NZHS E-CURRENT NEWSLETTER • NUMBER 62 • NOVEMBER 2022

NEW ZEALAND HYDROLOGICAL SOCIETY
E-CURRENT NEWSLETTER

INSIDE THIS EDITION

Conny Tschritter, NZHS Secretary

MESSAGE FROM THE EXECUTIVE

Kia ora,

Summer is coming and with it our annual NZHS conference. This year's conference will take place in Dunedin and is a joint conference with the Meteorological Society NZ. I'm really looking forward to it. The conference theme "Our water: a taonga in an ever-changing world" reflects the value of water to Aotearoa New Zealand. You can find latest version of the conference programme on the hydrometsoc website. Big thanks to the conference committee for getting all of this sorted. That must have taken quite a bit of time and effort. On top of this, the conference committee also managed to organise some amazing keynote speakers for us:

- Bridget Scanlon, a hydrogeologist and Senior Research Scientist at the Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin;
- Grant Hose, an Aquatic Ecologist and Ecotoxicologist from Macquarie University, Sydney; and
- Graeme Smart, a Principal Scientist for Natural Hazards and Hydrodynamics at NIWA.

Their bios are in this *e-Current* issue, so please check them out if you want to know more about the keynote speakers.

For those of you who arrive in Dunedin Sunday or Monday, check out the Science–Policy workshop planned for Monday. If you're staying until Friday, have a look at the two exciting field trip options planned. And if you have a little bit more time, why not check out some sights, like the spectacular Tunnel Beach or the albatrosses at the Royal Albatross Centre.

Last but not least, I want to thank OnCue for their help throughout the year with the NZHS 'stuff' in general, as well as with *e-Current* and the conference.

Hope to see you all in Dunedin.

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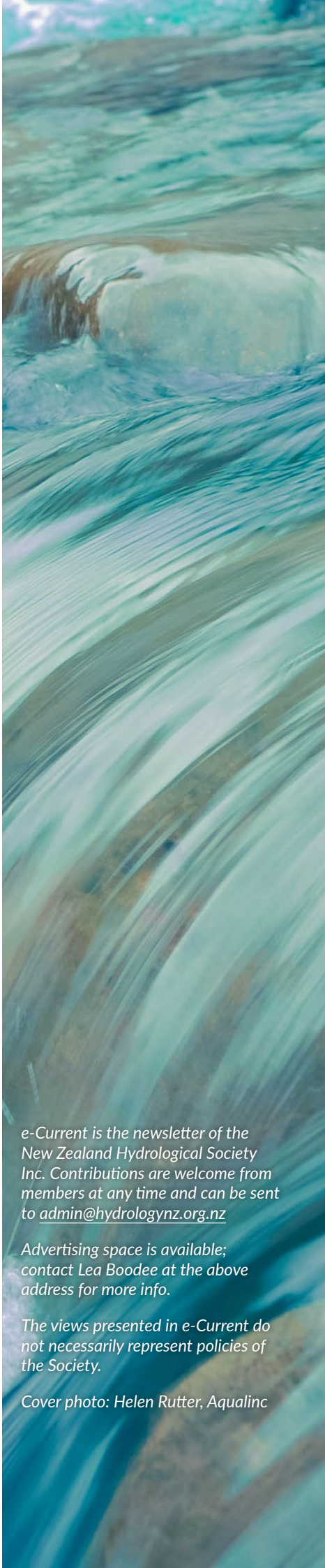
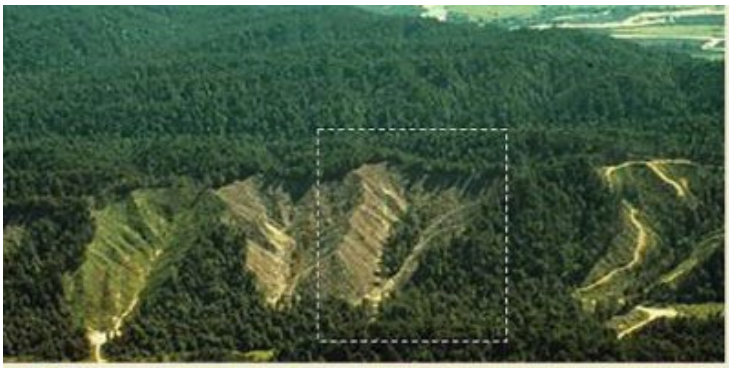


e-Current is the newsletter of the New Zealand Hydrological Society Inc. Contributions are welcome from members at any time and can be sent to admin@hydrologynz.org.nz

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

Cover photo: Helen Rutter, Aqualinc

UPCOMING EVENT



MAIMAI FIELD DAY

FOR RESEARCHERS, POSTGRADUATE STUDENTS, CONSULTANTS, GOVERNMENT SCIENTISTS

FEB 20, 2023

AN EVENT TO CELEBRATE 50 YEARS OF RESEARCH AT THE MAIMAI EXPERIMENTAL CATCHMENT AND TO ENCOURAGE ANOTHER 50 YEARS OF RESEARCH BY NZ SCIENTISTS

WHERE: THE MAIMAI EXPERIMENTAL CATCHMENT, REEFTON, SOUTH ISLAND, NZ

LED BY JEFFREY MCDONNELL (UNIVERSITY OF SASKATCHEWAN) AND UWE MORGENSTERN (GNS SCIENCE)

WITH SPECIAL GUEST SPEAKERS:
ANDY PEARCE (FORMER CEO MANAAKI WHENUA – LANDCARE RESEARCH)
TOM DUNNE (UC SANTA BARBARA)
MIKE STEWART (GNS SCIENCE)
BRIAN MCGLYNN (DUKE UNIVERSITY)
CHRIS GABRIELLI (SELKERMETRICS INC.)
MAGALI NEHEMY (TRENT UNIVERSITY)

ARRIVE FEB 19 - DEPART FEB 21

More Information visit:
water.usask.ca

Global Institute for Water Security USASK

GNS SCIENCE TE PŪ AO

UPCOMING EVENT

SAVE THE DATE: 28–31 MARCH 2023

CONFERENCE


NZHS
MSNZ
JOINT CONFERENCE
Our Water: A taonga in an ever-changing world
6-9 DECEMBER 2022
ŌTEPOTI DUNEDIN
www.hydrometsoc22.co.nz

CONFERENCE

2022 Keynote Speaker – Tues 6 Dec 9.30am

Bridget Scanlon

Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin

Bridget Scanlon is a Senior Research Scientist at the Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin. Her degrees are in Geology with a focus on hydrogeology with a B.A. Mod. from Trinity College, Dublin (1980); M.Sc. from the Univ. of Alabama (1983), and Ph.D. from the Univ. of Kentucky (1985). She has worked at the Univ. of Texas since 1987. Her current research focuses on various aspects of water resources, including global assessments using satellites and modeling, management related to climate extremes, and water energy interdependence. She serves as an Associate Editor for Water Resources Research and Environmental Research Letters and has authored or co-authored ~170 publications. Dr. Scanlon is a Fellow of the American Geophysical Union and the Geological Society of America and a member of the National Academy of Engineering.

Relative importance of climate and humans on water storage changes using GRACE satellite data

Understanding climate and human impacts on water storage is critical for sustainable water-resources management. Here we assessed causes of total water storage (TWS) variability from GRACE satellites by comparison with climate forcing, particularly droughts and irrigation water use, in major aquifers in the U.S.. Results show that long-term variability in TWS from 2002 – 2020 tracked by GRACE satellites is dominated by interannual variability in most of the major aquifers. Low TWS trends in the humid eastern U.S. are linked to low drought intensity. Although irrigation pumpage in the humid Mississippi Embayment aquifer exceeded that in the semiarid California Central Valley, a surprising lack of TWS depletion in Mississippi is attributed to streamflow capture. Marked depletion in the southwestern Central Valley and south-central High Plains totaled ~90 km3, about three times greater than the capacity of Lake Mead, the largest U.S. reservoir. Depletion in the Central Valley was driven by long-term droughts (≤5 years) amplified by increased groundwater irrigation. Low or slightly rising TWS trends in the northwestern (Columbia and Snake Basins) U.S. are attributed to dampening of drought impacts by mostly surface water irrigation. GRACE satellite data highlight synergies between climate and irrigation, resulting in little impact on TWS in the humid east, amplified TWS depletion in the semiarid southwest and southcentral U.S. caused by overexploitation of groundwater resources, and dampened TWS depletion in the northwest and north central U.S. related to conjunctive use of surface water and groundwater. Sustainable groundwater management benefits from conjunctive use of surface water and groundwater, inefficient surface water irrigation promoting groundwater recharge, efficient groundwater irrigation minimizing depletion, and increasing managed aquifer recharge.

CONFERENCE

2022 Keynote Speaker – Wed 7 Dec 8.30am

Grant Hose

Aquatic Ecologist and Ecotoxicologist, Macquarie University, Sydney

Grant is an aquatic ecologist and ecotoxicologist. His research examines the response of groundwater ecosystems, invertebrate (stygofauna) and microbial communities to environmental change, and develops tools for assessing change in ecosystem health and condition. Grant and his team undertake field surveys and laboratory-based experiments to identify correlative and causal links to community change.

His team has expertise in stygofauna taxonomy and using environmental DNA (eDNA) to characterise the composition and function of groundwater ecosystems. His current research focuses on the ecology of groundwater ecosystems and assessment of ecosystem health, ecological risk assessments and ecotoxicology for groundwater biota and the roles of stygofauna in providing ecosystem services.

Assessing change in groundwater ecosystems and why it matters

Groundwater and the subterranean ecosystems from which it is drawn are essential for the health and prosperity of environments, societies and cultures. Human impacts to groundwater, including over-extraction, contamination, salinisation and climate change threaten the health and condition of groundwater ecosystems to such an extent that they may no longer provide critical ecosystem services.

Assessing environmental change in subterranean ecosystems is a challenge due to limited accessibility of the subsurface environment, the relatively low diversity and density of organisms, and the limited knowledge of their taxonomy and functions. In this talk, I will provide an overview of the structure and function of groundwater ecosystems, and consider the threats, and potential impacts of those threats to the invertebrates (stygofauna) and microbes in groundwater. Robust sampling strategies and novel tools, including environmental (e) DNA, can provide insight into the diversity and ecosystem health of groundwaters. I will discuss sampling approaches and tools for measuring change in groundwater ecosystems, and why changes to groundwater organisms matter.

CONFERENCE

2022 Keynote Speaker – Thurs 8 Dec 8.30am

Graeme Smart

Principal Scientist for Natural Hazards and Hydrodynamics, NIWA, Christchurch

Graeme is Principal Scientist for Natural Hazards and Hydrodynamics at NIWA and a member of the UN Joint Expert Team (JET) that guides and coordinates hydrology across the WMO and other UN organisations. He has worked for the Swiss Federal Institute of Technology, the Indonesian Ministry of Works, NZ, German and Swiss foreign aid programmes and Volunteer Service Abroad. Graeme has advised on hydro and inundation forecasting/mitigating projects in Fiji, Hispaniola, Iraq, Indonesia, Malaysia, Samoa, Switzerland, Tanzania, Vanuatu and NZ. He helped set up the RiskScape software and patented the first pressure-operated electronic, river-flood meter (POEM). He has taught several university courses and published widely in fields related to flood forecasting, flow turbulence, flow resistance and hydrology. He is an entertaining and informative speaker.

Recent flood disasters – the exceptional phenomenon of global watering

Wars and pandemics have lately dominated news channels and obscured an extraordinary outbreak of serious flood disasters that have occurred around the world. Journalists now raise an eyebrow when reporting yet another "100-year flood" and tolerance or indifference may be creeping in as extreme events become more frequent. Just as there was widespread inertia in accepting that climate change was real, there is now similar inertia in accepting that the effects of climate change will be severe. Only the insurance risk industry seems to have understood the gravity of the situation and they are starting to refuse insurance cover for the properties which most need it. The wide-ranging lethargy is going to cost us dearly and it will become more and more difficult to manage climate-related hazards using conventional, plan-based or building-code type approaches when the playing field is no longer level, the goalposts are moving and the teams are playing-on, regardless of the rain. What is missing is proper recognition of the increasing seriousness of the problem. This hinders the informed planning and investment that is necessary to mitigate effects of the impending floods. A concerted effort is required to look for better ways to educate decision makers and publicise and explain the growing probability of extreme events. The mitigation process starts globally with urgent action to reduce the primary cause of the increasing flooding, - global warming, and ends locally with urgent planning that appreciates the residual risk in existing flood defences and plainly recognises that flood plains are plains that flood. We need to improve our flood warning systems and prepare our evacuation and disaster response strategies.

In order to bring home the message of the recent, phenomenal increase in global watering, this talk will document, visualize and explain some of the hundreds of exceptional flood events that have occurred over the past 18 months, both on the home front and overseas.

The imagery and statistics are sobering.

ARTICLE

Earl Bardsley, University of Waikato

Pumped storage on the Waikato River?

There was a little-noticed national grid emergency on the morning of Tuesday October 13, 2022. A fault in the Cook Strait cable caused restricted power transfer from the South Island to the North. This resulted in a call by Transpower for immediate North Island power savings. The fault was fixed quickly but illustrated a vulnerability of North Island power supply to sudden outages. The need for North Island peaking ability to provide power firming will become more important as further increments of intermittent wind and solar power are added to its generating mix. Relevant recent reports have been produced by Transpower (2022), the Boston Consulting Group (2022), and the Electricity Authority (2022).

Ideally, new North Island peaking plants (able to produce rapid-response power) would be emission-free and displace some or all of gas-fired generation capability. The two obvious candidates here are large batteries and pumped storage.

Batteries will play a role but the rising price of lithium makes difficulties for planning. Contact Energy recently cancelled its intended 100 MW battery because of price uncertainties. In addition, batteries are not strictly sustainable because they need replacement at some stage.

Pumped storage has capability to store more fast-response energy than the present generation of batteries. A North Island pumped storage scheme should ideally be near the grid and have minimal environmental impact. The upper reservoir should have high elevation above the lower, but without too much horizontal separation. This in turn implies stable geology in a location of high relief.

Two North Island sites stand out. Both are in close proximity in the southern Waikato. One site is located near Kinleith and has at least 14 GWh of energy storage capacity. This is sufficient to maintain, for example, 300 MW for two days. It is a closed-loop scheme, which shifts the same water backwards and forwards. This has energy value but is of minimal hydrological interest.

The second site is more hydrologically interesting. It has similar energy storage capacity but is open loop with Lake Whakamaru serving as the lower reservoir. The upper reservoir (Fig. 1) would need to be created by excavation of the summit region of a nearby rhyolite dome above the lake. It would probably

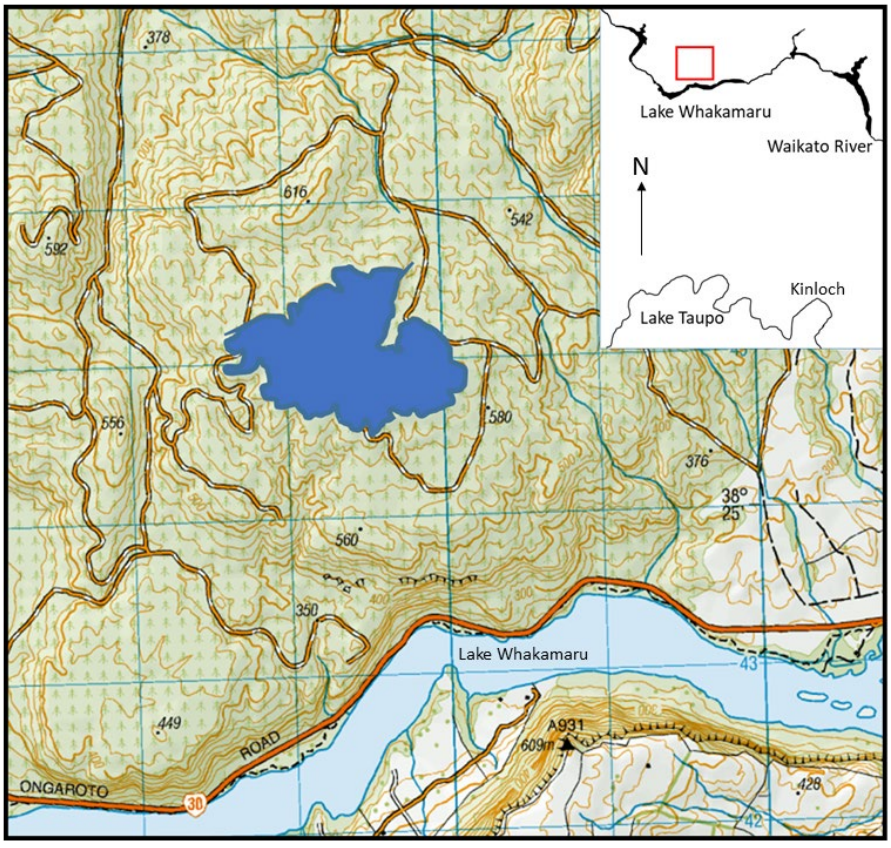


Figure 1. Possible upper reservoir (blue) at 600 metres asl, adjacent to Lake Whakamaru (lower reservoir). Map source: LINZ.

also serve as a local quarry in the initial construction phase. The local steep rock slopes (Fig. 2) could permit surface penstocks rather than more expensive rock tunnels.

If constructed, the scheme would need to work in conjunction with Mercury's Waikato River hydro operations. For example, generating 300 MW would add about 90 m^3s^{-1} into Lake Whakamaru. Pumping at this discharge from the lake might sometimes reduce spill at the nearby Whakamaru power station.

If both the open- and closed-loop schemes were constructed then this would add at least 30 GWh of fast-response energy storage capability at a strategic North Island location. At the University of Waikato we are looking to carry out simulations of this dual system to evaluate whether it might provide a power security buffer sufficient to eliminate gas-fired electricity generation.

Figure 2. Rhyolite cliffs adjacent to Lake Whakamaru, near the probable location of pumped storage penstocks connecting to the upper reservoir. Photo credit: Peter Bardsley.

ARTICLE

Greater Wellington

Investing in hydrogeological conceptualisation to enhance confidence in sustainable resource analysis and decision-making – Pirinoa/Onoke area of the Southern Wairarapa

Mark Gyopari, Rob Van Der Raaij, Rebecca Morris, Mike Thompson, Lindsay Annear, John Begg, Richard Kellett

Greater Wellington is developing a sustainable allocation plan for surface and groundwater resources in the Pirinoa/Onoke area of the southern Wairarapa. The effects of groundwater abstraction on the surface water environment are of particular concern within the side valley catchments of the Turanganui and Tauanui rivers (Fig 1). These hydrologically sensitive small river systems have

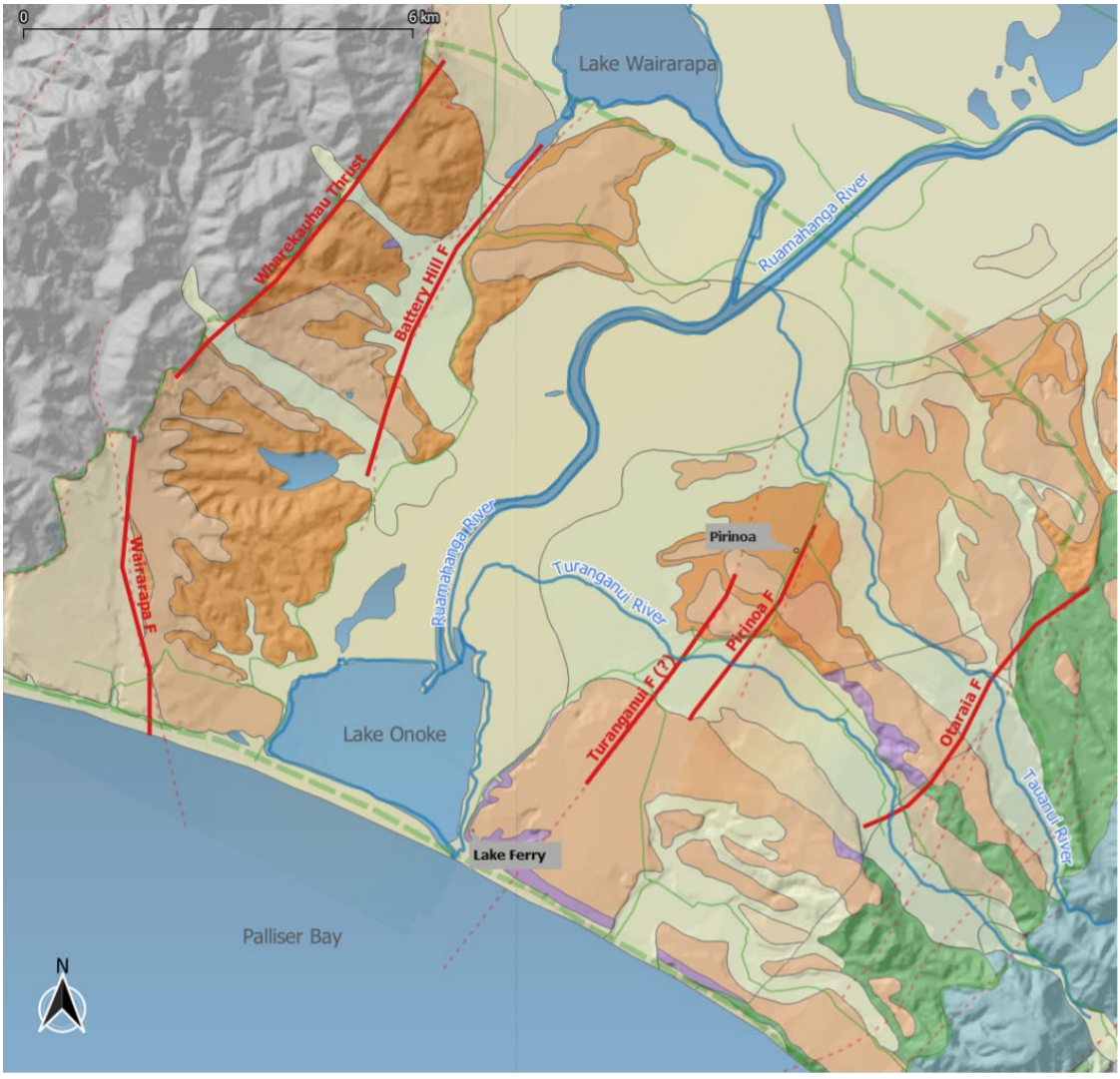


Figure 1. Pirinoa-Onoke study area, Southern Wairarapa. QMAP (1:250,000) on the Onoke/Lake Ferry area. Colours other than light yellow and mid-yellow represent older uplifted late middle and late Quaternary surfaces and thus can be considered part of the uplifted 'valley floor'

experienced unprecedented low flows and drying in recent years. Other resource management concerns relate to a remnant bush area of high ecological value that has experienced water stress and canopy die off, and the potential for saline intrusion at the Lake Ferry-Onoke foreshore.

It was determined that development of a sub-regional groundwater model needed to be supported by a more robust conceptual model than previously available given the geological complexity of the area – being influenced by complex tectonics involving high rates of uplift, tilting and major active faulting. This has been achieved by investing time and resources over a two-year period to develop a new geological analysis, undertaking water chemistry and age dating sampling and establishing river flow and groundwater level monitoring sites.

Geological modelling

The geological understanding of the Onoke-Pirinoa was revised through evaluation of existing data (bore logs and maps), new geophysical surveys (undertaken by GNS Science; Kellett et al., 2022) and geomorphological and stratigraphic analysis (J. Begg, pers comm). Geophysical surveys in the Turanganui and Tauanui side valleys, and extending into the main Ruamahanga Valley, were carried out to help identify the main aquifer and aquitard units and understand their distribution across the area and how they are influenced by several major active structural features. The geophysical surveys comprised a set of GroundTEM (transient electromagnetic) soundings and two ERT lines (electrical resistivity tomography). Figure 2 shows one of the ERT lines in the Turanganui valley and the hydrostratigraphic unit interpretations.

The resistivity characteristics of the sequence, in combination with other information, resulted in the identification of three lithostratigraphic water-bearing units ranging in age from Holocene to early Quaternary. The deeper productive aquifers units were interpreted to be of significantly greater age than elsewhere in the Wairarapa valley and shown to be dislocated by major faulting resulting in a semi-compartmentalisation of the groundwater system. For instance, Figure 1 illustrates the considerable thickening of resistive sediments to the east of the Pirinoa Fault (location TG11 in Fig. 1) which has yet to be explored or confirmed through drilling. The ERT lines proved particularly useful in contributing to evidence for the nature of connectivity between deeper aquifers and surface water environments. The surveys also provided valuable information on the location, thickness and extent of aquitard units.

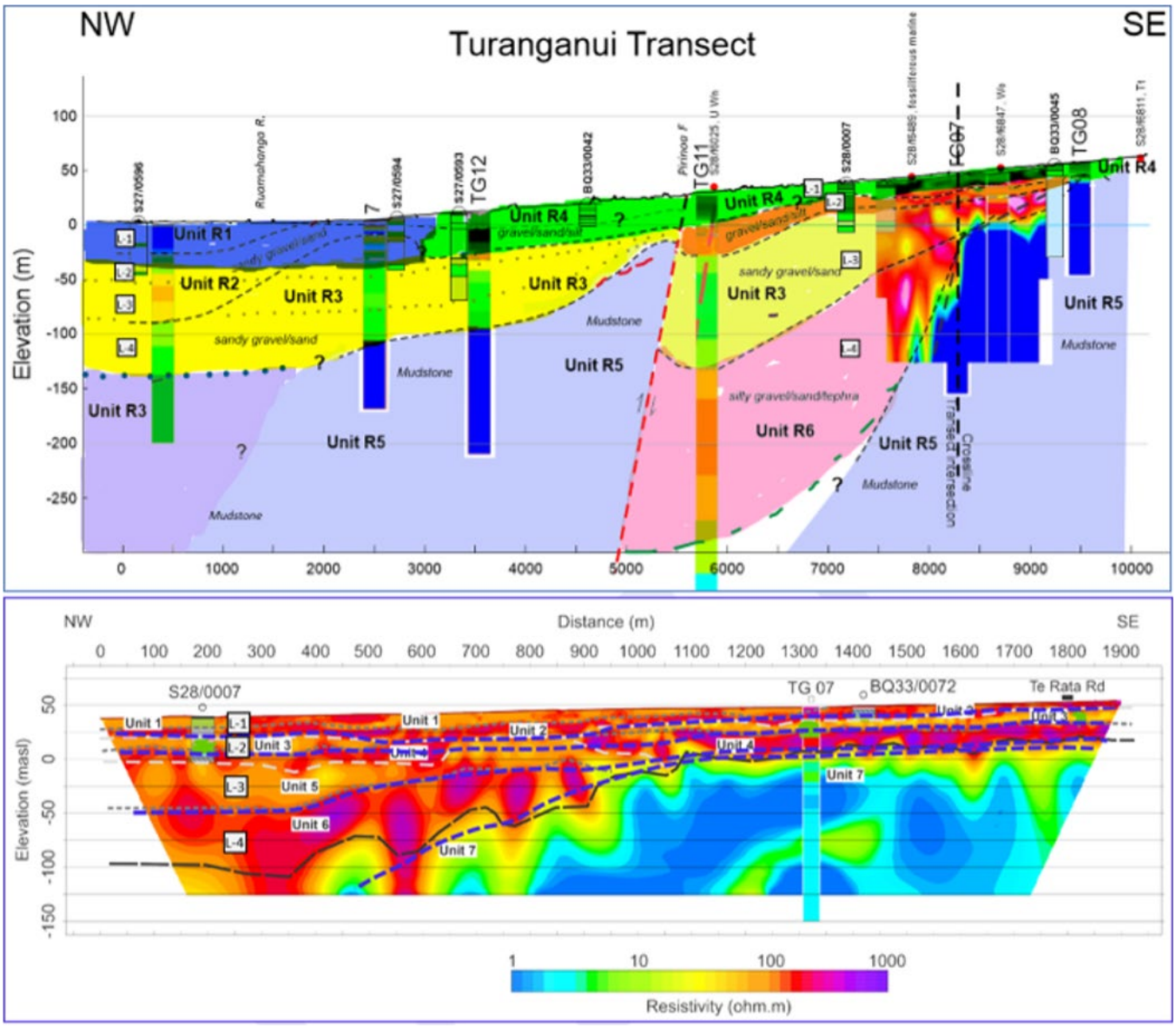


Figure 2. Turanganui transect (top) and ERT line (bottom, represented in the south-eastern part of the transect) showing representation of interpreted 4 layers in the Onoke groundwater model and geological structure.

Hydrochemistry and age dating

Chemistry data collected as part of this study, alongside historical chemistry data, were analysed using hierarchical cluster analysis (HCA) to help identify relationships between different water-bearing units. HCA identified clusters with similar chemical characteristics to clusters observed from an HCA analysis incorporating chemistry data from the wider Wairarapa (Daughney et al. 2009). Waters with lower solute loadings are found within the side valley catchments and along the sides of the main valley, while more evolved groundwater with higher solute loadings are found in the main valley. Groundwater age dating concurred with these findings, with groundwater in the main valley having mean residence times (MRTs) ranging from 50 years to greater than 180 years, varying with depth. Groundwater in the side valleys was generally much younger, with most sites having MRTs of less than 20 years. Seasonal age samples (summer / winter) were taken to help understand the connection of the deeper bores with surface water. Preliminary results show there may be changes in MRT with season at some bores.

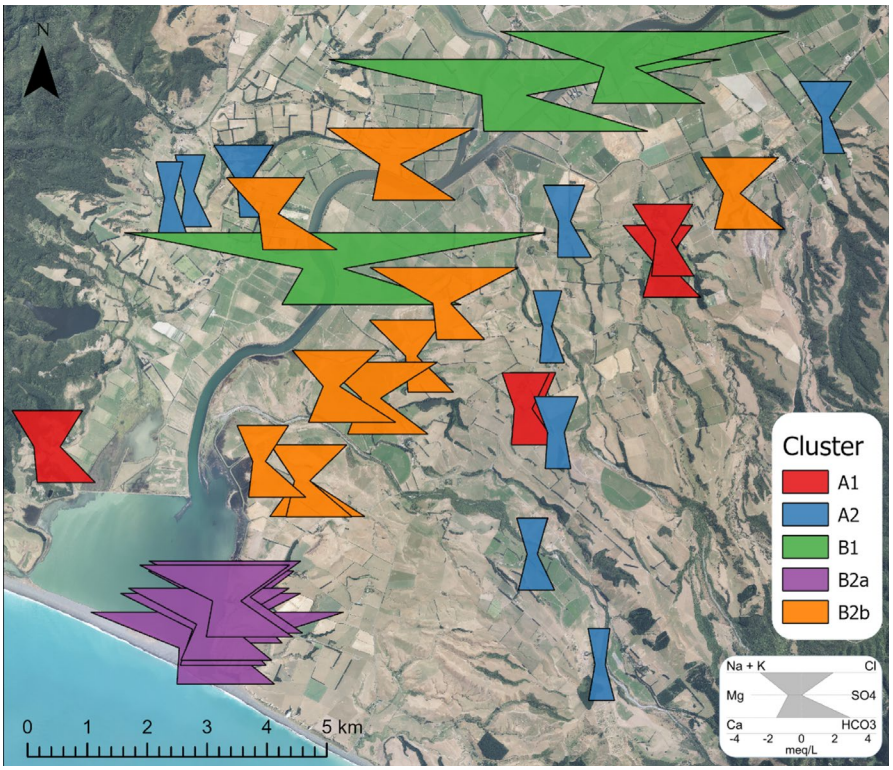


Figure 3. Map showing results of HCA analysis, with chemistry represented as Stiff diagrams

Numerical modelling

The purpose of developing a sub-regional Onoke model was to inform management of water resources in the Onoke area of the southern Wairarapa by Greater Wellington. Specific objectives included provision of insights into the flow dynamics of the groundwater system and to test variations of the conceptualisations developed through the geological and hydrochemistry investigations described above. Other objectives were to characterise the nature of groundwater – surface water connectivity and revise the groundwater allocation limits for the area, and provide insights into the probable causes of water stress in the remnant bush area in the Turanganui valley. Compared to previous modelling work (Gyopari et al. 2020), the Onoke model has improved geological confidence in some areas. The hydrostratigraphic sequence identified from the targeted geophysical investigations and assisted by a sub-regional geological analysis was extrapolated over the broader study area using a series of conceptual cross sections to help understand how different parts so of the hydrogeological environment relate. For example, the hydraulic connectivity between the Turanganui and Tauanui valleys, and the connectivity between the main Ruamahanga valley and the side valleys indicate that there are distinct domains that have variable hydraulic connectivity (as verified by the hydrochemistry investigations).

Preliminary results from the model suggest that not insignificant surface water depletion effects result from abstraction within deep semi-confined aquifers and that allocation limits should be constrained by these effects. Sea water intrusion risk appears to be low under the current full consented allocation and that additional coastal drawdown should not occur until verification of the offshore extension of the groundwater system becomes available. The water-stressed Te Rata bush remnant appears to be related to low seasonal water table levels that occur when the recharge source from the Turanganui River is reduced, resulting in the draining of the shallow aquifers in the upper reach of the Turanganui Valley. The extent and duration of dry river reaches (Fig. 4) appears to be the controlling influence on water table depth beneath the bush – which appears largely natural but is likely to be exacerbated by abstraction related river flow depletion.

Conclusions

A poor conceptual understanding can often form the largest source of uncertainty in a hydrogeological model and any water resource predictions and decisions that are informed by it. Investment in conceptual understanding of the Pirinoa area in Southern Wairarapa was considered essential for building confidence in the numerical modelling process. This has been achieved through a combination of geophysical, geomorphological and hydrochemistry methods. Geophysical techniques (ERT and ground TEM) proved particularly effective in terms of identifying the main hydrostratigraphic units and contributing to understanding groundwater–surface water connectivity. The new field data were used to build a three-dimensional conceptualisation of the groundwater system which was then tested and refined using a numerical model to ensure consistency with observations. Use of the model for resource management and limit-setting purposes is ongoing and the model is providing valuable insights into abstraction-related environmental concerns. The project provides a first stage in understanding the freshwater resources in this area to assist with current planning and decision-making requirements. It is likely that additional information obtained from ongoing investigations into the groundwater and surface water environments, in addition to an upcoming SkyTEM survey of the area, will result in further revision and refinement of the management of this highly complex hydrogeological environment over the next few years.

Figure 4. A dry section of Turanganui River in early autumn.

References

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UPDATE

Compiled by James Griffiths

NIWA update

Rolling eddies – new boundary layer theory

Boundary layers are found everywhere that a fluid flows past a boundary. Typical examples are flow over aircraft wings, flow in rivers and the wind in downtown Wellington. Until now, turbulent boundary layers have been modelled as "shear flows", whereby the flow is considered to comprise overlying elements or layers, with each layer retarded by shear stresses from its neighbouring layers, culminating in friction on the boundary. A completely new approach has been developed whereby the boundary layer is considered to comprise out-rolling eddies (see below Figure 1). Development of the concept shows that this provides a theoretical explanation for a boundary layer's streamwise velocity profile and gives an analytical solution for the von Karman's constant, a value that has befuddled researchers for the past 95 years. The new theory has been published in the *Journal of Hydraulic Research* with the editorial reviewer's conclusion that "it will be a great contribution to the turbulence literature".
[contact: graeme.smart@niwa.co.nz].

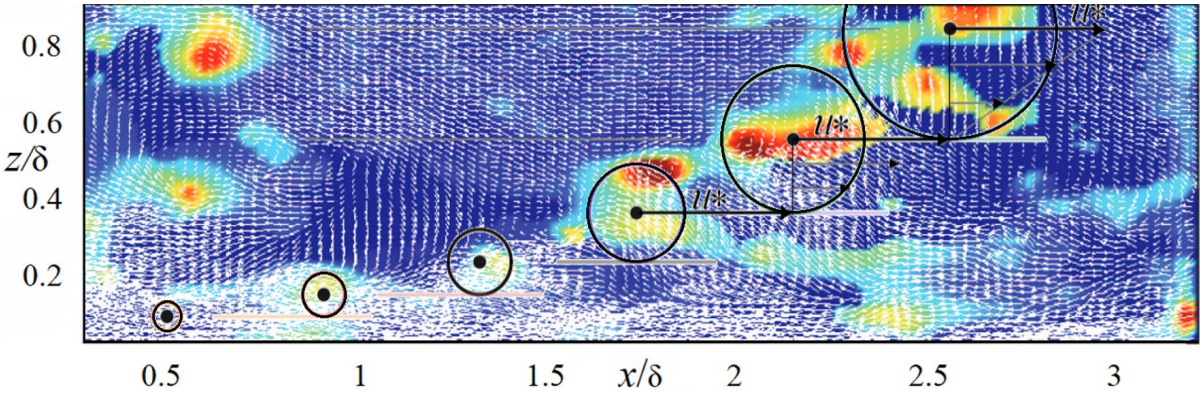


Figure 1. Measured vortices in a turbulent boundary layer are shown by the non-navy-blue colours. The new model's representation of turbulence by out-rolling eddies is denoted by the black circles.

New snow conditions tool

Seasonal snow and ice dynamics affect alpine hazards, recreation, tourism, stream ecology, hydro-electric generation, and water abstraction. Until now the public has had very little information to make informed choices about snow conditions in alpine areas. NIWA's Snow and Ice Network (SIN) collects information on the state of snow across New Zealand in real time. After a strategic science project to improve semi-automated QA/QC, the snow data is now ready to be published on a weekly basis throughout the winter.

Led by Jono Conway, a team from the Hydrology group, Comms, IT and EIO have updated the SIN website to show graphs of current snow conditions for 10 SIN sites (see Figure 2). The graphs update automatically once a week and allow the public to see whether snow

is tracking below or above normal for the time of year. The information will help people and organisations to better plan for winter conditions, understand climate impacts on snow, and forecast downstream river flows in spring. The data also showcase NIWA as a leading provider of snow information and expertise in New Zealand. [contact: jono.conway@niwa.co.nz]

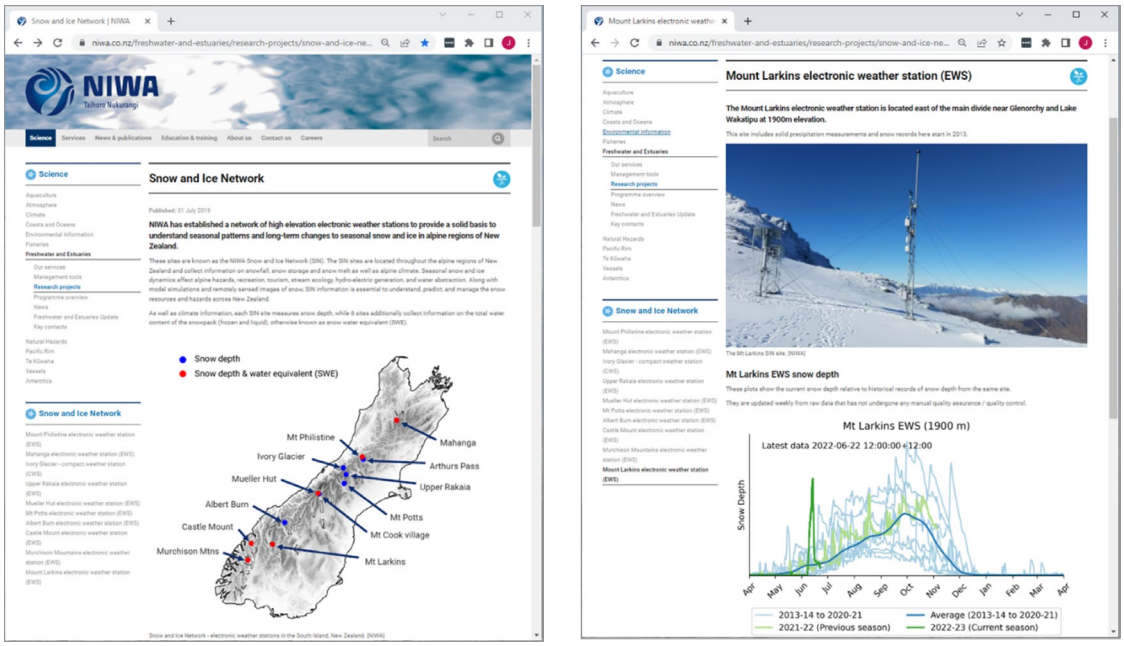


Figure 2. Snow and Ice Network page (left) and example of graph for Mt Larkins SIN site near Queenstown. https://niwa.co.nz/freshwater-and-estuaries/research-projects/snow-and-ice-network

Design Rainfall for Samoa

NIWA engaged with the Samoa Ministry of Natural Resources and Environment in December 2021 to develop Intensity-Frequency-Duration (IFD) design rainfall for the Apia urban catchments of Vaisigano, Gasegase, Loimata-o-Apaula, Fuluasou and Aleisa. The work was enabled through the Government of Samoa's Economy Wide Adaptation to Climate Change project implemented in collaboration with the United Nations Development Programme. The project developed IFD curves representative of conditions in Samoa's urban catchments that incorporated the different temporal and spatial records currently available. Functions were developed to scale daily rainfall depths to sub-hourly estimates for given annual return intervals (ARI). The method takes a reliable estimate of 24-hr duration rainfall for a given ARI and scales it to 18-hr, 12-hr, 6-hr, 2-hr, 1-hr, 30-min, and 15-min durations. Scaling was done using carefully derived functions developed from a limited set of high-quality, long-term datasets of sub-daily rainfall from across the Pacific region. These enabled the production of adequate first order (baseline) IFDs at stations with 30 or more years of rainfall records, that are taken to be representative of conditions in the lower, middle and upper Samoa catchment reaches. The IFDs will be used to model representative urban design flood inundation for different ARI events which help inform mitigation and hazard risk management applications in the Greater Apia area. [contact: shaun.williams@niwa.co.nz]

Improving the utility of digital elevation models

Software to improve Digital Elevation Models (DEM) for flood modelling has been developed in RA1 (Research Aim 1: Flood Mapping) of the Mā te haumaru ō nga puna wai ō Rākaihautū ka ora mo ake tonu. The software combines LiDAR point clouds with ocean bathymetry surveys and information extracted from Open Street Maps (OSM) and River Environment Classification (REC) to improve the DEMs' hydrological conditioning around rivers, drains, culverts and bridges. Specifically, OSM and REC reach flows (using the NIWA-generated NZ River Maps) and other river properties inferred from the LiDAR are used to estimate riverbed and culvert elevations that are incorporated alongside the LiDAR and ocean bathymetry elevation data. This is important for producing accurate inundation hazard maps. The described methodology has been configured into an automated pipeline on New Zealand eScience Infrastructure (NeSI) which will allow the method to be applied to model flood inundation in any Aotearoa catchment [contact emily.lane@niwa.co.nz or rose.pearson@niwa.co.nz]. [The software can be accessed at https://github.com/rosepearson/GeoFabrics]

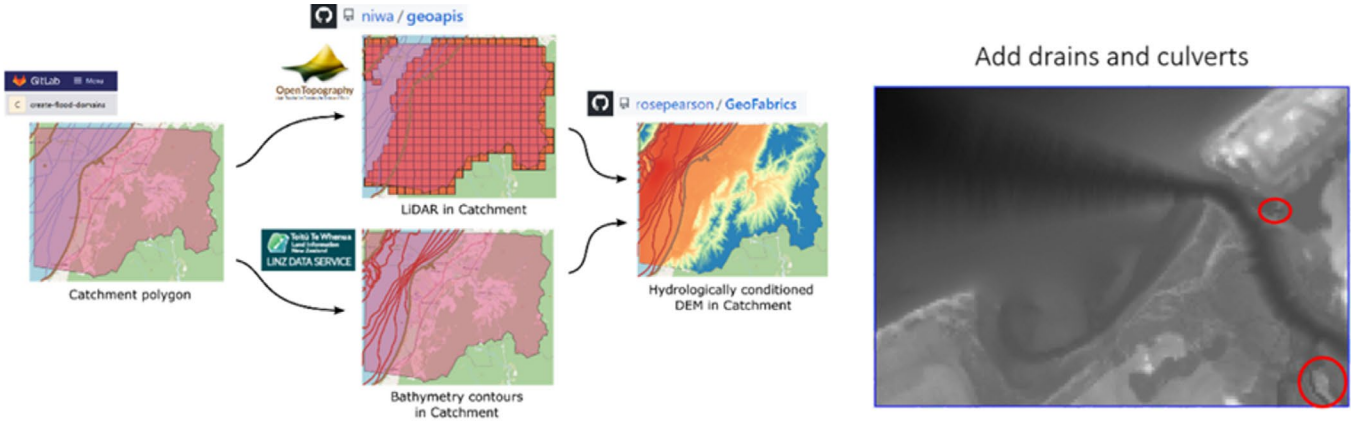


Figure 3. Workflow to combine the estimated riverbed and culvert elevations alongside any measured riverbed and ocean bathymetry contours, and the LiDAR-derived DEM into a single hydrologically conditioned DEM for the catchment.

On a related note, Céline Cattoën-Gilbert has just published a paper in the *Journal of Flood Risk Management* describing the national flood awareness system for ungauged catchments in complex topography (https://onlinelibrary.wiley.com/doi/10.1111/jfr3.12864).

Staff News

Dr MS Srinivasan, aka 'MS', is leaving NIWA in December to join MPI's Water Availability and Security team as Principal Adviser. MS is well known within New Zealand's hydrological community and will be missed by his colleagues at NIWA. Most recently he has been leading the Irrigation Insight team to deliver exceptional science to support improved environmental and productive outcomes for farmers. Through his focus on the pragmatic environmental, social and economic aspects of irrigation, and working with a collective of stakeholders, MS has influenced the timing and volume of irrigation practice and created a learning experience for all participants. Luckily MS will at least be staying local at MPI's Christchurch office.

UPDATE

Compiled by Maïwenn Herpe

GNS Science update

Photo 1. Our new hydrogeophysics intern Mathijs van den Adel.

Staffing

Mathijs van den Adel (hydro-geophysicist) joined the Wairakei team in September for a seven-month internship. Mathijs is working on quantifying the effect of climate forcing datasets on uncertainty in rainfall recharge produced by the National Groundwater Recharge Model as part of GNS' Groundwater research programme (SSIF funded). In particular, he studies the model ensemble uncertainty over both space and time, using spatial statistics in Google Earth Engine and Python.

Rogier Westerhoff will be seconded for 12 months, starting 1 December, to the Parliamentary Commissioner for the Environment office as a Senior Advisor – Research and Analysis, working on freshwater quality and quantity issues in Aotearoa.

Pierre Glynn is currently visiting New Zealand to attend the NZHS/MSNZ conference in Dunedin thanks to Royal Society of New Zealand Catalyst/Leader Fellowship funding. Pierre is an affiliated scholar with Arizona State University and Scientist Emeritus/USGS Science & Decisions Centre (USA) with a background in geochemistry & groundwater science. He is currently working with Paul White on the science and policy project in the GNS Groundwater research programme.

Photo 2. Richard Levy with his Blake Leader Award.

Congratulations to Richard Levy for winning a Blake Leader Award for his work to better understand climate change

The Blake Leader Awards recognise and celebrate people whose leadership has delivered high impact results and contributed to a more sustainable future for New Zealand.

Richard has delivered decades of scientific research and leadership investigating key climate change issues for New Zealand and the world. Currently he is leading two important climate research projects – NZ SeaRise and SWAIS2C (Sensitivity of the West Antarctic Ice Sheet to 2°C). At GNS, we're fortunate to see Richard's leadership in action every day – shaping GNS' contribution to a more resilient and sustainable climate future. You can read more about why Richard was honoured with this award on our website. Congratulations Richard!

Groundwater science-to-policy workshops

The groundwater science-to-policy workshops, mentioned in May's *e-Current*, have begun. The series of free workshops are designed to progress understanding of the groundwater science–policy nexus. The aim is to bring together a diverse group of experts from physical scientists and social scientists to lawyers, regional councils, central government and universities. Four two-hour online workshops were held in August 2022, and videos of these will be made available soon. The August workshops focused on (1) groundwater and the law; (2) records on engagement; (3) methods of iwi engagement (kaitiaki flow example), and (4) water budgets and groundwater allocation. These workshops were aimed at resource managers, policy-makers and researchers interested in improving groundwater science, management and policy making. Speakers included: Trevor Daya-Winterbottom (Associate Professor/ Deputy Dean Te Piringa – Faculty of Law, Waikato University); Pierre Glynn (Affiliated Scholar with Arizona State University and Scientist Emeritus Science and Decisions Center, USGS); Paul White and Frederika Mourot (GNS) and Te Rangikaheke Bidois, Kahuariki Hancock and Lee-Anne Rangimarie Bidois (Ngāti Rangiwewehi). This series attracted more than 30 attendees (50 registered) per session from a wide audience (central and regional government, universities, CRIs, consultancies).

A fifth workshop is currently being planned (covering topics including climate change adaptation and water accounting) for the day preceding the NZHS/MSNZ conference in Dunedin. All are welcome to attend – to register, please contact Paul White.

Summer of airborne aquifer mapping begins

The summer of Aerial TEM (transient electromagnetic) aquifer mapping work has begun and will take place in different parts of the country. Mapping surveys will occur in Northland, Gisborne and Southland this quarter. The Northland survey got underway in October, with Southland due to start in November and Gisborne in February 2023. Other (AIA) programme initiatives that are progressing or in the procurement phase are High Flow Harvesting, Surface Water Flow Monitoring, and Groundwater Drilling in Gisborne.

While this mapping is being completed under the AIA program*, it is part of a much larger effort by GNS Science to map and characterise New Zealand's aquifers, which will allow GNS to create advanced hydrogeological maps, methods and models to support sustainable and economic use of Aotearoa New Zealand's groundwater resources.

The aerial surveys are just one component of data collection, and it will take time for our scientists to interpret and analyse the raw data, but the ultimate aim is to provide the information in a useful format for councils, mana whenua and the community.

*Aqua Intel Aotearoa (AIA) is a partnership between Kānoa (the delivery arm of the Provincial Growth Fund) and GNS Science. It is a national science platform on regional water availability and storage. For more information, please contact info@aquaintel.co.nz

SkyTEM data modelling in Hawke's Bay

While the aquifer mapping projects mentioned in the previous story are beginning, the Hawke's Bay 3D Aquifer Mapping Project is much further along in the journey.

While separate from the AIA program, the aims and methods are similar and represent where the other projects are headed. Close to 8000 km of airborne transient electromagnetic (SkyTEM) data were collected in early 2020 over the Heretaunga and Ruataniwha plains and Poukawa and Ōtāne basins as part of the Hawke's Bay 3D Aquifer Mapping project. SkyTEM data processing and resistivity modelling has been completed for all 8000 km. To collect additional supporting datasets, a drilling programme was completed and reported in the Ruataniwha and Heretaunga plains areas. Hydrogeological interpretations and numerical groundwater model revisions are underway. To complete the work, the project has been extended until June 2023.

An online ESRI StoryMap and webmap were developed as a public outreach tool to provide access to 3D datasets and reports as they become publicly available. The first and current release is dated from June 2022 and includes results from the Poukawa and Ōtāne basins surveys (Figure 1). Subsequent releases are planned for 2023 as the Heretaunga and Ruataniwha plains survey results become available. The webmap (Figure 1) utilises online data-access developments funded by GNS since 2014 through multiple projects.

GNS is a contributor to the official Hawke's Bay Regional Council webpage for updates on the 3D aquifer mapping project. Publications are available online.

For more information, please contact Zara Rawlinson

Foged, N. 2022. Hawke's Bay 3D Aquifer Mapping Project: Heretaunga Plains, 3D hydrostratigraphic modelling. Aarhus University HydroGeophysics Group. 27 p.

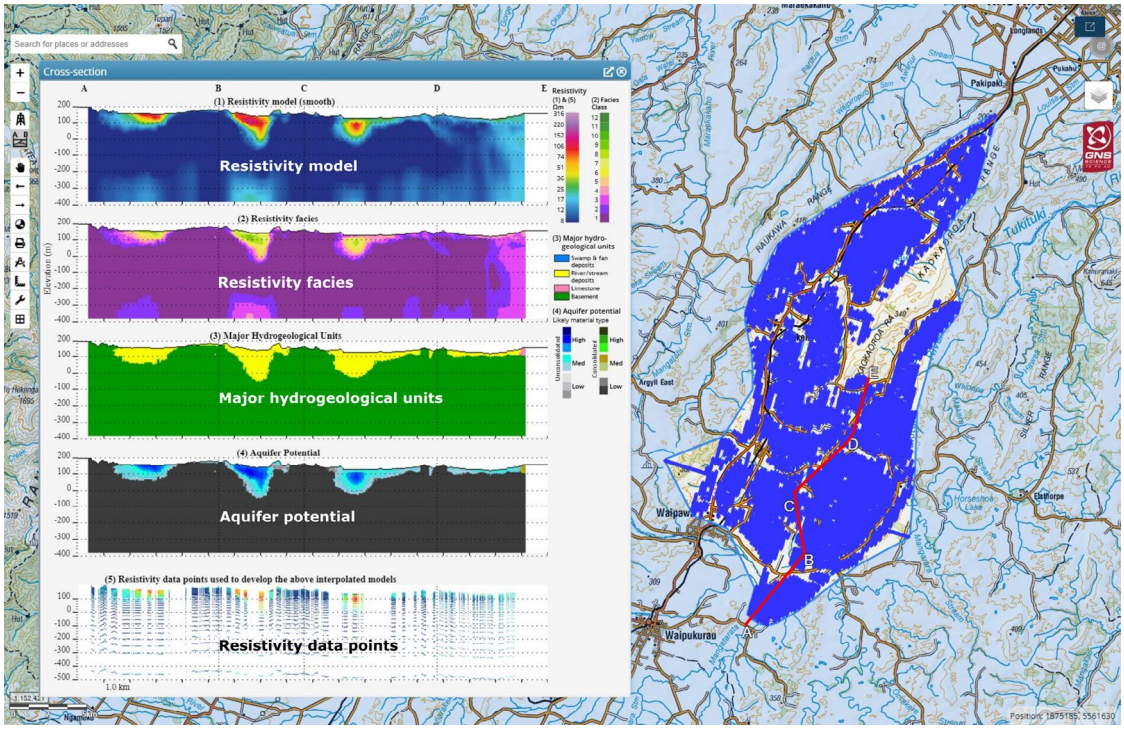


Figure 1. Example screenshot from the embedded webmap showing a cross-section through the Poukawa and Ōtāne basin 3D models. The cross-section shows the resistivity model and derived geophysical and hydrogeological interpretations.

Evaluating the magnitude of groundwater denitrification by measuring noble gases to quantify excess N2

One of the workstreams in our Groundwater research programme focuses on developing guidance and tools to address both established and emerging groundwater contaminants.

Quantifying in-situ denitrification within a groundwater system is only possible by measuring the dissolved noble gas concentrations. These concentrations allow us to directly assess the amount of excess nitrogen gas (N_2), the end product of the denitrification reaction in groundwater systems. Over the last year, GNS has been designing and building a new state-of-the-art facility in the Water Dating Laboratory (WDL) to measure noble gas concentrations (He, Ne, Ar, Kr, Xe) needed to calculate the magnitude of excess N_2. This new tool – a quadrupole mass spectrometer – complements the already available gas chromatography techniques for measuring noble gases Ar and Ne at the WDL and significantly enhance analytical precision and accuracy (up to 10x). This increased precision will allow us to detect where denitrification is occurring (and where it is not) in groundwater systems. These excess N_2 measurements can be combined with hydrochemistry and other tracer information (e.g., tritium ages) to better understand the processes governing nitrate load transport and fate in aquifers, which will inform effective land-use policies to maintain water quality. The new instrument will be fitted with an automated sample purification system for high sample throughput. Construction is currently underway, and this tool is expected to be available for internal and external stakeholders in mid-2023.

For more information about this new capability, or if you would like to participate in trial measurements, please contact Matthew Coble.

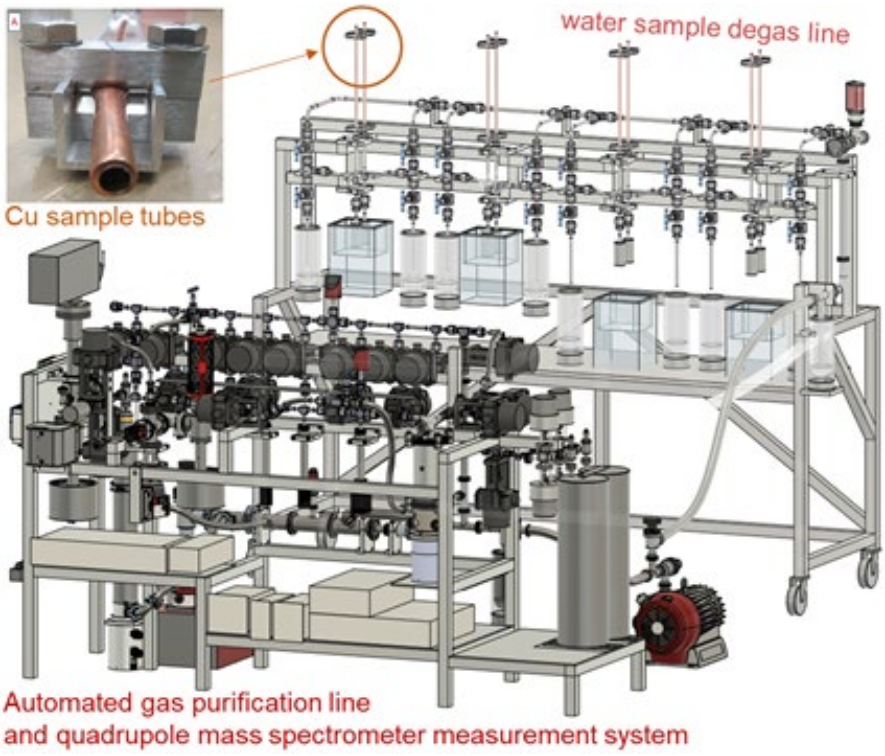


Figure 2. Design for the new noble gas mass spectrometer system at GNS' Water Dating Lab (Credit: Matthew Coble, GNS Science).

Using hydrochemistry to inform a groundwater restoration programme

To support the restoration programme of the Te Hoiere/Pelorus catchment (Marlborough), our scientists interpreted previous hydrochemical and age tracer baseline data to provide detailed understanding of the catchment functioning. The current environmental quality of Te Hoiere catchment is good but is deteriorating. This is evident in some of the sub-catchments, where water quality is being degraded. Marlborough District Council, Ngāti Kuia, the Department of Conservation, and the wider community are part of the way through the restoration programme in the Te Hoiere/Pelorus catchment with the aim to holistically manage the entire catchment, from the mountains to the sea (ki uta ki tai). TWOTW provides the understanding of the flow of groundwater and associated contaminants (nitrate) through the catchment. These projects have already provided important insights into the groundwater and surface water flow systems throughout the country.

For more information, please contact Uwe Morgenstern

Morgenstern U, Davidson P. 2022. Groundwater tracers for improved understanding of water and nitrate flow through Te Hoiere / Pelorus catchment to inform decision making in restoration programme. Lower Hutt (NZ): GNS Science. 21 p. (GNS Science report; 2022/50). doi:10.21420/937F-H779.

UPDATE

Compiled by Juliet Clague

Lincoln Agritech update

Figure 1. Shallow groundwater sampling in the Piako catchment, November 2022.

Critical Pathways Programme

As part of our Critical Pathways Programme, we have begun a shallow groundwater sampling campaign in the upper Piako study catchment this month. Our targeted approach uses inflatable packers to isolate discrete sections of the fully slotted screen (with no annular gap) with low flow pumping (up to 60 mL/min) to ensure representative samples of the shallow groundwater (up to 9 m depth). Samples are taken once field parameters (dissolved oxygen, pH, EC, temp) are stable and submitted for a range of analytes, including nitrate.

Figure 2. Measuring temperature variation across a pool in the Wairau River using distributed temperature sensing (DTS).

Braided Rivers Programme

The Braided Rivers team have been busy doing temperature surveys in the Wairau catchment using a flexible (portable) fibre optic cable to see how river temperature distribution compares with thermal imagery from a NIWA drone. We have done several surveys across pools and riffles and found much greater variation than the thermal imagery, which just captures temperature at the river surface.

Figure 3. Lab-based bioreactor column experimental set-up. Each cylinder is filled with woodchips or a combination of woodchips and biochar with iron/manganese oxides.

Doubling on-farm diffuse pollution mitigation programme

Lincoln Agritech and Land and Water Research Ltd (Greg Barkle), in close collaboration with the University of Waikato (Dorisel Torres-Rojas and Adam Hartland), recently completed the experimental/sampling phase of an investigation to determine how modified woodchips enhance removal of nitrate and phosphorus from subsurface drainage water. As part of the Doubling On-farm Diffuse Pollution Mitigation programme being led by NIWA, the experiment used subsurface drainage water collected from a dairy farm in Tatuanui and thermally modified woodchips (biochar) functionalised with iron or manganese oxides. Laboratory analyses of samples are ongoing and results of the experiment are expected to provide options for enhancing the effectiveness of woodchip bioreactors as a tool for mitigating nutrient load to surface waters.

Figure 4. Lots of rain means lots of drainage and lots of prepping and sampling in the rain! Preparing suction cups for sampling the following day by applying a tension, July 2022.

DairyNZ plantain experiment

The Lincoln-based team have been kept busy this drainage season with record rainfall events occurring in Canterbury. Working as part of the team in DairyNZ lead Plantain Proficiency and Practice Programme with Lincoln University, experimental plots trialling plantain mixed with ryegrass have been established on a Lincoln University Research Dairy Farm. Soil water is collected using suction cups and analysed for various N species, and it is hoped that the plantain treatment will leach less nitrate, and produce urine with less nitrate, to reduce on-farm leaching losses.

UPDATE

Compiled by Kate Mason

Aqualinc update

New recruits

We have recently welcomed two new members of staff to the Aqualinc family.

Bayley Pearce - Bayley is an Environmental Management Consultant. Her role involves undertaking environmental data analysis, environmental impact assessments and writing resource consent applications for groundwater and surface water takes, dairy shed effluent discharges and other related activities.

Nicole Calder-Steel – Nicole is a water science professional focused on improving understanding of freshwater and addressing resource management challenges. She has experience in catchment characterisation and current state assessment, resource assessment, and assessing land-use impacts on groundwater and surface waters.

Nicole has a strong understanding of the Resource Management Act, resource consenting, planning processes, the regulatory framework, and the application thereof. Nicole is an accredited Hearing Commissioner.

RESEARCH PROJECTS

N-Wise Irrigation field trial

The N-WISE IRRIGATION TRIAL has revealed more about drainage over the past twelve months than irrigation! The 2021/22 irrigation season was, quite literally, a washout. Soil moisture levels remained high enough from December onwards to wipe out any differences between the irrigation management strategies we are testing. An unexpected bonus of having a wet twelve months from 1 September 2021 to 31 August 2022 (902 mm of rain) was gaining a lot of drainage and nitrogen leaching measurements from each of the 18 large (4 square metres in area) lysimeters installed for the irrigation trial.

The drainage data reveals just how variable drainage can be across a paddock. While the average across all plots is about 490 mm, it ranges from about 220 mm to almost 700 mm. Some of this variability is very likely due to the volume of stones in the soil profile varying across a paddock. Spatial variation in the volume of drainage can also be the result of runoff. Analysis of our data has provided unequivocal evidence of localised runoff, which meant more water infiltrated into some lysimeters than others. That localised runoff on supposedly flat paddocks contributes to such a high degree of variability in the amount of drainage and Total Nitrogen leached highlights just how difficult it is to accurately model nitrogen losses from farms. Developers of such software face quite a challenge... If you'd like to know more about our N-Wise Irrigation field trial, please email John Bright, j.bright@aqualinc.co.nz, or catch up with him at HydroSoc this year.

Agile, adaptive water allocation policy

Many operative groundwater allocation policies set a fixed limit on the annual water take volume, and restrict the rate of take from bores "close to" rivers. The restriction on groundwater takes is based on the restriction regime applied to surface water takes from the relevant river. Monitoring data shows that for some significant lowland river/stream systems this isn't sufficient, and modelling has shown that it will not be sufficient under project changes in climate. Our hypothesis is that more agile water allocation policy is needed to enable timely, low transaction cost adaptation to climate change and climate variability. Policy response options fall into three categories: reduce demand, increase groundwater recharge, augment flow in affected surface waterways. Our focus has been on the effectiveness of policies that reduce demand. Our analysis shows that, for our case study area, groundwater take policies that reduce the daily rate of water take for all abstractors are more effective in maintaining lowland river/stream flows than annual volume-based limits. In particular, restricting the daily rate of all groundwater takes on the same basis as the restriction of surface-water takes is very effective. Under this type of policy, groundwater supplies would be very much less reliable than they are now, becoming similar to surface water supply reliability. For more information, come to John Bright's presentation at HydroSoc this year.

Drinking water safety

With the increasing focus on drinking water safety, we have been involved in a wide variety of projects, including identifying small suppliers in advance of the new regulations for drinking water suppliers, helping small suppliers understand their new responsibilities, water safety planning, and source water risk management area mapping for various councils. We have been working with MfE over the past few years to develop modelling guidelines for source water risk management area modelling. In an update of a project that we completed in 2018, we have also undertaken a national-scale assessment for MfE to determine what areas of New Zealand would potentially be affected if all drinking water sources were required to have source water risk management areas (SWRMAs) in place. Assessment of delineation methods is ongoing work.

Water availability and security

The results of the national-scale sensitivity analysis that we completed for MPI are now available online: https://www.mpi.govt.nz/about-mpi/our-work/fit-for-a-better-world-accelerating-our-economic-potential/water-availability-and-security/. This work examined sensitivity, in terms of retrenchment risk and changes in future development potential, to regulatory changes, climate change, and assumptions relating to the operation of water storage.

Shallow groundwater

Over recent years, Aqualinc have been working with Christchurch City Council to download groundwater level data from nearly 250 shallow piezometers across Christchurch. It's that time of year again for people to be out and about doing the rounds. Over the summer we will be moving forward with analysing the data and understanding shallow groundwater contribution to surface water flooding.

Ground source heat pumps

Aqualinc have been helping various clients with hydrogeological investigations to support GSHP consent applications. The technology is increasingly being used across Christchurch and New Zealand as a whole and offers a route to reducing the carbon footprint for many buildings.

UPDATE

Compiled by Theo Sarris

ESR update

Figure 1. Andrew Pearson (ESR) preparing the injection mix for the bacterial and viral indicator tracer experiment to characterise the fate and transport characteristics of the site.

On-site wastewater research site

Louise Weaver, Bronwyn Humphries, Andrew Pearson and Erin McGill

For the past two years ESR has been developing an on-site wastewater research site in North Canterbury within an alluvial gravel aquifer. The aim of the site is to investigate the principal relationships between key on-site wastewater design procedures and component performance, with chemical and microbiological risks to the post-Land Application System (LAS) discharge receiving environment, and in particular groundwater quality.

The site is a long-term research opportunity, and it is proposed to install and operate the site in five stages ranging from primary treatment discharging to a conventional trench LAS, to secondary treatment with UV discharging to a sand bed LAS. Characterising the flow paths and background groundwater chemistry and microbiology has dominated the past two years of work at the site. The new Hynds on-site wastewater management system will be installed in late November 2022 with intensive monitoring of the site to follow.

Due to the site being intensively monitored it offers ESR a wide range of opportunities to investigate the impact of wastewater-sourced Emerging Organic

Contaminants (EOCs), groundwater ecology (i.e. stygofauna), impacts of climate change, fate and transport of chemical and microbiological contaminants, drinking water protection zones and the calibration of models for on-site wastewater impact assessments (i.e. STUMOD).

For further information contact: louise.weaver@esr.cri.nz

Preventing Legionellosis: new technology to test engineered water systems

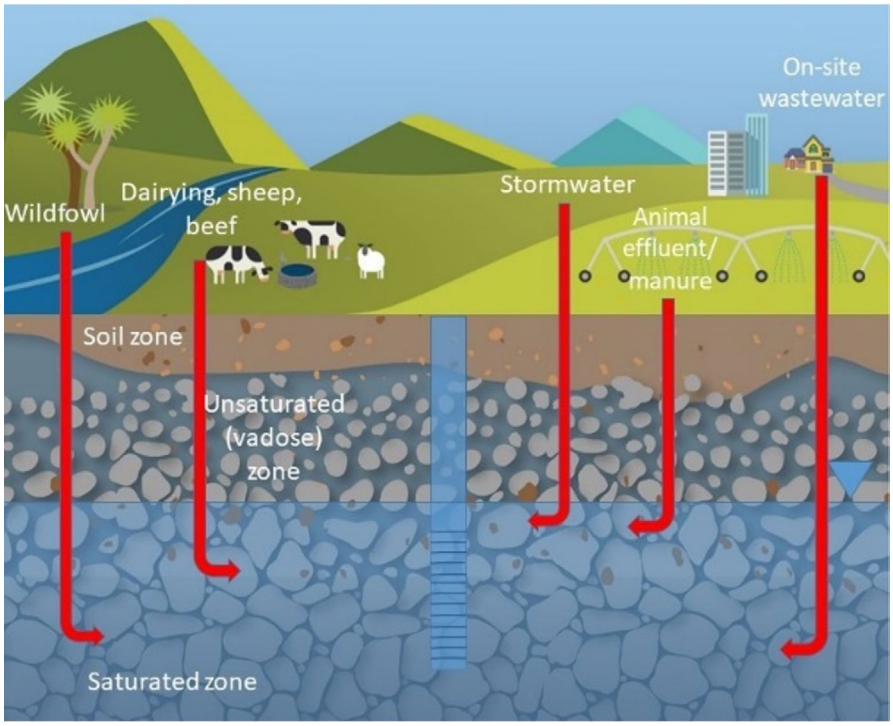
We have received an Explorer Grant from the Health Research Council to validate the novel *Legionella* surrogate that we have recently developed. Despite numerous legionellosis outbreaks worldwide attributed to contaminated engineered water systems (EWS), suitable tools are lacking for assessing control measures in EWS. We have recently developed a *Legionella* surrogate using surface-modified, DNA-encapsulated biopolymer microparticles that have similar physicochemical properties to *Legionella pneumophila*. Our preliminary work has shown promising results in mimicking *Legionella* attachment/detachment to/from biofilms grown on stainless steel in the presence and absence of residual chlorine. In this study, we will validate these novel microparticles for their suitability as a model alongside *L. pneumophila* in different plumbing materials with different biofilms.

Contact Liping Pang (liping.pang@esr.cri.nz) for more details.

Eco-rubber: A new technology for reducing waste and improving seismic resilience

A multidisciplinary research project between the ESR and the University of Canterbury has developed a cost-effective and sustainable eco-rubber geotechnical seismic isolation (ERGSI) foundation system for new low-to-medium-density low-rise residential housing. The ERGSI system consists of a horizontal seismic energy-dissipative filter made of granulated tyre rubber and gravel and a flexible rubberised-concrete raft footing. While the EGRSI foundation system is effective in reducing seismic demand at the foundation level, it is imperative that the system does not have any long-term negative effects on the surrounding environment through the leaching of contaminants from the tyre rubber:gravel materials. Leaching tests were undertaken on mixtures prepared using a combination of large and small tyre rubber and rounded and angular gravel. The results from these tests indicated leaching of hazardous components commonly found in tyres (e.g., zinc and manganese). Strong trends were observed with greater leaching from the smaller sized tyre rubber compared to the large tyre rubber, due to larger surface area. Small amounts of cobalt, chromium, nickel, arsenic, cadmium and lead were also leached from the tyre rubber. Calcium, sodium, magnesium and potassium were leached, which was attributed to feldspar minerals in the greywacke gravel. Results from this study will be used to identify suitable countermeasures, e.g., use of a reactive geomembrane to remove leached contaminants, to include in the design criteria for the ERGSI foundation system.

Contact Laura Banasiak (laura.banasiak@esr.cri.nz) for more details.



An updated Microbial Risk Assessment Tool

ESR and GNS have finished development of the updated Microbial Risk Assessment Tool. The tool calculates health risk to drinking water supplies associated with discharges from a range of land use activities that might occur within a source water risk management area (also known as a source protection zone). The tool is currently being tested in real-life situations by ECan scientists, while a more flexible and user-friendly interface is being designed by the ESR and GNS teams.

Numerical delineation of source protection zones

Our work for the GNS-led *"Te Whakaheke o Te Wai"* research program is entering its fifth year. Our numerical experiments continue and, using the West Melton case study, we examine whether vertical anisotropy or porosity proxies can be used in simple models to match the outputs of complex and computationally demanding stochastic simulations. We also investigate how backward particle tracking, which is the most commonly used approach for numerical delineation of source protection zones, compares with the more robust forward particle tracking, and what assumptions on particle termination need to be made to ensure a reasonable agreement between the two methods. This year's efforts will focus on bringing together our findings, in a guidance document for practitioners.

In the meantime, as part of ESR's SSIF project *"Securing New Zealand's Groundwater Supplies with Data Science and Numerical Tools"* our team is working with Victoria University on incorporating Deep Learning Image Recognition tools in the delineation of source protection zones in heterogeneous environments. And finally, in a paper we published recently in Water Research, we demonstrate that sentinel monitoring for groundwater quality, can provide an additional layer for protecting the public health and the safety of drinking water sourced from groundwater.

The team's most recent publications:

Paleologos et al. Paradigm shifts in incinerator ash, sediment material recovery and landfill monitoring. *Environmental Geotechnics* 0(0): 1-14, DOI: 10.1680/jenge.22.00089, in press.

O'Kelly, B., Pantos, O., Weaver, L., Sarris T. S., Goli, V., Mohammad, A., Singh, P., Singh, D.N. Fate and impact of nano/microplastic in the geoenvironment — ecotoxicological perspective. *Environmental Geotechnics* 1-13, DOI: 10.1680/jenge.22.00053, 2022.

Ariyadasa, S.; Billington, B.; Shaheen, M.; Ashbolt, N.J.; Fee, C.; Pang, L. 2022: Use of a novel DNA-loaded alginate-calcium carbonate biopolymer surrogate to study engulfment of *Legionella pneumophila* by *Acanthamoeba polyphaga*. *Microbiology spectrum* 10(4), e02210-22.

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Pang L, Tham A, Nilprapa P, Cocker A, MacDonald P, Adams R, Robson B, Wood D, Ward V, Nokes C. 2022: Cryptosporidium surrogate removal in pilot-scale rapid sand filters comprising anthracite, pumice or engineered ceramic granular media, and its correlation with turbidity. *Journal of Water Process Engineering* 46, p.102614.

Derx J, Linke R, Savio D, Emelko M, Schmidt P, Schijven J, Pang L, Sommer R, Stevenson M, van den Berg H, Rutjes S. From Groundwater to Drinking Water–Current Approaches for Microbial Monitoring and Risk Assessment in Porous Aquifers. Book chapter to *Inland Waters*, 2nd edition, Eds. Tockner, K. and Mehner, T. Section Structure and functions of inland waters, Ed. Griebler, C.

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Pang L, Lin S, Krakowiak J, Yu S, Hewitt J. 2022: Performance analysis of sheep wool fibres as a water filter medium for human enteric virus removal. *Journal of Water Process Engineering* 47:102800.

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Burbery, L., Abraham, P., Sutton R., Close, M. 2022: Evaluation of pollution swapping phenomena from a woodchip denitrification wall targetting removal of nitrate in a shallow gravel aquifer. *Science of the Total Environment* 820: 153194. http://dx.doi.org/10.1016/j.scitotenv.2022.153194.

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Tasalloti A., Chiaro G., Murali A. and Banasiak L. 2021: Physical and mechanical properties of granulated rubber mixed with granular soils – a literature review. *Sustainability* 13(8), 4309, 1-28.

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Wigley, K., Egbadon, E., Carere, C., Weaver, L., Baronian, K., Burbery, L., Dupont, P., Bury, S., Gostomski, P. 2021: RNA stable isotope probing and high-throughput sequencing to identify active microbial community members in a methane-driven denitrifying biofilm. *Journal of Applied Microbiology* 00, 1– 17. https://doi.org/10.1111/jam.15264.

UPDATE

Compiled by Monica Jasper

WGA NZ update

Team updates

Wallbridge Gilbert Aztec (WGA NZ) is excited to announce that **Josh Cumberland** has joined the team in our Ōtautahi Christchurch office. Joshua specializes in hydraulic and hydrologic modelling. His experience includes floodplain restoration and ecohydraulic modelling, flood hazard modelling and mitigation design, water supply modelling and urban flood modelling, and dam breach modelling and reservoir management. Joshua has joined WGA NZ to work on managed aquifer recharge and wetland restoration projects.

The Kirikiriroa Hamilton office (**Clare Houlbrooke** and **Catherine Howell**) have been busy with applications to take water for frost fighting and irrigation of horticultural crops across Waikato and the Bay of Plenty. A significant frost event in the Waikato in early October hit fruit growers hard – especially kiwifruit and blueberries. Growers are concerned about the potential increased frequency of such events in the future and are planning for water supplies to support frost protection. In addition, the team is working on several land developments and urban water supplies.

Figure 1. WGA attendees at the Australia Water Association's Water in the Bush conference

Brett Sinclair has spent the past few months in the Darwin office to help support the water group and partner on projects. He and the team attended Australia Water Association's Water in the Bush conference, where they learned about innovative solutions being used by water projects in the Northern Territory.

Figure 2: WGA NZ staff attending 40 year celebration in Brisbane.

WGA celebrates 40 years

WGA turned 40 this year and marked the occasion with celebrations of staff and clients across our offices. This year also marks 5 years since WGA expanded into Aotearoa New Zealand, with offices in Ōtautahi Christchurch, Tāmaki Makaurau Auckland, and Kirikiriroa Hamilton. We have been reflecting on our accomplishments in managed aquifer recharge, water resource management, and the relationships we've worked hard to build.

As part of the celebration, most of the team travelled to Brisbane to see our Australian colleagues for the first time since covid, and to show them how to party. The gathering was a good opportunity to focus on our purpose: creating a positive experience for our clients, empowering our people, and designing better environments for future generations.

UPDATE

Compiled by Lizzie Fox & Katie Coluccio

WSP update

Exciting updates!

The water resources capabilities at WSP have changed and grown within the two years since the last update! Team members with water resource expertise are now based across the country, still actively working in the water resources, groundwater and hydrology spaces while supporting WSP's specific stormwater, transport, and environment sector projects. Additionally, hydrogeology has formed as a new sub-team within WSP, with team members now based in both Christchurch and Auckland.

Staffing

There have been many new team members, changes in locations and role changes over the past two years.

Lizzie Fox who has been with WSP/Opus for the past six years has progressed to a Work Group Manager - Water and Infrastructure, currently based in Greymouth while continuing her hydrology work (and passion for all things hydro-data related!). **Will Conley Jr** has joined this year as a Principial - Water Resources in the Palmerston North office and is currently completing his PhD. He is an engineering fluvial geomorphologist by trade and brings 27 years' experience to the table with a love for connecting the dots between geology, hydrology, engineering and ecology. He is supported by **Aimee Calkin**, a Graduate Water Resources Scientist based in Christchurch who is also completing her Masters thesis part time.

The Wellington Water Resources team has **Isabelle Farley** as the new Team Leader, who joined us last year from the UK and is a very experienced TUFLOW modeller and hydrologist. She is joined by **Sarah Yeo**, **Amanda Riddle** and **Dillon Scherrer**, all Graduate Water Resources Scientists based in Wellington, who all studied at Otago! Sarah and Amanda both celebrated their Masters graduation ceremonies this year and regularly incorporate their knowledge on water resources projects. **Callum Bradbury** joined the group at the end of 2021 as a Water Resources Scientist with a strong skillset in modelling as well as data programming knowledge. **Bryce Warner** has moved to Christchurch and joined the WSP Water team there, while continuing to grow in his MIKE modelling capabilities and hydrology knowledge. **Kos Maas** (newly appointed Principal Hydraulic Engineer, and longest standing member of the Wellington team) and **Chusit Apirumanekul** (Senior Engineer – Water Resources) are both still working alongside the Water Resources scientists in Wellington, supported by **Harrison Stroud** (Graduate Water Engineer) under Work Group Manager **Alistair Allan**.

Over the past 18 months, the hydrogeology team has been busy integrating staff coming over from the Golder acquisition, welcoming new team members, and establishing itself as a service offering within WSP NZ. Our hydrogeology team is now six members strong. In our Christchurch office, we have **Eric van Nieuwkerk** leading as a Principal Hydrogeologist, bringing a wealth of hydrogeology experience

from New Zealand and overseas. **Terry Hughes** also joined the Christchurch team last year as a Senior Hydrogeologist, offering various expertise, especially in dewatering assessments and aquifer testing. **Katie Coluccio** joined WSP as a Hydrogeologist after finishing her PhD at University of Canterbury, bringing various skills to the team, specifically in the water quality space. **Logan McLean** has come across from Golder to WSP as a Hydrogeologist with well-honed field skills, including packer testing in challenging environments. **Amandine Bosserelle** has also joined WSP from Golder as a Senior Hydrogeologist, specialising in shallow groundwater hazards and saline intrusion modelling. In our Auckland office, **Louise Soltau** has joined as a Senior Hydrogeologist, contributing a range of skills to the team such as geophysical techniques and water supply studies.

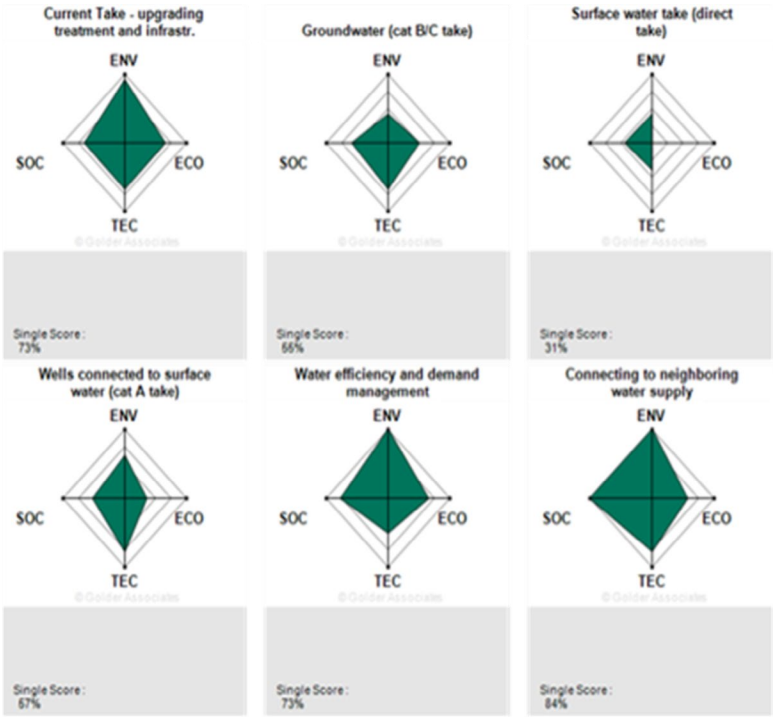
Lizzie Fox, Isabelle Farley, Sarah Yeo, Katie Coluccio and Amandine Bosserelle will be attending and presenting at the NZHS conference this year in Dunedin; we hope to see you there and catch up in person!

PROJECT HIGHLIGHTS

Carterton Alternative Water Supply Investigation

Carterton District Council (CDC) is interested in understanding potential alternative water sources within the district to address increasing demand for potable water due to projected population increases. A group of technical experts from a range of disciplines in both the water team and the regional business across New Zealand are currently involved in this project. This project involved analysing surface water and groundwater resources, creating suitability maps and carrying out a multi-criteria analysis to determine how CDC could enhance their resiliency and reliability of drinking water into the future. Of particular interest in this project is the use of the GoldSET MCA tool, to help assess the different water source options fairly in an easy-to-use way without undue bias. This was a tool developed initially by Golder and has been implemented on several WSP projects now to great success. An example of the outputs is shown below, during the preliminary assessment of feasible options before these were streamlined and more detailed analysis was undertaken. The results will inform CDC's future planning for the area and what water sources, treatment options and infrastructure would be beneficial.

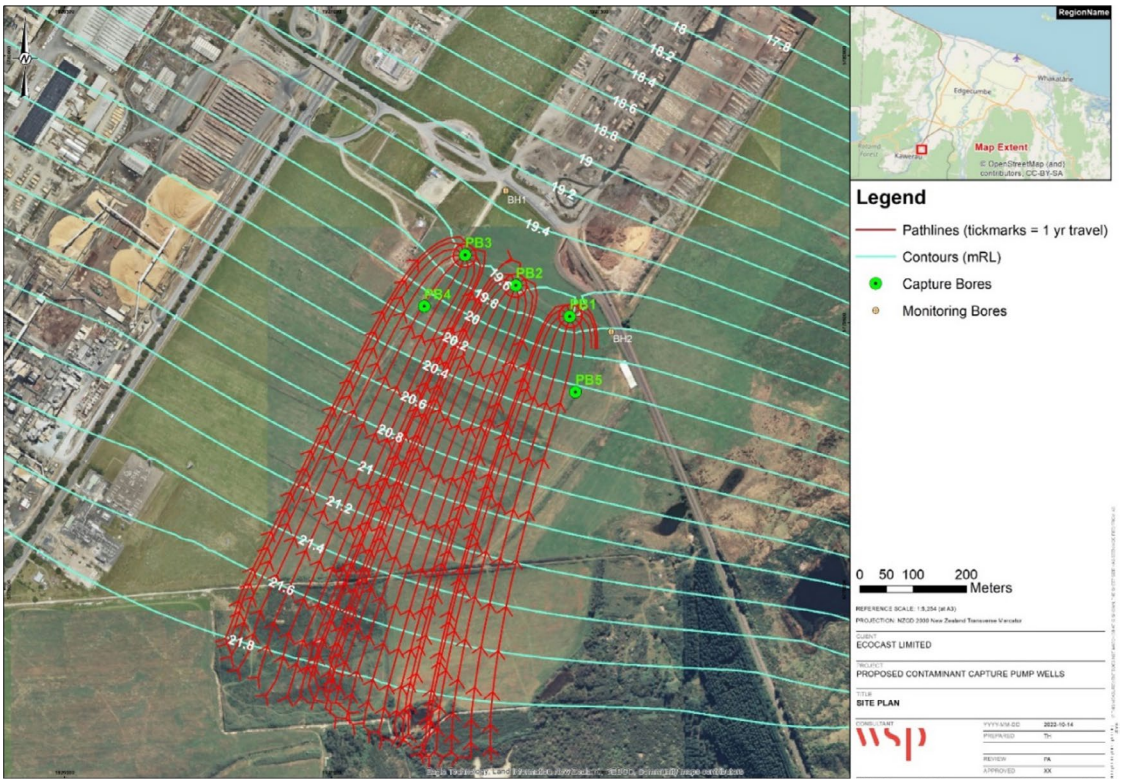
Check out the presentation at the NZHS conference to find out more details!



EcoCast Vermicomposting Site: Groundwater remediation for high nitrate concentrations

EcoCast owns and operates a vermicomposting site (worm farm) near the Kawerau pulp and paper mill, as shown in the diagram below. The worm farm comprises windrows of a mix of biosolids from municipal wastewater plants and pulp solids from the paper mills in a 50/50 mix. The windrows and the composting worms can leach high concentrations of ammoniacal nitrogen to ground, which converts to nitrate in the unsaturated pumice sand beneath the site and reaches the groundwater. We installed a network of monitoring bores around the boundary of the worm farm, and it has become clear that the concentration of nitrate in the underlying groundwater is rising. Groundwater levels in and around the site suggest that groundwater travels to the north. While the shallow groundwater is not used for any abstractive purpose other than irrigation, the nitrate levels exceed consent limits and remedial action is required.

EcoCast has decided to abstract the groundwater containing high nitrate concentrations and treat it to acceptable levels. To determine the extent of pumping required, we carried out an aquifer test in the underlying aquifers to estimate capture zones, number of wells required and their discharge rate to capture the plume of nitrate-contaminated groundwater. We used AnAqSim modelling software to determine that three wells drilled to a depth of approximately 15 m, evenly spaced along the northern boundary of the EcoCast northern property boundary were required to capture the high nitrate-containing groundwater. The well abstraction capture zones, groundwater flow path lines and groundwater contours are provided in the map below. A resource consent has now been sought from the Bay of Plenty Regional Council to allow the remediation project to proceed.



OBITUARY

Horace John Freestone

1942-2022

Horace Freestone, who became the second Life Member of the NZHS in 1998, passed away on 29 June 2022 aged 80 years.

Horace started his career in the Hydrological Survey of the Ministry of Works at Whangārei in 1961 and became leader of field parties in Whakatane (1963) and then Rotorua (1968). In 1968 Horace was involved in nuclear power investigations on the Kaipara Harbour. As a reflection of his meticulous approach to data collection and processing, Horace moved to the Hydrology Centre in Christchurch in 1978, where he drafted standard procedures, worked on field standards and ran national training courses. He moved to the Water and Soil Division head office in Wellington in 1983 from where he was in charge of the 16 field parties. He ran more training schemes and aided the introduction of micro-computers for data processing and telemetry for data retrieval from field sites.

He transferred to the Investigations Section of the Power Division, Ministry of Works, in 1986 and completed the Graduate Course in Hydrology at University NSW in the same year. This led to projects on sedimentation, floods, and low flows. Horace moved to Works Consultancy Services (later to become Opus) in 1988 and became the Hydrology Group Leader. During this time he employed and mentored a number of university graduates and developed a competent team of hydrologists. He worked on many projects from catchment modelling to probable maximum floods. These studies included improving New Zealand's longest lake level and river flow records used for power generation planning. In addition he facilitated NIWA field parties measuring high flows on the Clutha River at Clyde, at Waitaki Dam and on the Pukaki River, all probably near the limit for safe gauging from a jet boat. Other studies supported the re-consenting of major power schemes and enquiries into water supply and electricity generation shortages in the 1990s. He travelled to Cambodia to assist the Ministry of Mines and Electricity and made 15 trips to India on secondment to the World Bank. Horace retired as Principal Hydrologist in 2007 after 46 years' service.

Horace was always a tremendous supporter of NZHS, serving on the Committee for 18 years, and helping organise and giving presentations at conferences. In recognition of these contributions, Horace became the second Life member of NZHS in 1998.

He is survived by his wife Pauline (m. 1963), their four children and six granddaughters.

OBITUARY

Matt Hickey

1978-2022

It is with great sadness we notify the Society that Matt Hickey, a member of the New Zealand Hydrological Society for the past 20 years, passed away on 20 June 2022 at home with his wife, Sarah, and his mates by his side; aged 44 years.

After graduating from Otago University Matt was employed by the Otago Regional Council as a Resource Scientist and in a short period was promoted to Manager of the Science Team. Matt quickly became instrumental in the prioritisation, design, and implementation of science for water management in Otago. Matt used his incredible intellect to think strategically about how all the complex pieces would come together and how the policy and environmental outcomes could be balanced. You don't have to look far to see the legacy of his work: National Environmental Standards, resource management policies, objectives and rules in Otago, negotiated outcomes from Environment Court hearings, and consents.

As a passionate outdoorsman, Matt had extensive first-hand knowledge of the rivers and catchments of the South Island and he enjoyed taking Sarah and their daughter Matilda to many of these special places. Matt was passionate and committed to finding solutions based on robust science that looked after the environment and the people. In his hallway hangs a plaque from Farmers on the Lindis River *"For proving great science achieves good outcomes for all"*. A respected colleague, advisor, and mate who will be deeply missed.

Ko nga mea ka waiho e koe i muri i te oranga

e kore e mau ki te kohatu,

Engari ka au ki roto i nga hinengaro o etahi atu.

What you leave behind in life

is not etched in stone,

But is embedded in the minds of others.