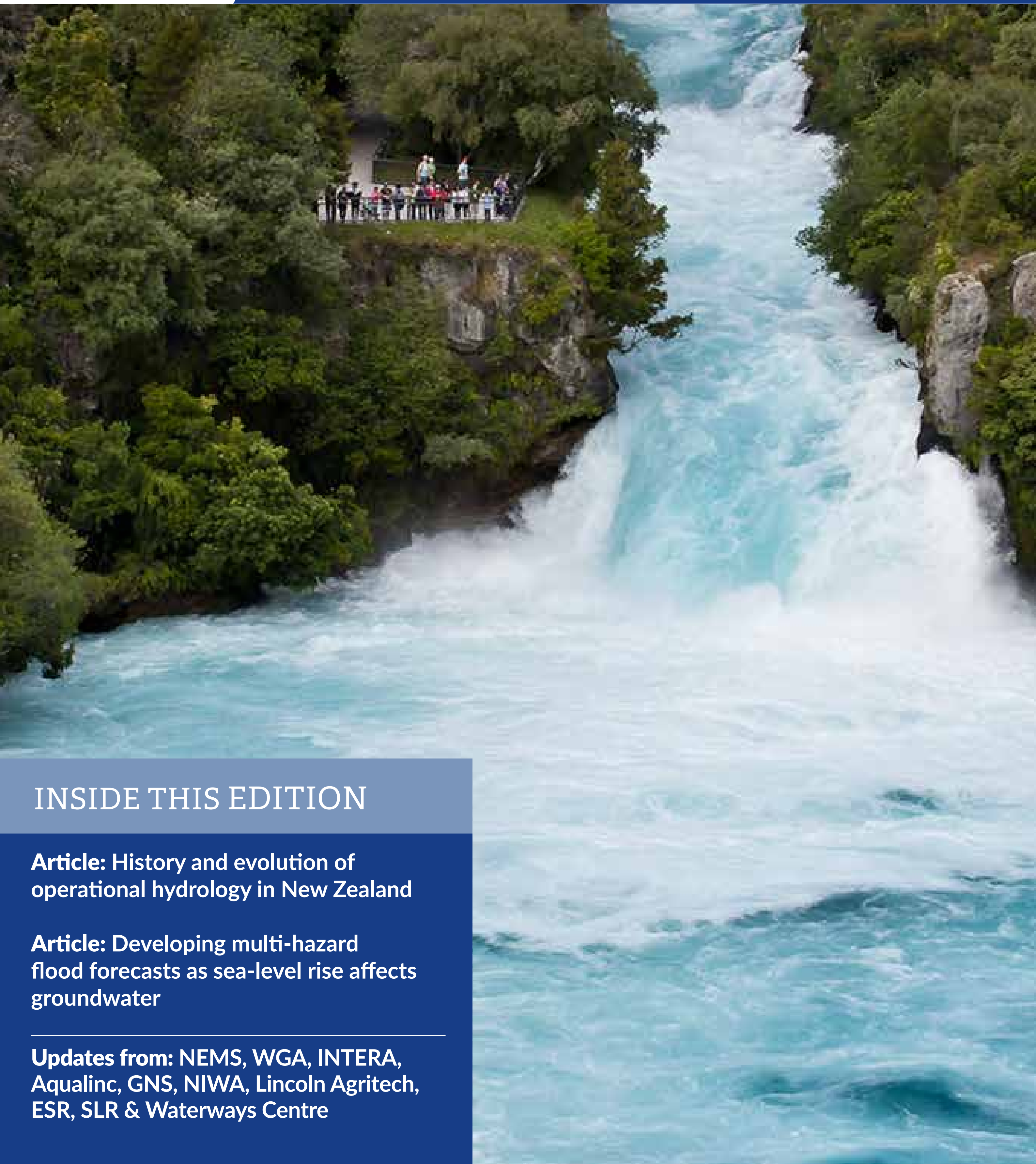
NZHS E-CURRENT NEWSLETTER • NUMBER 67 • APRIL 2025

NEW ZEALAND HYDROLOGICAL SOCIETY
E-CURRENT NEWSLETTER



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Mike Ede, Tasman District Council

MESSAGE FROM THE PRESIDENT

Kia ora New Zealand Hydrological Society members

Welcome to the first edition of E-Current for 2025.

First up, a massive shout out to JT, who hung up his boots and signed off as President at last year's AGM in Blenheim – a massive record-breaking stint as President. It is both humbling that you have trusted me to lead the society as well as being a daunting task of filling the role. With all the chaos in world politics hopefully the same doesn't happen for us and I will be trying, along with a great committee, to continue to have a prosperous society that is relevant for its members and the wider hydrology domain.

I have just come back from another successful technical workshop in Hamilton in late March with over 140 people in attendance and 17 trade stands showing their wares. It is rewarding to have international trade vendors say that this is one of the best events they go to worldwide and want to come back next year. This event keeps growing each year and wow, seeing all those remote boats on the Waikato River on a sunny field day! Let's hope the main conference at the end of the year reaches that same standard. We will be joining with the Meteorological Society for the conference, and having dropped in on a few conference committee planning meetings it looks to be a great event.

We have some changes afoot this year as we need to get a new constitution over the line to comply with the new societies act. The new constitution will be out amongst members soon and then for adoption at the AGM at the end of the year.

There are some changes coming up in terms of how we oversee the production of the journal as Richard Hawke has signalled his time as Editor is coming to an end. Watch this space.

Anyway, enough from me now and I hope to see you all at the conference later this year, if not sooner around the place.

Take care

Cheers Mike

Late addition: the 2026 Technical Workshop is heading to the West Coast! It will be great to back there again – it has been a while – can't wait.

5 little Surfbees in a row on the Waikato River

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e-Current is the newsletter of the New Zealand Hydrological Society Inc. Contributions are welcome from members at any time and can be sent to admin@hydrologynz.org.nz

Advertising space is available; contact Lea Boodee at the above address for more info.

NOTICES

Journal of Hydrology (New Zealand)

The Journal of Hydrology (New Zealand) is published twice a year. - https://www.hydrologynz.org.nz/journal-of-hydrology. Papers and Notes have been published on all aspects of hydrological science and management. There were excellent presentations at the Conference (as there always are!), and I encourage you to consider sharing your work with others through publication.

Papers and Notes can be sent to the Editor (admin@hydrologynz.org.nz) at any time. I aim to have papers and notes reviewed in under two months and publish accepted material within a year. 'Notes' are generally short, maybe 4 to 8 pages. Notes are intended to be pilot studies, work that is not completed or technical information (ie interesting and relevant material that is not a final article).

I am also keen to build my pool of potential reviewers. Hence, on the next membership update that comes out there will be a question asking if you are willing and able to be a reviewer, and if so what are your preferred topics. If you want to discuss your potential publication please don't hesitate to contact me.

Richard, Editor, Journal of Hydrology (New Zealand)
rhawke@linz.govt.nz

NZHS Award Nominations

In line with their mission to support and foster hydrology in New Zealand and elsewhere, and to enable NZHS members to receive advanced training in hydrological sciences, NZHS annually presents several student and non-student awards to its members.

A listing of all the awards, nomination criteria and nomination forms can be found on the NZHS website.
https://www.hydrologynz.org.nz/awards

Members are encouraged to think about colleagues who deserve some recognition for their contribution to hydrology and submit nominations.

NZHS| MSNZ Conference 2025

CREATIVE HYDROLOGY

We welcome (actually encourage) all members to send us a creative contribution for the next Current.

Q. What do you call a woman with a river on her head?
A. Flo

Q. What do you call a man with a whirlpool on his head?
A. Eddy

My friend said they couldn't pay their own water bill,
so I sent them a "Get well soon" card.

Jokes contributed by Lee Burbery, DairyNZ

Nicki Wilson. Rakaia Mosaics (2024), reduction woodcut, Limited-edition

By Nicki Wilson | Senior Scientist, Waikato Regional Council

"It was inspired by the time I spent working in Canterbury. Flying into Christchurch always had me imagining the groundwater flowing beneath the Plains and I loved looking down on the different colours created by different farming and irrigation practices." Nicki

NOTICES

Register Now for IAH 2025 – Join Us in Melbourne

Melbourne Convention and Exhibition Centre

The 52nd Congress of the International Association of Hydrogeologists (IAH 2025) will take place in Melbourne this September, in conjunction with the Australasian Groundwater Conference. We warmly invite NZHS members to attend this landmark event and join a global network of groundwater professionals, researchers, and decision-makers.

Themed "Groundwater Now and for the Future," the Congress will provide a platform to share innovative research, discuss challenges and solutions, and collaborate across sectors to advance sustainable groundwater management.

Highlights Include:

• A dynamic technical program with keynote speakers and panel sessions
• Pre-Congress workshops on Sunday 14 September
• Field trips, social events, and networking opportunities
• A vibrant host city with rich cultural and scientific offerings

Register now and explore the full programme at: https://iah2025congress.com/

NZHS 2024 Conference

We would like to thank all the attendees, presenters, and sponsors for making the 2024 NZHS Conference such a success.

We welcomed a group of delegates from diverse sectors: research, academia, consulting, iwi, industry and government. We were also thrilled to welcome 5 delegates from the Korean Water Resources Association to the conference. In total we had over 200 attendees, and participants enjoyed a diverse technical programme including 3 excellent keynote speakers, 114 oral presentations, and 12 posters. Presentations covered a diverse range of topics, including groundwater-surface water interaction, integrated catchment management, and modelling and prediction. Social events each evening provided great opportunities for networking.

A highlight of the conference was the Friday field trips. The Wairau trip explored the Wairau River/Aquifer system as a case study in the national Gravel Bed Rivers Project, while the Te Hoiere/Pelorus trip explored various initiatives as part of a catchment-scale restoration project.

The conference dinner at Pernod Ricard was another highlight. We loved seeing everyone getting into the Riverside Renaissance theme, with lots of excellent costumes on show! The band commented that they really enjoyed the vibe attendees brought to the dancefloor.

Many thanks to the Organising Committee for their hard work in organising this event: **Emma Chibnall, Peter Davidson, Mike Ede, Joseph Thomas, Charlotte Tomlinson, Scott Wilson, and Tracy Young.**

It's always great when we can get together in person, and we hope the connections and knowledge gained at the conference have inspired you and reaffirmed the importance of the work that we do, and what is possible when we work in a collaborative way. Thank you again for your contribution to the 2024 conference.

Conference Awards

Services to the Society: Peter Davidson, Marlborough District Council
Services to the Society: Helen Rutter, Lincoln Agritech
People's Choice: Philippa Aitchison-Earl, Environment Canterbury | *Insights from the past: a new source of historical groundwater quality data in Canterbury*
Gumboot Award: Shaliesh Singh, NIWA | *for giving out 'homework' during his conference presentation*

1st student: Alaina Baker, University of Canterbury | *Deep learning in the shallows*
2nd student: Ella Farrugia, University of Canterbury | *A Storyline Approach to Assess the Impact of Climate Change on the Hydrological Processes*
3rd student: Tara Forstner, University of Canterbury | *GroMBPy: A groundwater model build python package in the pipeline*
Student Poster: Jack McMecking, University of Canterbury | *Chasing storms: tracking event flow in an alpine catchment*

WGA

STUDENT PRIZES WERE SPONSORED BY WGA


Integrated Catchment Management – its evolution from theory to science to practice
Andrew Fenemor

ODE TO HUGH THORPE, PH.D, Esq:

Leader of NZ's Groundwater Research Team

You stride Canterbury's Plains toward distant mountain haze
While nothing escapes your raptor eagle gaze:
Neither sparkling, frothing weirs nor historic boxed drains
Neither concrete dam massifs nor water resource claims.

Nothing deters you, whether cataclysmic river forces
Whether walls engineered to deflect them from their courses
Whether spring-fed streams meandering towards The Shelf -
You know The Science, which thus upholds itself.

You understand what we 'mere mortals' don't
The subterranean forces which, as is your wont,
You authoritatively yet unassumingly front the crowd
Elucidating groundwater science for them aloud.

What awesome forces coalesce Canterbury's gravel fans,
Your engineering calculations train catchment lands.
Where recharge zone absorbs vast irrigation mix,
Refer: 'Groundwater Resources': Scott,D.M./Thorpe,H.R.(1986).

Thus porosity rules your enduring, relentless quest:
For permeable transmissivity, interglacial layers are best.
Specific yield and constant drawdown make your day
Where capillary fringe triumphs over the dreaded clay.

Who could contain the inexorable centrifugal curve
The velocity differential these fine rivers thus serve?
Who could calibrate the unconfined aquifer flow?
See Darcy's Law's interpretation, as all hydrologists know.

You register when potentiometric energy moves apace,
When drawdown reaches equilibrium via water-race.
You calculate evapo-transpiration and artesian retention
You harness weather sequences with innovative invention.

With a steadying hand and cool, informed appraisal
You allocate groundwater resources, referencing water table,
Whether thunderous torrents from recharged reservoir,

Or glacial pace saturation ex antediluvian centuries afar.
The Plains' myriad and extensive waterways inspire you, rightly so:
Heathcote's convoluted windings or the secret springs of Avon / Otakaro
Whether the violent moodswings of mighty Waimakariri
From turbid flooded wrath to an azure braided tranquility.

This inimitable resource graced thus by innumerable waterfowl:
Scaup, grebe, bittern and haughty swan, plus wide eyed owl.
All flock to sanctuary amidst artesian reservoir's bounty,
Giving teeming life to this super-saturated, shingled country.

You understand Water's evolved molecular structure, source of all life,
Your vast knowledge thus mitigates groundwater hearings strife.
Refer: Unconfined permeable aquifers/lakes/rivers/wetlands/historic drains.
Refer: Top groundwater scientist / devotion to duty / Canterbury Plains.

84th Birthday Ode to Hugh
30 September 2020
By his wife, Susan Thorpe

Ode read by Andrew Fenemor at the 2024 Conference dinner, Blenheim

NOTICES

OXFAM Update

Brenna Gotjé, Philanthropy Manager

I'm excited to share with you the progress and impact of the Kōtui Programme over the last six months. As a key supporter, your contribution is helping to drive meaningful change for communities in the Pacific region, empowering them in the face of climate breakdown and natural disasters.

The Kōtui Programme, a five-year initiative, is a collaboration between Oxfam Aotearoa and the New Zealand Aid Programme. It operates across four Pacific countries and focuses on systemic change for vulnerable women by enhancing access to resources and ensuring their inclusion in governance systems.

Key Highlights:

Timor-Leste Land Rights: Through our partnership with local organisations, we've empowered women in Timor-Leste to defend their land rights, including providing legal consultations and shifting social norms to allow land registration in women's names.

Success story:

Laurinda, a widow and farmer in Timor-Leste, has successfully defended her land from a dispute, thanks to the support of Oxfam partner, Rede ba Rai. Her story highlights the resilience of women in the face of adversity.

Solomon Islands:

Our efforts in Solomon Islands have led to women taking active roles in household decision-making around food security and climate resilience. This progress is supported by local organisations like our partner, WARA, which provides training and financial resources to women.

Papua New Guinea - FLOW Project: The FLOW project has completed construction of eight gravity-fed water systems, bringing clean drinking water to rural communities. We're also seeing a positive shift in attitudes around menstrual hygiene management, allowing girls to stay in school during their periods. Thanks to your support, we are creating lasting impact. Whether it's through building better healthcare infrastructure, empowering women to challenge traditional gender roles, or providing essential resources like clean water, the Kōtui Programme is driving systemic change in the Pacific.

If you have any questions or would like to learn more about specific aspects of the programme, feel free to reach out.

Thank you for your continued support in helping us build a more resilient, inclusive, and sustainable future for these communities.

ARTICLE

History and evolution of operational hydrology in New Zealand

Charles Pearson, NIWA

(Talk presented at "Securing Our Water Future: Embracing Adaptation and Collaborative Solutions", NZHS annual conference in Blenheim, 26-29 November 2024)

History, context, evolution

The social and hydrological context in Aotearoa / New Zealand (NZ) in the 1800s included Māori respect for water (Taonga, Mauri of Wai - Te Mana O Te Wai), signing of Te Tiriti (1840), negotiating rivers for transport, organising water supplies for cities/towns, and addressing electricity needs.

Drivers for operational hydrology (systematic monitoring and prediction / forecasting of the state of natural water) included flooding, bridging, water supply, electricity in the 1800s, hydropower, irrigation, flooding, hydrological science in the 1900s, and water quality (WQ), freshwater (FW) management, Treaty and iwi involvement, consents, irrigation, storage, floods, droughts, and climate change in the 2000s.

City drinking water supply developed from the 1860s with storage for water supply from ground water springs and rivers, such as the Dunedin reservoir in 1867, Karori earth dam in 1874, Wainuiomata reservoir, Auckland Domain springs and reservoir from 1866, and Western Springs pumping station to reservoirs at Ponsonby and Khyber Pass in 1877 and Mt Eden in 1888, and in Christchurch, use of artesian wells from 1863.

In 1904 the Public Works Department (PWD) produced a national report on NZ's hydropower potential. The first hydropower schemes were operating in the early 1900s, at Okere Falls and Coleridge, through to major Waikato and South Island power schemes in 1920s-80s.

NZ required bridges and tunnels for transport across its complex terrain, mountain ranges, river gorges, braided rivers. By 2009, NZ had 2000 rail bridges and 15600 road bridges.

Irrigation was required in drier, eastern areas (Canterbury, Otago, Wairarapa, Hawke's Bay, Gisborne). Ten water level stations were set up in the 1930s for Canterbury irrigation investigations.

Development of hydrology

Estimates of flow rates in rivers were required for hydropower, irrigation and flooding purposes from the 1890s to 1950s. Lake levels were collected for Coleridge (1890-1902), Wairua and Waikato rivers by PWD in 1903. By 1930 there were ~20 water level recorders for hydropower assessment on South Island lakes, Lake Taupo and the Waikato River.

In the 1940s catchment boards were established by the Soil Conservation and Rivers Control Act 1941, and by 1949 PWD had 'Hydraulic Parties' at Hamilton, Palmerston North and Blenheim. In the 1950s there was an increase in river flow gaugings and flood monitoring by PWD and catchment boards. In 1957 "Floods in NZ 1920-1953" was published.

Expansion of hydrology in 1960s-1970s included more field parties (at Whangarei, Rotorua, Whakatane, Gisborne, Napier, Whanganui, Turangi, Nelson, Christchurch, Dunedin, Invercargill, Timaru, Tekapo, Alexandra, Greymouth, Westport, Ministry of Works and Development, MWD), a national water level and flow network, the establishment of the Hydrological Society in 1961, the UNESCO International Hydrological Decade 1965-74, experimental basins, catchment board data, computing, data processing, and science centres.

The 1980s-2020s saw changes in computing and technology, mainframes to microcomputers, desktops, mobile phones, social media. The 1980s included the MWD Hydrology Centre, market forces, and climate change. The 1990s included the establishment of Crown Research Institutes (CRIs) and councils.

The hydrological drivers since the 1980s included hydropower potential and operations, flood warning and control, the Resource Management Act (1991), science restructures 1988-1992, the National Policy Statement for FW Management (NPS-FM) 2010s-2020s, WQ and climate change.

NZ Hydrological Society and operational hydrology

NZHS was formed to bring together practitioners to promote hydrological science, through annual symposia, including international conferences with IAHS, Institution of Engineers Australia and International Association of Hydrogeologists, and other NZ societies (Meteorological, FW Sciences, Rivers), the Journal of Hydrology (NZ) since 1962, and the Society's books. NZHS set up the annual operational hydrology Technical Workshops (every March) and the Operational Hydrology Achievement Awards in the early 2000s. True to its original purpose, it fosters strong links between hydrological science and operational hydrology.

Hydrological networks

Hydrological monitoring networks in NZ cover key components of the hydrological cycle - precipitation (rainfall and snow), glacier extent, evapotranspiration, soil moisture, ground water (quantity and quality), river and lake water levels, river flow, sediment, WQ, and geothermal monitoring. Uses of hydrological data include science understanding, trend analyses (climate, land-use), modelling (surface, ground water), resource management and consents, flood forecasting, frequency and droughts, hydropower and irrigation operations, water pressure-state modelling, and many unanticipated purposes.

Numbers of recording sites

Meteorological data and models: Rainfall and temperature recording was established in the 1850s (e.g., Albert Park 1853, Kelburn 1862), now with 1600 rain gauges run by MetService, councils and NIWA. There are 300 full climate / weather stations, around ten in alpine locations with snow monitoring.

Water level and flow recording: Began in the early 1900s. Central government ran over 300 sites up until science funding cuts in the 1990s reduced that number by 20%. Now councils operate over 1000 hydrometric stations; and NIWA runs around 300 stations.

Ground water: Monitoring commenced in the 1920s and there are now over 500 ground water level monitoring bores in NZ. GNS' National Groundwater Monitoring Programme (NGMP) has over 100 sites, providing a national database on the state and trends of NZ's groundwaters. LAWA (Land and Water Aotearoa) points to council ground water data.

Surface WQ: NIWA's National River WQ Network commenced in 1989 with 77 sites on 35 major rivers to detect significant trends in WQ, by monthly sampling, processed for 20 physico-chemical variables. Councils now run 1100 ANZ Guideline WQ sites.

Hydrological science – basis of operational hydrology

MWD Science Centres were established in the mid-1970s through to transition to the Department of Scientific and Industrial Research (DSIR) in 1988. The Hydrology Centre (Christchurch) included focus on nearby hydropower, irrigation and ground water. The Water Quality Centre (Hamilton) had proximity to WQ issues with central North Island lakes and the Waikato River. The Land Resources Science Centre at Aokautere, near Palmerston North, was a Soil Conservation Centre focusing on the impact of soil erosion on pasture productivity.

The Hydrology Centre (1970s-1992) comprised groups specialising in data processing, data quality assurance, Tideda (time dependent data) database and analysis software, catchment modelling, ground water, environmental hydrology, hydraulics, alpine hydrology, stream ecology / biology, water chemistry, electronics (loggers, telemetry). It was linked to the field teams (DSIR Water Resources Survey 1988-92), and the Kainga Instrument Centre (later Instrument Systems, IS) and the Kainga rating tank for calibration of current meters. The Hydrology Centre produced hydrological manuals and publications, database software, hydrological models, flood forecasting systems. Figure 1 shows DSIR Hydrology Centre staff in 1989.

When ten Crown Research Institutes (CRI) were established in 1992, the Hydrology Centre and WQ Centre went to NIWA, ground water to GNS, water chemistry, microbiology to ESR, and FRI hydrological monitoring (and Aokautere) to Landcare. The

Hydrology Centre moved to Kyle St in Riccarton, to MAF FW Fisheries, with staff from Taupo Laboratories and MetService, forming the basis of hydrological (2), hydrodynamics, sediment and hazard groups today, with FW and marine ecology, and the Christchurch field team. An IS special instruments facility was built on site in 1999.

Council monitoring, science and operational hydrology

Hydrological science / engineering and monitoring teams of catchment boards and regional councils have focused on FW management, flood warning and control, and consents for hydropower operations, irrigation takes. The Local Area Environmental Monitoring Group developed from council operational hydrology in the 1990s, as a council Special Interest Groups (SIG), for regional and national water monitoring coverage, for use in identifying trends in water quantity and WQ. Other council SIGs with links to operational hydrology include Surface Water Integrated Management, Groundwater Forum, CDEM, Hazard Risk Management, and working groups on FW, and National Flood Warning.

Council science strategies for surface and ground water include monitoring, NPS-FM, climate change; and catchment connections, drinking water, and sea level rise for ground water; and WQ, nutrients, sediment, ecology, and Matauranga Māori (Te Mana O Te Wai) for surface water. Councils with CRIs and consultants are the main providers of operational hydrology in NZ.

Councils developed NZ's National Environmental Monitoring Standards (NEMS), through a steering group of council operational hydrologists from the 2000s, with CRI technical and MfE financial support, providing consistent national standards for water level, rating curves, open channel flow, water metering, temperature, turbidity, WQ, hydrological and meteorological structures, etc.

Scientific and technological advances for hydrology and hydrometry

Scientific and technological contributions to operational hydrology include the growth of computing, databases (Tideda and Hilltop), use of ADCPs, the Virtual Climate Station Network, the Land Resources Inventory, S-map (soil moisture), Digital Elevation data, Digital River Network, River Environment Classification, surface water and groundwater hydrological models and remote sensing.

Hydrometric and science advances over the last 50 years have included evolving data loggers, telemetry and database software, and remote sensing through rain radar, drones and satellites. Modelling is being enhanced through use of data science (AI) and high-performance computing. Investment in hydrological monitoring has been through capital expenditure for ADCPs, jetboats, remote controlled boats, vehicles, and maintenance of equipment and infrastructure at recording stations, and investment in staff training (technical – instruments, loggers, telemetry, databases; safety – driving, heights, field work, confined spaces; and the establishment of a Diploma of Hydrology).

Floods

Recording of floods progressed from capturing historical flood marks, to systematic flow records, enabling operational hydrology tasks of flood frequency ("how often" – using at-site, historical, regional and frequency methods, and considering climate change) and flood forecasting ("when" – from subjective, rule of thumb, black box methods to distributed models and AI).

Operational hydrology's role in major flood events, includes preparation (monitoring, and developing frequency and forecasting methos for asset protection and stop bank design), measuring, pegging and forecasting during events, followed by surveying, estimating flood hydrographs and peaks, frequency studies, and infrastructure and resilience reviews.

Major flood events in the 1980s-2020s included Southland 1984, Gisborne 1988 (Bola), Greymouth 1988, Waikato 1998, Clutha 1999, Manawatu 2004, Bay of Plenty 2004, Westport 2021, and Hawke's Bay and Tairāwhiti Gisborne 2023 (Gabrielle).

Droughts

Drought assessment includes use of meteorological and hydrological data (rainfall, soil moisture, lake levels, river flows) for frequency, severity, duration analyses for reporting and warning of droughts. Notable events have included east coast agricultural droughts in the 1980s, Northland and Auckland droughts of the 1990s leading to the Waikato River pipeline to Auckland, and a drought leading to a hydropower crisis in winter 1992.

Seasonal outlooks (three months ahead) and hydroclimate outlooks (rainfall, temperature, soil moisture, river flows) for six broad climate regions of NZ (three per main island) have been published monthly for the last 25 years.

Current status of NZ operational hydrology

Strengths of operational hydrology include its funding by several mechanisms and strong regional drivers for monitoring, and for managing WQ, climate change, floods and droughts. Large population cities / councils have extensive operational hydrology. Challenges exist with variable funding capabilities across the country. Forecasts are still becoming operational. Bringing science solutions and technology to operations is a challenge, as is science funding.

Future NZ operational hydrology

The future focus is on climate change, WQ, more frequent and severe storms, flood and drought events. There is ongoing data required for models, use of remote sensing and new technologies. Emphasis is required on hydrometric infrastructure maintenance, upgrades, advances, flood resilience, and staff succession. Improved access and use of hydrological data, prediction and forecasting is required. Flood forecasting is improving with the use of AI for rapid real time flood map inundation forecasting.

Conclusions

Operational hydrology provides core data for increasing understanding of NZ hydrology, and information to identify and adapt to climate change in rainfall, temperature, drought, extreme weather events, floods and sea-level rise. NZ operational hydrology has strong links with the NZ Hydrological Society, connecting data and science. New methods from science and technology are being taken up by operational hydrology.

Figure 1: Figure 1: DSIR Hydrology Centre staff, Winchmore visit, 1989. Back: Graeme Smart, Heng Seng Low, Sai-On Chan, Tony Hill, Mark Rodgers, Murray Close, Stephen Thompson, Benoit (visiting French student), Steve George, Ude Shankar. Middle: Michael Drayton, Lee Ann Phuah, Charles Pearson, Guy Halliburton, David Leong, Alistair McKerchar, Paul Hutchinson. Front: Graham Macky, Warren Thompson, Ross Woods, Kathy Walter, Richard Ibbitt, Derek Goring, Cathy Kilroy. Front (crouching): Roddy Henderson, Barry Biggs, Maurice Duncan.

ARTICLE

Developing multi-hazard flood forecasts as sea-level rise affects groundwater

By Simon Cox, GNS Science

Climate change and sea-level rise are already affecting coastal regions and cities and seem poised to have unprecedented impacts. While erosion, coastal retreat, floods, and storm inundation are clearly visible, there are other complex and compound effects that are more difficult to directly observe and predict. Shallow groundwater is a largely unseen, and poorly understood, hazard – or contributor to hazards – that has potential to become a major problem where it is hydraulically connected to the sea in low-lying coastal areas. A paper by Cox et al. recently published in the AGU journal Earth's Future outlines a new methodology developed by GNS Science to help address the issue.

The paper outlines how the installation of relatively inexpensive monitoring networks can enable the development of suburb-specific groundwater maps, presenting Dunedin City as a case study. The effect of sea-level rise and extreme events on (i) pluvial flooding, (ii) emergent groundwater and (iii) coastal inundation can be forecast through analysis of groundwater fluctuation and its response to ocean tides and rainfall. Analysis of groundwater variability at each site, and spatial mapping of groundwater surfaces, highlights suburb-scale differences in hazard across South Dunedin, Harbourside and other low-lying coastal land. Unlike coastal inundation, rising groundwater is unconstrained by protective topography and presents as a creeping hazard, or contributor to hazards such as pluvial flooding, which can be widespread, occurring already, and difficult to defend against.

The work in Dunedin highlights how groundwater transfers the effects of sea-level rise surprisingly far inland, and also reveals the lowest-lying or shoreline-proximal suburbs are not necessarily the most vulnerable. Differences in frequency between episodic floods and permanent inundation are important for adaptation and mitigation. Now internationally peer reviewed, the methodology has underlying assumptions that result in conservative ('worst case') assessment which is needed for planning and managing multiple flood hazards in coastal regions.

Cox SC, Ettema MHJ, Chambers LA, Stevens SA, Bodeker GE, Nguyen Q, Diaz-Rainey I, Moore AB (2025). Empirical Models of Shallow Groundwater and Multi-Hazard Flood Forecasts as Sea-Levels Rise. Earth's Future, 13, e2024EF004977. https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2024EF004977

Key points:

• Shallow groundwater is a poorly understood hazard that will convey the effects of sea-level rise far inland.
• Empirical data and geospatial models of groundwater rise can enable multi-hazard forecasts of episodic and permanent flooding.
• Subsurface storage depletion, emergent groundwater and coastal inundation are variable potential factors in flood hazard over time.

Figure 1: Photo: Residents inspect East Avenue in South Dunedin during the 3-4 Oct 2024 floods. (Photo: Hannah Harland, South Dunedin Futures Programme, Dunedin City Council). In a newly published paper, South Dunedin is used as a case-study example of how groundwater monitoring networks can provide important information on flood hazard into the future.

Photo: Residents inspect East Avenue in South Dunedin during the 3-4 Oct 2024 floods. (Photo: Hannah Harland, South Dunedin Futures Programme, Dunedin City Council). In a newly published paper, South Dunedin is used as a case-study example of how groundwater monitoring networks can provide important information on flood hazard into the future.

UPDATE

National Environmental Monitoring Standards (NEMS)

Compiled By Raelene Mercer

(NEMS Project Manager) on behalf of the NEMS Steering Group

The 2024/25 term has been another busy one for the NEMS project, having delivered a series of water quality and freshwater biology workshops across the country, developed new NEMS and reviewed and updated a number of existing documents.

The NEMS Steering Group extends warm thanks to any and all of you who have provided time and expertise into NEMS activities. Collaboration and co-development are key to the ethos of NEMS, and demonstrate that collectively, we are all working towards standardised methods and processes for collecting and handling environmental data.

This year's reviews

New versions have been released of the following NEMS documents:

- National Quality Code Schema
- Processing and Archiving Environmental Data – new Annex for Air Quality PM10 and PM2.5
- Safe Collection of Environmental Data
- Water Level

Thanks again to the working groups involved with these reviews. The NEMS Steering Group have recently adopted a new document format, and the Water Level NEMS is the first example of this. You can check it out on the NEMS website now.

Assessment for the requirement for review is undertaken on an approximately 2-year cycle. Reviews allow for the consideration of feedback received on a particular document, updates and additions relating to new technologies and any other updates and advancements deemed necessary. For example, across the board, there has been the addition of a new QC 0 category in the Quality Coding Matrix. This is to allow data in its "as recorded" state (i.e. prior to any verification or processing) to be distinguished from QC 200 data defined as being of unknown quality, partially processed data or data from an external agency that is lacking a corresponding QC code.

Reviews are currently underway on:

• Turbidity	• Suspended Sediment
• Open Channel Flow Measurement	• Dissolved Oxygen
• Water Temperature	• Rainfall Recording
• Rating Curves	

You will see these new versions released over the next few months, some very soon. If you haven't already, you can register for notification on updates to various NEMS documents www.NEMS.org.nz.

New NEMS

This financial year, two new NEMS were funded by the Ministry for the Environment. These were our first spatial data NEMS. *"Indigenous Cover - Measurement of Indigenous Cover (Extent)"* has just been published on the website, and "Highly Erodible Land and Stabilisation Mitigations - *Measurement of the extent of Highly Erodible Land and Stabilisation Mitigations"* is nearing completion of its final draft and is planned to be published by the end of June.

Work plan for the new financial year

Work planning is underway for the 2025/2026 financial year. The key reviews for 2025/26 are the suite of Discrete Water Quality NEMS, and others will be undertaken as resources allow.

As always, development of new NEMS documents is subject to access to resources, and alignment with regional or national requirements; however, we want to know your thoughts on priorities. The following is a list of topics that the NEMS Steering Group has on the table for potential development, based on feedback from various regional sector Special Interest Groups (SIGs).

Potential new NEMS topics include:

• Barometric Pressure	• Deposited Sediment
• Continuous Nitrate Monitoring (groundwater)	• Landscape connectivity
• Land Fragmentation and Intensification	• Macrophytes
• Solar Radiation	• Gaseous Air Quality Parameters
• Fish Monitoring	• Ecosystem Metabolism
• Marine Sediment Sampling and Analysis	• Land Management - Soil Diversity
• Stream Habitat	

Please let us know your top three priorities, or any other topics you would like to add to the list (and their relative priority), along with a few words about why, using the Feedback form on www.NEMS.org.nz.

Uptake survey findings

Thanks to those in the regional sector who participated in this year's NEMS uptake survey, we appreciate your time and input. The uptake survey, while a requirement of the current NEMS funding agreement with the Ministry for the Environment, also provides the NEMS Steering Group with valuable feedback not otherwise received, and highlights perceived or real barriers to NEMS implementation.

It was pleasing to see that for most continuously measured variables, the level of uptake is significant, which indicates that we are well on the pathway to national standardisation for these methodologies.

Tools

Developing NEMS-compliant tools for field data collection? Your tools can be submitted to the NEMS team to be made available to be shared via the NEMS website. We have a moderation process in place to ensure the tools meet the requirements of the relevant NEMS. Check out the Tools and Resources page on www.NEMS.org.nz.

Final words

The NEMS Steering Group acknowledges the users of NEMS and their increasing focus on implementation and contribution towards the refinement of NEMS, as the true value of NEMS is realised in their use.

We are also very pleased to have received positive comments from overseas. Environmental and data practitioners from Canada, Australia, and Ireland have reached out to compliment the quality of New Zealand's NEMS and the process by which they are developed and have sought permission to reference the documents in their own work. This is a great reflection of the input from the lead writers, technical experts and working groups who have worked to develop the NEMS products to date.

WGA

Compiled By William Dench

Hydrogeology Team Update

WGA welcomes **Toby Beisly** to the WGA Hamilton Office. Toby is a recent graduate from the University of Waikato, where he completed his master's degree, focusing on the vertical profile of sediment movement on intertidal flats. Toby is passionate about the natural environment and the challenges that come with scientific discovery.

His previous research roles have provided him with hands-on experience using a variety of scientific instruments and data processing software, allowing him to excel in setting up and conducting high-quality monitoring systems. Toby's strong technical skills and adaptability make him a valuable addition to our team.

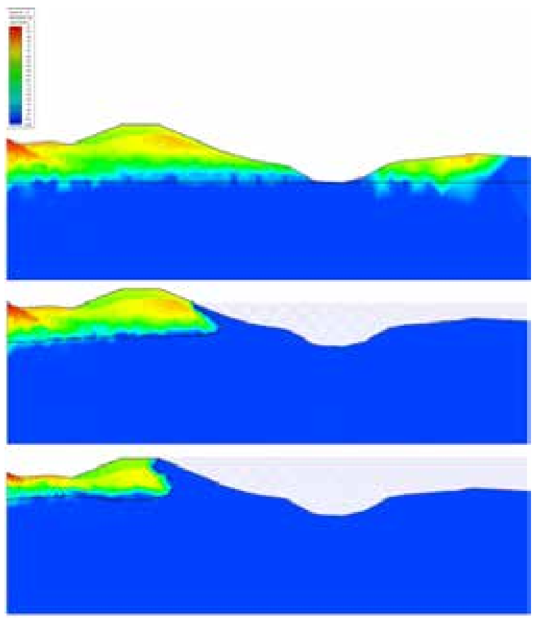
Photo: Toby Beisly

We are pleased to share that **James Manning**, a valued member of our team, has moved to the WGA Perth office. James joined the WGA Christchurch office in 2023 and has been developing his technical skills working in seepage modelling, dewatering assessments, pumping test analyses and drilling supervision. This move offers James an opportunity to immerse himself in a new environment and gain invaluable insights into the unique hydrogeological challenges and innovations across Western Australia. This exciting move marks an important milestone in his professional journey and in the continued

Photo: James Manning

Stopbank Solutions on the West Coast

WGA has been undertaking a series of SLIDE2 seepage modelling projects for stopbanks on the West Coast of New Zealand. These projects support stopbank design and stability assessments, helping to manage flood risks and ensure the safety of critical infrastructure. We are working closely with colleagues at Davis Ogilvie who are undertaking the geotechical analyses in the same modelling package, to provide outcomes that address the challenges of the West Coast geological and hydraulic environment. This work is part of our ongoing commitment to supporting local communities in developing reliable, data-driven solutions for long-term resilience.

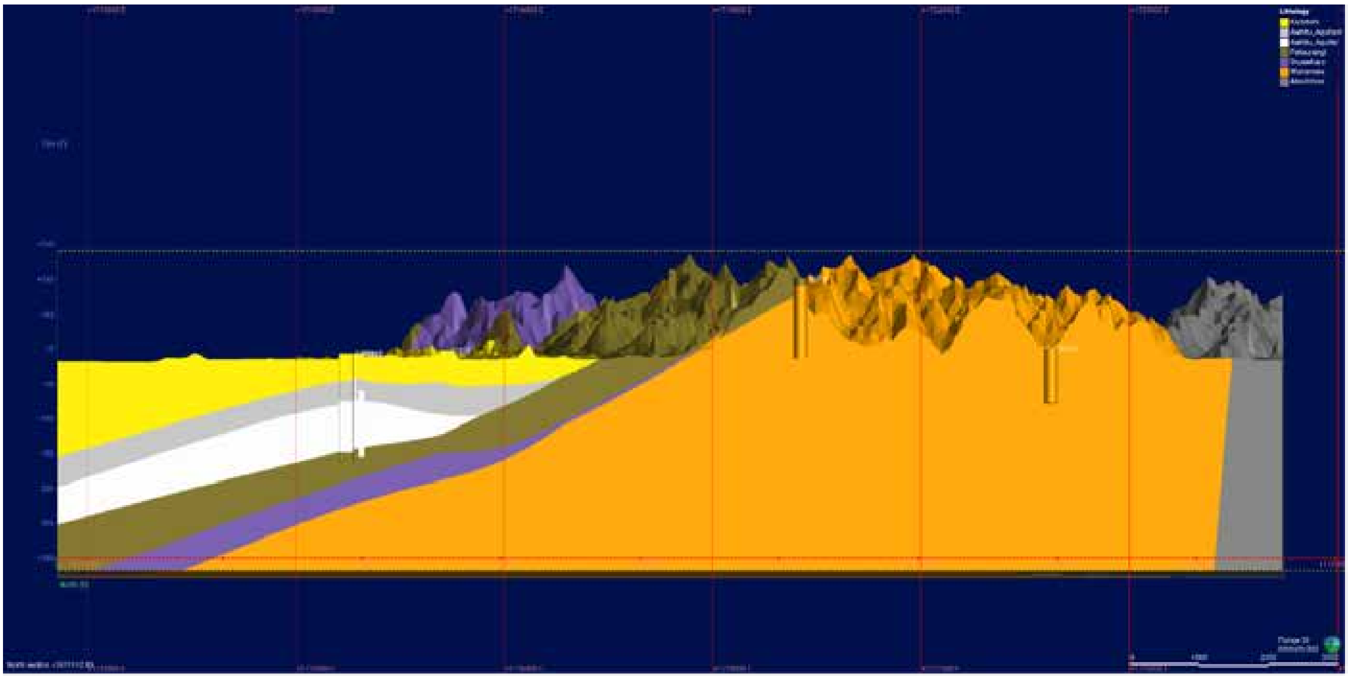


William Dench and Brett Sinclair have been developing a Tāpora Flats Groundwater Model

The demand for groundwater resources has increased following the expansion of irrigated land in the Tāpora Flats area of the Ōkahukura Peninsula. Abstraction from coastal aquifers, like those found under the Ōkahukura Peninsula, can result in declining hydraulic pressures and reduced groundwater discharge offshore, leading to saline water intrusion, rendering groundwater unfit for potable or irrigation use.

Subsequently, Auckland Council engaged WGA to provide a geological model and 3D numerical groundwater model of the peninsula to help evaluate groundwater resources in the Tāpora Flats area. WGA constructed a 3D geological model of the peninsula using Leapfrog and converted this model into a numerical groundwater model for Groundwater Vistas.

The geological and groundwater numerical models were used to support the Council in setting groundwater allocation limits. Copies of the models, together with model documentation, were provided to Auckland Council to enable the council to conduct their own scenario simulations internally, should future groundwater users seek new resource consents.



UPDATE

INTERA

Compiled by Jeremy Bennett

INTERA Incorporated is pleased to announce its growth into New Zealand through the recruitment of Brioch Hemmings and Jeremy Bennett in late 2024. INTERA (https://www.intera.com/) is an environmental and water resource consultancy headquartered in Austin, Texas with offices throughout the US and Europe. The company focuses on innovation and science and includes global leaders in groundwater modelling, geochemical characterisation and uncertainty analysis. INTERA has been active in New Zealand since 2020, and Jeremy and Brioch will be supporting local and international projects as well as the company's research and development programme, headed up by Jeremy White. INTERA's nearest colleagues are in Perth, Australia. The office is led by Matt Uliana, who has recently published an introduction to groundwater science through The Groundwater Project.

Working in water resources

INTERA are continuing to support clients in the water resources sector, including regional councils and water suppliers, with numerical model development and uncertainty analysis for decision support. Brioch has been working with Waikato Regional Council, facilitating groundwater nutrient transport management scenario modelling and associated uncertainty quantification. Jeremy B is continuing to support Greater Wellington Regional Council in managing water resources in their rohe. Jeremy W has been assisting Hawkes Bay Regional Council with development and implementation of a wide range of quantitative analyses to support groundwater and surface-water allocation and management in the Ruataniwha basin.

Mining support

We attended the 2024 Mine Closure conference in Perth, Australia, where the emphasis was on the transition of landscapes from mining activities in a sustainable way. Fellow INTERAns John Sigda and Toya Jones authored presentations on improving probabilistic predictions of post-closure groundwater solute loads and options analysis to reduce solute loading to surface water receptors at the Ranger Mine in Northern Territory, Australia. Jeremy B also attended the ALGA Groundwater and Mining Symposium in Perth in February 2025. The keynote presentation was given on innovation in water quality prediction by Tom Meuzelaar (Life Cycle Geo, USA), comparing mechanistic vs data-driven modelling approaches and the role that each play in understanding water quality.

INTERA celebrates 50 years

INTERA celebrated 50 years of doing stuff since 1974 with a gathering in Austin, Texas. This was a great opportunity for us to meet some of the legends of the company in a relaxed environment and to mark the retirement of former CEO Marsh Lavenue, a pioneer in the use of pilot points for groundwater model calibration. In keeping with the 1974 theme, we represented New Zealand well with a stirring rendition of 'I wanna be sedated' by the Ramones. Will we see a repeat performance at this year's HydroSoc conference… only time will tell.

Please reach out to Jeremy (jbennett@intera.com) or Brioch (bhemmings@intera.com) if you are interested in learning more about INTERA or collaborating with us.

GMDSI Workshop

Groundwater Modelling Decision Support Initiative (GMDSI) is an industry-funded and aligned project focused on improving the role that groundwater modelling plays in environmental management and decision making. GMDSI is managed by Australia's National Centre for Groundwater Research and Training (NCGRT) and administered by Flinders University.

GMDSI intends to hold a workshop in NZ in the week of 22-26 September, focusing on the latest advances in decision-support modelling and the practical application thereof. The workshop will be led by members of the GMDSI steering group, including Jeremy White (INTERA) and Cath Moore (GNS Science) and will provide valuable insights and hands-on experience for practitioners in the field. More information will be available on the GMDSI website (https://gmdsi.org/) and you can register your interest and preferences for the workshop using this online form.

gmdsi
Groundwater Modelling
Decision Support Initiative

UPDATE

Aqualinc

Compiled by Kate Mason

Aqualinc's 20th aniversary

We hosted a special staff event at the end of last year to celebrate Christmas and Aqualinc turning 20 years old. Our founders John Bright and Ian McIndoe sat down for a quick-fire chat and shared their thoughts and views from over the years on our contribution to water and soil intelligence in Aotearoa New Zealand.

Photo: John Bright (R) and Ian McIndoe (L)

Photo: Celebration cake

South Island Field Days 2025

We will be at SIFDs in Kirwee this year, sharing our site M526 with Lumen Environmental and celebrating 20 years of Aqualinc. We will be discussing how we can assist clients with what has become a rapidly changing and complex regulatory arena, as well as the usual field work (sampling, gauging, effluent pond drop tests) and more.

Photo: SIFD 2025

MyIrrigation (powered by SCADAfarm)

MyIrrigation (powered by SCADAfarm) is the result of a collaboration between Aqualinc and the SCADAfarm water management platform, and will provide our clients with improved water management, analysis and compliance using a cloud-based system that can be monitored, via their device (phone, tablet or PC), from anywhere in the world. This will allow them to manage their water use and consent compliance with ease.

The new system saw field data from the old systems seamlessly uploaded into the MyIrrigation (powered by SCADAfarm) platform. Apart from the old legacy systems the field instrumentation remains untouched, while the customer experience changes for the better.

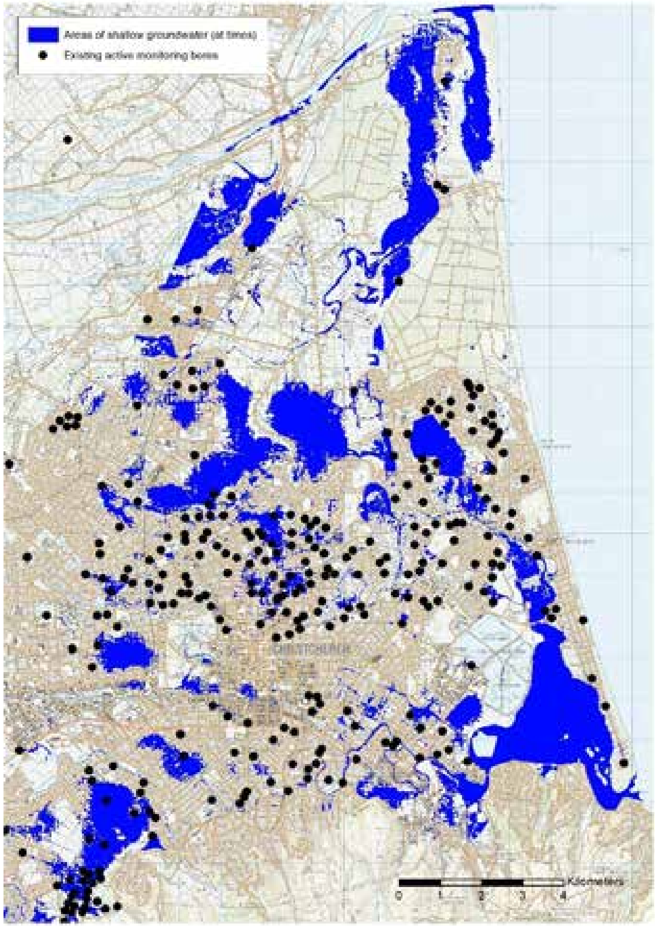
Photo: MyIrrigation (powered by SCADAfarm) demo images

Projects

The Aqualinc team have been busy with a mix of consenting projects for primary sector and Council clients, source water risk assessments, field work (sampling, gauging, effluent pond drop tests), and ongoing research projects (more on these in the next issue).

Christchurch City Council (CCC)'s APP Network

Each year we download and process shallow groundwater level data from Christchurch City Council (CCC)'s automatic piezometer programme (APP) network throughout Christchurch. The network was initially established as part of geotechnical investigations following the Christchurch earthquakes and has been re-purposed to focus on shallow groundwater. Recently we have used this data to generate maps (see below) of shallow groundwater levels that help to inform locations throughout the city where this might be a hazard (at times). We have also used our groundwater flow model to predict the additional changes in shallow groundwater levels that might occur due to future sea level rise, and this has been incorporated into the groundwater flooding risk mapping.



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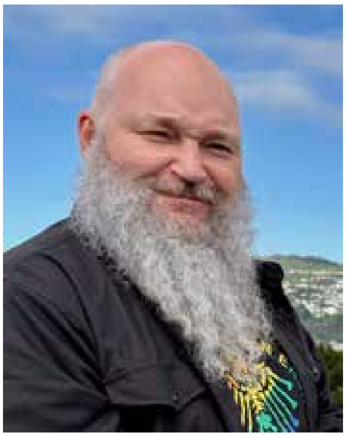
UPDATE

GNS

Compiled by Maïwenn Herpe

Staff news

We are thrilled to welcome two new additions to our teams:



Matthijs van Soest - Thijs joined GNS Science in December 2024 as an Isotope Hydrogeologist at the Water Dating Laboratory with a primary focus on operating and expanding the capabilities of the recently established noble gas analysis facility. During his seven years at the Earth Sciences Division of Lawrence Berkeley National Laboratory in Berkeley California, Thijs worked on using noble gas abundance and isotope measurements from water and gas samples as tracers in a wide range of hydrogeological processes. Thijs then worked for 18 years at the Arizona State University as a research scientist and was one of the main people responsible for building and operating the noble gas facility there. Thijs' initial research focus at GNS will be using the noble gas facility for denitrification studies. However, with the 2024 addition of a Thermo Helix MC+ noble gas mass spectrometer to the laboratory, capable of providing high-precision noble gas isotope ratio measurements, there is now opportunity for a variety of hydrogeological, geothermal and volcanological applications using noble gas abundance and isotope analysis. Many of these are pertinent to New Zealand, and Thijs is excited to work on this. For more information on the noble gas facility and mass spectrometer applications, please contact Thijs van Soest.

Tusar Sahoo - Tusar joined GNS in 2012 as a Geoscientist working on a range of projects including Sedimentary Basins and Tectonics. Since 2018, Tusar has been contributing to the groundwater team by processing and interpreting Airborne Electromagnetic (SkyTEM) data and building 3D aquifer models in the Hawke's Bay and Northland regions. Currently, he is interpreting SkyTEM data collected in the Wairarapa region and developing the associated aquifer potential models. He is also involved in our national aquifer mapping and 3D facies modelling programme. His research focuses on integration of multiple datasets (geological, geophysical, lithological and groundwater flow data sets) to understand complex subsurface processes and develop representative 3D aquifer models. Tusar officially joined the Hydrogeology and Geophysics Team in January 2025.

Hydrogeological mapping of Hawke's Bay through airborne electromagnetic (AEM) data and utilising SkyTEM data to inform groundwater flow models

The Hawke's Bay 3D Aquifer Mapping project (3DAMP) is now completed. The quality and resolution of the subsurface information obtained from this project will be a step change in the region's ability to manage its water resources. This five-year mapping project involved the AEM (SkyTEM) mapping of three important groundwater systems (Heretaunga Plains, Ruataniwha Plains and Poukawa/Otane Basin), as well as drilling, data interpretation, hydrogeological modelling and reporting. The final stage of this project was the incorporation of SkyTEM data into the Heretaunga Plains groundwater flow model, which will assist Hawke's Bay Regional Council with future management of this freshwater system.

The SkyTEM data has been used to update the Heretaunga Plains groundwater flow model by informing groundwater-model layers, parameters and boundaries (Figure 1), as well as undertaking a data-worth assessment. The benefits of incorporating SkyTEM data were found to depend on the type of model prediction and location of the prediction within the groundwater system – for example, improvements in predictions are greatest where they are sensitive to small- to medium-scale flow paths.

The combination of groundwater age data with SkyTEM data provided the greatest reduction in predictive uncertainty. This also highlighted that current numerical groundwater modelling may be under-representing uncertainty, particularly associated with potential groundwater flow across aquifer boundaries, for example, from the surrounding limestone ranges/hills into the Heretaunga Plains aquifer. Overall, the input of SkyTEM data has allowed us to reduce the uncertainty of decision making for the Heretaunga Plains area. This allows stakeholders to have a greater trust in the model and decisions that the model is used to inform. The 3DAMP project was co-funded by the Provincial Growth Fund, Hawke's Bay Regional Council (HBRC), MBIE (GNS Science Groundwater Strategic Science Investment Fund and Te Whakaheke o Te Wai Endeavour).

An online ESRI StoryMap was developed as a public outreach tool to provide access to 3D datasets and accompanying reports. GNS Science is also a contributor to the official HBRC webpage for updates on the 3D aquifer mapping project. Publications (20 reports in total) are available via the StoryMap tool.

Hawke's Bay was the first of five regions (Northland, Gisborne, Wellington and Southland) where GNS Science has collaborated with other authorities to undertake SkyTEM mapping, and, while the mapping is progressing in other regions, we are looking into other applications of the AEM technology, such as refining buried-fault mapping and enhancing landslide and volcanic research. For more information, please contact Zara Rawlinson.

Hemmings BJC, Moore CR, Rawlinson ZJ, Taves MW. 2025. Hawke's Bay 3D Aquifer Mapping Project: Numerical groundwater modelling experiments using SkyTEM data in the Heretaunga Plains. Wairakei (NZ): GNS Science. 298 p. Consultancy Report 2025/05

Rawlinson ZJ. 2023. Hawke's Bay 3D Aquifer Mapping Project: 3D hydrogeological models from SkyTEM data in the Heretaunga plains. Wairakei: (NZ): GNS Science. 69 p. Consultancy Report 2023/57. Prepared for Hawke's Bay Regional Council. Accessible here.

Rawlinson ZJ. 2024. Hawke's Bay 3D Aquifer Mapping Project: 3D hydrogeological models from SkyTEM data in the Ruataniwha plains. Wairakei (NZ): GNS Science. Consultancy Report 2023/117. 60 p. Prepared for Hawke's Bay Regional Council. Accessible here.

Rawlinson ZJ, Hemmings BJC, Moore CR. 2024. Hawke's Bay 3D Aquifer Mapping Project: Heretaunga Plains numerical groundwater model updates using SkyTEM data. Wairakei (NZ): GNS Science. Consultancy Report 2024/10LR. 14 p. Prepared for Hawke's Bay Regional Council. Accessible here.

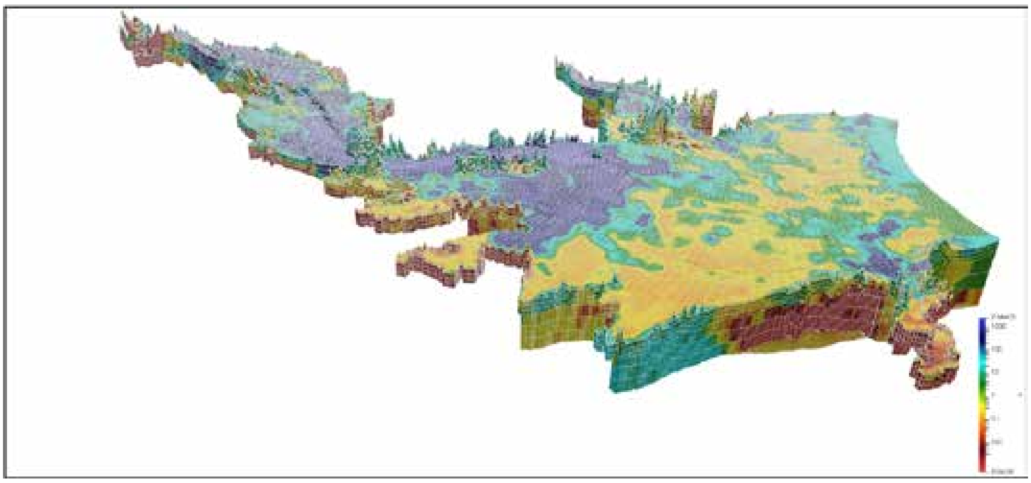


Figure 1. Geometric mean of SkyTEM-derived hydraulic conductivity (m/day) within each model cell of the Heretaunga Plains groundwater flow model, utilised to assist with assigning prior values of horizontal hydraulic conductivity.

Updated Aotearoa New Zealand Hydrogeological-Unit Map now available

GNS continues to progress the development of a 3D, digital aquifer map through facies mapping at the surface and sub-surface and the development of 3D facies models. Facies mapping is being sequenced using the 2D New Zealand hydrogeological systems as boundaries. Hydrogeological systems are defined as geographical areas with broadly consistent hydrogeological properties, and similar resource pressures and management challenges. Facies mapping is developed within a hydrogeological unit framework, which is a 2.5-D GIS dataset (overlapping, stacked polygons) that represents hydrogeological units (i.e. aquifers, aquitards, aquicludes and basement) developed in a nationally consistent manner and that illustrates geological layering.

As facies mapping and modelling progresses, updates are made to these digital datasets. The 2025 release features facies mapped at the surface and subsurface for the inland and coastal systems and minor revisions and fixes to system and hydrogeological unit boundaries. Click on the hyperlinks to access the datasets free-of-charge: New Zealand hydrogeological systems; New Zealand Hydrogeological-Unit Map (Figure 2).

Next planned improvements to the datasets include 3D facies modelling in coastal systems with input from regional councils, mapping of top and bottom surfaces in inland systems, and facies mapping of basement systems. For more information, please contact Stew Cameron.

White PA, Moreau M, Mourot F, Rawlinson ZJ. 2019.New Zealand Groundwater Atlas: hydrogeological-unit map of New Zealand. Wairakei (NZ): GNS Science.Consultancy Report 2019/144. Prepared for the Ministry for the Environment; [updated 2025; accessed 2025 Feb]. https://environment.govt.nz/publications/new-zealand-groundwater-atlas-hydrogeological-unit-map-of-new-zealand/

Moreau M, White PA, Mourot F, Rawlinson Z, Tschritter C, Cameron SG, Westerhoff RS. 2019. Classification of New Zealand hydrogeological systems. Lower Hutt (NZ): GNS Science. 28 p. (GNS Science report; 2018/35). https://doi.org/10.21420/42QW-MC74

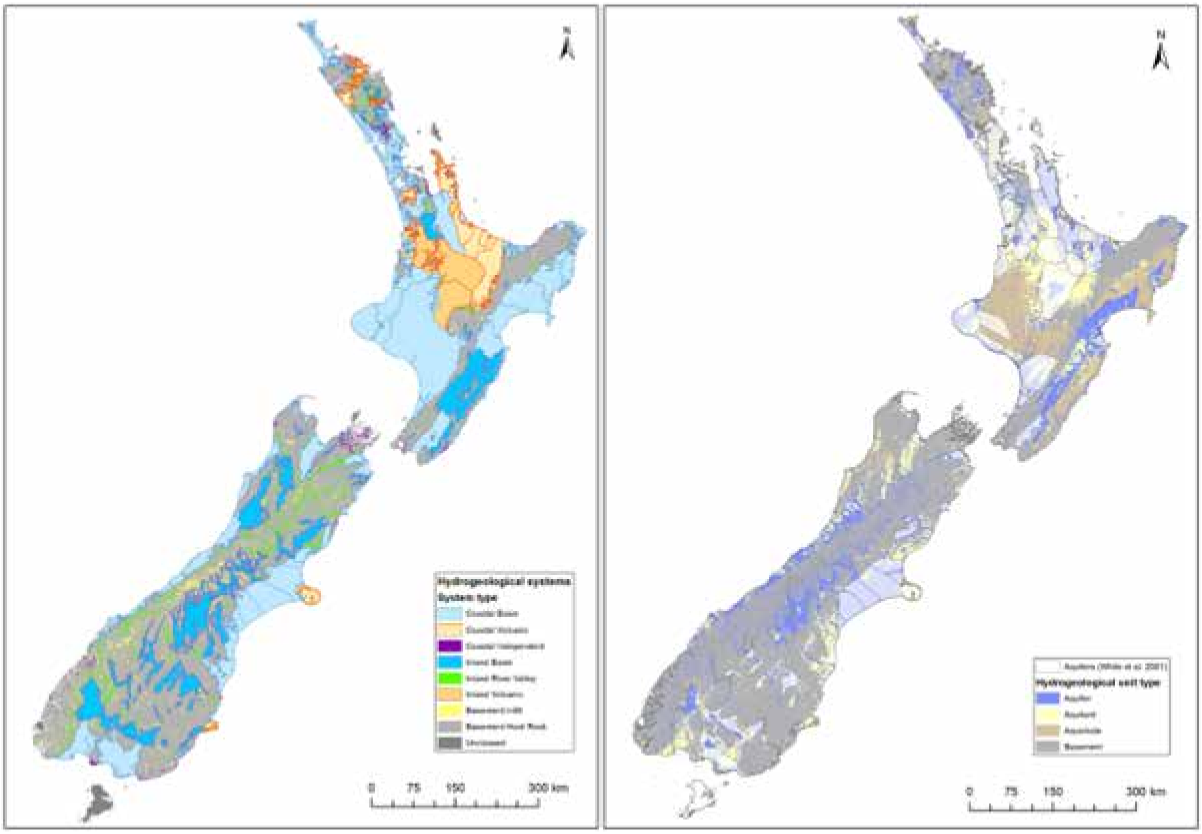


Figure 2. The New Zealand Hydrogeological Systems (left) and Hydrogeological-Unit Map (right) datasets. The datasets are accessible free-of-charge [here] and [here.]

Wairau Plain land cover impacts on groundwater levels

Understanding the potential impacts of historical land-cover change is important to address a key knowledge gap in the Wairau Catchment hydrological system and to identify the causes behind the decline in groundwater levels of the Wairau Aquifer for Marlborough District Council. Historical land-class data from NZ Topo 50 maps (1940s–1980s) were collated, digitised, georeferenced and integrated with the Land Cover Database v5.0 (1996–2018). These datasets allowed changes in land cover to be tracked and quantified.

The largest changes in land cover were a 21,576 ha (5% of total catchment area) decrease of high-producing exotic grasslands and an increase of orchard, vineyard or other perennial crop (17,234 ha) and exotic forest (10,270 ha). These changes occurred between the 1996 and 2018 land-class surveys. The land-class changes potentially increased water demand and, if so, may have contributed to the observed long-term groundwater-level decline. The new land-cover data were compared to hydrogeological data using graphical and statistical analyses. However, the lack of groundwater abstraction time-series data limited the ability to qualify or quantify the impact of land-cover changes on groundwater level. Recommendations include comprehensive monitoring and data collection of groundwater abstraction to enable a more conclusive assessment of the current abstraction effects on groundwater level. This would, in turn, support numerical models to assist future water management. This project was a collaboration with Landcare Manaaki Whenua and Marlborough District Council. For more information, contact Gemma Clark.

Clark GM, Curwen G, Davidson P, Moreau M, Narvaiza M, Mourot F. 2024. Potential influence of Wairau Catchment historical land cover change on Wairau Aquifer levels. Lower Hutt (NZ): GNS Science. 49 p. Consultancy Report 2024/65. Prepared for Marlborough District Council.

The role of Antarctic groundwater in climate change processes

Groundwater is a physical link between a series of key Antarctic climate, environmental and biological processes. Although difficult to observe, there is evidence that groundwater plays a significant role in the global water budget, ice-sheet dynamics, ecosystem function, and carbon and methane cycling (Figure 3).

However, many groundwater concepts in Antarctica are still hypothetical, awareness is low, and direct observations are limited. Volumes of Antarctic groundwater have yet to be considered in global inventories, knowledge of occurrence and flow is limited, and offshore flux is essentially unknown.

Therefore, the Scientific Committee on Antarctic Research (SCAR) has recently kicked off a Groundwater Action Group to bring the international scientific communities together to better address this cross-disciplinary topic. The Action Group aims to improve understanding of the flux and flow of liquid-water through the continental rock-mass and its interaction with, and influence on, the cryosphere and biosphere by bringing the international communities together to address this cross-disciplinary and wider continental margin topic and solicit wide international representation.

The co-chairs of the SCAR Groundwater action group are: Rogier Westerhoff (GNS Science, NZ), Sarah Seabrook (NIWA, NZ), Jill Mikucki (University of Tennessee, US), and Bernd Kulessa (University of Swansea, UK). For more information on the membership, please visit SCAR. For more information on the action group, please contact Rogier Westerhoff.

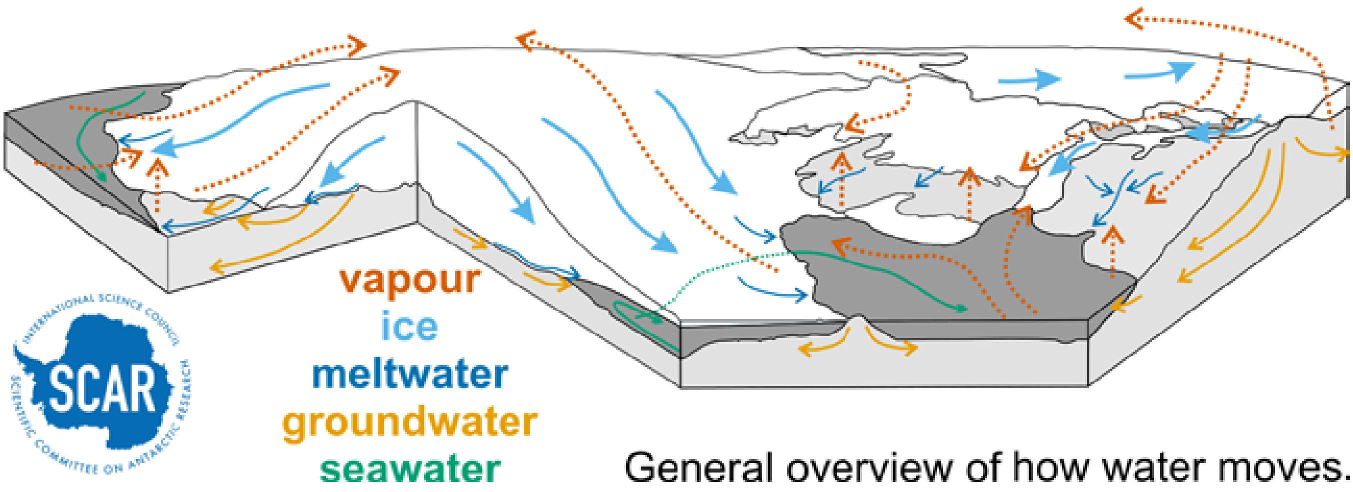


Figure 3. Schematic showing an overview of the movement of water in Antarctica.

UPDATE

NIWA

Compiled by Jim Griffiths

Wairau Plains groundwater

Marlborough District Council (MDC) has commissioned NIWA groundwater hydrologists to develop an integrated surface-groundwater model for the Wairau Plains to assess the impact from climate change and sea-level rise. The initiative is part of a broader effort encompassing three interconnected modelling approaches, all addressing sea-level rise, and pluvial and fluvial flooding. The groundwater model specifically aims to enhance land and water management in Blenheim and surrounding area by tackling the challenges posed by climate change and rising sea levels. NIWA is subcontracting GNS to assist in developing the conceptual model of the hydrological system. The project's outcomes will offer critical insights for regional adaptation strategies, and safeguarding vital community assets and ecosystems. Contact jing.yang@niwa.co.nz if you are interested in this project and for more information.

Bed level change in Ihutai/Avon-Heathcote Estuary

Christchurch City Council have a consent application for short-medium term flood and erosion protection measures at the edge of the Ihutai/Avon-Heathcote estuary. They need to determine whether activities along the estuary edge will contribute to "coastal squeeze" in the intertidal zone (and other areas favoured by seagrass) over the next 20 years. NIWA will provide advice on how sedimentation, vertical land movement, and sea level rise will impact bed levels, water levels and intertidal zones up to 2045.

So far, LiDAR data, vertical land movement assessments, and hydrodynamic modelling data for current and future sea level rise (SLR) scenarios have been used to support the assessment. Early results indicate that for southern parts of the estuary, the intertidal zone will remain unchanged (even under the most extreme SLR scenario the change in intertidal area is almost negligible). The influence of SLR increases at the northernmost extent of the investigation area where the intertidal zone could shrink by about 60%, reducing the proportion of seagrass to 53% of current levels (for the highest SLR scenario). However, lower SLR scenarios see a very small change in the extent of the intertidal zone and potential seagrass habitat. These insights will inform analysis by ecologists to support the resource consent application. Contact arman.haddadchi@niwa.co.nz for more information.

Enhancing river digital networks for improved water management

NIWA scientists are changing the way freshwater resources are managed through the development of multi-purpose river digital networks (DNs). These networks are used for policy-making, environmental planning, and scientific research, and serve as key inputs for classifications, models, and simulations that help shape water management strategies. Unlike traditional networks that focus on large rivers, the new approach will incorporate smaller streams, ditches, and ephemeral channels—water pathways that only flow temporarily. The new approach means that characteristics such as channel density, alignment, and coverage can be tailored to suit various applications.

A novel innovation of this research is an enhancement to the Strahler ordering system and the introduction of a multi-coloured labelling system. This new system allows users to dynamically adjust DN density, ensuring a single DN can serve multiple purposes with consistency and efficiency.

Below is an example of a generated network which includes:

- **Blue lines** resembling river channels seen on 1:50k cartographic maps but generated using LiDAR-derived DEMs for greater accuracy.

• **Purple lines** indicate ephemeral channels extending beyond cartographically mapped networks.

• **Red lines** highlight ephemeral flow pathways upstream of river channels on an 8m resolution grid.

This work marks a significant advancement in freshwater management, ensuring that digital networks remain adaptable, precise, and fit for a range of environmental and policy needs. Contact doug.booker@niwa.co.nz for more information.

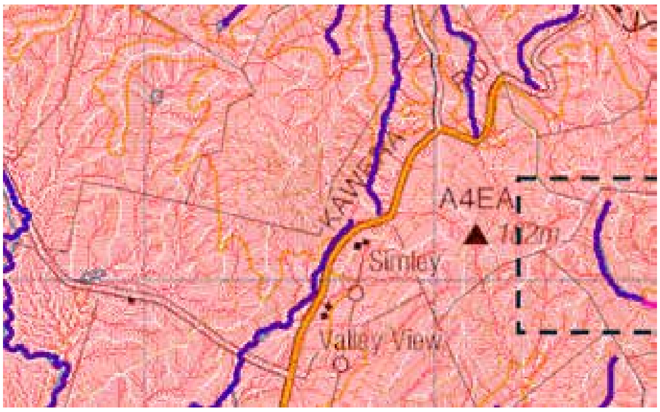


Figure 1. Example section of newly generated digital network for improved water management.

Subsurface processes in braided rivers

The five-year MBIE Endeavour Research Programme 'Subsurface Processes in Braided Rivers' came to an end in September. The research programme involved a large interdisciplinary research team, led by Lincoln Agritech, and with NIWA playing a key role leading the field component and surface modelling work. The project has focused on three study rivers, the Selwyn/Waikirikiri (Canterbury), Ngaruroro (Hawkes Bay) and Wairau (Marlborough), and all three rivers had significant floods during the course of the study. The research programme developed new understanding of how braided rivers work in the subsurface and importantly how management of braided rivers impacts groundwater recharge. Key findings are that braided rivers have a "braidplain aquifer" and are best considered as a "river system" that includes the water on the surface, the gravels of their bed and the water flowing through these gravels. This braided river system may be perched above the regional aquifer or connected to it. In disconnected settings, narrowing the braidplain reduces groundwater recharge. In connected settings, lowering the riverbed level reduces groundwater recharge. An economics assessment of alternative river management approaches showed that continued lowering of riverbeds (e.g. through over-extraction of gravel) could have a negative impact on market and non-market values. Raising and/or widening of riverbeds could have a positive market and non-market benefit. For more information relating to NIWA's role in this project contact Jo.Hoyle@niwa.co.nz.

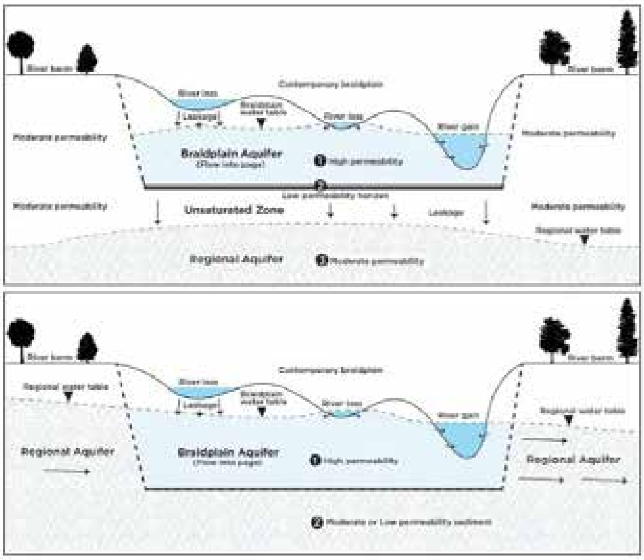


Figure 2. Conceptual models of subsurface processes in braided rivers.

Lower Waiau River habitat modelling

NIWA recently completed a collaborative project, working with the Cawthron Institute to model ecological habitat under a range of flows in a reach of the Lower Waiau River. This project was undertaken for Environment Southland and results will be used to inform water allocation decisions as part of Plan Change Tuatahi. NIWA's role in this project included both fieldwork and modelling. The fieldwork involved mapping substrate across wet and dry parts of the reach, and surveying depth and velocity throughout the reach at two different discharges to provide calibration and validation data for modelling. The modelling work involved development, calibration and validation of a two-dimensional numerical flow model that was used to map habitat suitability for a range of species. NIWA provided data to Cawthron Institute for them to undertake Net Rate of Energy Intake modelling. For more information relating to NIWA's role in this project contact Jo.Hoyle@niwa.co.nz.

Figure 3. Very chilly winter fieldwork in Southland, surveying bathymetry and mapping substrate in the Lower Waiau River.

UPDATE

Lincoln Agritech

Compiled by Juliet Clague

Hydrological Society Conference 2024

A strong Lincoln Environmental contingent attended "HydroSoc" 2024, presenting on varied topics. Presenters included Scott Wilson, Thomas Wöhling and Alice Sai Louie (Braided Rivers research and Wairau Plains studies), Guin Knight (groundwater recharge from ephemeral rivers), Linda Robb (radon in groundwater), Jungho Park (modelling high-frequency pH data in river water), Roland Stenger (transit times and hydrological pathways) and Helen Rutter (nitrate variability in groundwater and shallow groundwater and its interaction with urban infrastructure). It was an honour for Helen to receive an award for Services to the Hydrological Society.

The Lincoln Agritech team at HydroSoc 2024

Helen Rutter with her award

Emerging Climatic Pressures programme

We are well under way with our Emerging Climatic Pressures Endeavour Programme, investigating climate change impacts on the Waikato River. We recently held a mihi whakatau and karakia on the banks of the Waikato River at one of our telemetered monitoring sites to officially mark the start of our field research programme. Representatives from Ngāti Korokī Kahukura and Waikato Tainui welcomed us onto the site, we shared some kai and had many discussions around the research, the health of the river and climate change. Researchers and their PhD students from Lincoln University, the University of Otago, University of Auckland and University of Waikato shared their research aims and objectives, and Chris McBride and Tadhg Moore from Limnotrack provided information on the multi-parameter sondes to be installed.

At the field site on the banks of the Waikato River

Tadhg Moore from Limnotrack explains the different parameters being monitored using the sonde

New Zealand Mana Tūāpapa Future Leader Fellowship

Lincoln Agritech team member Jeff Lang has been awarded a New Zealand Mana Tūāpapa Future Leader Fellowship. This fellowship offers promising early career researchers the chance to excel in their chosen research fields by providing $820,000 over the next four years. Jeff will be working to develop and validate a novel approach to identifying past earthquakes, using the natural record found within caves in Aotearoa. Recent studies indicate that strong ground motions leave elevated traces of magnesium within stalagmites and stalactites. Magnesium and its isotopes will be analysed to identify signatures of historic earthquakes and validate these as a new marker for past seismic activity.

Braided Rivers research

The Braided Rivers Endeavour research programme, led by Scott Wilson, drew to a close in September 2024. The findings of the research have been fundamental in developing understanding of the impacts of river management on groundwater resources and have prompted a change in approach to river management in regional councils. Scott recently gave a briefing to councillors from Environment Canterbury on the results, and you can view that briefing here. The research has stimulated other interests and Lincoln Agritech has been working with the University of Canterbury on an MfE project to map rivers across New Zealand. Lincoln Agritech looks forward to continuing this important area of work in future projects.

Shallow groundwater

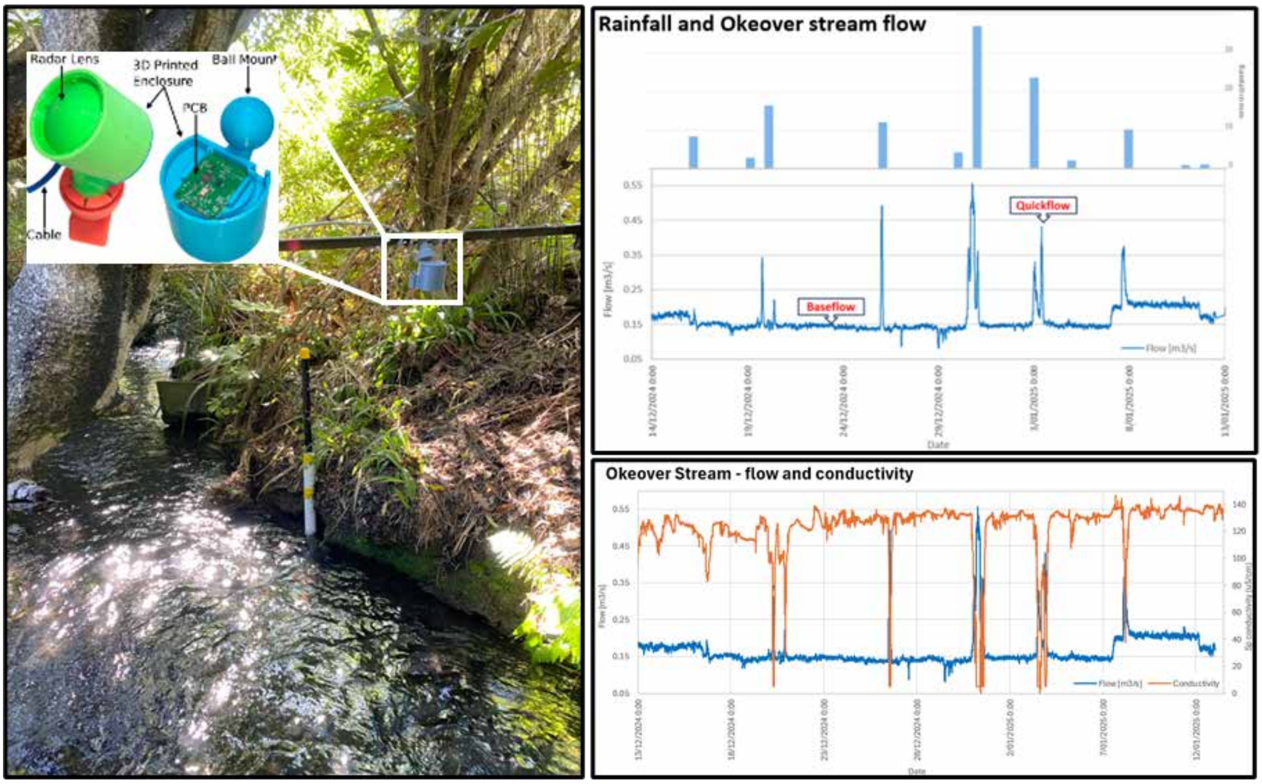
Helen Rutter was recently invited to talk about shallow groundwater and stormwater at the Brightstar Floods, Erosion and Catchment Management conference in Auckland. It was a small but fascinating conference with some excellent presentations on diverse topics related to flood resilience, erosion control, and sustainable catchment management. The aim was to foster collaboration among stakeholders and promote knowledge sharing, to work towards a more resilient and sustainable future.

UPDATE

ESR's Groundwater Team

Compiled by Laura Banasiak

ESR in the field



ESR has been trialling a novel low-cost radar sensor for non-contact stream flow measurements. The sensor design consists of a radar module, accelerometer and microcontroller, which was developed by BoSL Water Monitoring, Monash University (www.bosl.com.au). The sensor outputs both stream velocity and water depth, and with a known cross-sectional area a volumetric flow can be calculated.

Over an unusually wet Christchurch summer, Phil Abraham and Brent Gilpin deployed and tested the sensor in the spring-fed Okeover stream. The flow data correlated well with local rainfall and conductivity data, a useful surrogate measure of water quality.

The rainfall events caused flash flows in the stream and the average baseflow increased from 150 L/s, peaking at a maximum of 550 L/s. The quick-flow response from the surface runoff also caused a dilution in water quality. Quantifying stream flow is an important measurement in assessing the impact of contaminant loads on receiving environments. Low-cost monitoring solutions are key to communities being able to better understand local water quality trends.

Groundwater safety in a warming world

As the world continues to warm, groundwater is expected to support adaptation against climate change, particularly as groundwater is often more resilient to the impacts of climatic change than surface waters. However, in Aotearoa, few studies have sought to examine the vulnerability of our aquifers to climate change.

Our SSIF project (started July 2023) will develop new methodologies to quantify climate change effects on the physical, chemical and biological quality of groundwater and dependent surface waters and will leverage our findings to develop mitigation strategies. The three components of the project include:

(1) determining climate-related changes to recharge, water table elevation, and groundwater flow dynamics that have the potential to affect the quality of groundwater and connected surface water bodies in several different hydrogeological settings;

(2) determining the impact of increased groundwater salinity within the freshwater range (i.e., at increments below <1500 µS/cm) on pathogen survival (e.g., Campylobacter), and test the reliability of faecal indicator organisms (e.g., E. coli);

(3) examining the impact of predicted sea-level rise on the spatial extent of saline intrusion in coastal aquifers nationwide.

For component 3, we are developing a model that integrates nationwide water-level monitoring data to identify coastal areas with landward hydraulic gradients (i.e., where groundwater levels are lower than sea level). This model will then be used alongside published sea-level rise projections to assess changes in risk profiles under various climate scenarios.

Groundwater safety in a warming world

Over the past 6 years the ESR team **(Louise Weaver, Netty Bolton, Hayden Masterton, Judith Webber, Phil Abraham, Panan Sitthirit)** have been sampling the complex diversity in our groundwater. We have travelled across New Zealand in our search for Stygofauna and the foundation of these underground systems, the microbes that maintain our groundwater quality. Our report for MfE, *Groundwater ecosystems preliminary biodiversity of uncommon aquifers: Fractured Basalt and Coarse Sand*, is on the Ministry for the Environment website: https://environment.govt.nz/publications/groundwater-ecosystems-preliminary-biodiversity-of-uncommon-aquifers-fractured-basalt-and-coarse-sand/

Further, we recently completed another piece of work for MfE in collaboration with Massey University, NIWA and Wilderlab that established a database of taxonomic and genetic data on Stygofauna species. We have a database that we are finalising that will soon be available for Aotearoa to store libraries of Stygofauna, including sequence data and taxonomic identification (it will be available soon at https://geome-db.org/).

Our PhD student, **Prudence Gowo** (Auckland University), is coming into her final year and is busy preparing papers that will enable a molecular approach to identification of Stygofauna. Prudence has been developing a targeted approach to detect Amphipods and Syncarida in our groundwater. This tool will be incorporated into our database for development of a toolbox for the assessment of (ground)water quality.

Figure 1. Left: Hayden Masterton happily sampling in Auckland. Right: PhD student Prudence Gowo enjoying sampling for Stygofauna!

Decentralised wastewater management: toward enhanced freshwater and drinking-water safety

ESR's decentralised wastewater research, led by **Bronwyn Humphries** and **Louise Weaver**, continues to advance our understanding of risks from onsite wastewater management (OWMS) discharges to freshwater and human health. Our first paper from the GIS-based tool is soon to be published in Journal of Hydrology (New Zealand). The GIS-based map is being expanded out to other regional councils after initial success in Canterbury.

Bronwyn Humphries and **Greg Hatley** have recently written a report summarising the guidance in New Zealand on managing public health risks during emergencies, with a focus on WASH principles. The team are now working to establish updated guidelines, including community response.

A survey is about to start on the health risks from composting toilets in New Zealand. **Louise Weaver, Alex Meister** and **Panan Sitthirit** are undertaking a study on the efficacy of composting toilets for removal of pathogens. The study will look at composting stages of composting toilets used in New Zealand as a first step in providing guidance on managing the health risks when using composting toilets, including managing the risk of pathogen and contaminant transport to shallow groundwater.

Pathogens in groundwater: using novel surrogates, modelling and data science to understand their fate and transport in aquifers

A new project led by **Allanah Kenny** and **Theo Sarris** started in July 2023, builds on previous work by using novel surrogates and advanced modelling techniques to quantify pathogen transport in groundwater. A large-scale tracer experiment was completed at our Burnham experimental site at the end of last year, where both pathogens and novel pathogen surrogates were injected and tracked through space and time at multiple sampling wells.

We have also planned a series of laboratory experiments to study the survivability of various pathogens, while considering the complexities of the groundwater environment such as biofilm growth and freshwater biogeochemistry, which cannot be replicated in batch testing.

Additionally, ongoing work focuses on our Image-to-Image deep learning model, undertaken by PhD student **Loc Nguyen** at Victoria University. This model integrates data assimilation and AI to link conceptual geological representations, conditioning data, and field measurements to probabilistic space-time distributions of contaminant transport. Specifically, it aims to identify cross-domain mappings between heterogeneous hydraulic conductivity fields and plume propagation, while incorporating physical conditioning parameters. The model has so far demonstrated high accuracy and computational efficiency, and further developments are underway.

Developing 3D-printed bacteriophage biocarriers for the treatment of drinking water distribution systems biofilms

In this new SSIF-funded project initiated in 2024, ESR's Sujani Ariyadasa (project lead), Louise Weaver, Liping Pang and Craig Billington are working in collaboration with Hossein Najaf Zadeh of the University of Canterbury to develop a bacteriophage-mediated, environmentally friendly, and sustainable solution for treating biofilms in drinking water distribution systems. Bacteriophages (viruses that infect bacteria) are found abundantly in the environment and are increasingly used in a wide range of applications as a novel antimicrobial agent against hard-to-treat bacteria. This project aims to isolate bacteriophages from groundwater, surface water, and wastewater environments, produce phage mixtures with the ability to lyse strains of key biofilm-forming/dwelling bacteria *Pseudomonas fluorescens, Klebsiella pneumoniae, and Legionella pneumophila*, and develop a 3D printed carrier tool for the delivery of the phage mixtures in drinking water distribution systems.

In recent laboratory trials carried out by Sujani Ariyadasa and Amy Dellow (University of Canterbury summer student), 96 bacteriophage plaque forming units were successfully isolated (Fig. 2). These will be purified and prepared into mixtures with enhanced bacterial lysis activity in upcoming experiments.

Figure 3. Some of the bacteriophage plaque forming units isolated from groundwater (left, host: K. pneumoniae) and raw wastewater (right, host: P. fluorescens)

Recent publications and outputs

A new paper titled "Reducing Uncertainty of Groundwater Redox Condition Predictions at National Scale, for Decision Making and Policy" has just been published in Environmental Management by **Theo Sarris, Scott Wilson** (from Lincoln Agritech), **Murray Close, Phillip Abraham** & **Allanah Kenny.** This was part of a previous project that aimed to predict redox conditions across Aotearoa, as a key indicator of naturally occurring denitrification in the groundwater which is often used to inform spatial planning and targeted regulation.

We've also recently published a paper titled "A numerical investigation of the effects of model parameterization on the delineation of source protection zones under uncertainty" in Water Research by **Allanah Kenny, Theo Sarris, David Scott** & **Cath Moore** (GNS Science). This work was part of the GNS-led Te Whakaheke O Te Wai project and aims to provide guidelines and recommendations for practitioners in delineating source water risk management areas (SWRMAs) in complex heterogeneous alluvial gravel systems. Available at: https://doi.org/10.1016/j.watres.2024.123010

UPDATE

SLR Consulting

Compiled by Gillian Holmes & Deb Maxwell

Our New Zealand Hydrology, Hydrogeology and Coastal team, led by Tim Baker, provides a range of technical specialist services, covering all areas of hydrology, hydrogeology, water resource investigations, coastal processes and hazards, and management. The team has grown this year to nine technical consultants that service our national clients, with Fraser Philip joining the Wellington team in February as a Project Consultant. Fraser holds a Master of Science specialising in surface water hydrology and flooding, following a BAppSc in Environmental Management and Ecology, both from the University of Otago.

Recent projects

Te Arai geomorphology and riparian assessments

This multidisciplinary project brought together SLR's staff in hydrology, geomorphology and ecology to build an understanding of the geomorphic and fluvial systems within Te Arai catchment. As part of this, a high-level two-dimensional TUFLOW™ model was developed to estimate the likely relative hydraulic conditions (e.g., velocity, stream power and bed shear stress) of Te Arai during a range of design flows. Key areas of concern and riparian restoration actions were identified for Te Arai River based on outcomes of the geomorphic and hydraulic assessment. Lead by **Dr Jack McConchie**, and supported by **Oliver Anderson**, **Deborah Maxwell**, **Elysśa de Carli** and **Abigail Salmond**, these assessments are being used by Gisborne District Council to support the development of new regulatory provisions around the management of Te Arai River, providing recommendations to improve the health of the river, while balancing the risks around flooding, erosion, channel change, and bed aggradation.

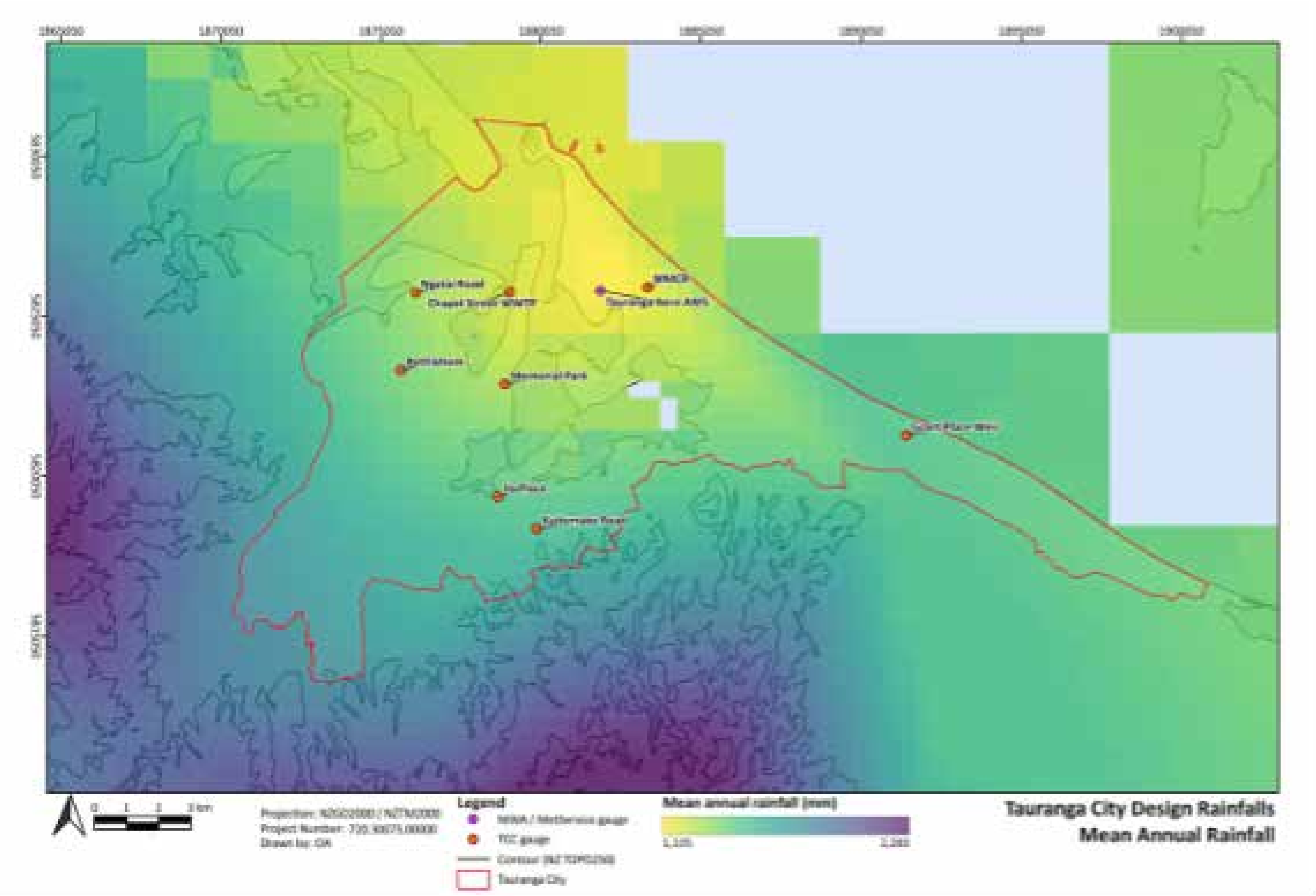
Solar farm flood hazard assessments

Our hydrology and hydrogeology team, **Charlotte Lockyer, Gillian Holmes, Deborah Maxwell** and **Oliver Anderson**, have completed a number of initial desktop and detailed flood hazard assessments for several proposed solar farm sites across New Zealand. Desktop studies provided a high level qualitative assessment of the likely flood risk at the site, considering the location of the site, topography, hydrology, hydrogeology,

land use and soils. Depending on the outcome from the desktop assessment, detailed flood assessments were conducted which involved developing a site specific TUFLOW™ hydraulic model and providing information on the likely extent, depth and velocity of flooding resulting from a range of design storm events. These models take into account the various constraints, varying levels of complexity, and amount of information available. The purpose of these assessments is to provide information that will inform design at various stages of the project and identify high-risk areas where panels or infrastructure should be avoided.

Tauranga City design rainfall 2023 update

SLR worked with Tauranga City Council to update their design rainfalls used for infrastructure planning. The design rainfalls had been previously updated in 2005 and were derived from the development of a virtual climate station for the city using nine available rainfall records across the city. With an additional 17 years of data and a better understanding of the potential effects of climate change, **Dr Jack McConchie**, **Deborah Maxwell** and **Oliver Anderson** reviewed the previous approach for using a single virtual climate record to characterise rainfall experienced across Tauranga city. Statistical and frequency analyses were updated and included design rainfalls adjusted for climate change. In addition, we derived empirical adjustment factors (multipliers) to account for the datasets having different lengths and temporal resolutions. By not relying on a single gauge and a fixed recording interval, the design rainfalls are informed by the spatial variability and randomness inherent in high intensity rainstorms.



UPDATE

Waterways Centre

Compiled by Amandine Bosserelle

Location: The Centre is on the 4th floor Beatrice Tinsley building, University of Canterbury, and the Forbes Building, 8th floor, at Lincoln University.

Our website is up https://www.waterways.ac.nz/

Teaching updates

Dr Leanne Morgan is teaching groundwater hydrology at UC at both undergraduate and postgraduate level in semester 1 of 2025 and student numbers are very strong. There are 50 students in the undergraduate (3rd year) Groundwater and Geothermal Systems course and 30 students in the postgraduate (4th year) Applied Hydrogeology course. Dr Morgan is also supervising three PhD students and three Master's thesis students.

Waterways students **Ella Farrugia, Alaina Baker, Stephanie Koviessen, Jack McMecking, Naflia Attamimi** and **Hunter Price** submitted their Master Theses in February/March 2025!

Research updates

Dr Leanne Morgan is involved in the 'Future Coasts Aotearoa' project. Future Coasts aims to transform coastal lowland systems threatened by sea-level rise into prosperous communities. This is a five-year (2021-26) collaborative Endeavour Fund research programme led by NIWA and funded by the Ministry of Business, Innovation and Employment (MBIE). Dr Morgan's latest publication from this project is:

Morgan LK (2024): Sea-level rise impacts on groundwater: exploring some misconceptions with simple analytic solutions. Hydrogeology Journal 32, 1287–1294. https://doi.org/10.1007/s10040-024-02791-1

Dr Morgan is also involved in the MBIE Endeavour-funded project 'De-risking carbon dioxide removal at megatonne scale in Aotearoa', which has the goal of removing up to one million tonnes of carbon from the atmosphere each year. This project is led by UC's Dr David Dempsey and commenced in 2025.

Dr Amandine Bosserelle is a Postdoctoral Fellow and her research focuses on coastal hydrogeology as part of the Future Coasts Aotearoa project. Amandine's research provides a national-scale model by classifying coastal shallow aquifers and predicting their vulnerability to sea-level rise. She is also investigating coastal near-surface unconfined aquifers using a range of methods from water quality (salinity) and levels monitoring to geophysics.

The latest publication from her doctoral research finished in 2024 includes:

Bosserelle AL, Hughes MW (2024): Groundwater monitoring infrastructure: Evaluation of the shallow urban and coastal network in Ōtautahi Christchurch. Journal of Hydrology: Regional Studies 55 https://doi.org/10.1016/j.ejrh.2024.101934

Bosserelle AL, Hughes MW (2024): Practitioner perspectives on sea-level rise impacts on shallow groundwater: Implications for infrastructure asset management and climate adaptation. Urban Climate 58 https://doi.org/10.1016/j.uclim.2024.102195

PhD candidate Tara Forstner has recently had a literature review article on groundwater hindcasting published from her PhD research in Journal of Hydrology.

Forstner TA, Morgan LK, Moore C, Kitlasten W (2025): Leveraging the past to inform groundwater futures: A review of data archives, reconstruction approaches and opportunities for groundwater hindcasting applications. Journal of Hydrology 656 https://doi.org/10.1016/j.jhydrol.2025.132924

PhD candidate **Alice Sai Louie** was placed runner-up in the Fall Walls Lab Aotearoa New Zealand competition for her pitch, Breaking the wall of hidden waters. She was also selected to attend Global Youth Science Summit in Singapore, engaging with leading scientists, including 11 Nobel laureates. She is now buckling down to finish her final PhD chapter on cable skin effect.

PhD candidate **Andrea Pozo Estivariz** has recently published an article from her PhD research in the International Journal of Climatology, focused on characterising heavy rainfall events leading to flooding in New Zealand. Andrea is in the final stretch of her PhD thesis, working on the development of a hybrid machine learning-hydrodynamic model for rapid prediction of flooding impacts.

Pozo, A., Wilson, M., Katurji, M., Cagigal, L., Méndez, F. J., & Lane, E. (2025): Characterising local flood-inducing heavy rainfall through daily weather types and large-scale climatic patterns: Aotearoa New Zealand study case. International Journal of Climatology https://doi.org/10.1002/joc.8762

PhD candidate **Connor Cleary** submitted his PhD in late January and is now working on publications arising from the work. Connor has taken up employment at Komawana Solutions Ltd.

Dr Rachel Teen's PhD was recently conferred, and she is working on manuscripts for publication. The first is close to being submitted to Water History journal, 'Influences on urban water strategies: Water governance biographies of two Australasian cities'. Rachel is travelling overseas in April and is keen to work for a water services entity on her return.