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AUTUMN 2019

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IRRIGATION NEW ZEALAND

www.irrigationnz.co.nz

IrrigationNZ: out & about

IRRIGATION EFFICIENCY TESTING IN SOUTH CANTERBURY

Over the summer IrrigationNZ was busy carrying out irrigation efficiency assessments on farms in South Canterbury and providing advice to farmers on our findings. We will be sharing the programme findings in an upcoming magazine.

IRRIGATION DESIGNERS GET TO GRIPS WITH DRIP MICRO

Our 2019 Certificate in Irrigation Design class got underway in January 2019. In February, a new drip irrigation design component was added to the course and a number of recent graduates also attended this session. We were privileged to have the Chief Designer from Netafim Australia and NZ, Gennaro Vellotti, deliver much of the drip micro training and share his expertise with the class.

SHARING OUR IRRIGATION STORY AT THE WANAKA A&P SHOW

IrrigationNZ went along to the Wanaka A&P show in March. We shared our award winning display about the role of irrigation in food production in New Zealand at the show. Our game encouraging people to guess which regions different foods grown with irrigation were produced in was popular with families.

MEETING WITH AGRICULTURE MINISTER

IrrigationNZ met with Agriculture Minister Damien O'Connor in March. At the meeting we again raised our concerns about a water tax (see our story on page 6 for IrrigationNZ's views on this). We also provided an update on a number of projects we are working on including fertigation, fish screen design and our irrigation efficiency testing programme.

Meet IrrigationNZ's new Chief Executive

Elizabeth Soal has been appointed as IrrigationNZ's new Chief Executive and took up her new position in late February. We spoke to her to get her views on the future of irrigation.

Tell us about your background.
I have a Degree in Law from the University of Otago and a Honours and Masters Degree in Political Studies.

I have been working for the Waitaki Irrigators Collective for the past eight years and until recently I was their Director of Strategy and Policy. The collective represents six irrigation schemes and independent irrigators. That role was focused on water planning, law and advocacy in North Otago and South Canterbury. It also involved public relations and media interaction, community education and managing relationships with different stakeholder groups such as iwi and environmental and fishing groups.

Before I took up the role at Waitaki Irrigators I worked at a law firm in the UK where I worked on agricultural law cases, and then in New Zealand I worked for the Ministry of Justice and then the Ministry of Social Development. The role with MSD was as a Regional Policy Advisor working on employment, labour market and social issues in rural communities.

I am also currently completing a PhD in Geography which is looking at changes in freshwater governance in New Zealand from the 1960s to today.

What future pressures and trends do you think will affect irrigators and irrigation as a whole?
There is currently a lot of awareness amongst the public about issues around water quality and also how we use water and this is changing the debate around water policy.

Historically, decisions on water use were made by regulators and water users, now the wider public has more influence on policy. This trend is only going to increase as people become more vocal.

Water is a crossroads between science, politics, cultural values and community feeling and sentiment with a lot of people having an emotional attachment to rivers and lakes.

A lot of the issues around water resources are complex and are long-term issues that are hard to distil into soundbites. The complexities tend to get lost in media coverage which tends to simplify the issues. People also adopt entrenched positions and it is difficult to get a genuine discussion around the issues.

As people become more aware of the limitations on water availability there is a trend to adopt newer technology to improve water use efficiency and effectiveness. In the past decade we have seen significant improvements in efficiency.

Climate change is a big issue. This will result in changes in rainfall with more high intensity rainfall events but longer periods of drought which will mean we will be looking at significant changes in the levels of water bodies in the future.

New Zealand will be faced with increased flooding events, urban water supply shortages and more demand for irrigation in existing and new areas – it's not just an issue which affects irrigators. To resolve this we are going to need to have some significant discussions around improving our infrastructure in urban and rural areas – that includes our natural infrastructure and our irrigation infrastructure in order to improve our resilience.

I would also expect to see changes in the role of iwi in the governance and management of water. We don't know yet what those changes will look like but they will also have an impact.

Elizabeth Soal.

What do you see as priorities for the irrigation sector for the future?
IrrigationNZ's future strategy identifies what I think are the key priorities for the future – to work on advocacy for the sector, improve our information base and have good training and standards in place which encourage ongoing improvement.

The signals from the government are that the way irrigation will develop in the future are not the same as how irrigation has developed in the past so we need to think about what the irrigation sector will look like in 20 years' time.

Advocacy is the most important activity from our strategy goals. This includes helping deliver the message that irrigation is key to community wellbeing. Irrigation has been demonstrated to be one of the most effective ways to improve community wellbeing – with studies showing irrigated areas have increased employment rates, more high value jobs, and an increase in school enrolment numbers.

Damon Summerfield.

March events

AN IRRIGATION THEMED VIRTUAL FIELD TRIP FOR SCHOOLS

From 19–21 March we hosted a Virtual Field Trip for schools across New Zealand with CORE Education. The field trip visited an irrigation scheme (Central Plains Water), Damon Summerfield's Sheffield farm which is part of the scheme and IZONE in Rolleston, one of New Zealand's largest business parks where many agricultural businesses are located. Over three days, school children saw and heard how water helps produce food and is important for our economy. Classes can also view videos from the trip and take part in the experience after the live event online at www.learnz.org.nz. The trip was aimed at children from 9–12 years.

SOUTH ISLAND AGRICULTURAL FIELD DAYS

IrrigationNZ will be at the South Island Agricultural Field Days from 27–29 March. Stop by and say hello to our staff if you're visiting the event!

A new water tax would affect everyone

IrrigationNZ says a proposed nationwide water tax would affect all Kiwis, and there needs to be more discussion about how this would impact households, farmers and businesses.

In a report released in February, the Tax Working Group has recommended the government consider introducing a water tax on all types of water use including hydro-generation, household use and commercial water use.

"This would result in higher power and food prices for households and businesses and higher rates bills to pay for the irrigation of parks and reserves as well as a direct water tax on household and business water use," says Nicky Hyslop, IrrigationNZ Chair.

The working party is proposing that the water tax could be used to fund the restoration of waterways nationwide.

"While we all want to see cleaner rivers, often the solutions to improving rivers require people to change their existing practices both on farms and to prevent urban wastewater discharges into rivers. Just allocating money will not be the most effective solution," says Nicky.

"We need to think about whether a water tax is equitable as water use varies hugely across regions based on rainfall. For example a Christchurch resident uses an average of 146,700 litres of water per year, while the average for a New Zealander is 82,800. Someone living in Christchurch would pay nearly twice as much in a water tax as someone living elsewhere and would also pay more in rates because in a drier climate the council will use more water to irrigate their local parks. Is taxing drier regions such as Canterbury, Otago, Hawke's Bay and Marlborough more heavily through a water tax a fair way to fund river restoration nationwide?"

"We also have concerns that farmers and growers in many regions may face significant water tax costs in excess of $10,000 a year which will make it more difficult to fund the environmental improvements we all want to see to improve waterways."

Nicky says there are similar equity issues for farmers and growers.

"Some regions receive a significant amount of rainfall and farmers don't need to use irrigation. Central Otago receives less than half the rainfall of Auckland, so farmers and growers rely on irrigation to grow stonefruit, wine and for pastoral farming to provide feed for animals. Only 7% of farmers use irrigation nationwide – why are those farmers being targeted to pay a tax which 93% of farmers won't pay when there are many regions which have very poor waterways but little use of irrigation?"

Nicky says that a water tax on hydro-electric power generation would also add to power bills for households and businesses and this tax doesn't make sense at a time when the government wants to encourage the use of renewable energy to meet climate change targets.

"Currently a number of regions are suffering from very dry conditions and we need to be developing more water storage as climate change is predicted to bring more frequent droughts in the future," she adds.

"We disagree with the suggestion in the report that introducing a water tax will encourage greater investment in water storage. If you look at the most recently approved water storage project – the Waimea Dam – a price increase for the dam construction nearly resulted in it not being built. Introducing a new tax on water use will add to be long-term costs of this and similar projects and make them less viable and less likely to be built. We really need more investment in these projects to ensure we have enough water to supply our growing population and get through more frequent future droughts."

"We also have concerns that farmers and growers in many regions may face significant water tax costs in excess of $10,000 a year which will make it more difficult to fund the environmental improvements we all want to see to improve waterways," she says.

"The report discusses how a water tax will encourage more efficient water use. There are already a number of existing incentives that encourage efficient water use including electricity costs and regulatory nutrient limit rules which require farmers to only use water when needed. The biggest improvements in water use efficiency come from modernising irrigation systems. Farmers and irrigation schemes have already invested $1.7 billion to modernise their systems since 2011, resulting in significant improvements in water efficiency. Introducing a major new tax will reduce farmers ability to replace an older irrigation system with a more water efficient model."

IrrigationNZ has been advocating against the introduction of a water tax since the idea was proposed in 2017 and made two submissions to the Tax Working Group. Nicky says the organisation will continue to advocate for its members on this issue.

The matter has been raised at a meeting

A new water tax could increase the cost of filling a pool, and council rates bills to pay for public parks and swimming pools.

with the Minister of Agriculture IrrigationNZ had planned in March and we will keep our members informed of our planned activities on this.

THE REPORT RECOMMENDATIONS

The group, "recommends greater use of tax instruments to address water pollution and water abstraction challenges if Māori rights and interests can be addressed."

The reports says that water abstraction taxes have a broader set of potential objectives than some of the other environmental tax opportunities. They include:

- rationing the total water take (i.e. pricing externalities)
- improving the efficiency of water use within allowable water takes (i.e. ensuring that water is allocated to its highest value use, including ecological and social uses)
- taxing natural resource use (i.e. capturing resource rents)
- funding the restoration of degraded water bodies.

The Working Group says the government has taken a regulatory approach to the first objective: minimum flows and maximum takes are set following processes outlined in the National Policy Statement for Freshwater Management. It says water tax instruments can play a complementary role by supporting the other three objectives.

The group acknowledges 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 says 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.

Power prices would be likely to rise as a result of a new water tax as hydro-electricity generation is the biggest consented water use in New Zealand.

THE GOVERNMENT'S RESPONSE

The government has said it expects to release their full response to the report in April 2019 after it has had discussion with officials and consultation between the political parties in power.

The Government has said it intends to pass legislation to implement any policy changes arising from the report before the end of their Parliamentary term. No policy measures would come into force until 1 April 2021 – allowing New Zealanders the opportunity to vote on any decisions made by the Government.

Labour and NZFirst agreed not to introduce any taxes or royalties on water in this political term as part of their Coalition Agreement.

Irrigation events and training

REGIONAL COUNCIL VERIFICATION TRAINING DAY, PALMERSTON NORTH

This Regional Council Verification Training Day has been designed for water metering and compliance staff and will run on Wednesday 10 April from 8.30am–4.30pm.

When the National Water Metering group met last August it was highlighted that there is a knowledge gap in the water verification space in many councils. This training day will give council staff a chance to refresh their knowledge or learn about verification.

It is also important for council staff to understand what is being asked of consent holders, the pros and cons of methodologies and to be able to audit service companies correctly.

The day will cover theory and include a site visit where the two most common methodologies will be undertaken – clamp on ultrasonic versus a flow rig.

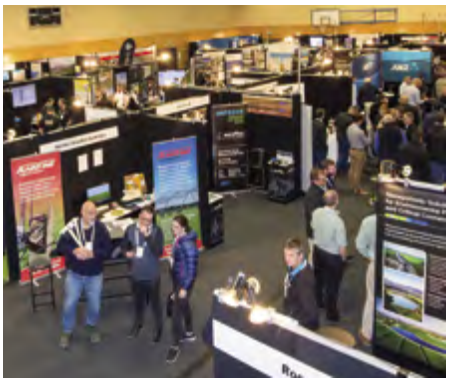
To attend: register online at www.irrigationnz.co.nz/events

SERVICE INDUSTRY VERIFICATION TRAINING, LINCOLN

This special two day training has been designed for service industry staff completing the verification training to obtain Blue Tick accreditation and will run on 8–9 May from 9am–4.30pm.

This workshop will cover theory on regulations, the RMA, verification methodologies and determining compliance. It will assist you to complete theory from the workbook. The trainer will be on hand to facilitate group discussion and assistance with questions.

To attend: register online at www.irrigationnz.co.nz/events



IF.2019 – IRRIGATION FUTURES, CHRISTCHURCH

IF.2019 is a two-day collective platform bringing together key leaders from across all sectors of the irrigation industry.

IF.2019 includes an exhibition of innovative international and local irrigation technology and a series of professional development and leadership workshops. It runs from 26-27 June. For more detail see page 24 in this magazine.

IrrigationNZ Achievements in 2018

MEMBERSHIP

3500 members.

Quarterly forums

hosted for irrigation schemes, user groups and industry. Forums help us understand and act upon our members' concerns and needs.

KNOWLEDGE

Added a new guide on Fertigation. This adds to our suite of 30 knowledge resources produced to support our members.

Together with New Zealand Young Farmers we hosted 40 Canterbury teachers for a day tour which includes stops at the CPW storage pond and an irrigated farm which produces high value crops. Teachers got to hear about the importance of irrigation as well as career opportunities in agriculture and the irrigation industry.

ADVOCACY

We have had a busy year working on behalf of our members. Our 2018 Conference drew nearly 500 attendees and received some great media coverage.

We met with Ministers David Parker and Damien O'Connor and a number of MPs from other political parties. IrrigationNZ was active developing a new Good Farming Practice guide and in developing options for the Land and Water Forum, a number of which have been picked up in the government's new Essential Freshwater plan.

We achieved a major win for our members through our advocacy work on Plan Change 5 in Canterbury which has saved irrigators $220 million.

We have advocated for members and prepared submissions on a range of issues including taxation, electricity, infrastructure, regional fees and charges, environmental legislation and regulations, climate change policy, and the Ngaruroro Water Conservation Order.

Working with irrigation schemes, we developed an award winning display on irrigation which was used at the Ashburton and Canterbury A&P shows.

TRAINING

719 people
attended 43 training courses
held around New Zealand.

35 workshops
were held to upskill **620**
farmers, farm managers and staff about irrigation, good management practice, and risk advice.

8 workshops
were held to upskill
99 industry professionals.

Establishing a Profession
We hosted a third intake of Irrigation Design Qualification students and we have been developing an Irrigation Engineering Apprenticeship.

"The design course is helping to create an industry standard. We're part of a process that will upskill people and set a higher standard for our industry."

– Feedback from 2016 Design Qualification student

PROJECTS

IrrigationNZ led a tour to Nebraska in September to generate new ideas on how to improve environmental performance and to see new technology and practices like fertigation.

We have developed a new online training system which will allow members to improve their irrigation knowledge without leaving the farm.

We also tested irrigation systems in Selwyn and shared the results with farmers and partner organisations in order to improve irrigation efficiency.

We have also been working on joint projects to improve fish screen design, and to communicate what changes are happening on farms to improve water quality in Selwyn, Ashburton and Waitaki.

LOOKING AHEAD

Looking to the future IrrigationNZ plans to:

- Continue to upskill and train irrigators to use water efficiently and develop training options for the irrigation service sector.
- Continue to support irrigation developments that grow the wellbeing of provincial New Zealand communities and improve the health of our rivers.
- Encourage and support new technologies and intiatives that improve the environmental performance of irrigated agriculture.
- Increase awareness of the role irrigation plays in food production and food security, and how it contributes to wellbeing in provincial communities.
- Support Māori to realise the potential of their land through irrigation development.

How we are dealing with agricultural drought in the UK

By Melvyn Kay, Executive Secretary, UK Irrigation Association.

The UK has just experienced its worst agricultural drought in the past 40 years and as we go into 2019 we still have continuing below average rainfall which is raising fears of a dry spring and major problems ahead for both rainfed and irrigated crops.

The UK has a (undeserved!) reputation for having a rather damp and grey climate but we are experiencing periods of drought that are seriously impacting agriculture. The UK is generally wetter in the west and drier in the east, where most of our fresh fruit and vegetables are grown. However, generally low rainfall, good warm growing conditions, combined with light loamy soils mean that supplementary irrigation is now an essential input on some 150,000 hectares for producing high quality crops for what is perhaps one of the most sophisticated food markets in the world – quality and timeliness are everything.

Droughts are not new in the UK – they are one of the many risks that farmers face. The drought in summer 2018 was particularly severe for agriculture, though not for our public water supply which has extensive reservoir capacity. Rainfed crops were hit hard and even irrigated cropping suffered because the drought meant low river flows and groundwater and farmers faced restrictions on direct abstraction for irrigation. Those with on-farm storage fared better as they had filled their reservoirs during the previous (wetter) winter months. But many were in danger of running out of water because of the excessively high summer demand and the need to irrigate right up to the end of the cropping season to lift root crops from the soil. The worry was about what happens next.

On-farm storage is the 'no-brain' solution to drought providing you can fill the reservoirs. Storage paid well this time, but it does not look good for the coming 2019 season. Continuing below average rainfall during the winter and forecasts of poor rainfall through to March and maybe beyond are causing serious worries among farmers. Over the eight months from May to December 2018, the cumulative rainfall in the south east is the lowest on record since 1910. Some farmers have managed to fill their reservoirs, but many are reporting these are only 25% full. Groundwater is not recharging and river flows, normally good at this time of year, already have abstraction restrictions in place.

In the short-term the Environment Agency, which is the guardian of our national water resources, is responding with a range of flexible abstraction conditions. These include extending the 'winter' abstraction season for filling reservoirs, arranging short term trades and temporary licence changes provided they are environmentally sustainable. Questions about 'borrowing' groundwater from next season's allocation where levels are good, is also under consideration. There is a good relationship building between Water Abstractor Groups (WAGs) and the Agency which means there are early discussions about water shortages. In some places voluntary restrictions on abstraction are put in place to avoid shortages later in the season. The Water for Food Group (WfFG) formed a few years ago and which brings together many abstractor interests has also significantly improved collaboration.

The 2011–2012 drought almost took the UK into unknown territory. Two years of summer and winter droughts and the possibility of a third dry winter threatened water supplies for the Olympic Games in London, not to mention public water supplies across the country. Most farmers were generally left to fend for themselves as irrigation is a commercial decision and not one for government policy. The Environment Agency set up a drought task force and developed a drought plan for the England. Its main focus is public water supplies but gradually we are beginning to differentiate drought into agricultural, environmental, and water supply drought. This is a major step change. Particularly for agriculture, as for most of the public drought just means dry river beds, stand-pipes in the street, and press sensationalism (which I well recall back in 1976!)

This drought also stimulated a major £10 million investment in research into drought forecasting and risk management. The impacts of this are now slowly coming on-stream as researchers try to interpret their science in a format that is useful and practical for farmers. Not an easy job, but one useful outcome is the D-Risk tool from Cranfield University which enables farmers to input basic farm management data, cropping, and water licence information and allows them go through a series of 'what ifs' to assess the risks to their businesses (www.d-risk.eu).

In the medium and long-term, the 'no-brainer' is more on-farm storage. Farmers are realising that storage for one year may no longer be enough and two years are needed to ensure continuity of supply. But constructing reservoirs is costly and farmers are reluctant to invest in an uncertain economic climate and the uncertainties of short-term thinking about abstraction licences. Local planning authorities do not help and obligatory archeological and environmental investigations can add considerably to the cost.

If you want to read more on drought then please go to our 'Resources' at our UK Irrigation Association website – www.ukia.org.
It includes information about our new Irrigators' Handbook which has just been published. This is a paper copy at the moment but we plan to create a pdf later this year.

Canterbury farmers trial nitrogen reduction options

As part of a new project, dairy farmers in Selwyn and Hinds will be trialling options to reduce nitrogen losses and sharing what works with other farmers nationwide.

Farmers operating in these two areas have the most challenging nitrogen loss targets to meet in New Zealand. Under regional rules, Selwyn farmers must reduce N losses by 30 percent by 2022 and in Hinds by 15 percent by 2025, 25 percent by 2030 and 36 percent by 2035.

Virginia Serra.

The DairyNZ project – called Meeting a Sustainable Future – was launched in December and will run over five years.

Thirty farmers are being invited to join the project in its first year and another twenty farmers can join in next year.

"As part of the project we will be working with farmers to look at how the whole farm operates, and from that identifying what options would be practical and most suitable for farmers to trial," says Project Lead Virginia Serra.

"We want to include changes to irrigation and effluent management, changing what crops are planted, how feed is used on farms and the different strategies around fertiliser use to see what impact this has and come up with a range of options farmers can use. Farms will trial different changes that best fit their operation."

As well as monitoring the environmental impact of changes, the project will also monitor the economic impacts of changes on production and profitability, and also record farmers' views on how practical making changes were on the farm.

Participating farmers will also be invited to take part in discussion groups to talk with other farmers about what's working and what's not working on their farms.

"This work is a great way for Selwyn and Hinds dairy farmers, along with others nationally, to watch and learn about the best options to reduce nitrogen losses and meet the future goals," says Canterbury Dairy Leaders Group Chairman Alister Body. "It will be very interesting to follow."

The project has a limited number of places still available to join the project in 2019, and places also available to join next year. To find out more and become involved, contact Virginia Serra on 021 932 515 or email virginia.serra@dairynz.co.nz

We can have both healthy rivers and healthy food

By Horticulture New Zealand Chief Executive Mike Chapman.

In February, Nelson's fires and dry conditions for farmers and growers highlighted the need for water storage; for plants, animals and people. With the Waimea River at dangerously low levels, fruit and vegetable growers run the risk of having no water. Unlike animals, trees and vines cannot be moved. If food producing plants die, it can take many years for a grower to get back into production. It is imperative there is sufficient water to keep plants growing and producing high quality, healthy food.

Moving up the country to Hawke's Bay, we have the Water Conservation Order (WCO) in the Lower Ngaruroro River and the Clive River. Horticulture New Zealand opposes the application for the WCO and has submitted evidence from nine experts to support its own evidence. Other primary industry groups and individual growers have also opposed the WCO. HortNZ's proposition is that we can have healthy rivers and healthy food, if all stakeholders work together to make a mutually acceptable plan. The problem here, which is replicated in many parts of New Zealand, is that there is not enough water for everyone and those who oppose water for animals and plants object on the basis that this will cause intensive farming. Many of the opponents believe that excess water, according to NIWA that is 80% of the rainfall, should for the good of New Zealand flow out to sea. More preference is given to jet boating, than to the ability for us to grow the food needed to feed New Zealand.

The rhetoric has become divisive and focused on single interests. Confrontation and adversarial processes are being relied on. Advocates for sensible water storage for the benefit of all interested parties are seen as not having regard for the environment. The irony is, water storage can enable the environment to be protected, river flows to be maintained, and for healthy food to be grown. Unless there is a marked change in attitudes, we will as a country be in crisis.

The time for change is now, and it requires urban and rural New Zealand to unite to make good use of the 80% of our rainfall that we do not use.

For example, on 29 January 2019 it was a hot day all around New Zealand. On that one day, Auckland used 524 million litres of water. That 524 million litres is equivalent to the amount of water 10,500 hectares of horticultural land would have used for one day of irrigation. There are just 120,000 hectares of land growing fruit and vegetables in New Zealand and not all of that land is irrigated. Land is only irrigated when water is needed. Whereas, urban supply is consumed on a daily basis. As our population grows, we will need much more water for urban New Zealand. So both urban and rural New Zealand have a common interest in making sure we undertake water storage for people and plants to live. In addition, to meet climate change challenges and progressively longer dry periods in our key food growing areas, adequate water storage will become an absolute must. Nelson and the entire east coast of New Zealand are prime examples of that.

In 2011, the global population surpassed 7 billion, and the United Nations (UN) predicts it will reach 9 billion by 2045. According to the UN Economist Intelligence Unit, our food system faces the pressure of producing about 70% more food for the growing population. Water and suitable land are needed to grow that food. This means that we are going to have to expand food production in New Zealand, not only to feed New Zealand, but also to help feed the world's growing population.

In late January 2019, there was a news item about the impact of Brexit on Britain published in the online journal BMJ Open. It stated that international researchers warn that there could be a further 12,400 cardiovascular deaths over the next decade in England, due to the UK's dependence on imported fruit and vegetables and the shortages of healthy food that are likely to occur post-Brexit. This is a warning for New Zealand. We need to ensure that we can feed our own population first, because the ability to import healthy food will be reduced in the future due to worldwide demand. The UK is heavily dependent on fruit and vegetable imports – 84% and 48%, respectively in 2017 – and costs for these are set to rise significantly after Brexit, the researchers said.

How we have operated in the past will not feed New Zealand and the world in the future. We need to radically change our thinking, and particularly our regional and central government planning, to provide water for people and plants, so that we can all survive.

Smart solutions for smarter farming

At WSP Opus, we help Kiwi farmers to make more informed decisions about their land and water management.

Our team of experienced resource management planners, environmental scientists, and engineers will help you cut through the environmental red tape so you can you can keep producing food efficiently within your local environment.

We work alongside you to develop robust farm infrastructure plans, resource consents and environmental management systems.

Our other services in the primary industries include irrigation scheme and farm dairy effluent system design, pond construction supervision and professional certification, the WSP Pond Drop Test, and wetland design and construction.

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What's the future of Overseer?

A recent report by the Parliamentary Commissioner for the Environment has raised questions about how Overseer is currently used as a regulatory tool, and suggested some significant changes to make Overseer more transparent and accurate.

"Almost any Kiwi involved with farming or nutrient management will have heard of the Overseer model. It was and is intended to be New Zealand's main computer tool developed to support farmers' efforts to minimise nutrient losses. Over a dozen years, use has shifted beyond this intention and the model is now required by many regional councils setting limits on nitrogen losses from farming to maintain water quality," says Professor Troy Baisden, Chair in Lake and Freshwater Science, University of Waikato.

"Overseer's path from helpful calculator to regulatory tool has been bumpy for both councils and farmers, and that is the issue the Parliamentary Commissioner for the Environment has investigated," he adds.

In a detailed 136-page report, the Commissioner has highlighted the limitations of Overseer as well as where it can be useful.

WHAT OVERSEER CAN DO

According to the report Overseer can be used to:

- estimate farm (and block) nitrogen losses from the root zone and phosphorus losses to second-order streams
- estimate whole farm greenhouse gas emissions
- model seven nutrients (nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, and sodium) and greenhouse gases (carbon dioxide, nitrous oxide, methane)
- estimate maintenance fertiliser requirements
- model most common farming practices and mitigations to reduce an environmental footprint (like lowering stock numbers, decreasing fertiliser application, irrigation management, types of feed and supplements)
- model proposed changes in the farm system (e.g. introduction of mitigations), and estimate nutrient losses and greenhouse gas emissions as a result of those changes
- model some instances of 'bad farming practice' (e.g. over-stocking, overfertilising, over-irrigating and winter applications of nitrogen fertiliser)
- model seven land uses or block types, with varying degrees of uncertainty.

WHAT OVERSEER CAN'T DO:

The report states that Overseer can't reliably:

- accurately model situations when farm management is changing – for example, when a land use has intensified
- check if the inputs result in a farming operation that is realistic or not
- capture any variation in nutrient losses within a block or capture short term patterns of nutrient losses
- help make any day-to-day management decisions (like when to irrigate)
- capture any losses associated with an incident (for example an effluent spill-over)
- model uneven fertiliser applications or applications too close to a stream
- model some novel farming practices and mitigations to reduce environmental footprint, such as urease inhibitors, pastures with plantain and chicory, use of dietary salt, and a full range of crops
- produce accurate estimates outside calibration ranges
- provide the uncertainty associated with an estimate of nutrient loss or greenhouse gas emissions
- model sediment and pathogens (e.g. E.coli)
- model phosphorus lost with mass movement of sediment (i.e. slips and landslides) from large storms
- identify critical source areas on a farm (such as stock camps on hill slopes) – unless these are modelled as separate blocks
- model impacts of the spatial layout of blocks or spatial relationships between blocks
- provide information on what happens to nitrogen beyond the root zone or phosphorus beyond a second-order stream.

KEY ISSUES WITH OVERSEER

From interviews with council staff, farm advisors and experts, the report identified four key application issues associated with Overseer:

- data input uncertainty
- version change
- the inability of Overseer to represent farm systems in particular regions
- uncertainty in a compliance setting.

Mistakes can be made when entering data into Overseer. They can also be made due to poor record keeping or incorrect estimates of inputs like fertiliser or supplementary feed. 'Work-around' solutions to input information on scenarios Overseer can't model can also result in inaccurate estimates – for example some types of crops are not modelled in Overseer, nor is double sowing of crops.

Version change was also highlighted by council staff and farm consultants as a major problem. For example, farmers in the Manawatū-Whanganui region faced issues with Overseer version changes in 2012. Under Version 5.4 of Overseer, the council considered about 80 percent of farmers in the region could comply with nitrogen loss limits in the regional plan. Under Overseer Version 6, the council estimated that only around 20 percent of farms would comply, and most farmers would require a tougher resource consent to continue farming. Horizons Regional Council is still working through issues this version change caused for its regional plan.

The report also notes that Overseer modelling is less reliable for some regions and farm models than others. The locations used for the 2012 Overseer calibration of nitrogen losses from pastoral blocks were primarily from the

Overseer models are better able to reflect nitrogen losses on dairy farms than arable or horticultural properties.

Waikato and Southland regions. The sites covered a limited range of soil types receiving between 600 and 1200 millimetres of rain, and a limited range of management practices. So nitrogen loss estimates for farms with high rainfall and those on shallow, free-draining soils (common in many parts of Canterbury) will have higher uncertainty. Higher uncertainty levels will also apply to cropping systems, as most sites used for calibration were dairy farms.

Environment Canterbury has expressed concern about the lower level of confidence in Overseer's ability to model arable and horticultural systems.

An inadequate range of calibration studies means Overseer estimates in regions such as Marlborough, Tasman, West Coast, Gisborne, Taranaki and Northland are less reliable. Regions such as Northland, Taranaki, Gisborne and the West Coast have no or limited S-map coverage, and therefore the more generic 'Fundamental Soil Layer' option must be selected within Overseer.

Council staff also raised concerns that given the uncertainties of Overseer's estimates, Overseer results could not be used for enforcement purposes, ranging from abatement notices to prosecutions.

REPORT RECOMMENDATIONS ON OVERSEER

The report sees the best way to address Overseer's shortcomings in transparency is through peer review, corroboration, uncertainty and sensitivity analysis. This will provide confidence to regulators and farmers that uncertainties associated with the model are within acceptable bounds. Overseer assumes that good management practices are occurring on all farms. To have confidence in a regulatory framework using Overseer based nitrogen-loss limits, regional councils must be satisfied that these practices are occurring on all farms. The storage and application of effluent on farms, and irrigation practices are two areas where the report identifies that farms may not be compliant.

Some of the key recommendations made by Parliamentary Commissioner for the Environment in the report are that:

- the government should decide if it wants to continue to use Overseer – and if it does then it should identify how it will improve Overseer
- best practice guidance for the development, evaluation, and application of environmental models in regulation should be developed
- Overseer owners and Overseer Limited should ensure that a comprehensive and well-resourced evaluation of Overseer is undertaken. Information on the data used to calibrate and test Overseer should be made available, along with the source code and calculations
- Overseer should become an open-source model but ownership and funding arrangements should be reviewed to enable Overseer to become the 'official' model to estimate nutrient pollution for water where appropriate
- funding arrangements should be reviewed to provide Overseer with funding stability long term
- the Ministry for the Environment should prepare guidance for councils on how to design plan provisions using Overseer as part of a framework with nitrogen loss limits
- a working group of council and Overseer representatives should review where regionally specific research is needed to inform Overseer modelling.

VIEWS ON THE REPORT

"Overseer was never designed to estimate limits and enforce compliance. Its original design was a nutrient budgeting tool for farmers. Overseer would not likely withstand legal challenge," says Dr Julie Everett-Hincks, Legal and Scientific Researcher, University of Otago.

"On the upside, Overseer is well used and reflects some of our farming systems well. That would be perfect if Overseer was still mainly a calculator to improve farm nutrient management. But, when used to enforce regulation, Overseer lacks the openness and transparency needed for scientists to review model results or develop improvements," says Professor Troy Baisden, BOPRC Chair in Lake and Freshwater Science, University of Waikato.

"The report concludes that Overseer has achieved a safe monopoly on regulatory use. Essentially, Overseer is the best model we have, because it is the only model we have. As a result, there are reasons to recommend the Government address issues of openness, enabling the science community to do more to check and improve Overseer."

"Catchment water quality is driven by action at the farm scale. Overseer is 'good enough' to model most complex farm systems and estimate nitrogen and phosphorus loss in response to farm practices. While parts of the model can be improved there's a risk that focusing on uncertainty delays action on farms," says Professor Richard McDowell, Chief scientist, Our Land and Water National Science Challenge.

"My opinion is that the best use of Overseer is to connect it to farm environment plans, and I would like to have seen this included as a recommendation. Farm environment plans should fall under the same national guidance recommended by the Commissioner for Overseer, to ensure plans are effective. Currently there is potential for significant variation in quality between 16 regional councils."

"Beyond this, Overseer needs to evolve so it is able to map and target critical source areas of nutrient loss within a farm (spatial variation) and measure the impact of day-to-day decisions on the farm (temporal variation). The next step would see Overseer and other models used to help farmers and growers identify the most suitable land uses for areas most prone to nutrient loss," says Professor McDowell.

In its 2018 budget, the government allocated $5 million to improve Overseer over the next four years. That funding was designated to develop modelling for a wider range of land types and farming systems in Overseer and provide the system with a more user-friendly interface.

HOW IS OVERSEER USED NOW?

The use of Overseer varies by regional council, as shown below. Some councils also use Overseer to set nitrogen loss limits at the catchment level.

Use of Overseer by regional councils and unitary authorities	No regulatory use of Overseer	Regulatory – permitted activity standard	Regulatory – nitrogen loss limits
Auckland Council		●	
Bay of Plenty Regional Council			●
Environment Canterbury			●
Environment Southland		●	
Gisborne District Council		●	
Greater Wellington Regional Council	●		
Hawke's Bay Regional Council			●
Horizons Regional Council			●
Marlborough District Council	●		
Nelson City Council	●		
Northland Regional Council	●		
Otago Regional Council			●
Taranaki Regional Council	●		
Tasman District Council	●		
Waikato Regional Council			●
West Coast Regional Council	●		

What is climate-ready infrastructure? Some cities are starting to adapt

By Mikhail Chester, Braden Allenby, and Samuel Markolf.

The most recent international report on climate change paints a picture of disruption to society unless there are drastic and rapid cuts in greenhouse gas emissions.

Although it's early days, some cities and municipalities are starting to recognise that past conditions can no longer serve as reasonable proxies for the future.

This is particularly true for the country's infrastructure. Highways, water treatment facilities and the power grid are at increasing risk to extreme weather events and other effects of a changing climate.

The problem is that most infrastructure projects, including the Trump administration's, typically ignore the risks of climate change.

In our work researching sustainability and infrastructure, we encourage and are starting to shift toward designing man-made infrastructure systems with adaptability in mind.

DESIGNING FOR THE PAST

Infrastructure systems are the front line of defence against flooding, heat, wildfires, hurricanes and other disasters. City planners and citizens often assume that what is built today will continue to function in the face of these hazards, allowing services to continue and to protect us as they have done so in the past. But these systems are designed based on histories of extreme events.

Pumps, for example, are sized based on historical precipitation events. Transmission lines are designed within limits of how much power they can move while maintaining safe operating conditions relative to air temperatures. Bridges are designed to be able to withstand certain flow rates in the rivers they cross. Infrastructure and the environment are intimately connected.

Now, however, the U.S. is more frequently exceeding these historical conditions and is expected to see more frequent and intense extreme weather events. Said another way, because of climate change, natural systems are now changing faster than infrastructure.

How can infrastructure systems adapt? First let's consider the reasons infrastructure systems fail at extremes:

- The hazard exceeds design tolerances. This was the case in Interstate 10 flooding in Phoenix in fall 2014, where the intensity of the rainfall exceeded design conditions.
- During these times there is less extra capacity across the system: When something goes wrong there are fewer options for managing the stressor, such as rerouting flows, whether it's water, electricity or even traffic.
- We often demand the most from our infrastructure during extreme events, pushing systems at a time when there is little extra capacity.

Record flooding of the Danube River inundates the town of Nagymaros in Hungary in 2013.

Gradual change also presents serious problems, partly because there is no distinguishing event that spurs a call to action. This type of situation can be especially troublesome in the context of maintenance backlogs and budget shortfalls which currently plague many infrastructure systems. Will cities and towns be lulled into complacency only to find that their long-lifetime infrastructure are no longer operating like they should?

Currently the default seems to be securing funding to build more of what we've had for the past century. But infrastructure managers should take a step back and ask what our infrastructure systems need to do for us into the future.

AGILE AND FLEXIBLE BY DESIGN

Fundamentally new approaches are needed to meet the challenges not only of a changing climate, but also of disruptive technologies.

These include increasing integration of information and communication technologies, which raises the risk of cyberattacks. Other emerging technologies include autonomous vehicles and drones as well as intermittent renewable energy and battery storage in the place of conventional power systems. Also, digitally connected technologies fundamentally alter individuals' cognition of the world around us – consider how our mobile devices can now reroute us in ways that we don't fully understand based on our own travel behaviour and traffic across a region.

Yet our current infrastructure design paradigms emphasize large centralised systems intended to last for decades and that can withstand environmental hazards to a preselected level of risk. The problem is that the level of risk is now uncertain because the climate is changing, sometimes in ways that are not very well-understood. As such, extreme events forecasts may be a little or a lot worse.

Given this uncertainty, agility and flexibility should be central to our infrastructure design. In our research, we've seen how a number of cities have adopted principles to advance these goals already, and the benefits they provide.

In Kuala Lumpur, traffic tunnels are able to transition to stormwater management during intense precipitation events, an example of multifunctionality.

Across the U.S., citizen-based smartphone

technologies are beginning to provide real-time insights. For instance, the Crowd Hydrology project uses flooding data submitted by citizens that the limited conventional sensors cannot collect.

Infrastructure designers and managers in a number of U.S. locations, including New York, Portland, Miami and Southeast Florida, and Chicago, are now required to plan for this uncertain future – a process called road-mapping. For example, Miami has developed a US$500 million plan to upgrade infrastructure, including installing new pumping capacity and raising roads to protect at-risk oceanfront property.

These competencies align with resilience-based thinking and move the country away from our default approaches of simply building bigger, stronger or more redundant.

PLANNING FOR UNCERTAINTY

Because there is now more uncertainty with regard to hazards, resilience instead of risk should be central to infrastructure design and operation in the future. Resilience means systems can withstand extreme weather events and come back into operation quickly.

This means infrastructure planners cannot simply change their design parameter – for example, building to withstand a 1,000-year event instead of a 100-year event. Even if we could accurately predict what these new risk levels should be for the coming century, is it technically, financially or politically feasible to build these more robust systems?

This is why resilience-based approaches are needed that emphasize the capacity to adapt. Conventional approaches emphasize robustness, such as building a levee that is able to withstand a certain amount of sea level rise. These approaches are necessary but given the uncertainty in risk we need other strategies in our arsenal.

For example, providing infrastructure services through alternative means when our primary infrastructure fail, such as deploying microgrids ahead of hurricanes. Or, planners can design infrastructure systems such that when they fail, the consequences to human life and the economy are minimised.

This is a practice recently implemented in the Netherlands, where the Rhine delta rivers are allowed to flood but people are not allowed to live in the flood plain and farmers are compensated when their crops are lost.

Uncertainty is the new normal, and reliability hinges on positioning infrastructure to operate in and adapt to this uncertainty. If the country continues to commit to building last century's infrastructure, we can continue to expect failures of these critical systems and the losses that come along with them.

Mikhail Chester, Associate Professor of Civil, Environmental, and Sustainable Engineering, Arizona State University.

Braden Allenby, President's Professor and Lincoln Professor of Engineering and Ethics, School of Sustainable Engineering and the Built Environment, Ira A. Fulton Schools of Engineering, Arizona State University.

Samuel Markolf, Postdoctoral Research Associate, Urban Resilience to Extremes Sustainability Research Network, Arizona State University.

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10/18

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Dairy farm insurance: farm owner's or sharemilker's responsibility?

By Alan Giles, Rural Business Development Manager, FMG.

Something we're often asked with regards to the farm owner/sharemilker relationship is who's responsible for insuring what.

Traditionally, the insurance needs for owners, contractors and sharemilkers are the same: domestic contents, farm contents (especially milk), implements, farm vehicles, business interruption and liability. Farm owners have the added responsibility of insuring their farm buildings, irrigators, and employee housing.

Ultimately it comes down to what your contract says, but in most cases there are going to be a lot of shared risks, particularly in the liability and business interruption space.

Maintaining business continuity is one of the biggest things that keep farmers up at night. Unfortunately it's often around claims time when they realise there were gaps in their cover, because their contract wasn't reflected in their insurance policy.

A recent example I saw was with a share-milking client, whose worker had accidently hit a Pivot Irrigator. The farm owner had this insured with another provider and due to the difference in policy response; there was a significant difference in how the claim was settled. As it turns out there was also confusion between the farm owner and the sharemilker as to how this was to be insured. All the while, the business was out an irrigator leading up to peak season.

On the other hand, because different insurers have varying levels of cover within their policies, we see a lot of duplication and farmers being over-insured, or paying premiums for things they didn't necessarily need.

Working with the same insurer is one of the best ways of avoiding this, and we're seeing more and more clients refer their contract or sharemilkers to us for this reason, particularly ahead of Dairy Changeover.

Working with both parties, I can sit down with them, understand what they're both trying to achieve, understand their business, what gaps they might need to cover, and tailor a solution that suits them both.

It certainly makes a difference at claims time too. There is a lot less friction working with one person, (who already knows you), rather than dealing with multiple agents.

It's the same reason why being a direct insurer works so well. We have our own Claims, Assessors, Underwriters and Consultants under one roof, so when the unexpected happens, we're not scrambling with multiple third parties to get your claim sorted. Our service is delivered by a single team working together, who also understands rural and knows how important it is to get you back on your feet as quickly as possible.

Dairy Changeover advice – a few things we've learnt from June 1.

- Check your contract before heading to your new farm. Make sure it's clear what your insurance responsibilities are and that you have the right cover in place. If you're unsure, or just want a second opinion, give us a call on 0800 366 466.
- Do a farm stocktake. We see a peak in farm theft claims around June 1. The most commonly stolen farm items are quad bikes, tools and chainsaws.
- If you're planning to move stock via public roads, make sure you have the correct permits or consents from your local council. Don't leave it until last minute.
- When driving stock on public roads, place your TW6 signs within 1km in front and behind the mob, and consider having at least two pilot vehicles.
- Arrange meetings and training sessions with new staff to go over farm procedures and processes for both farm operations and health and safety.

We've got over 110 years' experience delivering personalised risk advice to help New Zealanders like you. Created by farmers, for farmers, we're proud to be the largest New Zealand owned and operated mutual insurer.

At FMG we look at risk a bit differently – we don't avoid it – we stare it in the face and help you manage it so you can get on with what you do best. We understand that risk is a part of life out here – always has been and always will be. We also know that you can't get ahead without it.

If you would like a one on one, personalised conversation about your on farm or contractual insurance risks, give us a call on 0800 366 466.

New fertigation trial examines changes in nutrient losses

A new project to trial the use of fertigation – which could help reduce nitrogen leaching on farms – is now underway.

Pāmu (formerly Landcorp) is working with IrrigationNZ and Ballance Agri-Nutrients on the trial which has received funding from the Sustainable Farming Fund.

Fertigation is the application of small quantities of fertiliser through an irrigation system. Fertigation is used overseas, but is uncommon in New Zealand.

In September 2018, IrrigationNZ organised a study tour of Nebraska which visited farms and research institutions. IrrigationNZ Technical Manager Steve Breneger was one of the tour participants.

"In Nebraska, fertigation use is encouraged by University academics and Natural Resource District officials who manage water as a tool to reduce nutrient leaching. The state had problems with high nitrate levels in ground-water but nitrate levels are now reducing in many areas," says Steve.

"Fertigation allows for small amounts of fertiliser to be applied at a time, allowing more uptake of nutrients by crops. The farmers we spoke to talked about how it helped save on labour and reduce wear and tear on equipment as tractors don't need to be used to apply fertiliser, and also that it worked out as a more cost effective way of applying fertiliser over the longer term," he adds.

Pāmu started using fertigation in November last year at a Waimakariri dairy farm, and plans to expand the number of farms fertigation is used on to seven farms in Canterbury and four farms in Taupo.

Pāmu Farm Innovation Specialist Roo Hall joined part of the tour to Nebraska and was able to talk with fertigation specialists and farmers about the setup and use of fertigation. He also attended a Fertigation Masterclass which IrrigationNZ held in 2018.

"The farmers I spoke with in Nebraska were concerned with the pressure on commodity prices. By using fertigation they were able to reduce their expenditure on fertiliser which was one of their biggest expenses. Some farmers who had adopted fertigation were using up to 30-50% less fertiliser than conventional bulk applied farmers and still getting similar yielding crops in all instances."

"Here in New Zealand we wanted to trial fertigation to see if we could reduce our nitrogen losses while still maintaining our productivity on farm."

Roo says that the process of installing fertigation equipment has been pretty straight-forward, due to some of the key components being already available on overseas and local markets.

"One of the lessons I learned from talking with attendees at the Fertigation Masterclass was that if you mix the fertiliser on site and it isn't mixed correctly it can be quite problematic. So we decided to keep it simple and use a liquid urea fertiliser from Ballance which doesn't require mixing on the farm."

The farm has installed a 30,000 litre tank on site and the fertiliser is delivered once a month. A smaller 4,200 litre tank has been mounted onto a trailer and sources fertiliser from the larger tank. The trailer is rotated around the farm by tractor and connects to the base of pivot irrigators to supply nutrients. The trailer spends a day at each location so fertigation is carried out on a weekly cycle to each paddock in conjunction with irrigation scheduling.

Pāmu expects to pay off the cost of the installation of their fertigation system after four years and from then onwards it expects to save money on its fertiliser costs.

One of the main differences between using fertigation and conventional nutrient application via ground spreading or aerial top dressing is that as it does not require any additional labour to apply the fertiliser and it allows for small quantities of fertiliser to be applied at a time.

To date, on the first farm Pāmu has started using fertigation on they have reduced their overall fertiliser use by 20% over the summer.

As part of the trial, a Master's student who

Fertigation systems being installed on a Pāmu farm near Oxford.

is supervised by Lincoln University will be engaged to carry out research on how using fertigation has affected the nitrogen losses on Pāmu farms. Data will be collected over two irrigation seasons.

Nitrogen leaching losses haven't been calculated yet – but they could be higher than 20% as research undertaken to date in other countries has indicated that crops are better able to use nitrogen when its applied in smaller quantities, resulting in less nitrogen leaching.

Roo says that the quality of the pasture and fodder beet crop which is receiving fertigation actually looks better visually than it did before, with tissue sampling backing these observations.

"Not having contractors spreading fertiliser over the summer has meant that there is less compaction to the soil, less diesel being used and less health and safety issues to monitor on the farm," he adds.

The farm has been using fertigation since November and will use it until the end of March. It will use ground spreading to apply fertiliser in the spring and autumn time.

The trial will also look at the costs and benefits of using fertigation, as well as the practicalities of using it on the trial farms.

IrrigationNZ also released a guide to the use of fertigation in New Zealand for its members in December. The guide can be accessed online at www.irrigationnz.co.nz (search for 'fertigation').

"Fertigation is a precise science," says Steve Breneger. "The correct type of fertiliser must be used, the irrigation system must be capable of delivering fertiliser and compatible with the type of fertiliser and the mixing technique must also be correct. There are some pitfalls that can occur and the guide explains how these can avoided."

A Fertigation Masterclass was delivered by IrrigationNZ in 2018. IrrigationNZ is planning to host future fertigation workshops to upskill farmers and the irrigation sector.

We will keep irrigators up to date on the results of the field trial as they are released in the future.

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Insight documentary looks at irrigation in New Zealand

A recent RadioNZ Insight documentary looked at the future of irrigation in New Zealand, and how the government's decision to pull support for large irrigation projects would affect the country.

IrrigationNZ assisted RadioNZ to arrange a number of interviews for the documentary.

RadioNZ spoke to Sheffield farmer Stu Wright, an arable farmer who had recently joined Central Plains Water, about why he had installed irrigation.

"Central Plains was probably the last option to get water on the Canterbury Plains," Stu told RadioNZ.

"We had a family discussion, we decided we had been here for over a hundred years, and if we wanted to be here for well over another hundred years, then we needed water."

The farm has been in the family for 125 years and grows seed wheat, barley, potatoes, rye and has recently added a new garlic crop.

He explained that many companies require irrigation to be installed before they would sign a contract with farmers.

The documentary also spoke with Central Hawke's Bay farmer Hugh Ritchie about the challenges facing farmers in the region.

Hugh is one of the New Zealand farmers who produce 75% of the world's seed carrot crop.

With a court ruling stopping the Ruataniwha Dam from proceeding, and new rules requiring higher flows in the Tukituki River, farmers are facing uncertainty about their future access to water.

"Lifting of the river flows means there is the potential for significant water bans for six out of ten years. But there is no forecast as to which of the six years are on ban and which are not," Central Hawke's Bay Mayor Alex Walker told RadioNZ.

Central Hawke's Bay Mayor Alex Walker (left) and Dr Terry Heiler (right).

She said this makes it difficult for people to decide which crops to plant each year.

Dr Terry Heiler – the former Chief Executive of IrrigationNZ who is an engineer with over 50 years experience working on irrigation projects within New Zealand and internationally – told RadioNZ that New Zealand was water rich in comparison with most countries worldwide.

He told the programme that the government's decision not to fund small irrigation schemes was political and not logical.

Mike Chapman from HorticultureNZ said that climate change would increase demand for water, and more water storage was needed to feed a growing population.

While funding for big irrigation schemes had been declined, the government was allocating funding for smaller schemes via the Provincial Growth Fund.

RadioNZ reported that about 20 people or organisations have so far applied for Provincial Growth Fund funding.

Shane Jones told the documentary that some provincial growth funding might be available to support small to medium irrigation schemes to make land productive, and would be primarily, but not exclusively for Māori land.

Annabeth Cohen from Forest and Bird said that New Zealand needed to reframe how it was farming and change to more sustainable farming systems in the face of climate change.

Listen: The documentary aired in February and you can listen to it online at www.radionz.co.nz/national/programmes/insight

New rules requiring higher flows for the Tukituki River are creating challenges for Hawke's Bay farmers and growers.

IRRIGATION NEW ZEALAND

IF.2019

IRRIGATION FUTURES

26 & 27 JUNE 2019, CHRISTCHURCH

IF.2019 – Irrigation Futures is a two-day event bringing together key leaders from all sectors of the irrigation industry. The importance of irrigation will grow as climate change will create more challenging growing conditions. The adoption of new practices will continue to create better environmental outcomes. **IF.2019** will feature:

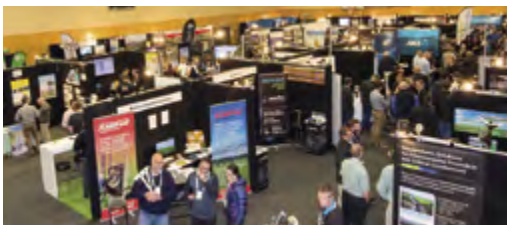
- professional development and thought leadership workshops sharing the latest research, technology and best practice with you so that you can take this knowledge back to your customer and deliver excellent, well informed advice
- a trade show showcasing international and local irrigation technology. This is a great opportunity to see how technology can improve irrigation efficiency to save money and meet increasingly tough environmental requirements
- **IF.2019** is a chance to experience something new – to discover new approaches to challenges we face now and in the future and view new technology which will help build a more resilient future.

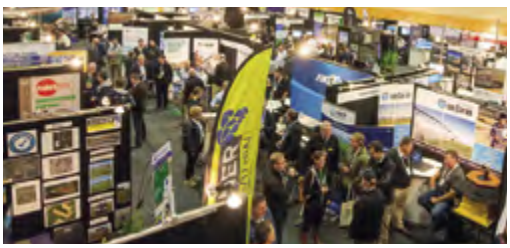
IrrigationNZ's biggest ever trade show!

Hosted at the Air Force Museum of New Zealand in Wigram, Christchurch, the IrrigationNZ trade show will run on both days of **IF.2019** – 26 and 27 June.

Whether you're a farmer, a rural professional, work in the irrigation industry, represent or are a member of an irrigation scheme this is a great opportunity to come along and view the latest irrigation technology. The trade show will feature both New Zealand and international exhibitors.

For more information on the event head to www.irrigationnz.co.nz





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  Half of Canterbury's irrigation systems will need replacement in the next decade. This workshop will cover redesigning irrigation systems to become more energy efficient – focusing on pumps and associated components. It will also look at assessing energy lifecycle costs to provide the best value options for clients. *Note: A prerequesite to attend is prior completion of an advanced pumping and hydraulics workshop.*

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  - Training staff on potential dangers of working with AC pipes
  - How to handle and dispose of non-friable asbestos
  - Investment in safe workplace environment and practices.

Workshop places are limited, so we recommend booking early to avoid missing out. Workshops are individually priced so you can choose to attend whichever events suit your interests.

IF.2019

IRRIGATION FUTURES

26 & 27 JUNE 2019, CHRISTCHURCH

IF.2019 and FAR'S Annual Conference – two great reasons to visit Christchurch!

Even if you're far afield, it's worthwhile planning to be in Christchurch from 26-28 June. Not only can you attend **IF.2019** but FAR's Annual Conference on 27–28 June will feature presentations focusing on soil, water and nutrients, crop protection and innovation and technology, along with field visits and a conference dinner.

Organiser Anna Heslop says the conference theme 'Research Leading Change' reflects the importance of research on decision making in the primary industries. "Whether the problem is around economics, productivity or compliance, research is essential to pinpoint what is causing a problem, and help inform decision making around solutions."

The international speaker at the event is Professor Fiona Burnett, who leads the Crop and Soil Systems Group at Scotland's Rural College, and chairs the UK Fungicide Resistance Action Group. She will give a keynote address in the crop protection session.

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Reconnecting the rural-urban divide through communication

Connecting people with different lifestyles is vital for breaking down the rural-urban divide, according to Eyrewell farmer Michelle Maginness.

"That's the only way to bring people closer together. We need to reach out and understand people who are living different lives and may not have ever been on a farm before which is a real possibility these days."

"We've got this disconnect between what's being reported in the papers about "dirty dairying" which is a tiny minority of farmers and what's actually happening on farm."

"Farmers care about their animals and land because they're their greatest assets but we haven't been good at communicating that and I think we need to show the public through our actions what we're doing to improve the environment."

Eyrewell dairy farmer Michelle Maginness is passionate about bringing rural and urban residents closer together through understanding and communication.

"Be proactive and talk to people in your community when you hear complaints about farmers and let them know what you're doing on your farm and invite them to visit. Let's show people what we're really about which is caring about animals and the land."

Michelle's passionate about Lake Ernmor; a 220-hectare dairy farm which is her fourth farm since starting out as a sharemilker after graduating from Lincoln University. She says people are often surprised to learn that she runs the farm and manages the milking of 740 cows, not her husband. However, the situation has improved since her younger years when she was regularly asked to direct visitors to the farm owner.

"I used to get really annoyed about it. People would ask to speak to the boss, not imagining that it could be me. These days I make a joke out of it and point them to the nearest man, who is often one of my staff. The look on their faces when they come back to talk to me is priceless."

"We still get some older farmers stopping for a chat on the road and asking my husband, who's a printer by trade, about the cows. He'll say, "I have no idea, you'll have to ask Michelle", which sometimes creates an awkward pause."

"Things have improved heaps though since I started out over 20 years ago. More women are active in running farms and there are lots of women working in a wider range of farming and farm consultant roles which I am really happy to see."

Michelle's husband Mark takes care of all the farm maintenance and was the primary caregiver for their two daughters when they were babies.

"I was back milking a few days after having my girls, so he did the childcare when they were little because I start at around 4am. My girls have grown up around animals and love being out on the farm. They don't use technology much which is rare for their age group, but I think that's fine as they're just happier being out and about doing stuff. It's great having the storage lake on our farm for water-skiing, paddle-boarding and swimming because we're outside most of the time."

Having access to irrigation via Waimakariri Irrigation Limited (WIL) has made a huge difference to Michelle's farm, along with advances in technology.

"We've been with WIL since the start and it's evolved so much over the last 18 years. We used to order water by fax in the beginning and now everything happens electronically. Without access to irrigation you wouldn't be able to farm here."

"They've been progressive about technology with tools like Regen and you need to keep up with the pace of change to make the most of these tools. It's all about adapting to changes and using technology to make life easier."

Good Management Practice (GMP) is something Michelle believes all farmers should be doing on their farms already. She views the Farm Environment Plan (FEP) audit process as the most valuable GMP tool for her farm.

"To be honest, when GMP first came out I was pretty appalled. I mean, was that not normal practice anyway for farmers?

"What I do really like though, is the auditing system where you pick up on little things you need to fix which might have been on your list for a while. It prompts you to get those things ticked off."

Michelle is excited about the future for herself personally and for farming in New Zealand. She believes that people from different backgrounds will be able to meet in the middle and create a more balanced view of farming.

"I see myself stepping back from a physical role on farm at some point in the future and when that happens, I am keen to be on boards related to agriculture and farming. I'm president of the Oxford Netball Club and involved with the PTA so I want to continue to be part of the wider community.

"Looking at farming on a wider scale, I think we can bridge the rural-urban divide by finding a way around our differences and reaching common ground. Farmers and non-farmers have more in common than we think. We all want to improve our environment and play our part and I think we can work more closely together to make that happen."

National Party releases discussion document on environment and water

The National Party released a discussion document called *Our Environment* in late February.

The document covers the party's ideas on water policy. It notes that "our water shortages are in distinct areas during summer and well designed and managed infrastructure can support improved water quality and sustainable agriculture."


Simon Bridges.

"We view infrastructure investment as critical to improving water quality and improving New Zealand's resilience to climate change. The Government has chosen to end support for water storage infrastructure whereas we will consider expanding support with a new Water Infrastructure Fund," says National leader Simon Bridges.

"New infrastructure is needed in cities to properly separate and better manage storm and wastewater, while in rural New Zealand sustainable water storage schemes are required to improve water quality and management."

National says they would like to see more investment in cities and regions on projects like the Waimea dam and proposes creating a new water infrastructure fund to improve water quality and management in both town and rural areas, and build resilience to climate change.

In *Our Environment*, National proposes working with water stakeholders and iwi to put in place a more efficient water allocation process, and set nationally consistent water quality standards for coastal waters to improve beach water quality.

It also proposes improving sediment management through stronger national guidance and adopting the Parliamentary Commissioner of the Environment's recommendations on Overseer.

Issues National is seeking feedback on are:

- Is there acceptance of the principle that polluters should pay?
- What is the role of central government and local councils in recognising and applying iwi interests?
- How do we ensure enough focus is placed on cleaning up degraded urban waterways?
- Where is the balance between environmental urgency and economic impact?
- When should standards for the management of diffuse nitrogen discharges be applied – on consent expiry, on limit setting, through permanent transfer or on a combination of some or all of these?
- What further practical steps should be taken to exclude livestock from water bodies?

IrrigationNZ is working on preparing a submission to the discussion document. To read *Our Environment* and make a submission, visit www.national.org.nz

Waimea Community Dam development underway

As a severe drought gripped the Tasman region, site work on the long awaited Waimea Community Dam got underway earlier this month.

"This project will deliver a secure source of water for our community for the next 100 years," says Tasman Mayor Richard Kempthorne.

"It will greatly improve the health of the Waimea River, which can't sustain the demands we're making of it at the moment. The benefits for our region are immense and will be felt by everyone who chooses to make Tasman their home for generations to come."

Work on the site in the Lee Valley near Nelson is being undertaken by Fulton Hogan and Taylors Contracting. Waimea Water Ltd is managing the construction of the dam and its future operation.

The new concrete faced rock wall dam is being built in the upper Lee Valley. At 53 metres high, it will hold a total of 13.4 million cubic metres of water in a 5km reservoir. 30% of the water stored in the dam has been allocated to supplement river flows when they become low. The rest of the water will be used to provide water for irrigators and urban water users, with the new dam able to store additional water to meet forecast future growth in water demand.

The dam will store water from the Upper Lee River – a tributary of the Waimea River.

THE CONSTRUCTION PROGRAMME

Ken Smales is the Interim Project Director for the dam project.

He says that during January and February the contractor was busy preparing safety plans, access plans and detailed construction programmes to submit to the Waimea Water Board and regulatory authorities.

The dam site is outside the cordon area of the Pigeon Valley Fire and wasn't directly affected by the fire, although physical groundworks were not able to begin until the prohibition of hazardous activities was lifted by fire authorities.

"The first part of the project construction is the development of an access road which needs to be upgraded," says Ken.

"The next stage of work involves excavating and clearing the site and then a concrete diversion will be built that will take the river through the dam site in a safe way so then we can begin building the dam on top of the diversion culvert."

Ken says after the site clearing work is completed the construction of the dam itself is expected to start in winter and take around two and half years. Once the dam is built it will take another three months to fill it with water.

The most technically challenging part of the project will be digging away the over burden and exposing the rock as a huge amount of geotech work needs to be carried out on the dam foundations.

"A dam is as good as its foundation, and our foundation design is based on the most up to date industry standards," Ken says.

The bulk of the dam will be graded rockfill, protected by a reinforced concrete face on the upstream side of the dam. A concrete spillway is part of the design and two sets of pipes provide environmental and irrigation water. Most of the rock will be sourced from the nearby area.

The dam site has three fault lines nearby – the Waimea Flaxmore Fault System, the Wairau Fault, and the Alpine Fault. As a result the dam has been designed to the highest seismic standards applicable in New Zealand. The concrete faced rockfill design provides very high levels of resilience to seismic loading.

THE HISTORY OF THE DAM PROJECT

The construction of the dam has been a long time in the making. In 2001 a severe drought hit Nelson and Tasman resulting in riverbeds drying up and saltwater threatening bores in the lower Waimea River. Three urban wells had to be shut down due to saltwater intrusion. Severe water restrictions affected both rural and urban water users.

Kiwifruit export crops from the region dropped from 3.5 million trays in 2000, to 1.5 million trays in 2001. The region spent much of the first half of 2001 under an extreme fire risk, with many walking tracks closed due to this risk, and forestry operations also slowed to reduce the fire risk.

Over the two decades that followed, numerous options were investigated looking at how to provide a more secure water supply for the region. These included other storage sites, pumping water in winter from the Waimea River into ponds and requiring urban households to install rainwater tanks to harvest water. However none of these options could provide enough capacity for urban and

rural water use as well as augment river flows, and would not have attracted co-funding from local irrigators, the government and neighbouring Nelson City Council.

IMPROVING TASMAN'S FUTURE WATER SECURITY

The summer of 2019 is proving even more challenging for Tasman than 2001 was and has highlighted the urgent need for the dam. In January, many areas of Tasman received less than 10mm of rain, with progressively more severe water restrictions being introduced during January, February and March.

Tinder-dry conditions led to the eruption on 5 February of one of New Zealand's largest fires, the Pigeon Valley Fire, with around 2,400 hectares affected.

In mid-February, Tasman District Council announced it would require most rural water consent holders on the Waimea Plains to reduce their water use by 65% while some users are on a cease take. These were the most severe water restrictions ever introduced in Tasman – during the 2001 drought a 65% rural water restriction was announced but never implemented as rainfall fell in the region.

In February and early March, businesses connected to the council water supply had to cut their water use by 25% and a ban on outdoor water use except for hand watering fruit and vegetables was also introduced in urban areas.

Moderate rainfall in early March has allowed the council to ease water restrictions slightly for rural water users as well as for businesses and households.

But the cost of the water restrictions to the local economy is significant. The council estimates that a 35 percent water restriction requirement costs the Tasman area $100 million in losses and the requirement for many water users to reduce water use by more than this amount will have a significantly greater economic impact.

Mayor Kempthorne said it was unfortunate the Waimea Community Dam was not in place yet as it would have avoided this drought having such dire consequences.

Without the dam, Tasman District Council forecasts that water rationing requiring urban users to cut their water use by 25% and rural users by 50% would be required in nine out of every ten years. Severe water restrictions limiting water use to only essential water use for health and hygiene could occur once every six to ten years.

The new dam is being designed to provide water for Tasman's growing population and to enable the community to get through a 1 in 60 year drought. The stored water would also enable a minimum river flow of 1,100 litres per second at Appleby bridge – this is the new minimum flow the Council will work to with a dam.

Up to 60,000m^3 per day can be supplied from the dam for urban areas. The dam will also be able to release up to 2,230 litres per second for irrigation and irrigate up to 5,860 hectares – an expansion of the current irrigated area of 2,000 hectares.

The design is future-proofed to allow for hydro-electricity generation to be developed at a later date – but this will be a Tasman District Council decision and venture.

WAIMEA WATER STRUCTURE

Waimea Water Ltd is a joint venture between Tasman District Council and Waimea Irrigators.

The seven directors on the Council

Controlled Organisation's Board represent the interests of three parties; with four directors appointed by Tasman District Council, two by Waimea Irrigators Ltd and one by Ngati Koata, recognising the recent settlements in the area.

Karen Jordan is the Chair of Waimea Water. She is an economist and chartered accountant who has worked for over 20 years on the commercial management of critical national infrastructure in the UK. Karen is also a director of City Rail Link Ltd in Auckland.

"The key thing is to have a small but highly experienced team of professionals who know how to manage these projects and can work very collaboratively with our supply chain partners to safely deliver both the asset and our commitments to our shareholders in terms of quality, time and costs ," says Karen.

Two very experienced engineers are also part of the board. One of these is Ken Smales who is acting as the project's Interim Director until a permanent appointment is made. Ken

The Waimea River.

has nearly 50 years of engineering experience and knowledge in all aspects of dams including design, consenting, construction, operation, safety, hydro power generation and irrigation. He worked on the Central Plains Water irrigation scheme development. The other is Doug Hattersley who is a chartered engineer with global experience of dam construction.

Waimea Water appointed Mike Scott as their new Chief Executive in February, and he will take up the new role in May.

Mike has a Master of Engineering degree with Distinction in Civil Engineering from the University of Canterbury. He has 27 years' experience in business and commercial development, strategy, planning, operations and engineering mainly in the energy sector in Australia, Scotland, the USA and New Zealand.

Mike has lived in Richmond since 2012, and he says he is excited about the instrumental role that the Waimea Community Dam will play to support the growth and prosperity of the Tasman region.

Mike Scott is Waimea Water's new Chief Executive.

Drought hits Tasman growers hard

One of Wai-West Horticulture's apple orchards.

Wai-West Horticulture (WWH) is one of the many food producers suffering from the severe drought affecting the Tasman and Nelson districts.

Julian Raine is the Chairman and a shareholder of WWH. The company employs 40 full time staff and 200+ seasonal workers to pick fruit and has eight properties on the Waimea Plains. They grow apples, kiwifruit and boysenberries over 250 hectares. Apple harvesting started in mid-February and will continue until mid to late April. In April and May kiwifruit will also be ready to harvest.

WWH harvested its boysenberry crop in December and January, alleviating some pressure on water requirements.

"In January we received only 8mm of rain, and we experienced extremely hot winds and temperatures into the 30s – registering record highs for January and February. This meant our properties experienced high levels of evapotranspiration resulting in the top 90cm of soil having no available moisture," says Julian.

These conditions set the scene for a massive fire to break out on 5 February in Pigeon Valley, around 30km south of Nelson and spread across 2,400 hectares nearby. Fighting the Pigeon Valley fire drew water from dams, ponds and other sources in the Wai-iti and Waimea catchments, worsening the water shortage situation.

Julian Raine.

While moderate rain during March has provided some relief for growers and has allowed the council to ease water restrictions back slightly to a 50% cut for many rural water users, the situation is still very serious for growers.

Julian said that the conditions Tasman experienced in February and early March were the worst he has seen in the 35 years he has been involved in horticulture in the region.

WWH has been making decisions about which varieties of apple and kiwifruit they can water on their very limited supply. Apples have not grown to their optimum size and some of their fruit crop has had to be re-thinned, sending potential export fruit to the ground.

Wells are starting to run dry and farmers are de-stocking. Federated Farmers is operating a feedline where farmers can make and receive offers of help (see www.fedfarm.org.nz).

Julian says it's not just rural properties suffering through the drought. Water restrictions are already in place for urban households and businesses with the threat of more severe restrictions being introduced if the area receives insufficient rain during March and April.

As a business WWH has invested in a number of water efficiency measures which will continue to be critical for their operation in future summers until the Waimea Community Dam is built.

They use mini sprinklers and drip irrigation line systems. The company originally used tensiometers but in recent years has replaced these with electronic probes which monitor soil moisture levels. An independent company monitors the probes and models future irrigation requirements to provide WWH with irrigation advice seven days in advance.

Julian says that prioritising certain apple varieties due to water shortages does create some challenges as irrigation block design didn't envisage turning the water off in some areas.

"Balancing water pressure and flows has been tricky," he says.

WWH is currently looking at the option of carting water in to supply their kiwifruit crop, but will only be able to do this for a short time as it is a very expensive exercise.

Weather conditions in Tasman this summer have highlighted how important the dam is for the future of the Tasman and Nelson districts, and Julian says the new dam will be critical to provide the area with reliable water.

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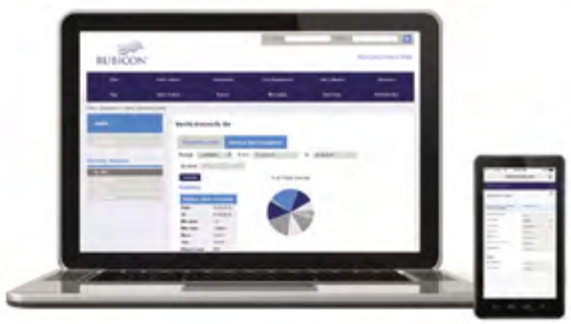

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River quality shows improvements, with more work still needed

LAWA recently released a second national trend report on river quality for sampling sites across New Zealand from 2008–2017, which showed that many water quality indicators were showing improvement.

The report also included national trends for the Macroinvertebrate Community Index (MCI) for the first time.

Suitable data was available for between 319 and 673 sites depending on which water quality parameter was assessed.

LAWA reports five trend categories – very likely improving, likely improving, indeterminate, likely degrading and very likely degrading. For all water quality indicators, except MCI, more sites showed signs of improving rather than degrading trends over the last 10 years (Figure 1). At some sites there was insufficient evidence to say if water quality is improving or degrading and these sites were identified as having indeterminate trends.

"This 10 year water quality trend analysis won't come as a surprise to any who maintain an interest in the health of New Zealand's rivers and streams. We are getting a consistent story from almost all water monitoring – around a third of our (routinely monitored) rivers and streams, lakes and groundwaters have reduced quality, attributable to human activities," says Professor Jenny Webster-Brown of the, Waterways Centre for Freshwater Management.

"The fact that more than 50 percent of the sites appear to have improved with respect to some parameters (e.g, clarity, ammonia and total phosphate concentrations), indicates that change for the better is possible when the source of contamination is correctly identified and effectively reduced. However, it only takes a single contaminant to disrupt an

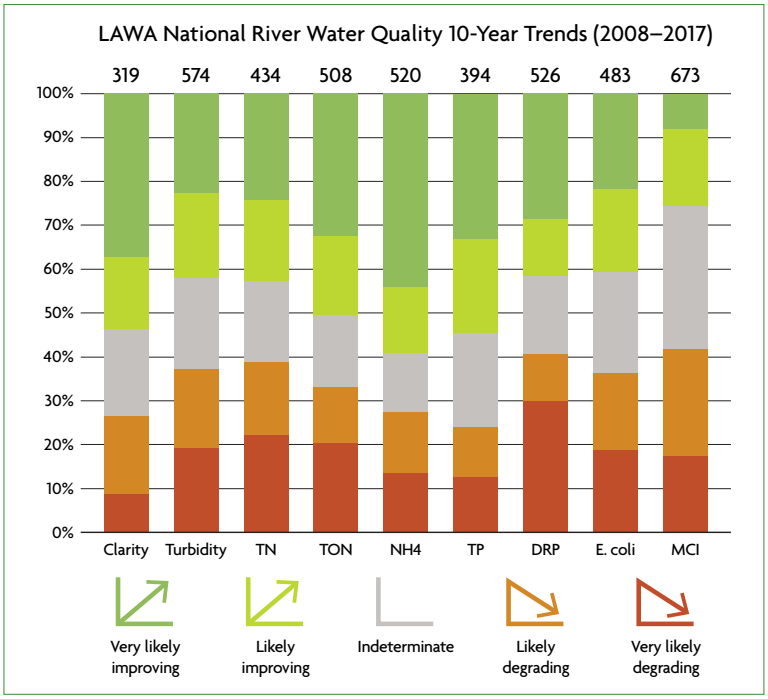

Figure 1. Summary of the proportion of sites with improving, indeterminate or degrading trends over the last 10 years (2008 - 2017). There was insufficient evidence to say whether water quality was improving or degrading at indeterminate sites. TN = total nitrogen, TON = total oxidised nitrogen, NH4 = ammoniacal nitrogen, TP = total phosphorus, DRP = dissolved reactive phosphorus, E. coli = faecal indicator bacteria, MCI = Macroinvertebrate Community Index. The number of sites with suitable data to be assessed for trends for each parameter is shown at the top of the bar.

The Pahau River in North Canterbury won the Most Improved River Award in 2017 thanks to efforts of local farmers to improve water quality. *(Photo: courtesy of Amuri Irrigation Company)*

ecosystem. Trend analyses such as this can show us where greater effort is needed to protect our water resources."

"MCI and other macroinvertebrate indicators can provide information about the ecological health of rivers, based on what we know about their sensitivities to stressors such as fine sediment," says Dr Scott Larned, NIWA Manager – Freshwater Research.

"NIWA and international researchers have reported lags between improvements in stream habitat and water quality and responses in macroinvertebrate indicators, particularly where the improved sites are far from sources of sensitive invertebrate species to colonise the sites. These lags may have contributed to the patterns in MCI trends compared with trends in water quality variables in the LAWA results."

"The LAWA 10-year trends release represents a significant step forward for New Zealand's environmental monitoring of rivers and streams. This is now a large, consistent dataset with a routine assessment," says Professor Troy Baisden, Professor in Lake and Freshwater Science at the University of Waikato.

"The dataset shines light into how we're doing on freshwater. Importantly, it shows improvements are genuinely possible and are happening. Equally it shows declines that need attention. It also reminds us we have a lot of work for scientists and society as a whole if we want our children to be proud of how we managed the freshwater they'll inherit."

"Now that we have this dataset, what can we do to make it better? A first step would be to ensure reporting better informs decisions. The LAWA release doesn't tell us where the problems are, or how bad they are."

LAWA NATIONAL RIVER WATER QUALITY 10-YEAR TRENDS (2008–2017)

	Very likely improving	Likely improving	Indeterminate	Likely degrading	Very likely degrading
Clarity	119	52	63	57	28
Turbidity	130	112	118	104	110
TN	106	79	81	72	96
TON	165	91	84	64	104
NH4	229	79	69	72	71
TP	131	84	84	46	49
DRP	150	69	93	56	158
E.coli	105	92	110	86	90
MCI	55	118	219	165	116

Table 1. The number of sites tested for nine water quality parameters. There was insufficient evidence to say whether water quality is improving or degrading at interdeterminate sites. TN = total nitrogen, TON = total oxidised nitrogen, NH4 = ammoniacal nitrogen, TP = total phosphorus, DRP = dissolved reactive phosphorus, E.coli = faecal indicator bacteria, MCI = Macroinvertebrate Community Index.

The New Zealand Water Model – a new water modelling approach

By Dr James Griffiths and Dr Christian Zammit, NIWA.

Freshwater management in New Zealand has two fundamental aims: to achieve sustainability and to minimise uncertainty about management actions such as consenting water takes and setting water-quality limits. Sustainability means that water is available in sufficient quantities and of sufficient quality to meet the needs of society and ecosystems today and in the future. Minimising uncertainty means reducing the likelihood that management actions will be ineffective or have unintended negative effects. Examples of unintended negative effects include river drying and fish kills due to excessive water allocation. To achieve these fundamental aims of freshwater management, models must be developed that can predict the effects of water and land use, environmental variability, and management actions on water quantity and quality and ecosystem response.

Models are needed for a simple reason: it is impossible to directly observe all the important environmental variables at all locations or to observe conditions in the future – models help us to make reliable predictions about unobserved locations and future conditions. Models that substantially improve water management in New Zealand will need to be both flexible and complex; flexible because they are needed for a wide range of purposes, and complex because they need to simulate complex natural and man-made systems (Figure 1). Ideally, these models will have a modular design, so that sub-models that represent hydrological, ecological and water quality processes can be added. To address the needs set out here, NIWA is leading the development of the New Zealand Water Model (NZWaM).

NZWaM is an integrated platform that will link a wide range of environmental data into a modular modeling system. The physical domain of NZWaM extends from the top of the atmosphere to rivers, lakes, aquifers and estuaries.

NZWAM-HYDRO

The New Zealand Water Model – Hydrology (NZWaM-Hydro) will be the first component of the NZWaM platform completed. It will provide essential hydrological information for land and water management and planning at national, regional, catchment, and sub-catchment scales in New Zealand. NZWaM-Hydro is scalable and the hydrological relationships in the model are transferable between locations, which make it suitable for many different applications. Potential applications include national and regional policy development, water allocation and flow setting, water accounting, and flow, flood and drought forecasting. The modular design of NZWaM-Hydro will allow coupling to sub-models that predict water quality (NZWaM-Water Quality) and ecological conditions (NZWaM-Ecology) as these are developed from other research NIWA is undertaking.

You can visit NZWaM – Hydro Use and Applications for the full list of potential uses of the model.

NZWaM-Hydro is being developed by a partnership between NIWA, GNS Science,

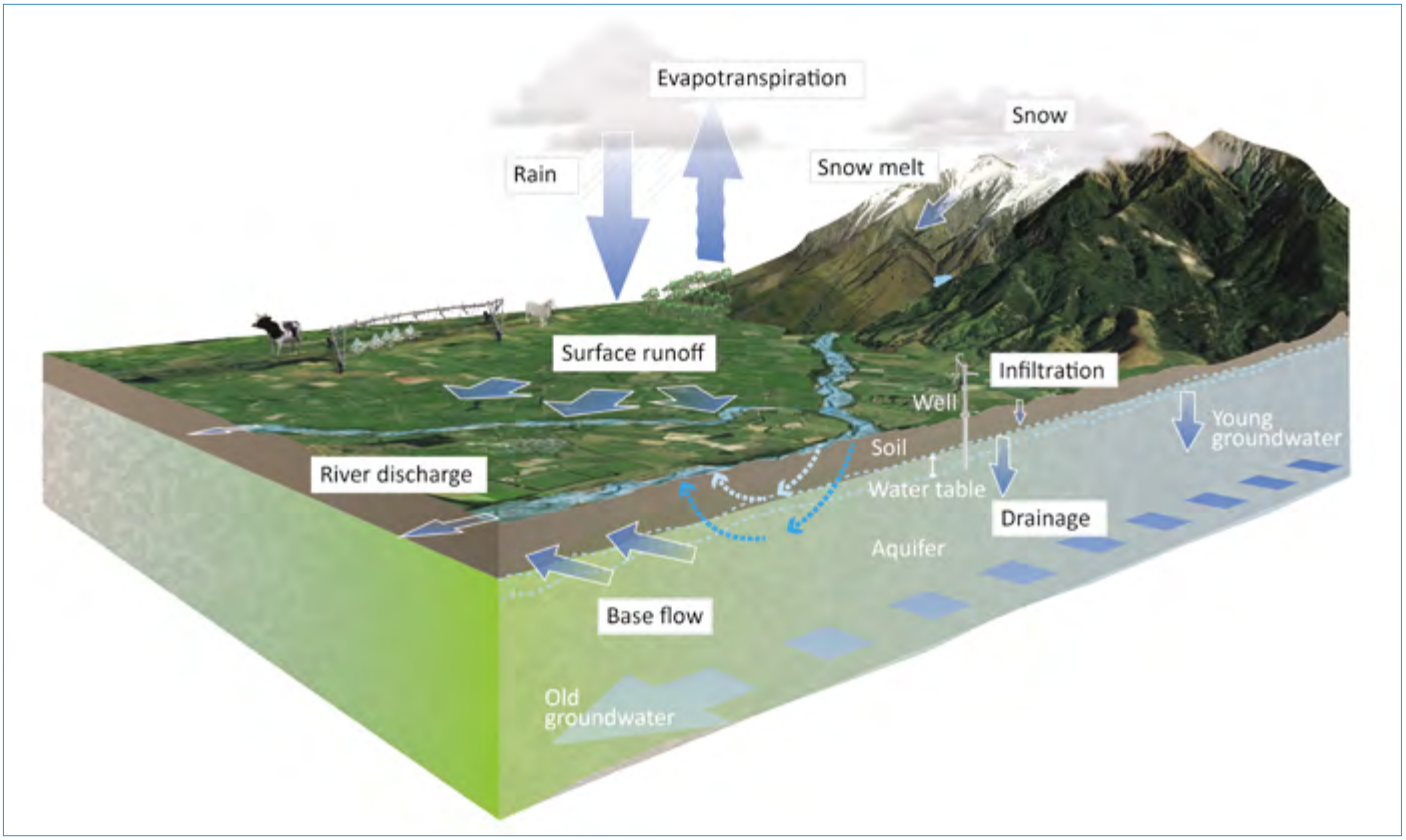

Figure 1. Hydrological processes that are represented in the New Zealand Water Model.

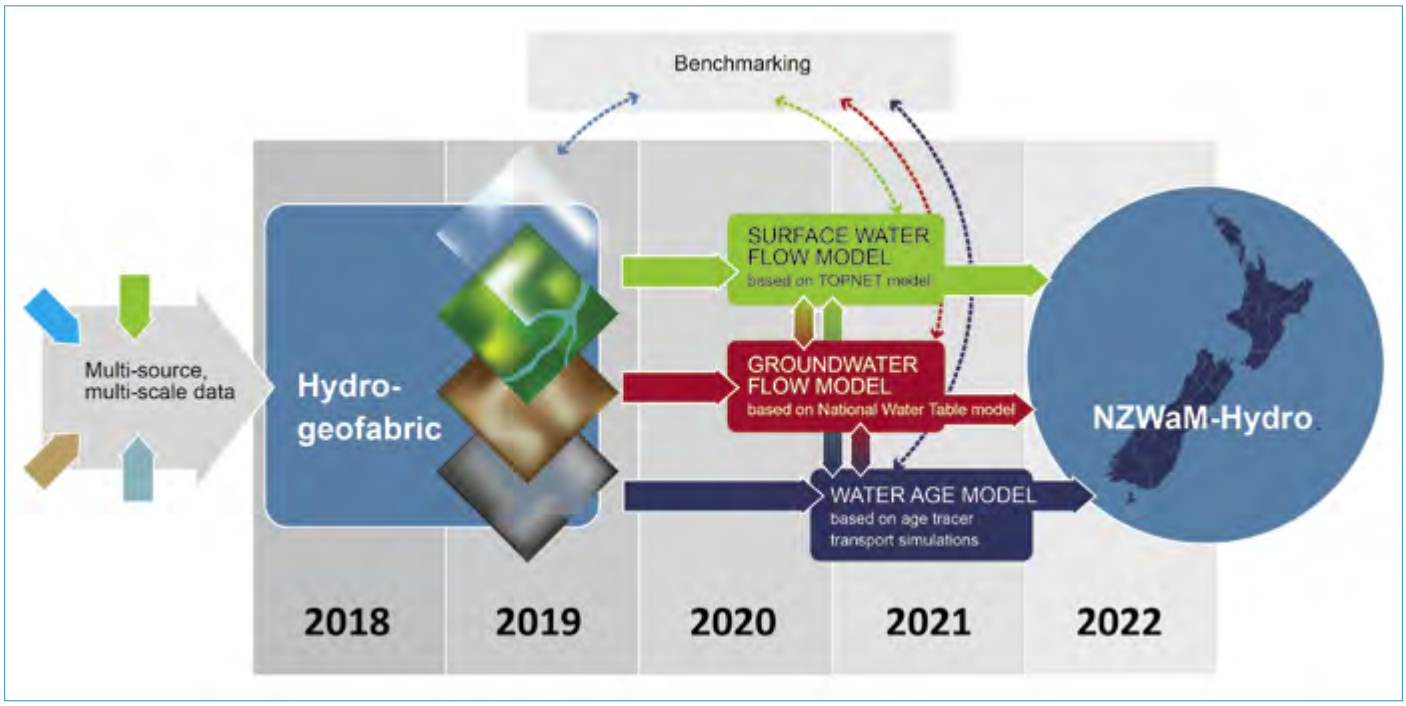

Figure 2. Key components of the NZWaM-Hydro modelling framework.

Manaaki Whenua – Landcare Research, Ministry for the Environment, Ministry for Primary Industries, and regional and district councils (Southland, Horizons and Gisborne).

KEY COMPONENTS

Figure 2 illustrates the key components of NZWaM-Hydro. At the core of NZWaM-Hydro is an integrated and dynamic geospatial database (hydro-geofabric). The hydro-geofabric will store harmonised, standardised and up-to-date geospatial information. That information includes spatial and temporal data from direct observations (e.g., river networks, soils, geology, land use, climate), and derived parameters (e.g., soil moisture content at saturation, hydraulic conductivity in different hydro-geological layers). It will also include an updated digital river network and water isotope data that is being collected by NIWA in collaboration with regional and district councils.

The surface water flow model of NZWaM-Hydro is based on the TopNet rainfall-runoff model, which is currently used in environmental flow setting and for evaluating water resources availability. This surface water flow model will represent evaporation, soil-moisture and groundwater recharge processes using the latest soil, landcover and climate data. It will be tested on a range of catchment types and conditions to maximise its applicability for all regions of the country.

The groundwater flow model is based on the GNS Equilibrium Water Table model. Its role is to predict aquifer hydraulic properties and groundwater fluxes. To develop the groundwater flow model, we bring together data in the hydro-geofabric, our understanding of losing and gaining streams, and water-table fluctuations from the GNS model.

The water-age model is being developed with surface and groundwater isotope data from ongoing surveys. The isotope data will be used to identify water from different origins (e.g., rainfall, shallow and deep groundwater), which will allow identification of flow path-ways within and between river networks and aquifers.

The surface water and groundwater models are coupled to represent water exchange between land, surface-water bodies and aquifers, and the water age model specifies the location and rate of water exchange. The three coupled models are designed to run on supercomputers at NIWA's High Performance Computing Facility

Finally, model benchmarking will involve the development and implementation of a state-of-the-art operational methods to test the above models with respect to observed surface and groundwater data. Guidance on the potential uses and limitations associated with the models will be produced.

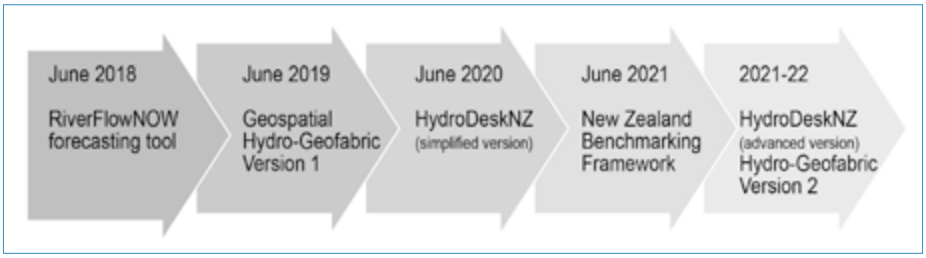

Figure 3. Schedule for delivery of the NZWaM-Hydro modelling framework.

THE STORY SO FAR

From 2016 to 2018 (see Figure 3), the development of NZWaM-Hydro has focused on the construction of the hydro-geofabric for the capture and storage of multi-scaled hydrological information. The surface water flow model and an associated national-scale river-flow forecasting tool are operational; the flow-forecasting tools is now being tested with stakeholders.

FUTURE PLANS

In 2019, data from the hydro-geofabric will be used for a conceptualisation of groundwater systems, which will improve our predictions of variation in groundwater levels in space and time. A user-interface, 'NZWaM-HydroDesk', will be released by 2020, and will allow a wide range of users to access data and model simulations held within the hydro-geofabric.

All components of NZWaM-Hydro are scheduled for completion by 2022, with a period of data quality assurance and benchmarking, and improvements to both the user-interface and hydro-geofabric.

For information on NZWaM, contact Dr Christian Zammit (Christian.Zammit@niwa.co.nz).

Our Land and Water takes on agricultural challenges

BACKGROUND

Our Land and Water is one of 11 National Science Challenges that are funding scientific research into issues of national importance. The challenges were designed to take a more strategic approach to the Government's science investment by targeting goals that, if achieved, will have major and enduring benefits for New Zealand.

Our Land and Water is one of the largest National Science Challenges and is funded by the Ministry of Business, Innovation and Employment $96.9 million over eight years. It is funding and coordinating research that tackles the biggest science-based issues and opportunities facing our primary production sector.

The National Science Challenges are tasked with taking a collaborative approach to research, building research teams that include scientists from different disciplines and institutions, and representatives from industry, iwi and regional councils. This approach helps create science that is relevant, trusted, and more quickly adopted.

We will be featuring some of the many projects underway as part of the challenge in this and future magazine editions.

BENIGN DENITRIFICATION

Nitrate is the most pervasive agricultural contaminant of New Zealand's fresh water, with around 40% of groundwater monitoring sites showing above-natural concentrations.

Two projects run as part of Our Land and Water are investigating natural denitrification processes that convert nitrate back into atmospheric nitrogen gas, either through soil bacteria or microorganisms in groundwater, before it enters freshwater bodies such as streams and lakes.

Understanding and measuring these natural denitrification processes is vital, because their capacity to reduce nitrogen varies a great deal spatially, even within the same catchment. "This leads you to conclude that some parts of a catchment are contributing disproportionately to river contamination," says Dr Ranvir Singh of Massey University, a key researcher in both projects.

"That is a very interesting research finding, because we did not know that this nitrogen reduction underground was that variable, and we are not utilising it properly."

Dr Ranvir Singh is leading a project to assess denitrification processes in Manawatu and Rangitikei.

A study in the Rangitikei river catchment in the lower North Island provides an interesting case study. The Massey University-led research for Our Land and Water analysed the likely result of strategically intensifying land use in more than 83,000ha of high nitrogen attenuation capacity areas in the catchment – while de-intensifying land use over about 10,000ha of low nitrogen attenuation capacity areas.

It found that nitrate loss from the root zone would increase by 55%, but because the leached nitrogen flowed through aquifers where a lot of denitrification occurred, most of this leached nitrogen was converted to gas. The result? Overall, the nitrate load in the river could decrease by 6%.

"The same intensification in a catchment where little natural denitrification occurs would likely show a significantly poorer outcome for water quality," says Dr Singh.

This highlights the potential of better understanding natural denitrification, and aligning intensive land use practices with high nitrogen attenuation capacity areas – "matching land use with land suitability," says Dr Singh.

The Benign Denitrification in Groundwaters research project is developing tools and techniques to quickly and accurately assess denitrification processes in the Manawatu and Rangitikei river catchments. Eventually, complete 'benign' denitrification hotspots will be measured and mapped across New Zealand's agricultural catchments.

It's important to map complete benign denitrification, because incomplete denitrification can release nitrous oxide – a harmful greenhouse gas – rather than dinitrogen (a harmless gas making up 78% of the atmosphere).

Measuring Denitrification is a complementary project led by Dr Uwe Morgenstern of GNS Science, which has developed and proven the first direct technique for measuring the extent of complete denitrification in groundwaters across New Zealand.

REASONS FOR WATER QUALITY IMPROVEMENT

Our Land and Water's research has highlighted some good news: the concentration of phosphorus in our waterways is decreasing in many areas.

Phosphorus has decreased at over 40% of measured sites in streams and rivers since 1994, and 65% of sites since 2004. That's despite an increase in national dairy cow numbers by 26% and the expansion of dairying into areas previously used for sheep farming.

Our Land and Water research investigated the possible factors contributing to reductions in phosphorus concentrations at these sites. Researchers found the three most likely causes for improvement were that on-farm strategies were mitigating phosphorus loss from land, industry guidelines were directing where to best use strategies (for example, in critical source

Professor Rich McDowell sampling water quality. *(Photo: Dairy Farmer)*

Phosphorus levels in rivers have been improving in recent years in many areas of New Zealand.

areas), and phosphorus was being mentioned more in policy instruments.

This research suggests that increased awareness and actions are beginning to minimise phosphorus losses, explains Professor Rich McDowell, chief scientist of the Our Land and Water National Science Challenge and the lead researcher on this project.

"When phosphorus enters freshwater it can stimulate the growth of algae, which isn't good for swimming, fishing or drinking, and it reduces biodiversity," he says. "Algal growth in New Zealand streams and rivers remains widespread due to agricultural phosphorus, but if losses continue to decrease there is a better chance of less algae in our waterways."

Interestingly, the research found little evidence that decreasing phosphorus concentrations are being caused by a decrease in fertiliser use, or a change in fertiliser form. However, this doesn't mean that these practices won't help – more likely, it's because these practices aren't yet widely adopted across whole catchments.

"Sales of 'alternative' fertilisers are still low," says Professor McDowell, "but targeted use of low-water-soluble-P fertilisers, such as reactive phosphate rock, can decrease phosphorus losses. Using these fertilisers in critical source areas is one of more than 40 mitigations Our Land and Water research recommends."

Industry guidelines can help direct where to best use on-farm mitigation strategies. Advances in farm mapping can allow these practices to be targeted even more precisely to critical source areas of phosphorus loss, improving their cost-effectiveness.

EUTROPHICATION PRODUCT FOOTPRINTING

In the future, the European Commission may require all products supplied to Europe to have data on their environmental footprint. This would include a product's contribution to 'eutrophication' – the environmental problems that can be caused by an excess of nutrients, such as nitrate and phosphate, entering bodies of water.

Unfortunately, current methods aren't sufficient to accurately calculate how a product, such as milk, contributes to eutrophication at all stages of its lifecycle, from pasture to consumer, says Dr Stewart Ledgard. He is leading Our Land and Water's Eutrophication Product Footprinting research project, and is a principal scientist at AgResearch.

Product Eutrophication Footprinting scientists are working with international researchers to develop eutrophication impact assessment models that can be applied in every country. These will allow the full environmental footprint of agricultural products to be calculated and compared, using methods set by the European Product Environmental Footprinting initiative.

Enabling this direct comparison may be good for New Zealand's primary industry exports. A recent case study showed a lower environmental footprint for eutrophication for a New Zealand beef product exported into Europe, than for average beef produced within Europe.

Testing the European Product Environmental Footprint of New Zealand dairy and red meat products has helped Our Land and

Dr Steward Ledgard of AgResearch. *(Photo: AgResearch)*

Water scientists understand the benefits and the opportunities of marketing New Zealand products internationally. The research has also considered the potential costs to farmers.

"Farmers won't always lose money by implementing changes to decrease the environmental footprint of their produce – but in many cases they will," Dr Ledgard acknowledges. "So the research team also collated and analysed all available surveys that asked consumers in Europe if they would pay more for beef with a lower environmental footprint."

"The survey results varied, but the meta-analysis showed that European customers were willing to pay an additional 30% or so for beef with the lowest environmental footprint." If a typical proportion of this retail price was returned to the producer, the case study research showed it could offset the costs to the farmer of producing a lower-footprint product.

How investment in irrigation is paying off for Ethiopia's economy

By Gebisa Ejeta, Distinguished Professor, Agronomy, Purdue University.

After rapid economic growth averaging 10% every year between 2004 and 2014, Ethiopia has emerged as an engine of development in Africa.

And there are no signs that ambitions for further growth are fading. This is clear from the government's blueprint to achieve middle-income status – or gross national income of at least US$1006 per capita – by 2025. This would see a rapid increase in per capita income in Ethiopia, which is currently US$783, according to the World Bank.

Ethiopia's growth has been propelled by at least two factors: the prioritisation of agriculture as a key contributor to development and the fast-paced adoption of new technologies to boost the sector.

A third of Ethiopia's GDP is generated through agriculture, and more than 12 million households rely on small-scale farming for their livelihoods.

One of the drivers of growth in the agricultural sector has been the expansion of irrigation. The country has seen the fastest growth in irrigation of any African country. The area under irrigation increased by almost 52% between 2002 and 2014.

This was achieved by investing in the sector, and by harnessing technology to expand irrigation to farmers who traditionally relied on rainfall to water their crops. This boosted productivity and income for farmers by helping them extend the growing season and become more consistent in their production.

Meanwhile, only 6% of arable land is currently irrigated across the whole of Africa. This means that there's huge potential to expand irrigation and unlock economic growth.

These factors are highlighted by a new report from the Malabo Montpellier Panel. The panel convenes experts in agriculture, ecology, nutrition and food security to guide policy choices by African governments. The aim is to help the continent accelerate progress towards food security and improved nutrition.

The panel's latest report analyses progress – and highlights best practice in irrigation in six countries. These include Kenya, Mali, Morocco, Niger and South Africa. Other African countries can draw lessons from the report's insights.

REASONS FOR SUCCESS

The report identified a number of common factors in countries where significant progress has been made to expand irrigation, including key policy and institutional innovations.

In the case of Ethiopia, one of the main reasons for its success is that agriculture and irrigation have been featured on the Ethiopian policy agenda since 1991. In addition, specialised institutions have been set up with clear commitments to maximise the benefits of water control and irrigation systems.

In addition, the government has invested in the sector and has plans to continue doing so. It aims to allocate US$15 billion to irrigation development by 2020.

The investment is expected to deliver a number of returns. These include:

- more efficient use of fertilisers,
- a reduction in the seasonal variability in productivity and
- better yields from irrigated crops grown.

Another major area of development has been the collection of data. This is an invaluable asset that allows for careful monitoring and management of resources such as water, especially in times of drought.

In 2013, Ethiopia's Agricultural

Transformation Agency began mapping more than 32,400 sq kms to identify water resources, particularly shallow groundwater, with the potential for irrigation development.

The final results of this mapping in 89 districts revealed nearly 3 billion cubic metres of water at a depth of less than 30 metres. This could allow approximately 100,000 hectares of land to be brought under irrigation, benefiting 376,000 families.

Finally, Ethiopia has harnessed the value of a full range of irrigation technologies. These have ranged from small-scale interventions to large infrastructure.

A joint project between the Ethiopian Bureau of Agriculture, local extension officers, and an NGO called Farm Africa, for example, helped women and young people adopt small-scale irrigation. This was part of an initiative to increase their incomes and improve their nutrition.

Overall, the project reached nearly 6,400 women and landless people. The irrigation project also benefited 700 farming families.

WHAT OTHER COUNTRIES CAN DO

In order to have food and income security and to attain broader development goals, countries need to make sure that all levels of government are engaged in planning and implementation. The private sector and farming communities also need to be involved to expand irrigation.

The experience of Ethiopia and other countries leading on irrigation can help other African governments develop country-specific strategies to effectively take irrigation to scale. The benefits of doing so, such as enhancing on-farm productivity and income, and improving resilience and livelihoods, are transformational.

The expansion in irrigated farming, coupled with reliable agricultural inputs and stable markets for the expected growth in farm products, has the potential to catapult Ethiopia to the forefront of African countries that have embraced agriculture as the engine of economic growth.

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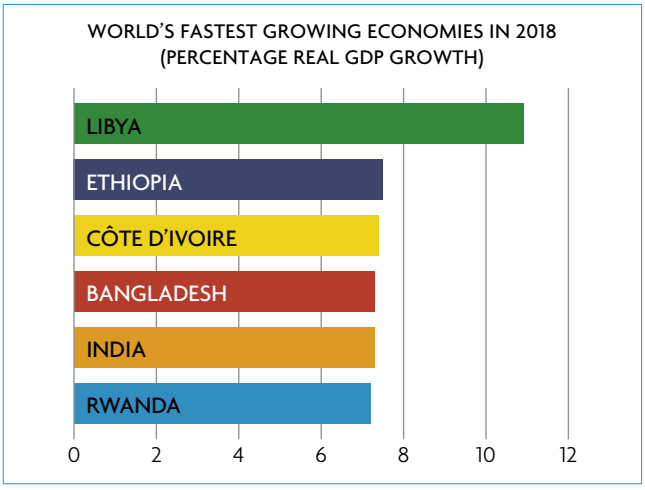

Seasonal climate outlook March–May 2019

OUTLOOK SUMMARY

A central Pacific El Niño is now occurring as the ocean and atmosphere have been weakly coupled for a third consecutive month. Traditionally, this occurs farther east toward South America and during the early summer season.

Mean temperatures are forecast to be above average for all of New Zealand.

For the autumn season, the regional circulation (flow of air) for New Zealand is likely to be influenced by the tropics to the north and the Tasman Sea to the west. Furthermore, when the tropics become the dominant driver of weather patterns, easterly quarter winds will become more likely. Otherwise, westerly quarter flow anomalies are favoured.

The continuation of warmer than average sea surface temperatures in the Tasman Sea as well as a central based El Niño may contribute extra warmth, moisture, and increased risk for occasional heavy rainfall events this autumn season, although long dry spells are forecast to begin the season.

For the current tropical cyclone season (November 2018 to April 2019), NIWA's Southwest Pacific Tropical Cyclone Outlook indicates that the risk for New Zealand is near normal. On average, at least one ex-tropical cyclone passes within 550 km of New Zealand each year. Significant rainfall, damaging winds, and coastal damage can occur during these events.

March to May 2019 temperatures are forecast to be above average (50–60% chance) for all regions of New Zealand. A particularly warm start is expected for the autumn season, but cold snaps and frosts are likely to occur in colder locations as the season progresses.

March to May 2019 rainfall totals are forecast to be normal or below normal (35–40% chance) for all of the North Island. Normal or above normal rainfall (35–40% chance) is expected for the west of the South Island with near normal rainfall elsewhere (45% chance).

March to May 2019 soil moisture levels and river flows are about equally likely to be below normal or near normal (35–40% chance) for all of the North Island. For the west of South Island, soil moisture and river flows are likely to be near the climatological range (i.e. near the long term normal) with near average conditions for the north and east of the island.

Northland, Auckland, Waikato, Bay of Plenty

- Temperatures are very likely to be above average (60% 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 about equally likely to be below normal (40% chance) or near normal (35% chance).

Central North Island, Taranaki, Whanganui, Manawatu, Wellington

- Temperatures are very likely to be above average (60% 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 likely to be below normal (40% chance) or near normal (35-40% chance).

Gisborne, Hawke's Bay, Wairarapa

- Temperatures are very likely to be above average (60% 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 about equally likely to be below normal (40% chance) or near normal (35% chance).

Tasman, Nelson, Marlborough, Buller

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

West Coast, Alps and foothills, inland Otago, Southland

- Temperatures are most likely to be above average (50% chance).
- Rainfall totals are about equally likely to be near normal (35% chance) or above normal (40% chance).
- Soil moisture levels and river flows are likely to be near the climatological range, i.e. near the long term normal (30–35% chance).

Coastal Canterbury, east Otago

- Temperatures are most likely to be above average (50% chance).
- Rainfall totals are most likely to be in the near normal range (45% chance).
- Soil moisture levels and river flows are most likely to be in the near normal range (40% chance).

Note: 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 from the Seasonal Climate Outlook published by NIWA.

An autumnal view of Central Otago *(Photo: Tourism Central Otago).*

A decade of change for irrigators

By Andrew Curtis.

It's hard to believe it's almost ten years ago I started at IrrigationNZ. Over this time I've seen a lot of changes occur in the irrigation sector.

The biggest and most exciting change has occurred due to new technology. On arriving at IrrigationNZ, I was dropped into a national discussion around water metering. IrrigationNZ was supportive of its compulsory introduction however others were arguing real-time measurement of data was too costly and there was no value in it! Live measurement is now a given for all water takes. This provides information to the regulator to demonstrate compliance but its main benefit has been around improved water management. Water measurement data, combined with other sensor data, is now being used to inform real-time decisions.

Give it another five years and technology will likely take over from humans altogether – with autonomous irrigation systems informed by remote sensing deciding when and where to irrigate.

The national and regional discussions on how to manage nutrient losses from farms were just starting up as I arrived at IrrigationNZ. Water quality had been declining for a number of years and it would be fair to say some farmers had pushed their farm systems beyond sustainable limits. The recent introduction of Audited Farm Environment Plans that focus on good management practice means we're now starting to see water quality improvements.

While these improvements are a huge step in the right direction, it won't be enough in some 'at risk' catchments. Recent overseas trips have highlighted the need to bring catchment scale infrastructure into the mix while also clearly identifying the problem before coming up with solutions. In many cases it could be more cost-effective to buy out and retire land in a particularly sensitive part of the catchment rather than place blanket requirements across everyone.

We also need to work through how we fund community scale solutions so all who benefit contribute. To get our water quality management system right we need to target the actual problem in the most cost-effective way. We've been very 'farm focused' to date – 'you will all decrease your nutrient losses by 20%' for example. This is largely driven by the focus of the RMA on individual effects. I'm not sure this is either fair or targets the problem and it may ignore more holistic, constructive options.

In the irrigation scheme infrastructure space over $1 billion has been spent on modernisation – from open channels to pipes and manual to automated control systems.

The other change has been the professionalism of the sector. Ten years ago irrigation schemes were governed and managed by shareholder directors and racemen were the only staff. Large schemes now have general managers, operations managers and environmental managers alongside scheme operators and are now much more future focused. Independent directors are now common and Boards largely focus on governance.

On the farm, there is an increasing understanding of the need to carefully manage irrigation in order to manage costs, boost production and manage nutrient losses. Our training programmes have developed over the past ten years from the odd event into a structured programme which delivered around 40 workshops last year with over 700 attendees as well as a new online training option. This is necessary given the requirements of Farm Environment Plans as well as the interest from farmers in upskilling themselves.

It's been an uphill battle getting the good word out there about change in our industry. But progress has been made and certainly the level of understanding about the benefits of water for agriculture are much more widely understood – so much so that freshwater rights are a looming topic. However, more can be done if more farmers are willing to 'put their head above the parapet' and tell the story of why they have irrigation and how they are reducing their environmental impacts. There is certainly more appreciation now of the role of irrigation than previously in the government following a number of meetings with IrrigationNZ. You only need to look to the parties submissions in support of the Waimea dam to see evidence of this.

In April we held our Conference and Expo which was a useful opportunity to see the latest technology as well as get the message out about all the changes going on the farm. In November, we manned a site at the Canterbury A&P Show which told how irrigation supports food production. Over the three days we had a huge number of positive interactions with urban Cantabrians, and only the odd negative comment. Changing the conversation to food – something everyone values and needs – allowed those who weren't farmers to see the value of irrigation.

Looking to the future, technology will continue to drive changes on farms – to the extent that it may be hard to keep up with all the changes. Many irrigators are well ahead of other farmers in terms of their environmental management practices. Many of the announcements the new government has made around environmental regulations – like introducing nitrogen limits and farm environment plans – are already a requirement in a number of areas where irrigation is widely used. Our irrigation schemes also need to be given credit for the role they have played in enabling best practice to be adopted through providing support and resources to farmers.

Although I'm no longer with IrrigationNZ, I will continue to be involved in the irrigation and water management sector and I will follow the future of the sector with much interest.

Andrew recently retired from his role as Chief Executive of IrrigationNZ.

The demise of the Maya civilisation: water shortage can destroy cultures

By Florian Aigner, TU Wien (Vienna University of Technology).
Mathematical models analysing the interplay between society and hydrological effects have been developed at TU Wien. They provide insights into ancient cultures – and our own future.

Something really drastic must have happened to the ancient Maya at the end of the Classic Period in the 9th Century. Within a short period of time, this advanced civilisation in Central America went from flourishing to collapsing – the population dwindling rapidly and monumental stone structures, like the ones built at Yucatán, were no longer being constructed. The reason for this demise remains the subject of debate even today. Model calculations by TU Wien may have found the explanation: the irrigation technology that served the Mayans well during periods of drought may have actually made their society more vulnerable to major catastrophes.

The lessons learnt may also help us to draw important conclusions for our own future. We need to be careful with our natural resources – if technical measures simply deal with the shortage of resources on a superficial level and we do not adjust our own behaviour, society is left vulnerable.

SOCIO-HYDROLOGY

"Water influences society and society influences water," says Linda Kuil, one of Professor Günter Blöschl's PhD students at the Vienna Doctoral Programme on Water Resource Systems, funded by the Austrian Science Fund, at TU Wien.

"The water supply determines how much food is available, so in turn affects the growth of the population. Conversely, population increases may interfere with the natural water cycle through the construction of reservoirs, for example."

Since water and society have such a direct influence on each other, it will not suffice to describe them by separate models. This is why researchers at TU Wien explore the interactions between sociology and hydrology and represent them by coupled mathematical models. The emerging field of socio-hydrology establishes mathematical interrelationships, for example between food availability and birth rate, or between recent water shortages that are still fresh in our memories and society's plans for building water reservoirs. These kinds of interrelationships, combined with a large amount of historical and current data, ultimately yield a complex system that produces different scenarios of human–nature interactions.

Linda Kuil.

THE WATER RESERVOIR: A BLESSING AND A CURSE

"It's well-known that the Mayans built water reservoirs in preparation for dry spells," Linda Kuil says. "With our model, we can now analyse the effects of the Mayans' water engineering on their society. It is also possible to simulate scenarios with and without water reservoirs and compare the consequences of such decisions."

As it turns out, water reservoirs can actually provide substantial relief during short periods of drought. In the simulations without reservoirs the Mayan population declines after a drought, whereas it continues to grow if reservoirs provide extra water. However, the reservoirs may also make the population more vulnerable during prolonged dry spells. The water management behaviour may remain the same, and the water demand per person does not decrease, but the population continues to grow. This may then prove fatal if another drought occurs resulting in a decline in population that is more dramatic than without reservoirs.

SUSTAINABLE USE OF RESOURCES

We will probably never know all the reasons for the decline of the Mayans. After all, wars or epidemics may have played their part too. The socio-hydrological model developed by the Günter Blöschl-led team of researchers at TU Wien does, however, tell us that droughts and water issues are one possible explanation for their demise and shows us just how vulnerable an engineered society can be.

"When it comes to scarce resources, the simplest solution might turn out not to be superficial and not always the best one," Linda Kuil believes. "You have to change people's behaviour, reassess society's dependency on this resource and reduce consumption – otherwise society may in fact be more vulnerable to catastrophes rather than safer, despite clever technical solutions."

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From left: MGI General Manager Craig Evens, MGI Chairman Alan Gibson, and retired Chairman Robin Murphy, with the Bill Scott sculpture presented to Mr Murphy by the company.

South Canterbury irrigation champion retires

Around ninety people gathered in Glenavy in December to farewell Robin Murphy from the Board of the MGI Irrigation Company.

Robin had served nearly thirty years on MGI's board and was a founding director of the Company, which took over the Redcliffs and Morven Glenavy schemes from the government in 1989.

Over that time, he has been a vocal champion for irrigation in South Canterbury and the benefits it brings communities and farmers. He has overseen the schemes modernisation and expansion, to become the largest in South Canterbury, and one of the largest in New Zealand. He was also a founding director of the Waitaki Irrigators Collective and a former Waimate District Councillor.

Speaking at Robin's farewell function, well known local businessman Gary Rooney said that Robin had always displayed strong leadership, charisma, and an entrepreneurial spirit. Mr Rooney also described Robin as a loyal employer and that anyone who gets to work for Robin "knows they are going to have a good day." Mr Rooney also said that without Robin's involvement the Waihao Downs Irrigation scheme wouldn't have happened.

MGI Board member Martyn Jensen said that Robin had given the community "his drive, his life, and his passion, when others would have turned their backs and said it was too hard."

Robin said that all his work over the years had been "a pleasure" as it was working for the community and led to the community benefitting from irrigation. He said that South Canterbury is the best part of the world but that the community wouldn't be what it was without irrigation. He said his wife, May, had helped him achieve his goals and she was never afraid to tell him when he was doing things wrong.

Robin's contribution to irrigation was recognised by IrrigationNZ in 2016, when he was awarded the Ron Cocks Memorial Award for outstanding leadership in the sector. He was also made an Officer of the New Zealand Order of Merit in the New Year's Honours List in 2016.

MGI commissioned an aquamarine and silver-coloured metal sculpture representing the Waitaki river, its water, and its movement through irrigation infrastructure as a retirement gift to Robin and his wife.

Robin plans to spend more time with his family during his retirement and carrying out more travelling. Robin's parting comment at his farewell function showed his quick wit when he said that, "I'm not sure if everybody has come tonight to celebrate our achievements or just to make sure that I leave!"

Robin and May Murphy enjoy the big reveal of their gift of a Bill Scott sculpture, to celebrate Mr Murphy's retirement.

2018 – a year of extremes

2018 was a busy year for the MetService who issued numerous severe weather warnings about extreme conditions.

The year started with January recording a remarkable 3.1°C above the long-term average.

"A record hot start in January was followed by a dramatic change in February. Two damaging ex-tropical cyclones, Fehi and Gita, caused widespread impacts. Cyclone Fehi arrived on 1 February with Buller and Dunedin declaring a State of Emergency, then Gita arrived on 20–21 February with seven provinces declaring a State of Emergency," says Lisa Murray, Senior Communications Meteorologist from the MetService.

Nelson and Blenheim experienced their wettest February since records began in 1941, with both centres receiving nearly four times their usual monthly rainfall. Conditions improved in these two regions over 2018, as the Nelson region had New Zealand's highest annual sunshine hours total during 2018 (2555 hours), followed by Bay of Plenty (2518 hours) and Marlborough (2503 hours).

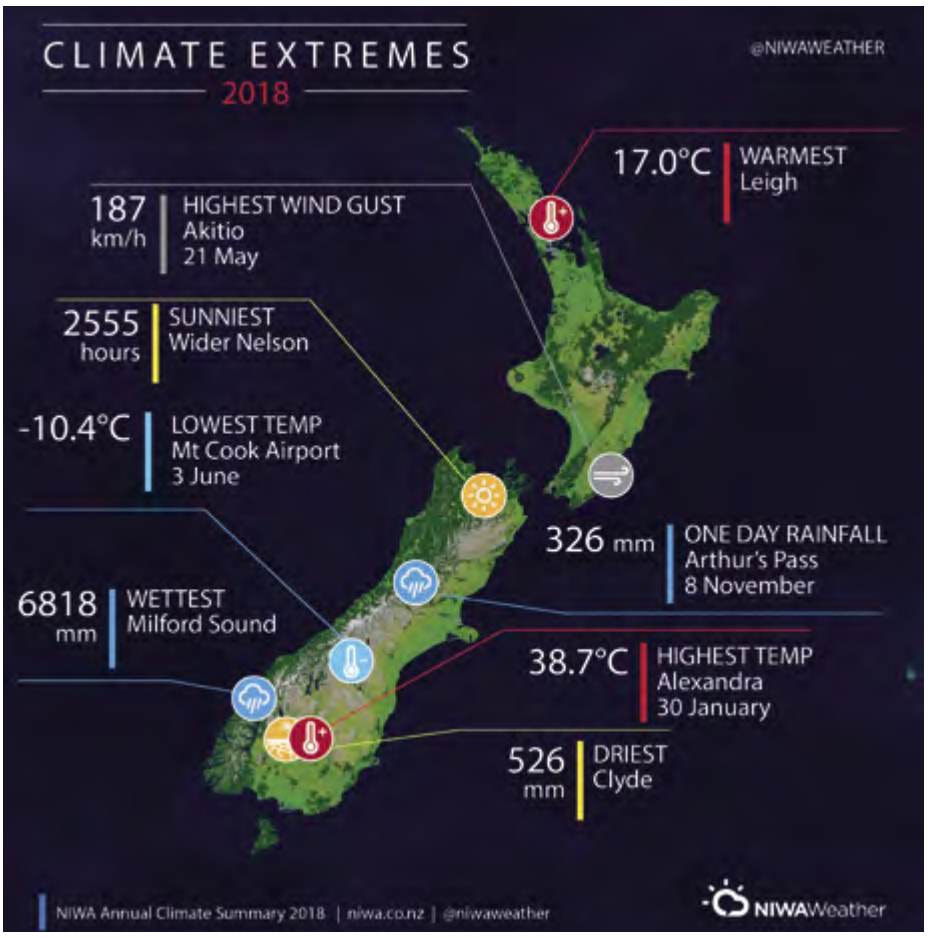
December was a particularly stormy month with 119,698 lighting strikes occurring during the month over New Zealand and coastal waters. On December 14, 33,218 lightning strikes occurred in just 24 hours.

"NIWA's climate summary confirms that we are experiencing the warmest group of years in our recorded climate history in the 2010s. This together with a similar situation with the most above average group of years for sea surface temperatures around New Zealand shows that global heating is having its influence in this very oceanic region," says Climate Scientist Dr Jim Salinger.

"For example, last summer's heatwave was unprecedented and covered an area the size of the Indian subcontinent – 4 million square kilometres. The largest ice melt from our Southern Alps glaciers occurred in the last 57 years when 3.8 cubic kilometres, or 9 percent of permanent snow, went down our rivers. This brought the total down to 37.5 cubic kilometres, compared with 60 cubic kilometres in 1962, a 38 percent reduction."

"This group of very warm years mimics what is happening with global heating where surface temperatures for planet Earth for the last four years have been also the warmest on record.

"And more heating is predicted for 2019 by the UK Met Office. Their 2019 forecast indicates that the year 2019 will be close to a record due to global heating and the added effect of the El Niño in the tropical Pacific. The Met Office forecasts the global average temperature for 2019 to be between 0.98°C and 1.22°C, with a central estimate of 1.10°C, above the pre-industrial average period from 1850–1900. Since 1850, 2016 is the warmest year on record with a central estimate of 1.15°C above the same baseline," says Dr Salinger.



(Graphics: NIWA)

TEMPERATURES IN 2018

Annual temperatures were above average (+0.51°C to +1.20°C above the annual average) across the majority of New Zealand, including much of the North Island as well as the western and southern South Island.

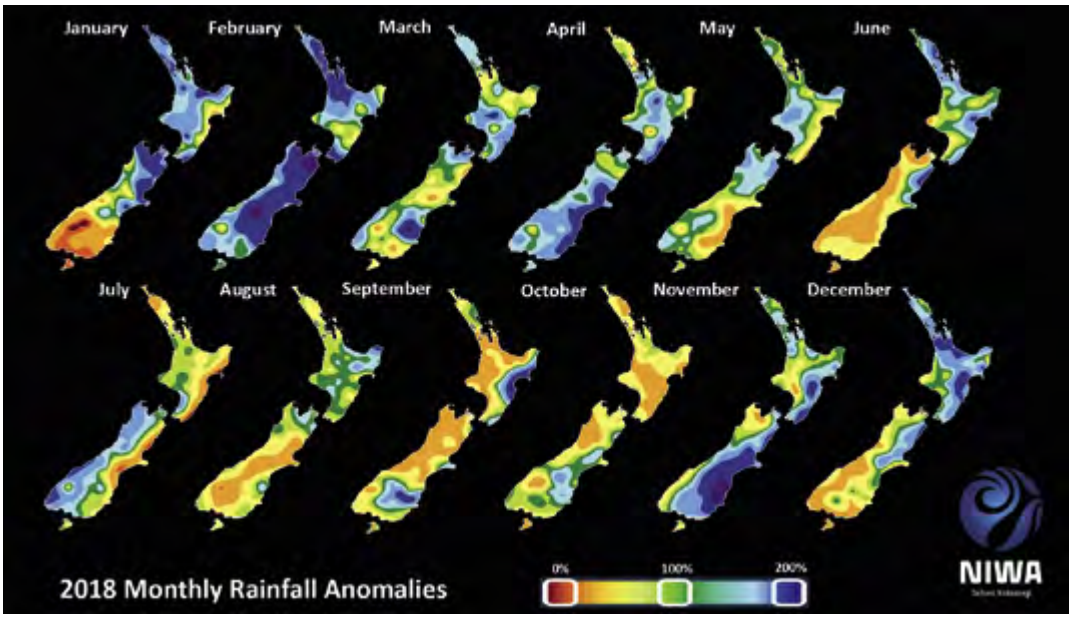
A small strip of well above average (>1.20°C from average) temperatures were observed in southern Manawatu-Whanganui. Elsewhere, near average (within -0.50°C to +0.50°C of average) temperatures occurred in parts of southern Canterbury, Otago, small parts of Auckland and the Far North. 2018 was the equal second warmest year on record for New Zealand, based on NIWA's seven-station series which began in 1909.

The highest air temperature of the year was 38.7°C recorded at Alexandra, followed by 37.6°C at Clyde and 37.4°C at Middlemarch, all on 30 January. The lowest air temperature of the year was -10.4°C recorded at Mt Cook (Airport) on 3 June, followed by -9.2°C at Ranfurly on 1 June.

RAINFALL AND DROUGHT

Yearly rainfall in 2018 was above normal (120–149% of the annual normal) across much of the eastern and upper South Island, as well as parts of Wellington, Wairarapa, Bay of Plenty, northern Waikato, and Auckland. Well above normal rainfall (>149% of normal) was observed in portions of southern Canterbury. Rainfall was near normal (80–119% of normal) for the remainder of New Zealand.

Prolonged dry conditions prompted the Ministry of Primary Industries to declare a medium-scale adverse drought event for the Grey and Buller districts on 10 January. This classification was extended to include Otago and Southland on 30 January. The lack of meaningful rainfall and persistent high temperatures raised the fire risk throughout Southland and Otago, particularly during the second half of January. As of 30 January,



Central Otago volunteer fire brigades reported responding to 208 callouts during January alone; which is as many as would typically be attended during an entire year.

While Central Otago was the driest area in New Zealand with Clyde (526mm), Cromwell (541mm) and Alexandra (556mm) recording the country's lowest rainfall totals, Otago experienced an extremely wet spring with Cromwell and Middlemarch recording their wettest spring on record.

Most areas of Canterbury experienced a noticeably wet year. At Christchurch Airport, which has weather readings going back to 1954, last year's rainfall totalled 865mm–235mm more than the 64-year average. Ashburton recorded just over 1,000mm of rainfall while Cheviot totalled 977mm.

SOIL MOISTURE

2018 began with below or well below normal soil moisture nearly nationwide, but soil moisture in the North Island and upper South Island gradually increased during January. Widespread heavy rainfall from ex-tropical cyclones Fehi and Gita during February resulted in well above normal soil moisture across most of New Zealand. During spring, soils became drier than normal in much of the country, although remained wetter than normal in southern Canterbury and Otago. Heavy rain in November brought widespread wetter than normal soils to the east of both islands, while a heavy rain event around Christmas did the same for the upper North Island.

Promising results from denitrification wall trial

Nitrate levels in groundwater have been reduced from 7.1mg/l to 0.5mg/l at the site of an Institute of Environmental and Scientific Research (ESR)-led denitrification wall trial at Silverstream Reserve in North Canterbury.

The 25-metre-long wall, which was installed in November 2018, is a world-first as denitrification walls haven't been tested in fast-flowing gravel aquifer systems, like those found in Silverstream.

ESR senior scientist Lee Burbery says he's delighted that the wall is working as anticipated.

"The wall itself is effectively removing all of the nitrate in the groundwater that passes through it. We are seeing a plume of treated groundwater extend down-gradient from the wall."

The denitrification wall acts as a groundwater filter. Woodchip mixed with gravel removes nitrate from groundwater passing through the wall. Carbon from the woodchip provides a food source for bacteria within the ground to convert nitrate in groundwater to a harmless di-nitrogen gas (N_2), which makes up 80 percent of the air we breathe.

The wall is split into two 12.5 metre sections, each of which is filled with a 50:50 mix of woodchip and gravel. The wall is three metres deep and five metres wide; the width being determined by groundwater velocity and nitrate concentration.

Lee says two different mixes are being tested within the wall to determine which type of material is the most cost effective and efficient at removing nitrates.

"One is the "Rolls Royce"; it has 20-40mm gravel rounds mixed with chipped wood. The other is material dug out of the site, screened and mixed with hogged wood. The second option could work better for landowners as it's more cost effective."

The test site was selected because of its shallow water table and high nitrate levels and it is far enough from Silverstream to ensure that the operation of the wall will not adversely impact on the waterway.

"We have 34 monitoring wells on the site which will be increased to about 50. It's important to ensure that there won't be any adverse effects with pollution swapping from the woodchip, but we haven't seen any evidence of this so far."

North Canterbury zone manager Andrew Arps says the project is an excellent example of the practical and collaborative approach that is being taken by the Waimakariri Zone Committee and partner organisations to deal with high nitrate levels in local waterways.

The new wall being installed. *(Photo: Tony Benny)*

"We're really pleased with the positive results to date and this ties in with other projects in the Silverstream catchment including the joint ECan-WIL infiltration trial and monitoring sites set up along the waterway.

"This year we'll be focusing on "Clean and Green Silverstream" which is a holistic and hands-on approach to cleaning up the stream and greening the banks. The only way forward is for everyone to work side-by-side and to cover the entire catchment from the springheads right through to the Kaiapoi and Waimakariri rivers."

The trial will run for two years, while the actual wall itself is expected have an operational lifespan of around 30 years. ESR lead scientist Murray Close expects the site to function as a demonstration model to show landowners how the concept works.

"We're trying to establish guidelines on how denitrification walls work, and this site will provide a practical example."

Due to the expense of sheet piling when constructing the wall, Murray says denitrification wells could be a more cost-effective option for landowners.

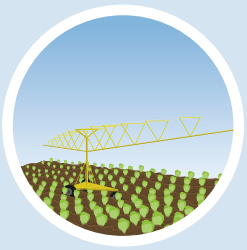
"One possibility is offset lines of wells. You could drill one-metre diameter wells and fill these with a mix of gravel and woodchip. The casings would then be removed, and this would work in a similar way to denitrification walls, but without the cost of sheet piling."

Murray believes that denitrification walls could be part of the answer to reducing Silverstream's high nitrate levels.

"All of the work being carried out at Silverstream addresses different parts of the puzzle. Our piece of the puzzle is what we can do to address the nitrates that are already in the groundwater.

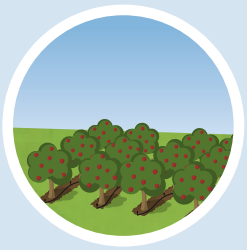
"I think it will take a combination of approaches to deliver the improvements that we want to see for Silverstream."

What is irrigation used for in New Zealand?



Vegetable production

90% of New Zealand land growing commercial vegetables is irrigated

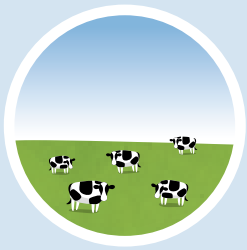


Fruit & wine production

Over **58%** of commercial production is from irrigated land

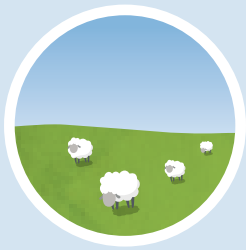
Grains & cereal crops

52% of crops are grown on irrigated land



Dairy

26% of New Zealand dairy grazing land is irrigated



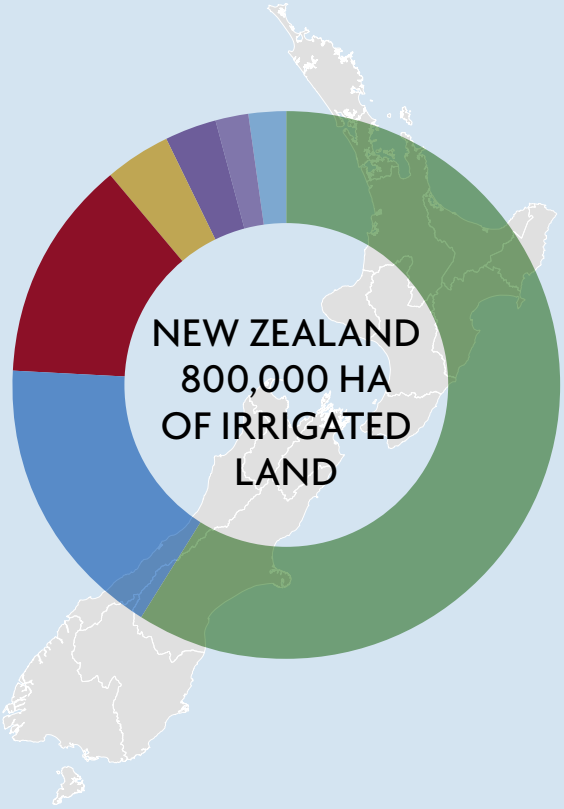
Sheep & Beef

2% of New Zealand sheep and beef grazing land is irrigated

*Note – Figures are taken from the 2017 Agricultural Production Survey. Based on industry knowledge, IrrigationNZ estimates that the use of irrigation for fruit, wine, sheep and beef production is higher than shown. Figures do not include livestock grazed on irrigated land for finishing.

New Zealand has approximately 800,000 hectares of irrigated land – 7% of its total agricultural land.

59% Dairy
17% Sheep & Beef
13% Grain Crops
4% Vegetables
3% Wine
2% Fruit
2% Other



TOWNS WHICH SOURCE THEIR DRINKING WATER FROM IRRIGATION SCHEMES:

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THE ECONOMIC CONTRIBUTION OF IRRIGATION TO NEW ZEALAND

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