Safety New Zealand Chief Executive Officer Jonty Mills.

"Do not leave older children in charge of smaller children around water. Be aware of all water safety hazards on your property and your neighbours. Any body of water presents a danger. A toddler can drown in a puddle and it takes less than a minute."

"In the last 10 years, there have been 58 preventable toddler drownings in New Zealand. The Ashburton District has many water races, irrigation ponds, streams and rivers, most of which are not fenced or restricted, and many are often on private properties," Ashburton District Council Chief Executive Hamish Riach explains.

"It is not realistic to expect every waterway in rural areas to be fenced. With so many potential drowning hazards around, it is vital that everyone is keeping a vigilant eye on their young ones at all times. The Council is proud to be working in partnership with local irrigation companies and Water Safety NZ to help reinforce this crucial message."

Water Safety NZ helped create the safety messages included in the video which were delivered by a range of local residents, including local farming families connected to irrigation schemes. Ashburton District Council filmed and produced the video.

Those involved in creating the video say it has been well received by the community.

"We have had some really positive feedback from a range of local organisations and people who have watched the video saying that they're really pleased to see us working together to promote this safety message," says Mel Brooks.

"We have had lots of comments from friends who think making the video was a wonderful idea," says Hayley Dampney.

Alongside partners Swimming New Zealand and The Warehouse, Water Safety New Zealand is working to get their Water Skills for Life aquatic education programme into every primary school in the country.

WATER SAFETY NEW ZEALAND'S ADVICE FOR PARENTS TO KEEP BABIES AND TODDLERS SAFE:

The team at Water Safety New Zealand and Ameliaranne Ekenasio – Central Pulse and Silver Fern netballer and Water Safety New Zealand ambassador – have this advice to share.

Provide constant active adult supervision at all times
Always keep babies and toddlers within arms' reach around water. It takes less than a minute for a child to drown.

If you're in a group, have an active adult supervision roster
Don't rely on older children to supervise younger ones in, on or around water. Constant active adult supervision is required at all times.

Identify water hazards in and around your property and your neighbour's
Any body of water is a potential drowning hazard for a small child including puddles, creeks, water races, troughs, drainage ditches and effluent ponds.

Empty water from unused buckets, paddling pools, and containers after use. Pools should be properly fenced and comply with the safety requirements under the Building (Pools) Amendment Act 2016 with properly working safety latches. Ensure pool gates are secure and locked at all times.

Ensure your toddler has a fenced play area away from any potential water hazards.

Use your Water Safety bathmat at bath times
Water Safety New Zealand works with Plunket to supply bathmats to new parents to keep toddlers and babies safe at bath time. The bathmats stop your child from slipping.

Avoid distraction
Put your phone away when supervising children around water. Their lives are in your hands and their safety requires your full attention.

Teach your children water safety behaviour
As soon as they are old enough to understand, teach your children things like: 'Never go near the water unless you're with a grown up.' It is important children are taught that while water is to be enjoyed, it must also be respected. Teach them about the risks and dangers associated with water based activities.

Wear lifejackets
Lifejackets should be worn whenever your child is around water as accidental immersions are a leading cause of preventable drowning fatalities in New Zealand.

Support your child and give them enjoyable and positive early experiences around water
It is important to begin your child's aquatic education early and is as simple as taking them to a pool for a fun splash around. It is crucial that every New Zealander can learn to enjoy the water from an early age so they can learn essential aquatic skills to keep them safe.

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Primary Industries businesses continue to drive forward, looking for smarter ways to use land and water resources by diversifying their farm practices within tight environmental and community expectations.

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Amuri Irrigation shareholders vote to proceed with new Hurunui scheme

Amuri Irrigation Company (AIC) shareholders have voted in favour of a proposal to construct a 7,000–9,000 hectare piped irrigation scheme on the south side of the Hurunui river.

This area has suffered from the impacts and effects of drought over recent years and a secure irrigation scheme will bring certainty and security to those farming in the area. The AIC shareholder decision, which was made at a meeting on 13 March, will enable the irrigation of farmland surrounding the towns of Hawarden, Waikari and the Scargill Valley.

Hurunui Water Project was unsuccessful with an earlier proposal for a larger scheme in the same area. The AIC proposal will provide an opportunity for a revised and smaller scheme than the one originally proposed by the Hurunui Water Project.

In late 2018, AIC made an offer to take over the Hurunui Water Project. The takeover offer was accepted by over 90% of Hurunui Water Project shareholders in early March. That offer was conditional on receiving sufficient interest in irrigation from Hurunui farmers and the support from AIC shareholders. 90% of AIC shareholders voted in favour of resolutions for the construction and financing of an irrigation scheme and almost 7,000 hectares of expressed interest in irrigation was received from Hurunui farmers.

"AIC shareholders have shared the vision of the AIC Board to take the social and economic benefits of irrigation to their neighbours south of the Hurunui. We would like to thank our shareholders and the Hurunui farmers for their support thus far. We will continue to work hard to get a share offer into the market as soon as possible to raise equity to fund the scheme development," says David Croft, Chair of AIC.

AIC irrigates over 28,000 hectares of land in the Amuri Basin taking water from both the Hurunui and Waiau rivers and recently delivered a $87M pipe upgrade of its open canal distribution network.

"We anticipate that one company managing most of the water use and environmental impacts of irrigation in the Hurunui River catchment will provide benefits for the community and efficiencies for all irrigators," says David Croft.

The proposed irrigation scheme will use some of the consents currently held by the Hurunui Water Project along with unused water within the AIC schemes, when available. The Hurunui Water Project consents currently authorise water use over a much larger (58,500 hectare) area. The reduced scale of the AIC proposal will significantly reduce the environmental risks associated with the proposed scheme compared to the original proposal.

AIC needs to invest in water storage in the future to allow for higher minimum flows in the Hurunui River. A single water storage facility will provide increased reliability both north and south of the Hurunui River.

All AIC shareholders must have Farm Environment Plans. The scheme offers education and training to its farmers on nutrient management and irrigation efficiency and is focussed on continuing to improve water quality. In 2017 the Pahau River, which flows through the middle of the existing scheme area, received the Supreme Award at the New Zealand River Awards for reduced *E. Coli* concentrations over a ten-year period.

If the share issue is successful and a new scheme is developed, the new irrigators supplied by the scheme will have Farm Environment Plans that require efficient irrigation systems from the outset and be subject to the same rigorous oversight and regular audits as existing irrigators.

Amuri Irrigation Company (AIC) currently irrigates 28,000 hectares of land in the Amuri Basin drawing water from the Hurunui and Waiau Rivers. *(Photo: AIC)*

New irrigation is planned to be developed in farm land surrounding Hawarden, Waikari and the Scargill Valley. *(Photo: AIC)*

How future trends will impact New Zealand agriculture

The Ministry of Business Innovation and Employment recently released a new report identifying the global mega trends likely to affect the future of food and farming, and the implications for New Zealand's science and innovation system.

The report was commissioned from Sapere Research Group and includes a review of international literature and interviews with international experts along with New Zealand science providers and primary sector representatives.

The report identifies three international mega trends:

- enhanced environmental consciousness
- new technological developments and transformational science, and
- changing consumer preferences and other trends.

The report finds that global consumers are increasingly demanding products that fulfil a growing range of environmental demands and incorporate new technological developments and transformational science. It also finds that in addition to environmental and welfare concerns, consumers will continue to be increasingly concerned with food quality, safety, health benefits, provenance, ethics and biosecurity.

Dr Marcos Pelenur, the Ministry of Business, Innovation and Employment's Manager of Science Policy, says that MBIE will use these results to help inform the government's science investment plans.

ENHANCED ENVIRONMENTAL CONSCIOUSNESS

The majority of interviewees believed that consumers are increasingly moving away from a pure price focus and more towards a wider value focus, which includes looking at the environmental harm of the product.

This shift, which experts considered is highly likely to continue in future, raises the bar as farmers need to be able to transparently demonstrate that environmental concerns are at the heart of their food production, rather than a necessary and unavoidable by-product. Major retail chains are also likely to reflect the concerns of their consumers in product selection.

TRANSFORMATIONAL SCIENCE

Advances in the science of genomics offer the potential to speed up the process of developing crops and livestock with desirable and valuable traits that meet productivity, quality and environmental goals.

Gene editing causes targeted mutations in an organism's genome that can range in size from a 'tweak' to adding or removing whole genes. In New Zealand, gene editing is currently regulated as genetic engineering. A number of other countries are considering whether and how to regulate it.

In the case of plants, gene editing can:

- improve disease resistance
- delay flowering time
- increase oil content
- raise nutritional quality
- increase tolerance to drought.

For animals, gene editing can:

- increase muscle yield in cattle
- de-horn calves
- eliminate allergens from milk
- improve disease resistance (for example bovine tuberculosis)
- remove unwanted proteins.

In addition to food security motivations, some experts highlighted the potential for gene editing to improve environmental outcomes. The selection choices associated with gene editing could result in fewer inputs being used in the production of crops or livestock.

Plant-based protein and cellular agriculture are also two major alternatives to animal protein which could transform agriculture.

Plant-based protein involves the development of a meat substitute using plant material only. Cellular agriculture is a process of cultivating meat and other agricultural products from cells in a bioreactor rather than from livestock on a farm.

There are various reasons for developing alternative proteins, from a desire to see far fewer animals used for food, to reducing the amount of land used for animal food production, to ensuring that the world has enough, nutritious food available for a growing population. However, major players in the manufacture of plant-based protein are doing it for sustainability reasons.

CONSUMER CHANGES

Today's consumer has different tastes, preferences and concerns to the consumer of 30 years ago. Most interviewees mentioned the potential for a continuation of an existing trend towards more demanding consumers. In addition to environmental and animal welfare concerns, experts think

The existing trend for consumers to be more demanding is expected to grow.
(Photo: US Department of Agriculture, d2590-1, CC BY 2.0)

consumers will continue to increasingly demand improvements to food quality, safety, healthiness, provenance, ethics and biosecurity.

Social media is thought by experts to accelerate and magnify the role of provenance, traceability, ethics, and health in agricultural and food markets. Both positive and negative events are easily captured on film and rapidly shared with a wide audience.

Increasingly consumers are expecting to be able to access information about products at the point of sale, see rating scales for quality based on customer reviews, and provide feedback immediately. There are examples of supermarket chains using apps that allow users to scan a code on fresh food like meat and vegetables to instantly see where the produce originated and to view nutritional information.

OTHER CHANGES AND TECHNOLOGIES

Robots are increasingly being used on farms around the world. They are labour saving and more efficient as they can repeat processes without error and work for long periods of time without requiring breaks.

Particular areas where robotics could result in fundamental shifts to existing practices are in fruit picking and robotic dairy cow milking.

The use of robotics could also result in better environmental outcomes through better monitoring and management of soil and animal quality and the elimination of disease while reducing the use of agrichemicals.

Vertical farming involves growing stacked layers of produce in an indoor, controlled environment like a warehouse or factory.

Vertical farming enables environmental conditions like irrigation and temperature to be precisely controlled to increase yields and maintain year-round production. It can also reduce the distance crops have to travel to reach the end consumer and thereby increase the quality and consistency of produce.

Gene editing of animals and plants will affect the future of agriculture.

Indoor vertical farming. The report says that as New Zealand has ample land there is less need to adopt vertical farming here. *(Photo: US Department of Agriculture)*

While vertical farming and the increased use of robots are expected to affect food production worldwide, vertical farming, and to a certain extent the use of robotics, are concentrated on crop production while New Zealand farming is predominantly pastoral. The relative abundance of land in New Zealand also means there is less need to adopt vertical farming as a less land intensive farming model.

The use of sensors, drones and other electronic devices can generate significant amounts of data. Artificial intelligence and 'the internet of farm things' will also allow farmers to trial changes designed to enhance production while lowering the costs of doing so. Sensors could be used to decide when is the best time to pick fruit, or used on animals to detect illnesses. Drones could be used to detect agricultural pests early or to spot areas where irrigation is not optimal.

KEY SUMMARY FINDINGS

The report's high level findings are:

1. The trends identified internationally were confirmed as also being relevant to domestic trends for New Zealand which require a number of new areas of research. The breadth and depth of research required creates new challenges for existing research providers. They require research institutions to acquire additional science skills, and skillsets will increasingly need to be fused with non-biological skill sets, such as market research and customer insight. The additional skills will need to be developed by research providers, or accessed through collaboration with other parties.
2. There is an increasing fusion of skills. Knowledge and understanding of the customer will be important, and the combination of traditional land-based farm systems research with new techniques from social sciences such as economics, will be required to meet future challenges.
3. There is an imperative to get on with things sooner rather than later. Scientists commented that much of the research used today to meet environmental challenges was first conducted ten to twenty years ago. Research to meet the challenge posed by future trends will need to be undertaken soon.
4. Joined up thinking is lacking. A range of strategies exist across the primary sector. These occur in individual organisations, in sectors, and in government departments. A single over-arching national strategy does not exist. Interviewees thought this lack of co-ordination was detrimental to New Zealand.

The full report 'Current land based farming systems research and future challenges' can be read online at www.mbie.govt.nz (search for the report title).

Schools visit farm to learn about irrigation without leaving the classroom

Over 3,000 primary school students from across New Zealand learned more about the role of irrigation in food production through a virtual field trip which brought the farm to their classroom.

The Virtual Field Trip designed for students in years five to eight ran from 19–21 March and visited a number of locations in Selwyn district in Canterbury. The field trip was organised by CORE Education and IrrigationNZ.

The trip allowed classes to take part in three live web conferences where children could ask a range of experts questions, and view 11 short online videos explaining more about water and irrigation.

134 classes and 3,088 students enrolled in the trip. The actual participation rate was higher as classes were not required to register to view the videos. 1,200 users (made up of classes and some individual students) viewed the online resources.

On day one of the field trip the children had the opportunity to find out more about how the recently opened Central Plains Water scheme provides water to farms, and how decisions about who can use water and how much water can be taken are decided. The trip visited Central Plains Water's Sheffield storage pond and the Waimakariri River which the scheme draws water from.

Day two of the trip involved a visit to Sheffield farmer Damon Summerfield's property. Damon grows a range of arable crops, and also uses irrigation to help finishing lambs on his farm. He exports seeds worldwide and produces wheat for local mills.

Damon demonstrated how his irrigation system worked and talked about how it enables him to farm differently. "Having irrigation allows me to grow crops quicker, and to get contracts from a variety of companies for different crops only available to irrigators," he explained.

Since adding irrigation, Damon has started growing chrysanthemum seed for export to Asia and mustard seed, and also improved his crop yields.

Day three of the field trip visited IZONE, one of New Zealand's largest business parks. The Rolleston industrial park is home to many agricultural businesses and Selwyn Mayor Sam Broughton discussed how water was important to Selwyn from an environmental perspective as well as for recreation and to the economy by

At the Waimakariri River – Fiona Crombie from Central Plains Water is interviewed by Andrew Penny about how the scheme transports water from the river to farms.

Selwyn Mayor Sam Broughton (left) is interviewed by Andrew Penny (right) in IZONE about why water is important for Selwyn.

supporting farming activity and jobs in places like IZONE.

The day also included a visit to the Selwyn River to hear about a planned project to recharge the river using alpine water from the Central Plains Water scheme so that it will have improved flows over the summer in the future.

"The virtual field trip is fantastic. It enables children to learn about a range of concepts and subject areas in a really meaningful way. This technology enables us to engage with a huge number of schools about water, irrigation, and issues like climate change in an interactive and exciting way. It can be difficult reaching people in urban areas located a long way from farms, but this concept allows us to bring the farm right into the classroom," says Elizabeth Soal, Chief Executive of Irrigation New Zealand.

Virtual field trips are popular not just with school classes but also with children who complete correspondence and home schooling.

Children had the opportunity to ask over 30 questions to expert panels during the three live web conferences. Questions they asked included: how is water made, when did irrigation start being used, why do some countries have more water than others and how do we clean our waterways?

COMMENTS FROM SCHOOLS AND STUDENTS

"It was cool to hear about the cultural values of waterways in this field trip. We have learned about Mahinga kai but hadn't made the link to this content so that was awesome," said a participating class from Mount Hutt College in Methven.

A class from Our Lady of Assumption School in Christchurch said that the trip, "broadened our knowledge about the future of water in Canterbury. It also created lots of discussion with the students – as one student said: "water is liquid gold."

Some of the comments from students participating in the trip included, "doing this field trip was interesting because I was learning about irrigators and water on earth," "it made me think of lots more questions," and "my dad builds irrigators so it gave me lots of information to talk to my Dad and the class about."

Twenty-eight teacher evaluations were completed of the Virtual Field Trip. 100% of teachers said the field trip was appropriate and 97% said it was effective.

Join the field trip:
Schools and children who didn't view the Virtual Field Trip live can still participate in the field trip by viewing the trip videos online at www.learnz.org.nz/water191

Sheffield farmer Damon Summerfield with crops he grows using irrigation – wheat, barley and chrysanthemum seed.

CPW's Sheffield storage pond was one of the locations the field trip visited. *(Photo: Central Plains Water)*

Challenge looks at how to build trust and capture more of our agricultural earnings at home

Our Land and Water is one of 11 National Science Challenges that are funding scientific research into issues of national importance.

Our Land and Water is one of the largest National Science Challenges and it focuses on science-based issues and opportunities facing our country in our primary production sector and its relationship with our land and water resources.

We are continuing to profile some of the projects underway as part of the challenge.

Building strong relationships is the starting point to create a social licence for farming. *(Photo: Chris Williams)*

BUILDING TRUST IN OUR PRIMARY SECTOR

As New Zealand's primary sector intensifies, it is increasingly under public scrutiny. While Kiwis generally value primary production, some people see the environmental, social or cultural impacts of some primary production systems to be unacceptable.

Understanding what is necessary to gain and maintain public trust and approval – known as a social licence to operate – is important for the wellbeing of farmers, foresters and local communities. Without a social licence to operate, the primary sector could be affected by a loss of public confidence resulting in legal action, conflict and regulation.

As part of the Trust and Social Licence project Our Land and Water research has looked at the importance of social licence to primary sector practices, as well as trust between government, industry, community and media.

"The core elements of social licence involve a community feeling it can trust a company or industry to 'do the right thing', and follow through on its promises," says project lead Peter Edwards, previously at Scion, now at Manaaki Whenua Landcare Research.

"Some communities take on risks when businesses use their area's natural resources, so social licence can also require compensatory benefits such as safe jobs or improved infrastructure."

Individual operators, like dairy farmers, have a personal stake in social licence, Peter says.

"They have to live in communities, and if people don't trust them or accept how they undertake their activities, it can have a personal impact."

Social Licence to Operate. *(Image: Our Land and Water)*

The initial research undertaken suggests the best way for farmers to build social licence is to build relationships.

"Good two-way relationships are a solid foundation for building trust," says Peter. "Often people that have grievances simply want to be heard, and to know their input has been genuinely considered."

On a national scale, industry bodies would also do well to engage and build relationships with communities.

"Probably the best approach is to work on a community-by-community basis to build support," says Peter – an approach that should also include urban communities. "People in the main centres have strong interest in rural communities they're attached to."

Industries need to be on the front foot and consider their social licence before they set up new operations, says Peter. "But it's not a licence that's granted in perpetuity, they need to continually work at it, and change as industry practices, communities, people and their values change over time."

BOOSTING NZ'S SHARE OF OUR PRODUCT EARNINGS

New Zealand earned $42 billion from primary sector exports in 2018 – but overseas consumers pay about six times that amount to buy our country's produce. Our Land and Water's Integrating Value Chains research programme is investigating how farmers and growers can earn more of that value in a way that incentivises sustainable land use and rewards good environmental, social and cultural practices.

Science leader for the research is Professor Caroline Saunders, director of the Agribusiness and Economics Research Unit (AERU) at Lincoln University.

"The way we are producing food and beverages is generating premiums we don't always receive," says Caroline. "We need to figure out how to capture value that is then shared with the producer – we must transform our supply chains into value chains."

NZ's export sector generated $42 billion in 2018. Capturing more of the product's value to overseas markets could boost that figure significantly. *(Photo: Paul Sutherland Photography)*

The research team working on the Integrated Value Chain project is creating new knowledge on premium market segments that will pay higher prices for New Zealand agri-food exports with particular attributes. This research is pinpointing what customers in these premium markets value most about New Zealand produce, and also identifying how 'value chains' of businesses, from producer to retailer, can collaborate to deliver what these customers value most highly.

A key issue is how to make the qualities of New Zealand produce clear to distant customers. A good example is the Taste Pure Nature campaign, launched by Beef + Lamb NZ. That initiative used consumer surveys from Integrating Value Chains researchers as it developed its New Zealand 'red meat story' for international consumers. The potential extra revenue from the US market is $238 million.

The research team have just completed five case studies of New Zealand enterprises that are successfully creating, capturing and sharing more value. The key findings will be published on the Our Land and Water website (www.ourlandandwater.nz) in June.

"Our vision is that New Zealand is producing high-value products across all sectors," says programme manager, Professor Paul Dalziel of Lincoln University. "We want to help businesses and entrepreneurs create and share more value from overseas consumers to local producers. We are grateful to the enterprises working with us, including Te Hono, Fonterra, ZESPRI, Ngāi Tahu Pounamu, Wakatū Incorporation, Taupō Beef and Lamb, ANZCO and AsureQuality."

The Integrating Value Chains programme has generated several interesting reports on consumer choices, including kiwifruit and yoghurt in Shanghai, and for beef and wine in California. The reports can be read and explored through an interactive tool at www.sustainablewellbeing.nz.

REASSESSING HOW WE CAN PROTECT STREAMS FROM CONTAMINANTS

The New Zealand dairy industry's Water Accord requires farmers to exclude livestock from all large fourth-order streams "wider than a stride and deeper than a Red Band."

Our Land and Water research as part of the Assessing Contaminants with Stream Order project looked at whether excluding livestock from these large streams would substantially decrease the load of contaminants (nitrogen, phosphorus, sediment and *E. coli*) entering waterways.

Surprisingly, the answer was no.

"We discovered that fencing only large streams to exclude stock would have less effect on freshwater quality than originally thought," says Rich McDowell, chief scientist of the Our Land and Water National Science Challenge and the lead researcher on this project.

The results showed that loads from large streams (over one metre wide and 30cm deep) in flat catchments dominated by pasture accounted for, on average, 23% of the national load of all contaminants. This suggests additional mitigations are needed to reduce the 77% of contaminants entering waterways from smaller streams in rolling to steep land.

Strategies could include fencing (which is currently not required), but Our Land and Water research has also identified around 40 other mitigation strategies. These include many that are potentially more cost-effective than fencing, such as preventing red deer from wallowing, contour ploughing and the placement of forage cropping away from streams.

This research is now being used by local government to develop policy to improve the quality of freshwater. For example, Taranaki Regional Council has committed to fencing more streams than those covered by central government's proposed stock exclusion regulations.

PHOSPHORUS BEST PRACTICE

Our Land and Water's research into phosphorus application (in the form of fertiliser and farm dairy effluent) has shown that regional rules and industry good practice guidelines do not prevent phosphorus leaching through stony free-draining soils with low capacity to absorb phosphorus. Soils like these are common in Canterbury, the second-largest dairy-producing region in New Zealand.

Fertiliser and farm dairy effluent (FDE) contains phosphorus, which can enter waterways through runoff or leaching from agricultural land. In freshwater, phosphorus can stimulate algal growth, which affects our ability to use rivers for swimming, fishing, drinking, and reduces biodiversity.

"More research needs to be done to determine whether applying less FDE at a lower rate would decrease phosphorus losses," says lead researcher Rich McDowell, chief scientist of the Our Land and Water National Science Challenge. "Until we know this, the research suggests that farmers should try to avoid applying FDE to freely draining shallow stony soils under irrigation."

"Farmers could also use technology that reduces the phosphorus concentration to very low levels," says Rich.

Phosphorus can also be made less available for loss through effluent coagulation technology.

Industry bodies and regional and central government can use these results to strengthen guidelines and regulations beyond current recommendations, particularly regarding the use of FDE on soils of low absorption capacity, in order to meet community and government expectations.

The Our Land and Water 2019 conference will be held on August 12–13; see ourlandandwater.nz/news-events

The what and why of system maintenance

By Kenneth Bracht.

People often ask what steps they should take to maintain their irrigation equipment and ensure it has a long life. That's a good question, but to understand the value of preventative maintenance, it's important to know why it should be done.

Irrigation machines will run a long time without maintenance, but like a car (or anything else), they will eventually have failures. When your car needs transmission work or your truck's brakes start to squeal, you have options. You could take it to the repair shop. You might have a spare vehicle you could drive for a few days, or you could even keep driving it (not recommended!).

With a pivot, you don't have a backup.

A week of downtime at a critical stage in the growing season could significantly reduce the yield. That yield loss could equal a substantial amount of money, which could in turn have a considerable impact on your operation, especially in challenging economic times like growers are facing now.

The "why" of regular maintenance for your irrigation equipment is to assure reliable uptime. If you perform this maintenance during the off-season, trouble-free operation throughout the growing season is much more likely. Now that you understand the "why," the "what" follows naturally.

1. WINTERISE!

Depending on your geography and climate, one important thing to do is prepare for winter. To winterise your pivot, drain your pipelines, and make sure you also drain any condensed water from wheel gearboxes and gear motors.

In addition, perform normal greasing of parts at least yearly. Steel moving on steel without proper lubrication can lead to unnecessary wear and tear on irrigation equipment. Be sure to grease all moving parts, including the pivot point bearing, towable hubs, corner legs and rollers.

Don't forget: Cleaning your sand trap is essential, mainly if you have water quality problems or your irrigation water contains sand.

2. KICK THE TYRES

Check for correct air pressure in your tyres to reduce rutting. Also, check your machine's lug nuts to ensure they are tight.

3. GIVE GEARBOXES A LOOK

Maximise the life of your drive train and keep it operating trouble-free by examining the gearbox for leaking seals, which could cause failure during the year if they run low on gear lube.

4. ARE THE U-JOINTS OK?

Check the U-joints between the gearbox and gear motor. If there is more than ¼ inch of movement, they should be replaced. These inserts will eventually wear out; replacing them when you see the beginnings of wear can save you costly downtime.

5. TOWER BOX TEST

Be sure all tower box contactors are performing correctly and are not "chattering." This is one aspect of "routine" maintenance that's not so routine… and is often forgotten.

Remember this: Make sure your centre drive is operating properly; it should run smoothly and quietly. This is another component that often goes unchecked and can cause downtime during the growing season.

6. SCRUTINISE SPRINKLERS

Sprinklers and regulators should be inspected; nozzles, pads and regulators should be changed after every 10,000 hours of operation.

7. ALIGNMENT INSPECTION

Check your machine's alignment — correct alignment reduces structural stress on the pivot and allows it to run straight.

8. CONTROL PANEL CONDENSATION

Ensure water is not getting into your control panel and compromising the electrical components in any way.

9. WHEEL TRACK MAINTENANCE (AKA TILLING & FILLING)

Be sure to fill and till deep wheel tracks during the off-season to reduce stress on tillage, harvest and irrigation equipment. Wheel tracks should be tilled to the depth of the track to allow your irrigation machine to run properly. Consider changing to a different type of tyre to increase ground contact, adding flotation options like three-wheel base beams, or modifying the sprinkler package to reduce water application in the wheel tracks to help prevent future tracking problems.

MISCONCEPTIONS

One of the biggest misconceptions about irrigation system maintenance is that upkeep is an added expense. That's not really true.

Without proper maintenance, the additional cost comes later – when you can least afford it – and your machine breaks down in the summer heat.

Parts will fail… eventually. Just like your truck's brakes, it will happen. For example, even the most durable sprinkler packages do wear out, giving you less-than-uniform water application, which results in your crop getting less water than you think.

Replace the parts nearing failure when you can – all at one time – as opposed to making multiple trips to the field and experiencing multiple periods of downtime. Doing so is actually less expensive in the long run.

We've talked about what to do and why it should be done; lastly is the "who." Contact your local pivot dealer to schedule an original equipment manufacturer-trained pivot service technician to perform a preventative maintenance checkup today.

The growing season doesn't end with harvest. Taking care of your irrigation equipment in the offseason will prevent costly repairs and downtime next year. Take preventative steps now, and your irrigation equipment will run reliably through the next growing season. Contact your irrigation dealer for more detailed maintenance requirements.

Kenneth Bracht is the senior director of global aftermarket parts for Valmont Irrigation. He has an economics degree from the University of Nebraska-Lincoln and has been in the irrigation industry for more than 20 years. Reprinted from Irrigation Today, Vol. 3, Issue 2.

Technology guides irrigation decisions on Canterbury farm

Making informed decisions using technology has created more productive land use while reducing environmental impacts, according to Eyrewell farmer Mike Smith.

Mike Smith and his family run two adjoining dairy farms which together are just over 500 hectares, and milk 2,000 cows. They also operate a run off block of 160 hectares.

When their farming partnership began in 2010, one of the first tasks was to boost soil fertility, along with adding soil moisture monitors, soil temperature monitors and flow meters.

"We wanted to know where we were sitting with our soil types, soil fertility and soil moisture-holding capabilities to make really well-informed decisions," Mike says.

"A lot of farms were only testing selected blocks of land, but we decided to test every single paddock individually to get the best results."

As a result, Mike noticed that the side of the property where effluent was being spread had much more organic matter and better water-holding qualities.

He then added an irrigation system to the other side of the farm to improve soil quality.

"With our individual approach to soil testing, each paddock gets exactly what's needed and that's better for the bottom line and the environment. It's much more common now. Why would you apply excess fertiliser when you don't need it? We don't want it going into our streams and we don't want to waste money."

Having accurate information is vital for Mike, who says advances in technology have revolutionised farming.

"At any time of the day I can check exactly what's happening on my farms using an app on my phone."

"We can break everything down into small details to build up an exact picture of what's happening."

Eyrewell farmer Mike Smith hopes to pass his farm on to one of his daughters. He is pictured with his youngest daughter Millie (6) and dogs Ted and Blackie. *(Photo: Gina McKenzie)*

APPROACH TO IRRIGATION MANAGEMENT

The Smiths recently replaced an area that was irrigated with K-Lines with three centre pivots and there are now nine pivots operating on the farm.

"With K-Lines there is a big time and labour factor involved and they would over irrigate, whereas the pivots are much more efficient and apply water uniformly," Mike says.

Now all of the pivots on the farm are connected to soil moisture monitoring tools and the irrigators can be controlled through an app which allows the systems to be switched on and off from anywhere in the world.

This also allows service technicians to check on the system remotely and identify and correct problems.

Mike says his approach to managing his irrigation is not to over or under irrigate but to get it spot on and he relies on technology to help him make the right decisions.

"If you're deciding whether to irrigate the weather forecast is a big factor. I don't use just one service like the MetService but use three or four different services to get an overall picture. If we know there's 20mm of rain coming I can stop irrigating early."

"Having access to soil moisture monitoring and soil temperature data is also important. In April we saw the soil drop from 18 degrees one week to 12 degrees the next week. If we apply

more water when the soil is cold it can drop the temperature by another 2 degrees and actually make the soil worse so you need to monitor the temperature carefully."

Maintaining his irrigation systems well is also a priority.

"The water we use is quite silty as it's drawn from the Waimakariri River. This means we need to check our pump impellors and nozzles every winter as they can wear out which results in the nozzles applying too much water or the pumps not operating correctly."

The cost of operating an irrigation system is an incentive to use water efficiently as every day the irrigation system can be switched off saves $500 in power.

Mike says they want to continue to look into what technology is out there and how this can be harnessed to save labour or operate more efficiently.

His interest in adopting new technology means that he's now looking into whether a fixed grid irrigation system (also known as solid set irrigation) would be feasible and cost effective on the farm.

He also believes the general public are not aware of how accurate modern technology is, particularly when it comes to irrigation.

He sees this as contributing to the rural-urban divide, but believes positive interactions can help people to reach common ground.

"A few weeks ago, I saw a woman taking photos of an irrigator running on a rainy day. I stopped and had a chat to her.

"She thought the irrigator shouldn't be running because it was raining. I whipped out my phone and was able to show her the soil moisture levels in real time so she could see why the irrigation was running.

"She said she had no idea that we were using that level of technology. Let's show people the facts and share what's really happening on farms."

Mike thinks developing a Farm Environment Plan is helpful and the audit process has helped him fine-tune on-farm processes.

"For us, it was a matter of making some small tweaks and doing more record-keeping. It's important to be constantly improving and we've really stepped up our technology so we can prove that every irrigation event is justified."

"We've also got a great relationship with WIL (Waimakariri Irrigation Ltd). It's really important to stay involved and to work closely together because we put a lot of trust in each other."

Water tax off the table for now

In April, the government issued its response to the Tax Working Group's report.

THE TAX WORKING GROUP RECOMMENDATIONS

The Tax Working Group recommended introducing a capital gains tax, as well as taxes on fertiliser use and water abstraction.

The group acknowledge that water abstraction is a particularly challenging policy area in New Zealand owing to a range of different interests in the resource. If Māori rights and interests can be addressed, the group said that water tax instruments (including auctioned tradeable permits) could be useful tools for improving the efficiency of water use. They could also be a significant and sustainable source of revenue over the long term.

THE GOVERNMENT'S RESPONSE

The Government decided not to adopt the Working Group's recommendations to introduce new capital gains, fertiliser or water taxes.

The Government stated they had no plans to introduce a water or fertiliser tax in this term. In issuing its decision, the Government referred to the work programme already underway to achieve improvements to water quality.

However, the Government may consider an environmental footprint tax as part of its longer term work programme.

The Labour Party itself also has not ruled out campaigning on a water tax in future elections.

IrrigationNZ is pleased that the water tax is off the table for now and says that the water tax the Working Group proposed on all types of water use, including hydro-electric use would have affected all New Zealanders through higher power and food prices for households and businesses and higher rates bills.

"We need to be developing more water storage as climate change is predicted to bring more frequent droughts in the future," IrrigationNZ Chair Nicky Hyslop says.

IrrigationNZ has been advocating against the introduction of a water tax since the idea was proposed in 2017 and has made two submissions to the tax review process, as well as meeting with Tax Working Group representatives and a number of politicians.

How will a changing climate affect farming in Canterbury?

A recent workshop at Blinc Innovation Hub looked at the impact climate change would have on farming in Canterbury.

Associate Professor Dr Anita Wreford of Lincoln University's Agribusiness and Economics Research Unit (AERU) said that the impacts of climate change on Canterbury would result in:

- higher temperatures (an increase of 0.7–1 degrees by 2040)
- increased winter rainfall
- decreased spring rainfall
- more heavy rainfall events
- more frequent and intense droughts
- some increase in storm intensity, wind extremes and thunderstorms
- an increase in the number of hot days
- a decrease in number of frost and snow days.

Dr Wreford says that more flexible, adaptable farming models are likely to be more robust in an uncertain environment. Developing diversity in products, location or the timing of production can also help to make systems more resilient.

International evidence suggests early action on both climate change mitigation and adaptation is usually more cost-effective than delaying action.

Dr Sinead Leahy of the New Zealand Agricultural Greenhouse Gas Research Centre discussed the impacts climate change could have and strategies to mitigate agricultural greenhouse gases.

Dr Sinead Leahy of the New Zealand Agricultural Greenhouse Gas Research Centre.

Dr Leahy said the amount of temperate change that will occur this century will depend on whether greenhouse gas emissions are curbed worldwide. If efforts to reduce emissions are not taken, or are not successful, temperatures could rise by 2–5 degrees by the 2090s. If aggressive action is taken soon to reduce emissions worldwide then temperature increase could be as little as one degree.

If emission levels continue to remain at high levels then the number of hot days (25 degrees or more) is expected to increase significantly. By the year 2100 many areas of Canterbury could expect to experience 60–100 days a year which are 25 degrees or hotter.

Under the Paris Agreement, 185 countries have agreed to work to keep global temperature rise below 2 degrees above pre-industrial levels and to endeavour to limit temperature increases to 1.5 degrees.

Under the agreement New Zealand committed to reduce greenhouse gas emissions to 30% below 2005 levels by 2030. The Coalition Government is also planning to implement more ambitious targets for 2050. More detail on this is included in this story under the 'Planned climate change legislation' section.

Dr Leahy said that New Zealand has an unusual emissions profile for a developed country as 49% of our emissions come from agriculture, whereas in most developed countries agricultural emissions make up a much smaller percentage of overall emissions. Agricultural emissions are predominantly methane with a smaller amount of nitrous oxide. In other sectors, carbon dioxide is the largest type of greenhouse gas emitted.

More frequent westerly winds could result in more wind damage on farms unless good preparations are made to prevent infrastructure damage.

MITIGATION OPTIONS FOR AGRICULTURE

Dr Leahy said there are three approaches to mitigating greenhouse gas emissions.

1. Further increases in animal productivity and farm efficiency and the implementation of known technologies
2. Additional emerging technologies that directly seek to reduce emissions
3. Constraints on the level and types of agricultural activity and movement towards low-emitting land uses.

Using existing proven mitigation options without having a significant impact on profitability is only expected to reduce biological emissions by 5–10% in New Zealand. These options include reducing emissions by changing feed and reducing the amount of feed eaten by reducing livestock numbers, and improving the efficiency of farm systems.

The Selwyn River in flood. More frequent heavy rain events bringing flooding are expected to occur this century due to climate change.

Emerging technologies would be needed to achieve more significant reductions in agricultural emissions. The main options being studied are:

Methane

- low methane animals
- low methane feeds
- a methane vaccine
- methane inhibitors which reduce methane generating microbes

Nitrous oxide

- nitrification inhibitors
- low emitting plants
- grazing management

Soil carbon

- increasing and reducing the loss of soil carbon
- identifying ways to measure and increase the carbon content of New Zealand grassland soils
- deep inversion tillage.

Dr Leahy says that a package of greenhouse gas mitigation options will be needed in the future which are tailored to each farming system. Promising mitigation options are being developed which could be implemented in the future.

The farming and rural professional sector also lack good information and expertise in greenhouse gas emission assessment and mitigation options and need more information and training.

NGĀI TAHU FARMING'S APPROACH TO MANAGING EMISSIONS

Rhys Narby of Ngāi Tahu Farming said that some of the on farm effects they expected to see as a result of climate change included:

- longer drier droughts
- higher average temperatures
- less rainfall but more heavy rainfall events leading to more flooding
- higher supplementary feed costs
- more damage to infrastructure, including to pivots from Nor'West winds
- larger seasonal variations in yields and profits
- changes in crop choices including the introduction of more drought tolerant plants.

Ngāi Tahu Farming had their emissions footprint calculated using 2016 as their base year. That found that 58% of their emissions came from livestock and 37% from fertiliser use.

They had already achieved a reduction in the amount of CO^2 emitted per kilogram of milk solids in their last financial year.

Continued over...

The effects of climate change in Canterbury

Low emissions scenario: 0.7°C warmer by 2040 and 0.7°C warmer by 2090.

High emissions scenario: 1°C warmer by 2040 and 3°C warmer by 2090.

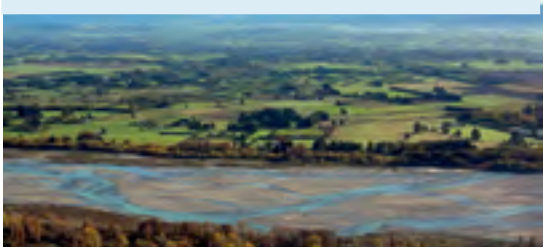
There is likely to be little change in annual rainfall in Christchurch and Hanmer by the end of the century. In Tekapo, annual rainfall is likely to increase by 5% by 2040 and 7% by 2090.

Winter rainfall is likely to decrease by 6% in Christchurch and 5% in Hanmer, but increase by 16% in Tekapo by 2090.

There may be an increase in the frequency of westerly winds over the South Island, particularly in winter and spring.

Significant decreases in snowfall are projected. The number of snow days may decrease by up to 30 days per year by the end of the century.

Data: from the Ministry for the Environment, *How could climate change affect my region?*, www.mfe.govt.nz/node/16689



Rhys says that knowing where the opportunities are in your business is key to understanding how to reduce emissions.

Ngāi Tahu Farming has identified a number of actions they want to take including a goal to plant 1.2 million trees at Te Whenua Hoi which would also serve to create a passage for birds across the Canterbury plains.

They also want to reduce fossil fuel use and are talking with suppliers about using bio fuels and looking at renewable energy options. Improving their irrigation efficiency by using variable rate irrigation (VRI) and putting in place water management strategies is another step they are taking.

Rhys sees fertigation – which allows fertiliser to be applied in small quantities via centre pivots – as a very promising technology they could use to significantly reduce the amount of fertiliser they use.

Ngāi Tahu Farming is also closely monitoring developing technologies including livestock vaccines, the progress on developing low nitrogen cows and gas emitting blockers in livestock.

Their overall goal is to reduce their agricultural emissions by 29% by 2030 – a target which Rhys says is pretty "scary" right now.

Planned climate change legislation

In May the government introduced the Zero Carbon Amendment Bill. The Bill is now open for submissions until Tuesday, 16 July 2019. See www.parliament.nz for submission information. The government plans to pass the Bill in late 2019 and then establish a Climate Change Commission.

The Climate Change Response (Zero Carbon) Amendment Bill aims to set a framework for New Zealand's transition to a low emissions and climate resilient economy.

The original proposal was for a separate piece of legislation called the Zero Carbon Bill. The Government has now decided to introduce it as an amendment to the current Climate Change Response Act 2002. This will ensure that all key climate legislation is within one Act.

The new Bill will do four key things:

1. Set a new greenhouse gas emissions reduction target, to:
   - reduce all greenhouse gases (except biogenic methane) to net zero by 2050, and
   - reduce emissions of biogenic methane within the range of 24–47% below 2017 levels by 2050 including to 10% below 2017 levels by 2030.
2. Set a series of emissions budgets covering a five year period to act as stepping stones towards the long-term target. Three emissions budgets are required to be in place at any one time, meaning that they are set 10 to 15 years in advance.
3. Require the Government to develop and implement policies for climate change adaptation and mitigation. Emissions budgets, and the plan for achieving them, will be set by the responsible Minister based on advice from the Climate Change Commission.
4. Establish a new, independent Climate Change Commission to provide expert advice and monitoring, to help keep successive governments on track to meeting long-term goals.

Farm Dairy Effluent Design Accreditation Programme

WHY USE AN ACCREDITED COMPANY?

Using an Accredited Company means you know that you will have a design that meets best industry practice and your consent requirements.

Companies have agreed to ensure designs meet the New Zealand Code of Practice for Farm Dairy Effluent Design as well as have their quality assurance process and designs audited every two years.

There is also an independent complaints process should you not be happy with the work of an accredited company.

RECENT REVIEW SHOWS CODE OF PRACTICE MEETS MOST COUNCILS' REQUIREMENTS

An assessment in December 2018 looked at whether the Farm Dairy Effluent Code of Practice (FDE COP) meet the rules and policies of councils. Of the ten councils assessed, the COP was equal to or better than their requirements.

Ultimately the COP requires that there is enough storage to prevent the pond from overtopping and to be able to hold all effluent until soil moisture is in a deficit period and can cope with the effluent applied.

The FDE design must also have an application rate that is suitable to the soil type to prevent ponding and run off by not exceeding the infiltration rate. These align with the councils' objectives and requirements.

If the council conditions are stricter than the COP, the designer must comply with the consent.

Council's Assessed: Northland, Waikato, Bay of Plenty, Taranaki, Horizons, Hawke's Bay, Wellington, Canterbury, Otago and Southland.

WHERE TO FIND ACCREDITED COMPANIES: Visit **www.irrigationnz.co.nz/accreditation** to find the list of accredited companies. Or you can contact IrrigationNZ for more information at **accreditation@irrigationnz.co.nz**

Farmers and growers invest in improving sustainability on farm

A new survey has found that farmers and growers are highly focused on making their operations more sustainable, and have also been investing in using water more efficiently.

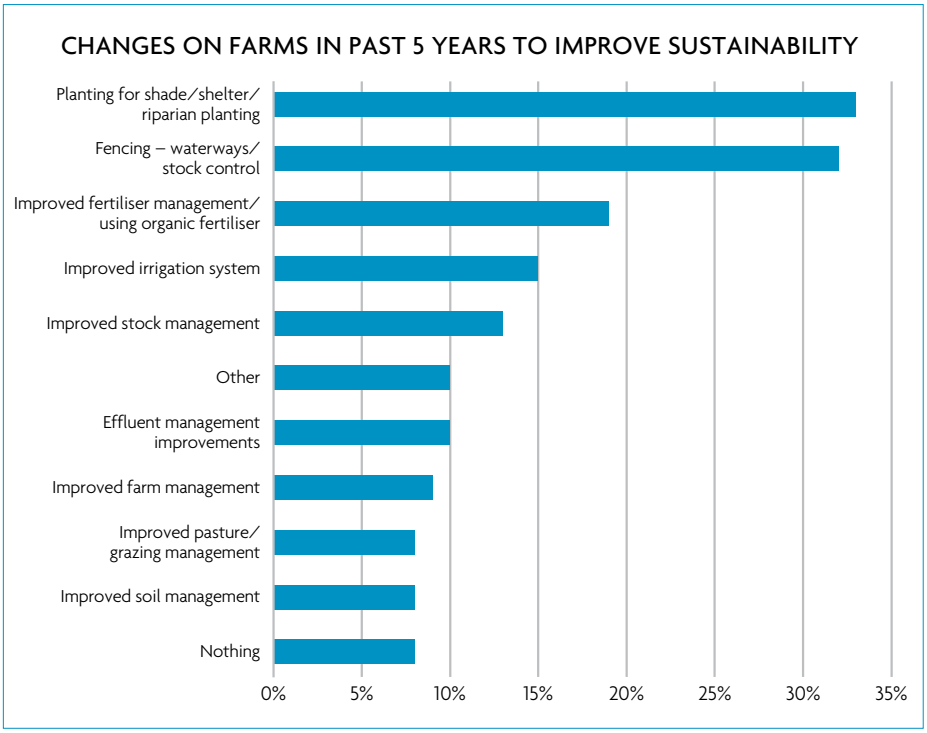
The Neilson Research report was prepared for the Ministry of Primary Industries. It surveyed 700 farmers and growers including dairy, sheep, beef and arable farms, and horticulture and viticulture properties.

The survey found that 92% of farmers were focused on making their farm more environmentally sustainable, up from 78% since the last survey in 2009.

Some of the specific actions farmers commonly mentioned taking were riparian or shelter planting, fencing, improved fertiliser management and installing more efficient irrigation systems.

"The survey shows that farmers have a better understanding of what they are able to do on-farm to be more environmentally sustainable, with the exception of greenhouse gas emissions reduction – an area where we know farmers feel they need more information and advice," says Minister for Climate Change James Shaw.

52% of farmers surveyed felt that current climate or severe weather patterns were having a moderate or major impact on their farm and business, and 69% of farmers said that over the next five years they had a major or moderate focus on working to become more resilient to severe weather patterns.



Overall, climate change is expected to result in fewer frosts which could allow for the spread of some pests. Western and southern New Zealand regions are expected to have increased rainfall and warmer temperatures, which could create better growing conditions. However, farms in the eastern and northern regions of the country are likely to experience more frequent droughts. The impacts from more extreme rainfall events can create a range of issues at a farm level, such as increased soil erosion and more flooding and slips.

62% of farmers say their farm or business is well equipped to adapt to the environmental impacts of more severe weather patterns and changing climatic conditions. The proportion feeling well equipped has declined since 2009 when 68% felt they were well equipped.

Planting trees and native vegetation is the top activity farmers reported taking to improve their environmental management. *(Photo: Andrew Penny, LEARNZ)*

TOP ACTIONS TO MAKE FARM MORE SUSTAINABLE			
Dairy	Livestock (sheep, beef, deer)	Arable	Horticulture & viticulture
Planting for shade/ shelter or riparian planting (41%)	Fencing – waterways/ stock control (44%)	Improving irrigation/ using less water (24%)	Reduced chemical/ herbicide/ pesticide use (27%)
Fencing – waterways/ stock control (39%)	Planting for shade/ shelter or riparian planting (37%)	Nothing (24%)	Improving irrigation/ using less water (23%)
Effluent management improvements (39%)	Improved fertiliser management/using organic fertilisers (20%)	Planting for shade/ shelter or riparian planting (19%)	Improved fertiliser management/using organic fertilisers (19%)
Improved fertiliser management/using organic fertilisers (23%)	Improved stock management/lower stock numbers (17%)	Improved soil management (17%)	Planting for shade/ shelter or riparian planting (16%)
Improving irrigation/ using less water (18%)	Improved pasture/ grazing management (12%)	Improved fertiliser management/using organic fertilisers (14%)	Improved soil management (12%)

WATER USE AND IRRIGATION

The survey turned up some interesting results on water use and irrigation.

67% of farmers surveyed said they had worked on using water more efficiently over the past five years – this response included both properties using irrigation and farms that use water for other purposes. 41% of farmers and growers also said that using water more efficiently was a focus for the next five years. Canterbury farmers had a higher than average focus on water efficiency – with 52% saying improving their water use efficiency was a future focus.

The top areas of focus over the past five years overall were:

- Protect and improve animal health and welfare (91%)
- Improving financial management and profitability (89%), and
- Decreasing production costs (84%).

The top areas of focus mentioned for the next five years were:

- Improving financial management and profitability (54%)
- Protecting and improving water quality (50%), and
- Increasing returns per unit of product (50%).

Improving irrigation systems was also mentioned as one of the most common changes made on farms in the past five years, even though not all of the farmers surveyed were using irrigation.

The table above shows the most common actions taken to improve environmental management. Within New Zealand, based on agricultural production survey data, horticulture and viticulture have the highest use of irrigation, followed by arable farmers, dairy and then other livestock farmers.

Overall, 33% of farmers and growers with irrigation reported they had invested in adding or improving water storage infrastructure or were in the process of doing this. 32% of irrigators had invested in irrigation infrastructure to make their property better able to cope with changes to the climate or were doing so now.

36% of farmers had also made changes to improve the energy efficiency of their irrigation systems or were currently working on this.

TOPICS FARMERS/GROWERS WANTED MORE INFORMATION ON

The most commonly mentioned topics those surveyed wanted more information on were:

- Managing severe weather events (12%)
- Pasture/grass issues (8%)
- Evidence based information (7%)
- Carbon issues/ETS/Kyoto requirements (7%)
- Water use/management and irrigation (7%).

Minister O'Connor says farmers face a changing climate. "They need to prepare to cope with the intensifying weather effects of climate change and at the same time reduce their environmental footprint – that takes investment in infrastructure, and means you need to be financially viable."

"The Coalition Government is scoping the development of resources and information for farmers to fill the knowledge gap in ways to reduce emissions, and working with the sector to develop practical on-farm knowledge."

IN BRIEF

GOVERNMENT INVESTIGATION INTO ORC WATER FRAMEWORK

In May the government announced it would be carrying out an investigation into the adequacy of Otago Regional Council's planning framework relating to discharges of contaminants to land and water, and water consents. This will focus particularly on the Manuherekia, the Upper Cardrona and Arrow Rivers, and whether the planning framework will be appropriate and will allow enough time to consider applications for new water permits once deemed permits expire.

The investigation is expected to be undertaken over winter and a report prepared for the Minister for the Environment by early September.

IrrigationNZ is pleased that the investigator has been named as Peter Skelton, who is a former Environment Court judge and was a government-appointed commissioner and later councillor at Environment Canterbury.

IrrigationNZ will keep our Otago based members informed of any opportunities to have input into the investigation.

Christchurch groundwater: extraction and distraction

By Tim Muller.

It's so easy these days to vent our outrage via an online petition or social media rant. There aren't too many issues left that people are willing to march in the streets over. But groundwater, apparently, is one of them. In November last year I wrote for the Spinoff (*Bottle rockets: why are we all so angry about groundwater?*) about Cloud Ocean Water – just one example of the controversy around water bottling which has played out in communities around the country and shows no sign of going away.

In December, the controversial application to change the conditions of Cloud Ocean's groundwater take consent was granted by Environment Canterbury (ECan). More recently, more than 1,000 people marched in protests sparked by plans to expand Cloud Ocean's bottling operation to include a neighbouring site. Now Christchurch City Council (CCC) is supporting legal action against ECan. Don't worry, there's an online petition too – with about 38,000 signatures.

What hasn't changed is that the debate around this issue has been highly emotive, often at the expense of being well-reasoned. This is understandable to an extent. Water is both a resource and a taonga – essential to every ecosystem and almost every social, cultural and economic value we hold dear. We should be passionate about it.

However, good water management decisions are made when passion holds hands with reason – starting with our values as a community and then using the best science to ensure those values are enhanced or protected.

In the public debate on this issue, that last step has been sorely missing. Consider this: I reckon I've read the best part of 50 media articles on Cloud Ocean's groundwater take, but I've yet to come across one which included an interview with a hydrogeologist (groundwater scientist). I even searched online in the hope I was wrong on this, but only found a bunch of articles on the Cloud Ocean story which Google ominously informs me are "missing: science."

I'm not one to uncritically pile in on our national pastime of bashing journalists, but in this case I think criticism is warranted. How can we expect the public to be well-informed participants in local democracy and the consenting process when the media sidelines scientific voices on an issue that has a critical scientific dimension?

THE SCIENCE AROUND GROUNDWATER

So then, let's talk about science.

When groundwater is pumped to the surface, the water levels around the well reduce. This isn't a problem in itself, but it can lead to a range of other effects. The most common ones are drawdown (when the reduction in water levels around the pumping well extends far enough to affect other wells), stream depletion (when pumping from a well affects flows in a nearby stream), or subsidence (when groundwater level reductions affect land stability). You also have to consider how much water is flowing through the aquifer, which determines how much can be sustainably pumped from it each year (usually called allocation).

The common factors with all of these direct effects of pumping groundwater are that they're well-understood, relatively easy to model, and routinely considered as part of any consent application for a groundwater take in New Zealand. Also, the end use of the water is almost irrelevant. There are a few niche situations where water use matters – for instance frost-fighting and irrigation can partially recharge underlying aquifers, depending on the geology and the efficiency of the irrigation system. But normally, once you know the well location and the underlying geology, all that really matters are the rate and volume of the water take.

The volume, of course, featured prominently in coverage of Cloud Ocean Water and the "more than one billion litres" of water they have consent to take each year. This statement is true – it's actually 1.6 billion litres (or 1.6 million cubic metres (m^3), to use a more sensible unit). But the intent is clearly to make it sound like an unusually enormous amount of water. I've read very few attempts to put this number in context, and the petition I mentioned above even raises concerns that Cloud Ocean's take will "drain the town supply."

The fact is that just about any continuous water take will get to massive-sounding volumes soon enough, especially if expressed in litres per year. A modest groundwater take of 1 litre per second would clock up 30-odd million litres in a year (or 30,000m^3), almost certainly without causing any discernible environmental effects.

Also, any discussion of water allocation issues which doesn't address the size of the water source will be misleading or worse. As shown in the graph, water bottling takes make up a tiny proportion of the groundwater which flows beneath Christchurch each year. If you don't trust the ECan numbers the graph is based on, I tried making a similar graph based on GNS estimates of the total Canterbury groundwater resource (521 billion m^3, or about half a cubic kilometre if you prefer), you couldn't see the volume for bottling in that one as it's negligible in comparison.

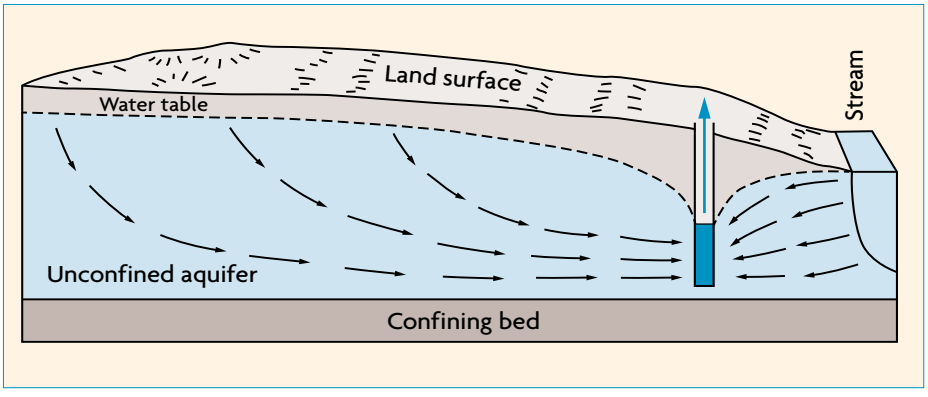
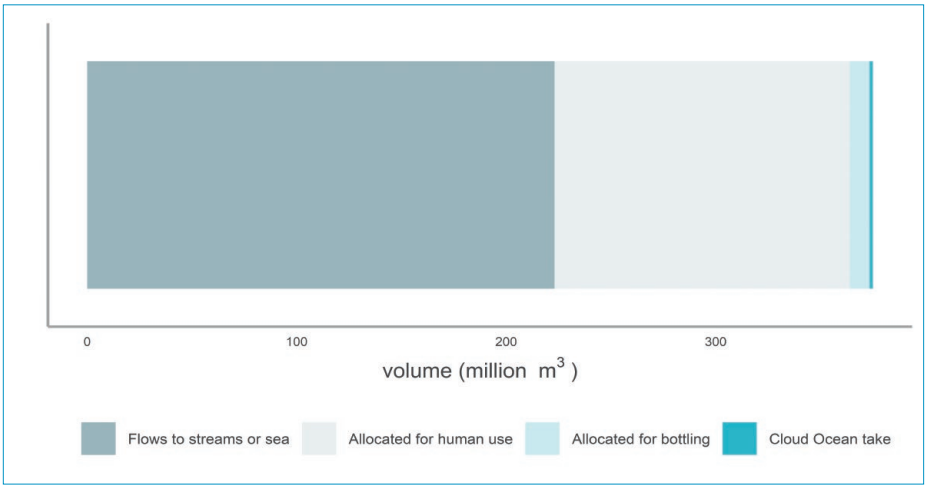
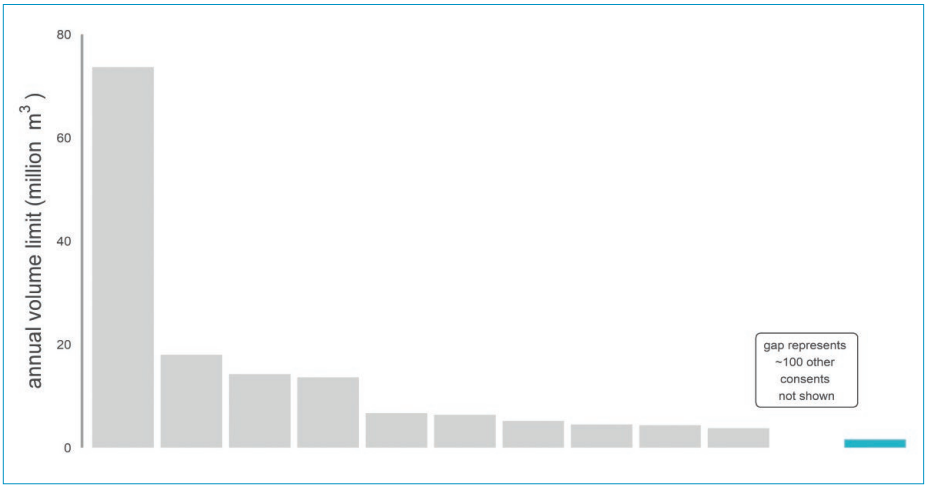


Illustration of a reduction in water levels and stream flows due to groundwater pumping.
(Source: US Geological Survey)



Cloud Ocean water take and other bottling takes as a proportion of total Christchurch groundwater resource. *(Data source: ECan)*



A comparison of the Cloud Ocean annual groundwater take limit (blue) with 10 of the largest groundwater take consents (grey). *(Data source: ECan consents database)*

The annual volume allowed by Cloud Ocean's consent is significant, to be sure, but as shown it's not up there with the big Canterbury water users. 1.6 million m^3/year is between two and fifty times smaller than the ten largest groundwater takes I could find, which are for a mixture of community supply, irrigation, fish farming, and industrial activities (but no water bottling, as far as I could see). This is based on text pattern matching from ECan's online consent database, so it's possible there are some other very large consents with non-standard conditions that didn't get picked up.

All of that said, while the volume and rate of take are usually the most important factors, the Cloud Ocean consent is actually an exception to this. This is because the recent application was to change the conditions of an existing consent, without any change to the rate or volume. Instead, they wanted to continue taking the same total amount of water but spread across two bores instead of one, with the new bore being much deeper.

I wasn't involved in any way, but I've read most of the publicly available information (which ECan seem to have been really proactive about releasing, by the way). As the Resource Management Act (RMA) requires, ECan's decision focussed on the effects of the change. In particular, there was plenty of discussion about modelling drawdown on a CCC public supply well, and appropriate backflow prevention devices to avoid any cross-contamination between aquifers. To state the obvious, these aren't normally the kind of issues that would get people marching in the streets (and regrettably, none of the placards I saw on the news coverage focussed on backflow prevention hardware).

Anyway, you'll be pleased to know that, as far as I can see from the public document trail, the appropriate valves were located. Also, CCC's own experts advised in November that "that there will be adequate available drawdown for existing and future CCC bores, provided they are designed and operated in an efficient manner." (Pro tip to the lawyers fronting the CCC-funded court challenge: don't open with that quote.)

OTHER ISSUES BEING DEBATED

Like all other water uses, water bottling also has indirect effects. Most obviously plastic consumption, which is the reason I don't drink bottled water myself. The problem with these indirect effects of water use is that generally speaking, they're less certain, more complex, and extremely difficult to compare objectively. Which is worse: spray drift from an irrigated orchard, or factory wastewater discharges? The answer depends on so many variables that the question is almost meaningless. A further complication is that, for effects related to horticulture and agriculture, irrigation is required in some climate zones but not others. Should two farms with the same nitrate leaching rates be regulated differently because one of them is irrigated?

If this is about controlling the indirect effects of water use – in this case bottling – a far better solution would be to control the activity directly causing those effects, not the groundwater take itself. And I'm all for a serious push to reduce plastic use, but if that's the issue why do we have protest marches about bottled water but not soft drinks?

Another frequently raised objection is the fact that bottling plants aren't charged a royalty on the water they use, as is the case for mining companies. Setting aside the firestorm about who owns water that doing so would inevitably generate, comparing water bottling with gold or oil extraction makes little sense because groundwater is not a finite resource. Groundwater taken sustainably this year will be back again next year, and still there for future generations.

Again, it's our community values that shape the decisions we make about water, at least as much as science. And there's nothing wrong with that. But it is important to realise that there's a real cost to major public outrage about what is, from a scientific perspective, not a particularly significant environmental issue. Every hour, dollar, and placard devoted to this issue is one that's not being spent on the real environmental issues of our time, like surface water quality and climate change. We have to ask ourselves whether the attention on this issue is really advancing our values, or if our energy and (where required) outrage would be better directed elsewhere.

Tim Muller is an environmental scientist with Landpro. All views expressed and any errors are his own.

Tasman hops growers look to the future after eventful summer

A booming hops industry with a reputation for excellence internationally continues to develop around Nelson, and irrigation underpins the industry's productivity.

Freestyle Hops is one of the hops producers working to build their business and share their knowledge with other growers.

The farm was one of the earliest to grow hops in Nelson, when the Eggers family established hops more than a century ago after arriving from Germany.

Four years ago Bruce Eggers sold the farm to American company FS Investments. The company was looking for a New Zealand investment and the country had a reputation for growing premier hops.

"We were drawn to the amazing terroir of Upper Moutere after drinking exceptional beers from all over the world brewed with New Zealand grown hops," says FS partner David Dunbar.

Freestyle Hops appointed Kiwi General Manager Sean Riley to run the farm. The connection to the Eggers family also continues today at Freestyle Hops, as Bruce's daughter Annette Eggers is the farm's Marketing and Exports Manager.

Freestyle Hops grows nine varieties of hops on 92 hectares of land, with plans to expand the growing area to 120 hectares next year.

Hops are dormant over winter and begin to grow again in September. In late October and November seasonal workers are busy 'training' the hops to grow taller by putting up string the plants can use to climb up.

"Hops are one of the fastest growing plants around, you can see them climbing up and growing day by day," says Sean.

The hops are harvested in late February and March, and then dried.

IRRIGATION USE

Irrigation and nutrients are important for the hops growth. "Hops are nitrogen and potassium hungry," Sean explains.

Water is stored on the farm on two storage dams. When the Moutere Stream has higher flows, the farm has a permit to take water and store it in their dams for use in the summer.

The property had previously been using overhead sprinklers but is now working to replace these with drip irrigation.

"I left the New Zealand hops industry ten years ago to work in Australia where drip irrigation was widely used. Drip irrigation allowed them to be much more conservative with their water use and after seeing that I was sure that we could use drip irrigation more in New Zealand," says Sean.

Much of the property is now irrigated with drip irrigation and Sean says this is better at wetting the roots of the plant than overhead sprinklers. It also saves time as when overhead sprinklers are used, the hops plants can cling to the sprinklers and would have to be removed manually by staff.

Switching to drip irrigation also allows Freestyle Farms to apply nutrients with the water through fertigation. The plants typically require 25mm of water each week, and fertigation allows the farm to apply small amounts of water and nutrients regularly.

The farm has seven weather monitoring stations on site which monitor soil moisture, temperature, and rainfall to help determine when irrigation is needed.

A CHALLENGING SUMMER

Like other Nelson/Tasman farmers and growers, the past summer was a difficult one for Freestyle Hops.

A severe drought developed across the area in February and March, with a massive fire also affecting the region in early February.

"The drought had an adverse effect on the season as nothing compares to rain. We just managed to sneak through with our stored water and now we are anxiously awaiting rainfall to recharge the dams," says Sean.

Sean says the fire got close to their property and they had concerns that the lingering

The Pigeon Valley fire got alarmingly close to the Freestyle Hops farm.

The farm's drip irrigation system.

smoke from the blaze could have affected their crops which were nearly ready to harvest.

"The way in which we dry the hops requires large fans which suck the air through large radiators into our kilns and with the smoke still present it could have tainted our hops. Thankfully this was not the case."

"During the fire there were an army of helicopters working hard dipping into irrigation storage dams pulling the water out to fight the fire. It seemed most of the time in the early stages of the fire the helicopters struggled to get close enough to the fire wall to make a massive impact. It certainly was a scary time."

FUTURE PLANS

While much of their hops crop is exported to North America, Freestyle Hops also has customers in Europe and Asia. It also provides customised processing and harvesting services to domestic New Zealand craft breweries like Wellington brewery Garage Project.

"The flavours and aromas of our hops are unique and we love working closely with a talented group of brewers to keep improving what we do on farm. The goal is to continue coaxing unique and exciting flavours from our beloved little valley using the best tools available, like drip irrigation," says David Dunbar.

Freestyle Hops has joined with Garage Project and the Ministry for Primary Industries (MPI) on a $13.25 million seven year Primary Growth Partnership project.

The project will be delivered by Hāpi Research (a joint venture between Freestyle Hops and Garage Project) and funded by Hāpi Research and MPI.

New Zealand hops are hotly sought after internationally, and growers can't currently meet the worldwide demand.

The Primary Growth Partnership Project, called Hāpi – Brewing Success, aims to undertake work which will benefit all growers.

"The Hāpi – Brewing Success PGP programme will create a cross-industry research and development programme that's commercially viable, sustainable in the long-term, with strong commercialisation pathways driven by the market," says MPI director-general Martyn Dunne.

The hop plants being trained to climb up strings.

"The programme will help growers and brewers to explore new possibilities for our hop growing and craft beer industries."

The programme is looking at introducing new varieties of hops into New Zealand, developing a unique New Zealand craft beer, trialling the use of precision agriculture practices and supporting growers to improve their production and develop their businesses. It will also look at how to support entry into new international markets.

It aims to boost hops revenue by $89 million by 2027 and create 835 new jobs in the hop growing and craft brewing industries.

As part of the precision agriculture aspect of the project, next year Lincoln University will be working with Freestyle Hops to quantify the changes using fertigation can make to production, nutrient use and nutrient losses, and identify its pros and cons. This research will be shared with other growers.

Investment in water storage projects planned

The Provincial Growth Fund (PGF) will invest up to $18.5 million in water storage to unlock land use potential in Northland. Up to $13 million will be made available from the PGF for a horticultural development project in the Eastern Bay of Plenty which includes the development of water infrastructure. $800,000 has also been allocated to undertake further investigations on water storage in the Wairarapa.

FUNDING ANNOUNCED FOR WATER STORAGE IN NORTHLAND

"Up to $18.5 million will be invested to help investigate and, if feasible, construct community-scale water storage and use options in Kaipara and the Mid North," Regional Economic Development Minister Shane Jones said when announcing the funding in April.

"This project is the largest PGF investment to date in water storage. Regional Economic Development Ministers backed the proposal because of the real opportunities that ensuring a more reliable water supply could bring to the region – up to $150 million in increased horticulture earnings per year and up to 1,150 jobs created."

"The region is vulnerable to droughts and floods, so better access to water will give landowners greater options to utilise their land, develop new markets and maintain and grow a skilled workforce."

"This project is relatively small in scale, compared to proposed water projects in the past, and enjoys wide support from local government. It will alleviate pressure on surface and groundwater resources, and will reduce sedimentation, a key water quality issue for the region, as land use shifts towards horticulture."

"It will also mean better access to water for use on Māori-owned land – the development of which is a key objective for the PGF."

The funding will be used first for initial feasibility work, then any potential construction phase, with stop or go points at each stage to allow a re-evaluation.

"The feasibility work will include technical, environmental and economic analysis, as well as activities to get the project ready to start construction. This includes engagement with the local community to ensure they benefit from any proposed scheme."

Northland Regional Council will receive the funding and will work with other councils in the region, iwi and the community to undertake the necessary work required to support the project's construction.

Currently only a small area of Northland (roughly 8,500 hectares) is irrigated, most of which is used for horticulture. The region is home to two irrigation schemes built in the 1980s – one near Kerikeri and the other at Maungatapere, near Whangarei.

Northland Regional Council and the region's economic development agency Northland Inc have welcomed the government's funding announcement.

"The most recent of the scoping studies showed investing in water storage and use option projects in the mid-North and Kaipara could potentially create hundreds of jobs and boost the regional economy by tens of millions annually," Hokianga-Kaikohe Councillor Justin Blaikie says.

Councillor Blaikie says that – like the existing Kerikeri scheme – any new water storage and use ventures would have a predominantly horticultural focus and would allow for increased planting rather than enabling the conversion of land to dairy.

"This is a region where we get pretty high rainfall in one season and drought in another. How do we work it so that rainfall becomes an asset, and how do we future-proof our region in light of climate change challenges?," says Northland Inc's acting CEO Vaughan Cooper.

"We need to focus on new water storage and use schemes to ease the impact of drought and also deliver economic and environmental benefits."

HORTICULTURAL DEVELOPMENT IN THE EASTERN BAY OF PLENTY

In May the government announced that the Provincial Growth Fund would be investing in a project to enable horticultural development

"This is a region where we get pretty high rainfall in one season and drought in another. How do we work it so that rainfall becomes an asset, and how do we future-proof our region in light of climate change challenges?"

An aerial view of Kerikeri. The Kerikeri irrigation scheme has boosted employment opportunities and income in the area. *(Photo: Andrew Penny, LEARNZ)*

in the Eastern Bay of Plenty.

The planned project will involve the development of water infrastructure, the creation of a kiwifruit orchard, a trial nursery and science lab and a living wage horticulture pilot project. It will take place on 100 hectares of Māori owned land in Te Kaha. The project could create year-round employment for up to 175 people over three years.

A kiwifruit orchard and trial nursery are part of the planned project in the Eastern Bay of Plenty.

The Te Kaha Landowners Group will receive a $370,000 grant initially, and if planning is successfully undertaken up to $13 million could be invested in the project.

"The Eastern Bay of Plenty is home to some of New Zealand's most isolated communities and represents some of the most challenging areas of rural deprivation. Full-time employment has not been readily available for most whānau in these regions for generations," says Regional Economic Development Minister Shane Jones.

WAIRARAPA WATER STORAGE INVESTIGATIONS TO CONTINUE

The Provincial Growth Fund is also investing $800,000 to investigate the development and construction of community water storage in the Wairarapa.

"The water supply is becoming unpredictable in the region, particularly during the summer months. Without it local businesses relying on water could be increasingly impacted, limiting their ability to operate and grow in the region," says Fletcher Tabuteau, Under-Secretary for Regional Economic Development.

"Research has shown that in the next 25 years, an additional 1,000 hectares of apples can expect to generate 1,300 more jobs and $81 million a year in GDP for the region. To make this happen, a reliable water supply will be needed. This project has the potential to provide up to 18 million cubic litres of stored water for the region to be used in a time of need."

Previous studies have found that having a reliable water supply would also enable increased land diversification into horticulture, viticulture, arable cropping and lamb finishing. It would also supplement domestic water supplies and mitigate the impacts of drought.

The PGF's investment will go to Wairarapa Water Limited (WWL) to support a review and update of a 2015 pre-feasibility study which investigated six potential water schemes in the region, of which the Wakamoekau water storage option on the Ruamāhanga River was found most favourable. It will also update the study with recent climate change projections.

Water is one of three focuses of the Wairarapa economic development plan.

Kurow-Duntroon scheme modernisation underway

In January 2019, work got underway on a $45 million upgrade of the Kurow Duntroon Irrigation scheme.

The work will double the scheme area from 2,000 hectares to 5,500 hectares, with supply to 4,100 hectares at day one. It will replace the existing 44 kilometre open canal race with a 59 kilometre pressurised piped network.

Five pump stations and one vacuum pump station will also be developed as part of the project.

The switch to a modern more efficient piped system will allow more land to be irrigated. Most of this is already irrigated land which will shift from being irrigated with water drawn from smaller streams to using water from the larger Waitaki River and Lake Waitaki.

Within the scheme area, about 1,700 hectares is irrigated from mining permits which allowed water to be drawn from smaller streams. These permits are due to expire in 2021 and minimum flows will be set for the streams.

The project has benefits for the environment and for farmers, as it will enable smaller streams to have higher flows while shifting farmers to use water from the lake which stores water from the Waitaki River behind the Waitaki Dam.

The switch will provide irrigators with almost 100% reliable water from the scheme.

The Kurow Racecourse area prior to pipes being installed.

Up until now their water reliability has been relatively low as smaller streams will often run dry in the middle of summer. There was little certainty that farmers would be able to draw water from small streams in the future over summer when minimum flows are set.

The piped network will run from the Waitaki Dam to Duntroon.

Marcus Brown is the Project Manager for the modernisation project.

"Conditions were very dry in late summer and into autumn and this has allowed good progress to the made on the first stage of works," he says.

Five pipeline crews are operating at the moment and around seventy people are involved in the project works currently and this number will increase in the coming months.

Pipe laying across major river crossings has been completed already, and nearly 10km of pipe has been laid.

The team is working to re-establish a piped link between the Waitaki Dam and Kurow and complete this by September so it's operational

The main construction base for the Kurow Duntroon modernisation project.

for the irrigation season. The new piped network will connect to the open channel system while work to create a new piped network from Kurow to Duntroon continues in spring.

The aim is to have the whole piped network from the Waitaki Dam to Duntroon completed by late November with testing and commissioning work undertaken over the summer so that this new network can start operating in February.

The existing open water race canal network is not fully lined and is experiencing significant leakage. The new infrastructure which will replace it will have a design life of over 80 years.

The Kurow-Duntroon Irrigation scheme was constructed in 1965 by the Ministry of Works. Since the time the scheme was constructed the use of flood irrigation on farms serviced by the scheme has dropped significantly as farmers have increasingly adopted spray irrigation systems. The use of flood irrigation is expected to further reduce in the future due to regional council requirements.

The scheme area was originally 1,600 hectares and was expanded in 1971 to add another 400 hectares of land. In 1989 the scheme transferred to community ownership when the Upper Waitaki Irrigation Company was formed. The name was changed in 2015 to Kurow-Duntroon Irrigation Company.

The scheme area includes a mix of dairy, sheep and beef farming and viticulture. There are not expected to be any conversions to dairy in the near future.

The project is being supported by loan funding from Crown Irrigation Investments and Waitaki District Council. Fifty-eight shareholders currently own shares in the scheme.

Nature's whims cause water crises. Its infrastructure can stop them

By Karen Villholth, Principal Researcher; also Coordinator of the global partnership GRIPP, Groundwater Solutions Initiative for Policy and Practice, International Water Management Institute.

Across Asia, man-made structures have stood powerless to avert tragedy after tragedy during 2018's rainy season. Hundreds remain missing in Laos following the collapse of the partially built Xe-Pian Xe-Namnoy hydroelectric dam, which followed relentless rainfall.

Elsewhere, more than 300 people have been confirmed dead after the worst downpours in a century overwhelmed dams in the Indian state of Kerala.

Dams are vital for energy needs and economic growth. But they've been criticised for posing risks to local communities and the fragile environments in which they are built. In the case of both Laos and Kerala, questions are being raised about the long-term suitability and sustainability of dam building projects in the light of recent disasters and the continued threat of climate change.

At the same time "green" infrastructure – a term for nature-based structures capturing stormwater underground and in wetlands – is gaining popularity. It was the topic of the United Nations' 2018 World Water Development Report, which called for concerted efforts to feature natural infrastructure among the solutions when addressing increasing vulnerability and water insecurity.

And, as projects that harness nature-based structures in places like Kenya and Sri Lanka are showing, green infrastructure can be a valuable tool in helping vulnerable communities to face the double threat of flooding and drought. Research and practise from India over the last 30 years demonstrate this, through integrated watershed management that involves local stakeholders.

A farmer works a pair of oxen to drive a water wheel in rural Rajasthan. The wheel draws water from a deep well up onto crops. India is piloting a project to divert monsoon flows to recharge aquifers.

SAND DAMS IN KENYA

One example of a successful "green" infrastructure approach can be found in the town of Kitui in Kenya, situated 150km east of Nairobi. The land in Kitui is semi-arid. Rain falls in two wet seasons, usually as infrequent, intensive storms. During the dry season, surface water sources are scarce. It takes a long time to walk to the few reliable water sources.

In response to these challenges, and given the good geological conditions for constructing sand storage dams, the government has budgeted for 2,000 sand dams to be built by 2021. Sand dams are simple dams on seasonal smaller rivers that use naturally accumulated sand behind the dam wall to create a subsurface reservoir for water. Sand dams can store up to 10,000 cubic metres per year.

The water these dams save can be abstracted throughout the dry season, avoiding problems found with standard dams such as evaporation losses, contamination from other sources and malaria.

Thanks to this technique, the distance to drinking water sources in the dry season has declined by 1,700 metres, on average. In some cases it's dropped from more than 10 kilometres to less than one.

More water and soil moisture has become available for agriculture, increasing the irrigated crop area by 400%.

Typically, the increase in income surpasses the construction and maintenance costs of sand dams. This makes them economically sustainable options, and the dams are now spreading to Burkina Faso, Ethiopia, Tanzania and Uganda, where seasonal river flow and a suitable subsurface renders them viable and sought after.

UNDERGROUND TAMING OF FLOODS

Other natural infrastructure is hidden below the ground. Around half of the water we use for irrigation is found in underground aquifers. Finding ways to keep those aquifers fully charged helps communities to stay a step ahead of climate change. Water can be safely stored in times of excess, then made available again in times of scarcity.

In India, the International Water Management Institute is piloting a project to divert monsoonal flows from irrigation canal systems into underground aquifers, via specially designed ponds.

The project showed that each system is

A pilot managed aquifer recharge project in Mid Canterbury is raising groundwater levels and reducing nitrates.

enough to store up to 70,000 cubic meters of water underground each year without any detrimental impact on the environment or groundwater quality. This amount of water enables local farmers to grow up to 35 hectares of crops in the winter season or 11 hectares in the dry season.

Local villagers perceive that their water availability has improved for both domestic and agricultural uses, and the underground taming of floods approach has now been incorporated into the Rampur District development plan, opening the way for broader implementation.

URBAN WETLANDS CRUNCH THE FLOODS

The Sri Lankan capital of Colombo is a city built on wetlands. This complex network of water bodies has the capacity to store enough water to fill 27,000 Olympic-size swimming pools, reducing the risk of flooding.

It also helps reduce extreme temperatures across at least half of urban Colombo through evaporative cooling. Yet these wetlands are disappearing at an alarming rate. In some areas, as much as 60% of the wetland area has been lost since the 1980s. The current overall rate of loss due to urban expansion is estimated at 1.2% per year. Unless this trend is reversed, the wetland area will decline by one-third over the next two decades.

Local institutions have responded with a comprehensive plan for better wetland management. This features 20 concrete action points.

These include the formation of a wetlands committee to coordinate efforts and institutional contributions. Wetland benefits are also being incorporated into the government's urban planning, ensuring this "green" infrastructure is protected. Recently, the Sri Lankan cabinet approved an order to halt all land reclamation and destruction in the wetlands, and declared the ecosystem a protected zone.

WORKING WITH NATURE

Worldwide water crises show no signs of slowing. It is time we paid more attention to nature's own engineering. At times, the best course may be to combine it intelligently with human invention. The time for relying solely on man-made infrastructure has past. We need to work with nature, if we are to temper its own extremes.

Urban growth in Colombo, Sri Lanka, has resulted in wetland areas reducing.

New trust brings farmers and industry together to address environmental concerns

Grassroots sustainability is being promoted by a new farmer-led group in Canterbury, which aims to collaborate with industry and local authorities to address environmental concerns.

The Waimakariri Next Generation Farmers Trust (the Trust) was established in response to new plan changes and rules affecting farmers in the district. It aims to help convey information between local and regional councils, industry organisations, farmers and the wider community.

The Trust is the first farmer-led group in the Waimakariri district. Its seven trustees, aged between 28 and 35, are either farm owners or managers. It is hoped the membership base will eventually represent all 350 farms throughout the Waimakariri.

A key focus is communicating directly with Waimakariri farmers to raise awareness of environmental policy changes, and ensuring they have support to implement good farm management practices.

It is also hoped a single, united voice will give the Trust credence to be viewed as a key stakeholder working in partnership with local authorities, regional councils and industry groups in addressing environmental concerns.

Chairperson Scott Evans, a dairy farmer in Oxford, says the group was formed to unite the rural community in their goal of protecting the environment for future generations.

"A key objective of the Trust is to work alongside industry and local authorities in the development of environmental policy," says Scott.

"Farmers have a lot of local knowledge and we want to ensure this grassroots perspective is not overlooked. We need practical, achievable changes that positively impact the environment and incorporate farmer-driven solutions.

"At the end of the day we all have the same aim, and that is to ensure the environment is protected now and into the future."

A key impetus for the formation of the Trust is the Waimakariri Zone Committee's Draft Zone Implementation Programme Addendum (ZIPA), released by Environment Canterbury in December 2018. The ZIPA features a set of recommendations to address water quality and management issues, with specific priority areas.

According to the ZIPA, some dairy farms will need to reduce their nitrate levels by a further 15 percent beyond Good Management Practice (GMP) by 2030, while all other consented land users will need to make a further five percent reduction. It also recommends that all farmers in the zone reach Baseline GMP by 2020.

Trustees Victoria Trayner, Sam Spencer-Bower, Andrew Olorenshaw, Sarah Gard and Scott Evans.

"Farmers have a lot of local knowledge and we want to ensure this grassroots perspective is not overlooked. We need practical, achievable changes that positively impact the environment and incorporate farmer-driven solutions."

The document acknowledges that it will be "very challenging for farmers to meet the new limits."

"Some farmers may feel that the new limits are unachievable, while other members of our community may feel we are not going far enough or fast enough," it states.

The ZIPA in its current format is not achievable for many farmers, says Evans.

"We have already taken significant steps forward in terms of reducing nitrates and investing in new technology to enable more efficient irrigation. It's important that we remain profitable to ensure we can continue with these initiatives and keep heading in the right direction."

The Trust is actively working with industry organisations to make a case for the changes it wants made to the ZIPA, and will be making a submission when public consultation begins in mid-2019.

Many farmers are already "going above and beyond" in terms of protecting their natural environment, says Evans.

"Farmers are some of our best environmentalists. Riparian management, Farm Environment Plans, stock exclusion, irrigation management, wetland restoration and new technologies are just some of the investments we are making to ensure the land remains viable for the benefit of the wider community."

Environmental spend by dairy farmers in the Canterbury/Marlborough region was $170,000 per farm in the five years between 2010 and 2015, according to a DairyNZ and Federated Farmers survey – nearly double the national average of $90,000.

"It is part of our social licence and responsibility as caretakers of the land to ensure we stand up and take ownership for the environmental issues we are all facing," says Evans.

Industry experts will explain policy changes, and outline on-farm initiatives for reducing environmental risk.

If you're interested in joining the Trust contact Scott Evans on 021 678 235 or Sam Spencer-Bower on 021 921 332.

Using drones in agriculture and irrigation

By Marika Yang.

Professor of Mechanical Engineering Kenji Shimada and his team of researchers at the College of Engineering at Carnegie Mellon University in Pennsylvania are using drone technology to help detect and restore damaged water canals in Japan that are critical for the agricultural economy.

Unmanned aerial vehicles, also known as drones, are being increasingly used for commercial, scientific, agricultural, and infrastructural uses. With this technology, scientists and engineers are now better-equipped to solve problems and alleviate issues in these fields.

Kenji Shimada, professor of mechanical engineering, and his team of engineers are using autonomous technology to detect damage to agricultural water canals in a town in Niigata, an agricultural district on the northwest coast of Japan. These canals are essential for the rice farming economy in the region and total approximately 40,000 kilometres throughout Japan.

Damage to the canals accumulates annually due to age, earthquakes, and extreme weather. They can only be analysed and repaired during the two-month dry season each year. Of these two months, one and a half of them are currently devoted to laborious inspection by technicians who walk along the canals to manually identify, measure, and record damaged areas. This leaves only half a month for repairs.

"40,000 kilometres are equivalent to the equatorial circumference of Earth, and the manual labour for inspecting and evaluating the condition of water canals is enormous. We automate the work by flying autonomous drones equipped with high-resolution cameras and detecting cracks and wear with machine-learning algorithms," said Shimada.

Shimada and his team have developed a systematic framework with a fleet of drones and coordinating cars to assess the canals effectively and efficiently, extending the coverage area and minimising inspection time. Di Deng, a Ph.D. candidate in mechanical engineering, works on the coverage planning aspect of the project. Last year, she traveled to Japan to conduct field tests of the drone in different types of water canals.

"Over the summer, we flew our autonomous drone in Japan and tried different sizes of water canals, so the system can automatically decide the position of the drone inside the water canals," said Deng. "We tried out the widths of the water canals that go from 5 metres to 2.4 metres. We could clearly see a lot of stone exposed, so these were the places we needed to repair."

Using public maps and research data, the research team has formulated an algorithm to plan the drones' path along the canals. They can fly along canals of different sizes in multiple directions to record complete video of the walls for crack detection. The type of commercial drone chosen for the project is limited to thirty minutes in the air and must stay within a range of a few kilometres from the remote controllers. This makes it impossible for the drones to cover all of the canal in one flight. To ameliorate these limitations, they are paired with cars parked within the maximum distance away that provide batteries and coordinate to pick the vehicles up when needed. Once they have recorded video of the entire canal, the data from the images is fed into a neural network to detect damaged areas and map them in CAD models. To plan the paths of the drones, a scaled map of a canal is converted to a graph. This graph is then divided into subgraphs, which represent the areas they will cover. The team also graphs the roads to generate a route for the car that is within communication distance of the drones. The cars are programmed to automatically find alternative routes if faced with traffic.

"We believe that this type of technology is critical to keeping the aging infrastructures healthy and safe—it enables faster, cheaper, and more regular inspection and monitoring."

The team presented their research at the International Conference on Intelligent Robots and Systems (IROS) in October. In the future, they plan to tackle potential road blocks. In addition to the battery and time limitations, logical challenges to this project include potential vehicle collisions, aerial constraints (flying zones, aerial traffic, and other regulations), and inaccurate maps and measurements. Another long-term goal is to develop large-scale automated vehicle planning.

"We believe that this type of technology is critical to keeping the aging infrastructures healthy and safe—it enables faster, cheaper, and more regular inspection and monitoring," said Shimada.

Rice paddy, Kamo-shi, Niigata Prefecture, Japan. *(Photo: Yamakidoms, CC BY-SA 2.0)*

The drone working in a canal. *(Photo: Di Deng, College of Engineering, Carnegie Mellon University)*

Seasonal climate outlook May–July 2019

OUTLOOK SUMMARY

A weak, central Pacific El Niño continued during April, as patterns of enhanced rainfall persisted in the vicinity of the International Date Line. Although El Niño is forecast to continue during the upcoming three-month period, it may weaken later in 2019.

Air pressure is expected to be higher than normal to the west and north of New Zealand and below normal to the south of the country, resulting in more westerly quarter winds than normal.

Temperatures are forecast to be above average in the north and east of the North Island and east of the South Island and about equally likely to be above average or near average in all remaining regions. Warmer than average coastal and Tasman Sea surface temperatures may influence several spells of unseasonable warmth through the season, particularly in eastern areas, contributed to by frequent westerly air flows.

Rainfall is about equally likely to be below normal or near normal in the North Island and in the east of the South Island, most likely to be near normal in the north of the South Island, and about equally likely to be above normal or near normal in the west of the South Island. Influenced by El Niño and a progressively more active Tasman Sea, frequent fronts are possible for western areas through the season.

During April 2019, marine heatwave conditions continued in the Tasman Sea. Warmer than average seas may lead to a reduction in the intensity and duration of cold spells during the coming season, however frosts are still to be expected.

REGIONAL PREDICTIONS FOR THE MAY–JULY 2019 SEASON

Northland, Auckland, Waikato, Bay of Plenty

- Temperatures are most likely to be above average (55% chance).
- Rainfall totals are about equally likely to be near normal (35% chance) or below normal (40% chance).
- Soil moisture levels and river flows are most likely to be below normal (50% chance).

Central North Island, Taranaki, Whanganui, Manawatu, Wellington

- Temperatures are about equally likely to be above average (45% chance) or near average (40% chance).
- Rainfall totals are about equally likely to be near normal (40% chance) or below normal (35% chance).
- Soil moisture levels and river flows are equally likely to be below normal (40% chance) or near normal (40% chance).

Gisborne, Hawke's Bay, Wairarapa

- Temperatures are most likely to be above average (55% chance).
- Rainfall totals are about equally likely to be below normal (40% chance) or near normal (35% chance).
- Soil moisture levels and river flows are about equally likely to be below normal (40–45% chance) or near normal (40% chance).

Tasman, Nelson, Marlborough, Buller

- Temperatures are about equally likely to be above average (45% chance) or near average (40% chance).
- Rainfall totals are most likely to be near normal (45% chance).
- Soil moisture levels and river flows are about equally likely to be below normal (40% chance) or near normal (40–45% chance).

West Coast, Alps and foothills, inland Otago, Southland

- Temperatures are about equally likely to be above average (45% chance) or near average (40% chance).
- Rainfall totals are about equally likely to be above normal (40% chance) or near normal (35% chance).

Lake Opuha in snow. *(Photo: Opuha Water)*

- Soil moisture levels are about equally likely to be above normal (40% chance) or near normal (35% chance) and river flows are most likely to be above normal (45% chance).

Coastal Canterbury, east Otago

- Temperatures are most likely to be above average (50% chance).
- Rainfall totals are about equally likely to be near normal (40% chance) or below normal (35% chance).
- Soil moisture levels and river flows are about equally to be below normal (45% chance) or near normal (40-45% chance).

Probabilities are assigned in three categories: above average, near average, and below average. In the absence of any forecast guidance there would be an equal likelihood (33% chance) of the outcome being in any one of the three categories. Forecast information from local and global guidance models is used to indicate the deviation from equal chance expected for the coming three-month period.

This is an extract of the Seasonal Climate Outlook published by NIWA.

Sheep moving to greener pastures after snowfall. *(Photo: ©mychillybin.co.nz/William Connell)*

The science of weather forecasting

NIWA climate scientist Trevor Carey-Smith gives a snapshot of the complex process NIWA uses to provide the best available weather forecast to farmers taking part in the Irrigation Insight programme.

Irrigation management can be complex as environmental factors, economic return and resource efficiency need to be balanced to achieve optimal outcomes. The availability of advanced technologies in data collection, telemetry, processing and forecasting is providing opportunities to improve water management. A critical step in achieving this is to ensure that New Zealand farmers have access to the best available weather information in a form that can be readily used to make every-day decisions. The Irrigation Insight programme is working to provide irrigating dairy farmers tools that can deliver this.

NIWA staff discuss irrigation with farmers participating in the Irrigation Insight Programme. *(Photo: NIWA)*

THE IRRIGATION INSIGHT PROGRAMME

The Irrigation Insight programme is a five-year MBIE-funded project that aims to examine, on irrigating dairy farms, the ease and effectiveness of using improved weather forecasting and drainage estimations to on-farm water management using a co-innovation approach.

Led by NIWA with the support of programme partners DairyNZ, Fonterra, IrrigationNZ, AgResearch and research partner LIC, the programme focuses on finding solutions that are economically sound and environmentally responsible. Environmentally, the aim is to reduce drainage and leaching from over irrigation. Economically, the focus is to reduce the on-farm costs associated with irrigation management and to save farmers' time spent on making irrigation decisions, without compromising the effectiveness of decisions made.

In its third year the project is now aiming to co-develop management tools for improved irrigation practices with our partners, farmers and stakeholders.

WHAT MAKES FORECASTING DIFFICULT IN NEW ZEALAND?

New Zealand is a group of relatively small islands surrounded by a large body of water. The position of the Southern Alps, which is directly in the path of prevailing weather systems, results in a South Island of two halves – a dry east and a wet west. The same is true to a lesser extent in the central North Island. This means that rainfall conditions can vary considerably even over a short distance and are highly dependent on the wind.

Over the last irrigation season, one of the Irrigation Insight monitoring sites in North Canterbury received more than 5mm of rain on 23 different days and more than 10mm on 13 days. Nature provides a good dose of irrigation itself; knowing when and where this occurs is important, but difficult to achieve.

ARE WE THERE YET? HAS THE SCIENCE OF FORECASTING MATURED ENOUGH TO BE RELIABLE?

The science of weather forecasting has come a long way over the past few decades. The accuracy in terms of both spatial precision and the useful range of forecasts has increased steadily as numerical weather prediction models have become more sophisticated and computing power has expanded.

However, reliable forecasts that are easily applicable to irrigation management are not generally available in New Zealand. Currently it is common for farm managers to access more than one online weather forecast and use their judgement to form their own "consensus forecast" from which decisions are then made.

As part of the Irrigation Insight programme, NIWA is providing tailored rainfall forecasts to a small number of farmers in the Canterbury region.

HOW IS NIWA TACKLING THIS CHALLENGE?

These forecasts are based on global and regional numerical weather prediction models which are post-processed into a single forecast that also includes a measure of our confidence in the accuracy of the prediction.

NIWA-provided forecasts used in the Irrigation Insight programme are built on three pillars:

1. UK Met Office Unified Modelling System

For weather forecasts 6 to 10 days into the future, NIWA relies on numerical weather prediction models with global coverage from our international partners, including the UK Met Office, whose Unified Model now runs globally with a resolution of 12km over New Zealand. It is one of the top two or three forecast models currently available and is widely used around the globe by organisations such as the Australian Bureau of Meteorology, the Korean Meteorological Agency, the Indian National Centre for Medium Range Weather Forecasting and the US Air Force.

Improved accuracy over the first three days of the forecast is obtained using two local implementations of the same Met Office Unified Model system. Both local models are run every six hours, using results from previous runs to provide initial conditions, and provide forecasts at hourly time steps:

- New Zealand Limited Area Model (NZLAM) – Provides forecasts three days into the future at 12km resolution. NIWA

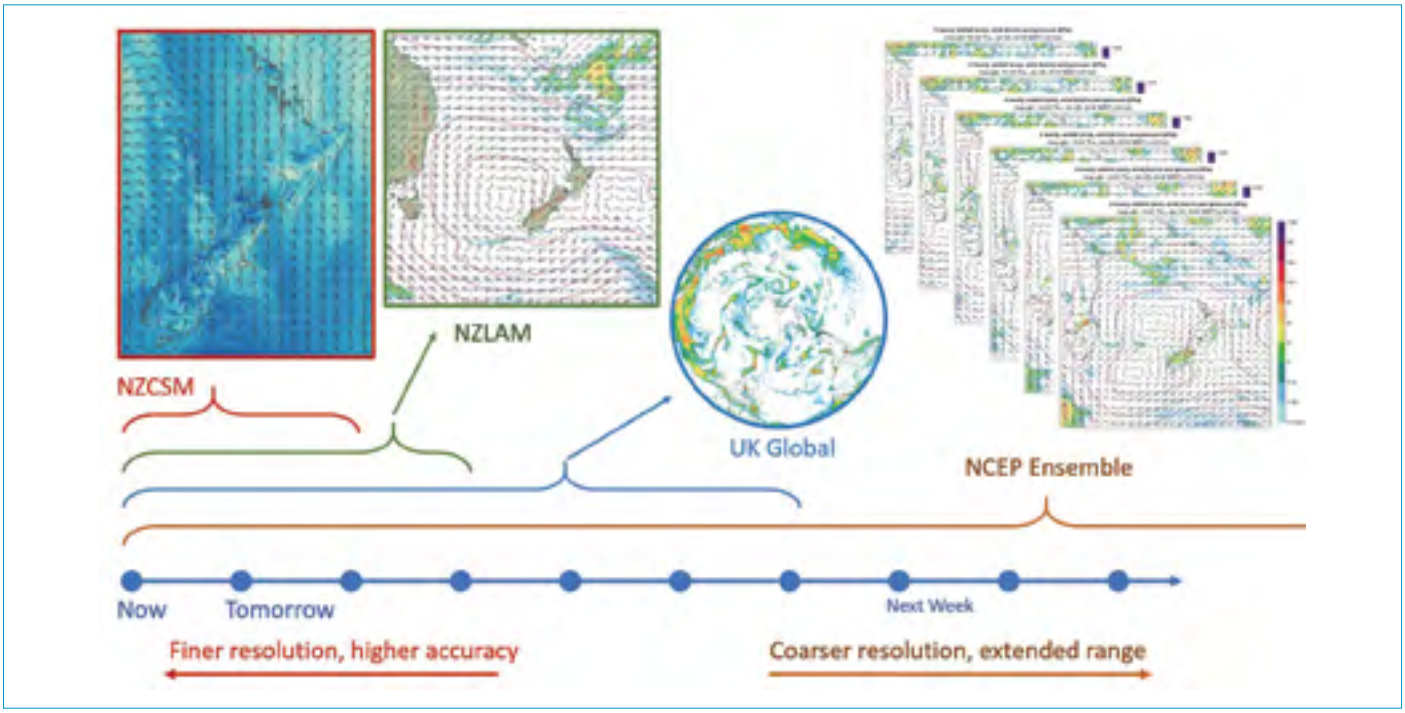


Figure 1: A selection of the numerical weather prediction models used at NIWA showing the range of time scales covered. NZCSM and NZLAM are run locally using NIWA's high performance computing facility. *(Graphic: NIWA)*

collects a huge number of observations that 'tune' the model at run time to produce the best results. Advanced four-dimensional assimilation algorithms optimise the model to fit best to the observations. All this means that NIWA's forecasts are continually checked against the actual weather that occurred at the time, and future forecasts are adjusted accordingly.

- New Zealand Convective Scale Model (NZCSM) – Provides forecasts 48 hours ahead at 1.5km resolution, which is the highest resolution of any operational model in New Zealand, meaning we get the best representation of New Zealand's unique landscape and the effects it has on local weather conditions. Valleys, hills, water bodies and other features that most models cannot see contribute significantly to local weather and when such features are resolved, forecasts for arbitrary locations are more accurate.

2. NIWA climate monitoring network

Even though these models are at the cutting edge of what is currently possible, their forecasts still contain errors. Where observations are available, site-specific forecasts can be improved by comparing past forecasts with historic observations and using advanced statistical methods to reduce consistent errors in the model predictions. Forecasts from multiple numerical weather prediction models can then be combined and used to estimate the most likely rainfall amount and its uncertainty. NIWA creates these seamless (or unified) 2- to

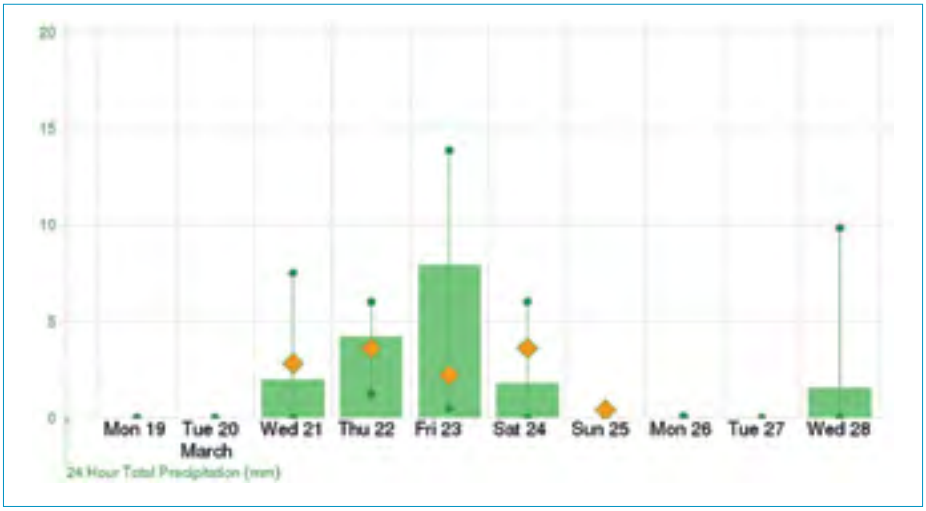


Figure 2: An example forecast showing expected daily rainfall amount (green bars) along with the likely range (green dots). What happened is shown by the orange diamonds. *(Graphic: NIWA)*

(Photo: NIWA)

10-day forecasts every six hours for locations across New Zealand. As well as rainfall, other weather variables are provided including air temperature, wind speed and direction and relative humidity.

The resulting seamless forecast includes estimates of the uncertainty which can be represented in several ways; commonly either as a range, from minimum to maximum likely amounts, or as a probability of exceeding some pre-defined amount. These quantify the risks associated with forecasts, which farmers can use to inform their decisions.

3. NIWA's High Performance Computing Facility

NIWA has sophisticated environmental modelling and forecasting capabilities that are underpinned by our High Performance Computing Facility which is managed in conjunction with the New Zealand eScience Infrastructure. It is comprised of three different, but interconnected machines, which are capable of processing more than two thousand trillion calculations per second. This system allows NIWA to run the high-resolution NZCSM model four times per day, with each 48-hour forecast taking a little over two hours to complete.

WHAT DOES THIS MEAN FOR FARMERS?

Combining this forecast information in a sensible and accessible way should enable more strategic planning, and hopefully reduce the need for farmers to triangulate their information from various weather information sources.

However, a rainfall forecast by itself is of limited benefit. It is also necessary to know how it will impact local soil conditions, pasture growth and ultimately farm production. For irrigation management, knowing what the soil moisture of an irrigation block will be over the next one to two weeks, with and without applied irrigation, is of critical importance.

To this end, another key part of the Irrigation Insight programme is the monitoring of soil moisture at multiple depths. This data can be used to provide not only historical and current soil moisture information, but also by incorporating weather forecasts, predictions of soil moisture a week to ten days into the future. By altering irrigation scheduling, the farm manager can then minimise the risk of both plant stress and soil drainage events.

WHAT MAKES NIWA FORECASTS ACCESSIBLE?

This season, Irrigation Insight pilot farmers have been involved in co-designing with researchers and stakeholders a forecast tool that suits their operational requirements. This is likely to include rainfall forecasts linked with current soil moisture conditions to provide predictions of soil moisture thereby helping the farmers to see the implication of their practice in real-time. The programme hopes to test the new tool during the next irrigation season on the pilot farms.

HOW SUCCESSFUL HAVE WE BEEN?

It is early days yet, but the signs are good. Despite only having access to the upgraded forecast and monitoring equipment data this irrigation season, the programme farmers are already noticing a difference. At a recent event one pilot farmer said that it is like driving down the road in the fog, "If the fog clears and you can see ahead you can make better decisions – that is what this information is allowing us to do."

To find out more about the programme visit www.irrigationinsight.co.nz.
You can stay up-to-date with the programme by signing up for the regular e-newsletter on the website home page.

Worldwide irrigation development could feed billions

A new study has found that worldwide the use of irrigation could increase by nearly 50% and help feed billions more people.

The study was carried out by researchers at the University of California, Berkeley, Columbia University, New York and the Polytechnic University of Milan.

It was undertaken using a spatial biophysical assessment of consumptive water use for cropping production assuming current cropping practices continued.

It found that global water consumption for irrigation could increase by 48% and that irrigation could expand into 26% of the world's rainfall fed agricultural land. This would produce 37% more calories which could feed an additional 2.8 billion people.

If current unsustainable irrigation extraction practices were eliminated then worldwide calorie production could still increase by 24% and feed 1.8 billion people.

Expanding irrigation could result in calorie production doubling in 50 countries – including 29 African countries. China, the United States, India, Russia, Brazil and Nigeria could benefit the most from developing more irrigation.

By expanding irrigation, China alone could feed an additional 382 million people, while India and Russia could together feed 483 million more people.

Irrigation development could also allow countries like Mexico, Iran, Germany and Italy which currently import food to become more self sufficient and reduce their exposure to shocks to the global food production system.

Globally crop production depends on receiving water from rainwater and irrigation. Irrigation is limited by water availability in a number of areas and in other areas water extraction exceeds what is sustainable long term.

The assessment looked at 16 crops: barley, cassava, groundnuts, maize, millet, oil palm, potatoes, rapeseed, rice, rye, sorghum, soybeans, sugar beet, sugar cane, sunflower, and wheat. These staple crops currently take up 73% of the world's cultivated land and make up 70% of global crop production.

The assessment took account of the need to maintain environmental flows and to identify areas where irrigation could replace rainfed agriculture without threatening freshwater ecosystems.

The study only considered the expansion of irrigation into already cultivated lands and did not consider the impact of increasing cropping frequencies which could occur with irrigation.

Many regions could benefit from having irrigation installed, however in the wettest climates adding irrigation was not considered to be justified as the cost of installing irrigation outweighed the marginal production increases that could occur.

While the study found that worldwide the amount of irrigated land in the world could expand significantly, it assumed that consumption for household and industrial uses would remain constant. However, population growth is expected to increase competition for water between agricultural, urban and industrial water users. The study also notes that climate change will alter water availability and evapotranspiration rates.

Future world population growth

2018	2030	2050
7.6 billion	8.6 billion	9.8 billion

(Data source: United Nations)

Mountains and rice fields of Nepal. *(Photo: Sharada Prasad CS, CC BY 2.0)*

Wheat is one of 16 stable crops which could held feed billions of additional people if non irrigated crops were irrigated to produce higher yields. *(Photo: Neil Williamson, The Wheat Field, CC BY-SA 2.0)*

Dujiangyan: The 2,200-year-old Chinese irrigation system that is still used today!

By April Holloway.

The oldest irrigation system in the world is in China. Called Dujiangyan, it is also the only surviving monumental non-dam irrigation system from the ancient past. A marvel of Chinese science and engineering, Dujiangyan was built over 2,200 years ago. This system is still used to irrigate over 668,700 hectares of farmland, drain floodwater, and it provides water resources to more than 50 cities in the Sichuan province today.

Dujiangyan is the brainchild of Li Bing, a local official of Sichuan Province over two millennia ago. It arose to confront the frequent flooding of the Minjiang River, a tributary of the Yangtze River. Li Bing and his son discovered the river was overflowing due to spring melt-water coming from the mountains which burst the banks of the slow-moving waters below. A dam was out of the question as Li Bing had been told to keep the waterway open for military vessels. Thus, Li Bing's solution was to create an artificial levee which could move some of the water to another area and then make a channel in Mount Yulei to send the excess water to the dry Chengdu Plain.

King Zhao of Qin funded Li Bing's project and tens of thousands of laborers were put to work. They built the levee by creating long sausage like baskets of bamboo filled with stones, known as Zhulong. These were held in place with wooden tripods called Macha. Natural topographic and hydrological features aid the system in irrigation, draining sediment, controlling flooding, and controlling water flow. No dams were required.

One of the most amazing features of the engineering project was the creation of a channel through Mount Yulei. It is worth noting that workers did this before gunpowder and explosives were invented. Li Bing's solution to cut through the hard rock was to use a combination of fire and water to intermittently heat and cool the rocks until they cracked and could be more easily removed. It took eight years to create a 20 metre wide channel through the mountain.

The completion of the system brought an end to flooding in the area and helped

The 'Fish Mouth' levee. Part of the Dujiangyan irrigation system. *(CC by 2.0)*

Dujiangyan, Chengdu, Sichuan Province. The LanQiao bridge gate over PuYangHe river. The bridge provides a great view of the famous Dujiangyan Irrigation System.

make Sichuan the most productive agricultural region in China. Li Bing's ambitious project is now recognised as the 'Treasure of Sichuan.'

Scientists continue to admire Dujiangyan today for one particular feature – the harmonious way it manages water for humans yet enables ecosystems and fish populations to continue naturally. This stands apart from dams which block up and alter nature's ways.

Dujiangyan is now a UNESCO World Heritage Site and it underwent a major renovation in 2013.

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The outer and constructed inner river that are part of the irrigation system. *(CC by 2.0)*

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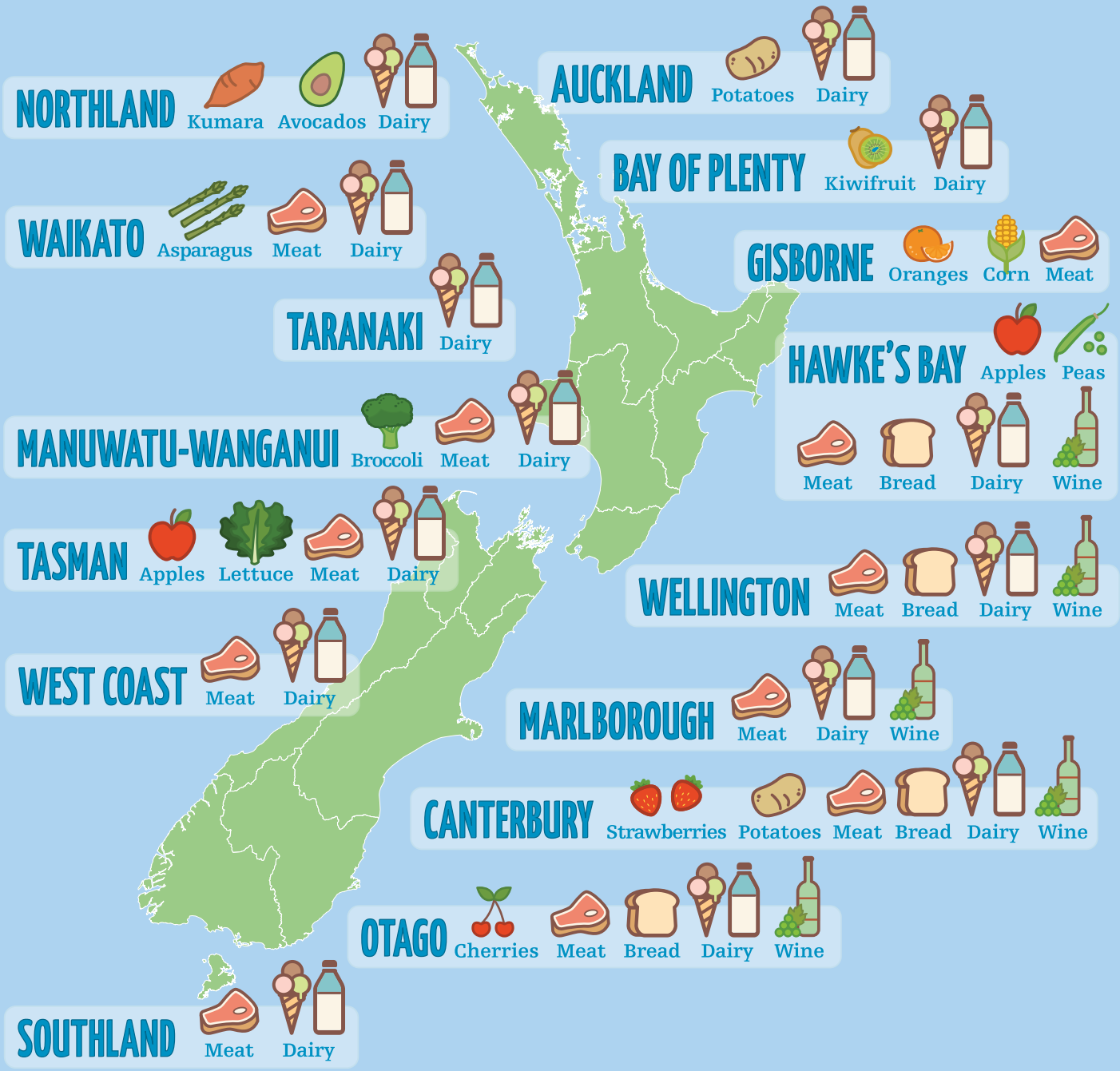

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