NZHS E-CURRENT NEWSLETTER • NUMBER 63 • JUNE 2023

NEW ZEALAND HYDROLOGICAL SOCIETY
E-CURRENT NEWSLETTER

INSIDE THIS EDITION

Richard Hawke, NZHS Executive Committee

MESSAGE FROM THE EXECUTIVE

Kia ora,

Another year and another unexpected start to the year. I want to start with acknowledging all those who have had a particularly challenging year. To start the year we really have had hydrology in the news and an ever growing list of 'extreme' events. For many in the Society, or their wider whanau, this meant a long list of challenges. I know I speak for everyone else when I say we are thinking of you.

I want to thank the Organising Committee and those who participated in our NZHS conference in Ōtepoti / Dunedin in December. At the conference it was a pleasure to award Life Membership of the Society to Barry Fahey; Outstanding Achievement Awards to Jeff McDonnell and to John Bright; an Early Career Scientist Award to Andrew Pearson; and Services to the Society Awards to: Jo Dickson, Clare Houlbrooke, Mike Ede, Joseph Thomas, Maurice Duncan, Tim Davie, Mike Thompson, and Raelene Mercer.

Barry is just the 5th Life Member of the Society and his Award reflects his longstanding commitment to hydrology and the Society. Given Barry graduated from Otago Boys High School and then – after time in the United States and Canada – returned and worked extensively on the Glendhu Catchments it was fitting to award Barry his Life Membership at the Dunedin Conference.

Jeff McDonnell has contributed deeply and continuously to NZ hydrology since he first came to NZ as a PhD student at the University of Canterbury. He is a global ambassador for hydrological sciences in NZ, has won a host of international awards that also showcase NZ, and has publications and a CV that are truly outstanding. It was timely that Jeff was then in New Zealand in February and we were able to present him with his award as part of the Maimai Field Day (Jeff's PhD was based on the hydrology of the Maimai).

John Bright is well known for his contributions to the management of water and land resources in NZ, his research leadership at the NZ Agricultural Engineering Institute, which has become Lincoln Ventures, and then his leadership at Aqualinc.

With my "Editor" hat on I would like to encourage all of you who presented at the conference, or have been involved in the extreme weather events over 2023 to consider submitting an article or note to the Journal. Some of you might remember that back in 1997 the Society published "Floods and droughts: the New Zealand Experience" Edited by M. Paul Mosley & Charles P. Pearson. I think a Journal devoted to 'floods and extremes' would be a wonderful compilation if people would like to submit their recent experiences.

With it now being May the “summer” field season is (basically) finished and we are expecting winter to arrive. So, while most of us are still enjoying warmer than usual weather and plenty of autumnal colours I want to encourage you to put the Australasian Groundwater & NZHS Joint Conference, 28 Nov – 1 Dec Tāmaki Makaurau | Auckland in your diaries. It is our pleasure to join again with the Australian Chapters of the International Association of Hydrogeologists (IAH) for this year’s conference. The conference theme is “Manaaki Wai (caring for our water): learning from the past, adapting for the future”. It captures the idea that water is a living entity, with its own mauri (life force) that needs to be respected and cared for, which is central to te ao Māori (Māori worldview). I know it will be another wonderful conference. And, if you would like to be the Editor for the Society my current term comes to an end at the AGM, which will be held on the Wednesday of the Conference.

I want to highlight NIWA’s delivering field and analytical training in Samoa (along with their local (NZ) hydrological modelling work; Hoa Pham’s articles of (first) Northland’s recent drought and then Northland’s recent extreme rainfall; and the updates from a number of organisations and thought-provoking articles.

Ngā mihi,

Richard

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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.

The views presented in e-Current do not necessarily represent policies of the Society.

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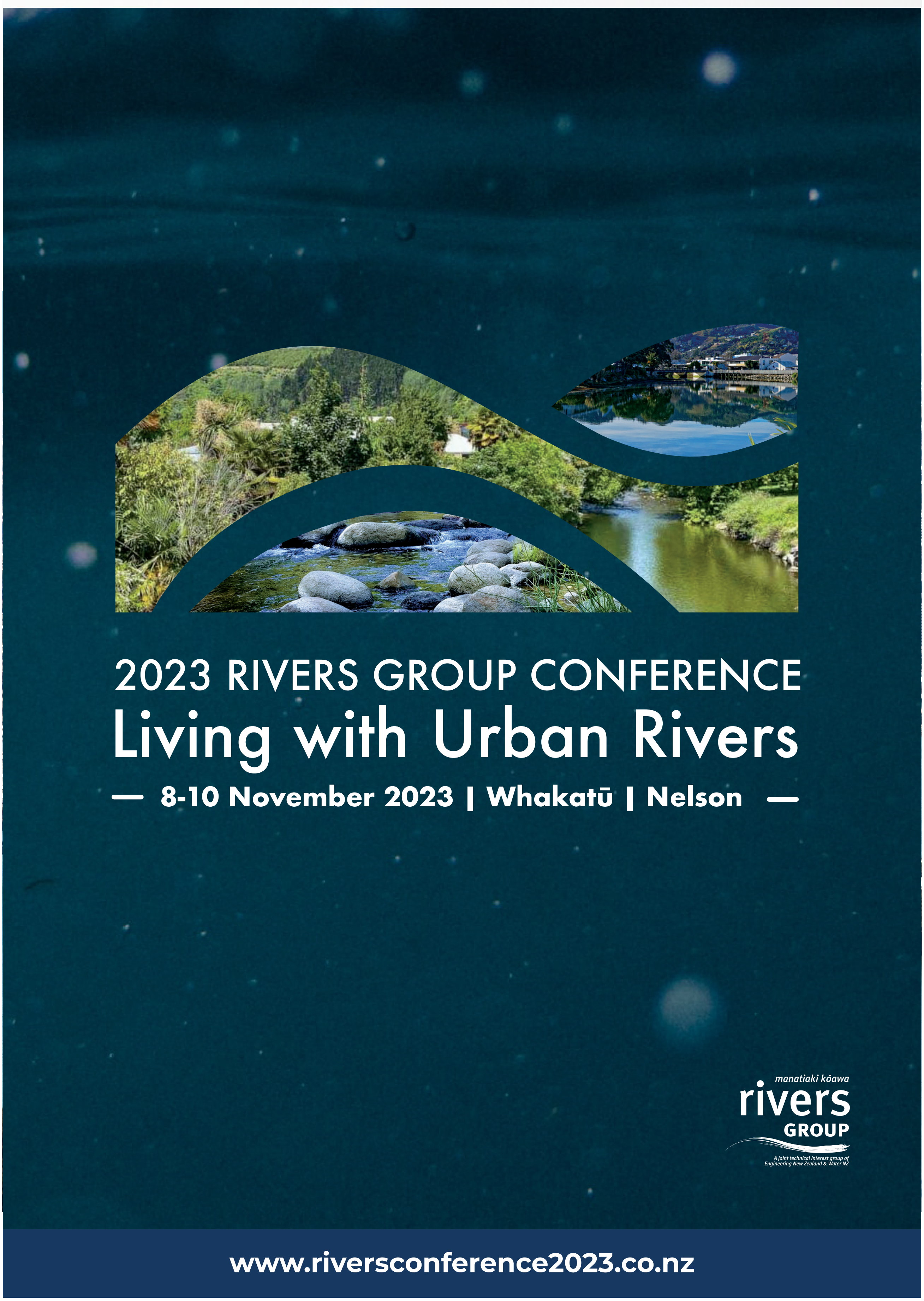
2023 RIVERS GROUP CONFERENCE
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NOTICES

Editor, Journal of Hydrology (New Zealand) – an opportunity for you

At the New Zealand Hydrological Society AGM – which will be on Wednesday 29 November, during the NZHS conference in Auckland (28 November to 1 December 2023) – nominations for the role of Editor will be sought.
Richard Hawke, who has been Editor for a number of years, is keen to pass the baton on to someone new. Richard is very happy to mentor and assist a new Editor. Laura Keenan, the assistant editor, and Jo Dickson (who prepares the page proofs) will also assist a new Editor.
The primary role of the Editor is to ensure the continued successful publication of the Journal of Hydrology (New Zealand). It is an incredibly rewarding and interesting role! Anyone interested in the role is encouraged to contact Richard (rhawke@linz.govt.nz / admin@hydrologynz.org.nz).

Journal of Hydrology (New Zealand) – a call for papers & notes

The Journal of Hydrology (New Zealand) is published twice a year. - https://www.hydrologynz.org.nz/journal-of-hydrology
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). Papers and Notes have been published on all aspects of hydrological science and management. I encourage you to consider sharing your work with others through publication.

I am keen to publish a special issue of the Journal on the recent extreme weather events. While there will be research for many years on its impacts, I am hoping that people already have interesting papers and notes they wish to share.
If you want to discuss your potential publication please don't hesitate to contact me.
Richard, Editor, Journal of Hydrology (New Zealand)

NOTICES

ONZM for former Hydrological Society Member!

It was great to see Emeritus Professor Paul Worthing Williams, of Auckland, awarded an ONZM (For services to geoscience and environmental science).

Paul is known to many of us as he was a Professor at the University of Auckland. His research and teaching interests covered geoscience and environmental science, particularly, hydrology, hydrogeology, caves, karst, climate change .... Paul was on the NZHS Executive 1979 – 1984 and a long-term Society member. In fact, while retired from academia he is still publishing. His latest paper is: 'Arthur Marble Aquifer and Te Waikoropupu Springs, New Zealand: Flow Contributions and Nitrate Sources', Carbonates and Evaporites 38(2), 1-18 (2023). Congratulations Paul.

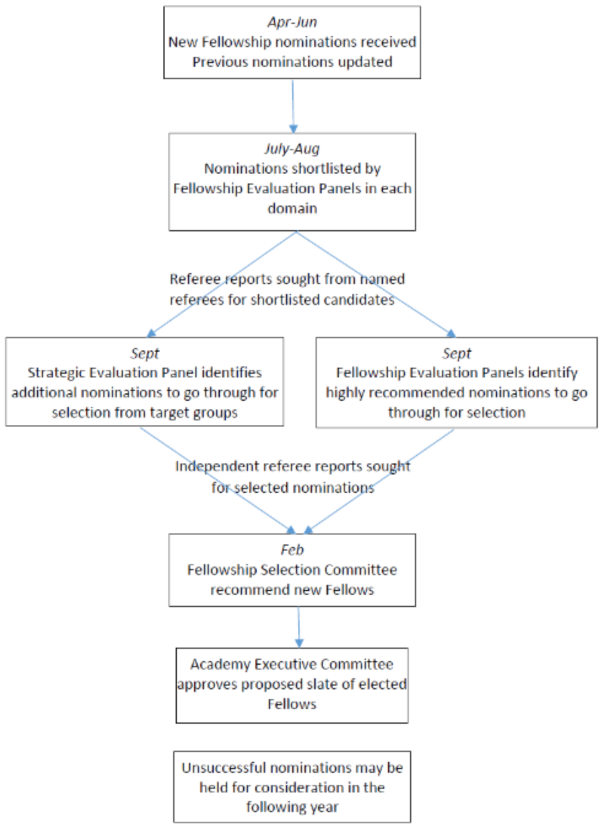
Request for nominations for Royal Society fellows

The Academy of the Royal Society Te Apārangi call for new Fellowships, Ngā Ahurei a Te Apārangi, and Honorary Fellowships, Ngā Ahurei Honore a Te Apārangi, nominations for 2023 are open now. Fellowship of the Royal Society of New Zealand is an honour proposed by one's peers and conferred for distinction in research or the outcomes resulting from intellectual endeavour (Advancement).

Details of the nomination process and requirements can be seen below and more details here, and the closing date is 30 June 2023.

Please note that the Academy is focused on increasing the diversity of nominations from under-represented groups, particularly with respect to gender, ethnicity, and employment context.

If you have anyone you would like to nominate, please get in touch with Louise Weaver in the exec committee and she will progress the nomination as we have to nominate through the Constituent Organisation route, of which NZHS is a member.



Update on the Oxfam Flow project in Papua New Guinea

Brenna Gotje, Philanthropy Manager, Oxfam Aotearoa

Your unwavering commitment and profound compassion have made a remarkable difference in the lives of countless individuals and communities in Papua New Guinea. There has been some great progress that we have achieved together, as we strive towards a fairer and more just world for all.

The FLOW Project's Main Goal is to Improved Health, Resilience and Quality of life for remote and vulnerable communities, particularly women and girls in rural PNG. The project takes place with 12 communities within the Henganofi District to improve infrastructure by installing safe systems and sanitation infrastructure in 12 schools and health centres.

Water infrastructure is complete or close to complete (within weeks) for three primary schools in three communities, with a total student population of 1,131 children (goal: 12 schools, approx. 5,400 children). We will probably be able to provide water taps to more than 12 schools, because there are also other schools (e.g., pre-primary and secondary schools) that are near the primary schools that will also benefit from the water infrastructure.

Sanitation and hygiene training, including menstrual hygiene management training, has been carried out in six primary schools. Sixty-one teachers have been trained and 1852 students participated in the training. Two-hundred and seventy three reusable sanitary pads have been distributed to date, with a further 1000 procured and ready for distribution. All six schools are now providing soap and hand towels for handwashing and have seen improved attendance from girls who had previously stayed at home during menstruation.

Water infrastructure is complete or close to complete (within weeks) for two health centres (goal: 8 health centres – each hosting 450 visits/week). As meaningful engagement with health centre staff has proven difficult due to frequent absences, the team has shifted the focus of sanitation and hygiene training to communities. Hygiene and sanitation training to take place in 5,000 households (approx. 20,000 people in 12 communities). There are a number of different stages of training for communities on hygiene and sanitation:

- A process to motivate communities to take responsibility for eliminating open defecation (6 of 12 communities now certified Open Defecation Free, total population 3993);
- Follow-up training on gender equity (168 people trained).

Our heartfelt thanks for your continued support.

Dr Andrew Pearson, Recipient, NZHS Early Career Scientist Award

Dr Andrew Pearson developed a passion for hydrology after moving to Aotearoa from the UK, to undertake a doctoral degree on climate change impacts on cave hydro-geochemistry at the University of Waikato. After completing his PhD, he became interested in resource management and groundwater quality, and worked for Environment Canterbury as a Groundwater Scientist. Since January 2022, he has been a Senior Groundwater Scientist at the Institute of Environmental Science and Research (ESR), with a primary focus on groundwater quality and remediation.

Andy has been passionate about raising awareness of hydrological science and the value of our water culturally, recreationally, biologically and as a life-supporting resource. For example, he discussed cave hydrology on Radio New Zealand. He wrote an article about groundwater for children, which was published in the journal 'Frontiers for Young Minds'.

At Environment Canterbury he wrote a technical report on the sources, occurrence and mechanisms for arsenic and manganese presence in Canterbury's groundwater. This report highlighted that some coastal areas are at relatively higher risk of contamination, owing to sources of labile organic carbon, sluggish flow rates and reducing redox conditions that can release arsenic and manganese from aquifer minerals. The findings from this report have proven valuable to Environment Canterbury, where their scientists recently referred to this report when determining the cause of drinking-water discolouration in Timaru District Council's Ōpihi water-take.
At Environment Canterbury, he also regularly provided technical advice to consents planners on proposed activities that would utilise or impact Canterbury's groundwater or groundwater users.

At ESR, he is working projects such as 'fingerprinting' pollution hotspots using DNA and emerging organic contaminants (EOCs), monitoring the release of biological and chemical contaminants from onsite wastewater systems, and utilising denitrifying bioreactors in shallow groundwater systems. He has been leading and contributing author to a number of significant publications over the past few years.

Andy's passion and desire to communicate his scientific findings to experts and non-experts at national and international scientific conferences and other public has earned him the New Zealand Hydrological Society's Early Career Scientist Award for 2022. In Andy's words "I consider my personal skills to be one of my best attributes, and I have worked alongside and shared data with researchers from different institutions and from different cultural backgrounds."

NOTICE

Barry Fahey, Life Member

Dr Barry Fahey has been and remains one of New Zealand's experts on forest hydrology. He has been a long-serving and committed supporter of the NZ Hydrological Society during his long career.

Barry must have set a record for his span of publications in the Society's Journal. His first was in 1964, reporting research findings from his Master's thesis at Otago University (Fahey, 1964). His most recent was on the hydrological effects of forest harvesting in the Glendhu (upland east Otago) experimental catchments, when he was 80, in 2021. This paper followed a long series of papers from the Glendhu experimental catchments, including papers in the Journal, with colleagues and in major international journals (e.g. Bonell et al., 1990; Fahey & Watson, 1991; Fahey & Jackson, 1997; Fahey et al., 2010; Fahey & Payne, 2017; Fahey et al. 2018; Bathurst et al. 2020; Fahey & Payne, 2021).

Barry was and remains a strong supporter of the NZ Hydrological Society, and especially for introducing and mentoring younger hydrologists to join and present their work. Barry was a long-serving member of the Hydrological Society executive, serving on the executive from 1986 to 1993 and as Secretary alongside his colleague, treasurer Lindsay Rowe from 1995 to 1998, a time of substantial growth for the Society.

After graduating from Otago Boys' High School in 1958 Barry enrolled in a BA programme at Otago. He graduated in 1961 with a double major in Geography and Geology. This was followed by a trip to Wellington, which included a discussion and summer job offer from Kees Toebes (Kees was a driving force in the formation of the Society, the President for the first 12 years of the Society and the Chief Scientific Hydrologist with the Water and Soil Division of the Ministry of Works). This led to a growing interest in hydrology and, after a couple of summers working as a field assistant for the Green Island office of the Hydrological Survey Barry began a masters study of rainfall interception under radiata pine in the Silverstream catchment, which was completed in 1964 (Fahey, 1964).

Kees Toebes again helped with the decision about whether to stay in NZ and work in hydrology, or head offshore for post-graduate study. Kees told Barry that he would need to do mathematics to Stage III if he was to have a successful career in hydrology. Barry considered this to be a rather daunting prospect and instead decided to enrol as a PhD candidate in the Geography Department at the University of Colorado in Boulder. While he expected real research expertise in hydrology in Boulder, this was not the case and so Barry gravitated back to his interest in geomorphology. He was soon working with the Institute of Arctic and Alpine Research (INSTAAR) on a topic involving periglacial landform development on Niwot Ridge in the Front Range of the Colorado Rockies.

After graduating in 1970, Barry accepted a position in the Geography Department at the University of Guelph in Ontario, Canada. He spent the next 15 years undertaking research into periglacial landforms in the Colorado Rockies and on Baffin Island in the eastern Canadian Arctic, as well as conducting laboratory-based investigations into the efficacy of periglacial processes in alpine environments. During this time he also had two sabbaticals back in the Geography Department at Otago studying the upland schist tors and associated landforms of Central Otago.

Like many kiwis, Barry was keen to return (and perhaps the weather in Guelph helped this desire…) and that happened when Colin O'Loughlin appointed him to the Forest Research Institute (FRI) in September 1985. At FRI Barry had the opportunity to refocus on hydrology, and especially the effect of land-use change on water yield, sediment yield, and water chemistry working with three other NZHS stalwarts Rick Jackson, Lindsay Rowe and Andy Pearce. This included working up data from the Maimai experimental catchments near Reefton, a New Zealand location with a long and significant impact on international hydrological research and understanding.

In 1993 Barry was able to begin working with Dave Murray, another noted Otago hydrologist and NZHS member, on whether snow tussock was able to augment streamflow through fog interception. This proved to be a rather controversial topic, and has generated much debate among hydrologists and ecologists on the relative importance of fog interception in the water balance of tussock grasslands in Otago (eg Mark and Rowley, 1969, Mark and Rowley, 1976, Ingraham and Mark, 2000, Ingraham et al, 2008, Davie et al., 2006, Fahey et al., 2011).

Following FRI becoming part of Manaaki Whenua Landcare Research, and in line with Barry's interest in land-use change hydrology, he assumed responsibility for the operation of the Glendhu experimental catchments. These catchments, in the headwaters of the Waipori River west of Dunedin, had been established in 1980 to assess the environmental impacts of converting tussock grassland to plantation forestry. They have served as a natural laboratory for a variety of investigations undertaken by students in the Geography Department at Otago and a long list of hydrological insights. Advances in forest and land use hydrology became regular themes of NZHS conferences through the research of Barry and his colleagues during their FRI/MWLR decades. Barry officially retired in 2005 but continued his work in these areas as a Research Associate with MWLR.

Barry received the Society's Outstanding Achievement medal in 2000 for his impact in both hydrological science and in New Zealand's water sector. As a life member, he now joins a select group who have contributed in a significant way to the membership of the NZ Hydrological Society, and to the Society's continuing success.

We salute and thank you Barry.

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Mark, A.F.; Rowley, J. 1969: Water yield of low-alpine snow tussock grassland in Central Otago. Journal of Hydrology (NZ) 15: 59-79.
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NOTICE

John Bright - New Zealand Hydrological Society Outstanding Achievement Award

Dr John Bright is nationally recognised for his contributions to the management of water and land resources in New Zealand.

Following a BSc in physics and BE(Hons) in agricultural engineering at the University of Canterbury, John joined the Ministry of Works and Development as an Irrigation Engineer, and was involved in analysis and design for scheme feasibility investigations and upgrades of existing schemes in Canterbury and Otago.

During his time at the Ministry of Works, John had the opportunity to work on development of computational techniques and software development. This included the development of procedures for optimal management of on-farm irrigation, using differential dynamic programming techniques, and also for simulation of unsteady flow in open-channel irrigation distribution systems, including the capability of simulating the operation of automated control gates. This work culminated in a PhD in Agricultural Engineering from the University of Canterbury in 1986.

Following his PhD, John held various roles engineering and research leadership roles in the NZ Agricultural Engineering Institute, which eventually became Lincoln Ventures Ltd.

The IrriCalc soil moisture balance and irrigation simulation model, which is based on the outputs of John's PhD research, has been widely used in consulting and research projects. A number of Councils around New Zealand have used IrriCalc as the basis of setting volumes for reasonable irrigation water use, either through bespoke regional guidelines, or via an online portal that gives results for the whole country.

In the 1990s, John was part of the small team that developed the IrriCAD irrigation design software, which is now the leading software world-wide for the design of sprinkler, drip and micro-irrigation systems.

He pioneered the development and use of spatial database-driven methods for flood damage assessment in New Zealand. For the application of this work in the Wellington and Manawatu regions, he received a NZWWA merit award.

John has also undertaken investigations and led training courses in Turkey with regard to on-farm irrigation and drainage matters.

In the 1990s, two of John's significant research projects at NZAEI/LVL were the artificial aquifers (set up in the water lab at Lincoln University to better understand water and nutrient flow through homogeneous and heterogeneous aquifers) and the linear lysimeter (set up at Te Pirita to measure drainage and nutrient flow below the crop root zone).

In 2004 John founded Aqualinc Research with Ian McIndoe and was the Managing Director until 2015. His technical and business leadership of Aqualinc has resulted in the company growing into one of New Zealand's leading groups of water resource specialists, occupying a unique space at the interface between consulting and research.

John's work with Aqualinc has been a mix of research-based consulting and government-funded research programmes. He was a lead author of the Canterbury Strategic Water Study, which helped to lay the foundations for the Canterbury Water Management Strategy and influenced the choice of methodology used for water resource investigations used in other Regions. John's work on water allocation frameworks became a key feature of the Marlborough Environment Plan, and he continues to consult on projects related to water availability, allocation, and water and nutrient accounting.

John has ensured that younger team members have had the opportunity to gain postgraduate qualifications through research programmes that he managed.

John brings a pragmatic engineering mind-set to complicated water management problems, and is respected for his ability to clearly communicate complex issues to clients and stakeholders.

John has been a long-term member and supporter of the Hydrological Society, and regularly presents at the annual conferences.

It is with great pleasure that we award him the NZHS Outstanding Achievement Award this year.

NOTICE

Jeff McDonnell - New Zealand Hydrological Society Outstanding Achievement Award

Jeff has been a continuous member of the society for 35 years, since he was a PhD student at the University of Canterbury. Jeff was a Commonwealth Scholar to New Zealand and studied with Ian Owens, Andy Pearce and Mike Stewart—all well-known NZHS members. For the past many decades, Jeff has contributed deeply and continuously to New Zealand hydrology, furthering the development of the science of hydrology through his studies at the Maimai catchment in the South Island.

Jeff has published around 50 papers on New Zealand hydrology from 1988 to 2021 (out of the 300+ papers in his CV (https://water.usask.ca/hillslope/index.php)). He has held visiting appointments at Landcare, GNS Science and Victoria University and advised four postgraduate students who based their field research at Maimai (Dean Brammer, Brian McGlynn, Chris Graham and Chris Gabrielli). Remarkably, three AGU Horton Research Grants (for best PhD proposal in hydrology) have come from this work. Jeff has also advised seven postdocs focused on model development at Maimai including Ali Ameli, Fabrizio Fenicia, Jim Freer, Taka Sayama, Jan Seibert, Kellie Vache, Markus Weiler (all professors themselves now in the UK, Japan, Switzerland, Germany, Canada and the USA). Collectively, Jeff and his former students and postdocs continue the Maimai research, producing a 2021 synthesis paper in *Hydrological Processes* titled “The Maimai M8 experimental catchment database: Forty years of process-based research on steep, wet hillslopes”, led by Jeff and with each of them as co-authors with Jagath Ekanayake, Uwe Morgenstern, Mike Stewart and Ross Woods. That work makes the complete Maimai database now open to future generations of scholars in New Zealand and abroad.

The body of work that Jeff has led at Maimai is worthy of the NZHS Outstanding Achievement award, because the work has influenced our process understanding of rainfall-runoff generation. His 1990 *Water Resources Research* paper on macropore flow of old water (cited over 750 times) showed how the seemingly divergent past findings at Maimai could be explained using a first-for-its-time combined hydrometric-isotopic approach. That was one of a series of papers through the 1990s that Jeff led that dealt with the evolving perceptual model of Maimai behaviour—summarised in a review paper by Jeff and Brian McGlynn in 2002 in *Journal of Hydrology* (cited 296 times). His modelling work at Maimai pioneered several new approaches: his 2002 *Water Resources Research* paper with Jan Seibert introduced the concept of soft data, developed and tested at Maimai (cited over 550 times), and his 2007 *Water Resources Research* paper with Markus Weiler brought preferential flow features into a hillslope model of the trenched hillslope at Maimai installed by Ross Woods and Lindsay Rowe (cited 223 times) showing how random soil pipe placement could lead to network-like subsurface stormflow behaviour. There are more highly cited Maimai papers by Jeff than I have room to mention here but his 2003 *Water Resources Research* paper with Brian McGlynn is one of the first papers on hydrological connectivity, showing key mechanisms of how the small M8 catchment was connected to its larger

Maimai valley watershed (cited 300 times).

Beyond Maimai, Jeff published in 2017 on isotope tracing of tree transpiration at the Christchurch Botanical Garden aimed at testing his two water worlds hypothesis (outlined in his 2014 *Nature* paper). Similarly, his 1990 *Water Resources Research* paper with Mike Stewart and Andy Pearce at the Glendhu catchment developed new ways to weight deuterium variations in storm rainfall (cited over 300 times). In the past few years, Jeff and his PhD student Chris Gabrielli, together with Uwe Morgenstern and Mike Stewart, have presented a series of papers on deep groundwater tritium concentrations and their link to fast runoff behaviour in streams, getting at fundamental questions of why streamwaters are so young when groundwater is so old—necessary understanding for water management in New Zealand.

To summarize, Jeff has been active in New Zealand hydrology for 35 years; he has been the biggest champion for Maimai hydrology; and a global ambassador for hydrological studies in New Zealand. The many awards he has won elsewhere (International Hydrology Prize, Dalton Medal, etc.) have largely been based on his achievements in New Zealand hydrology and his work at Maimai.

It is with great pleasure that we award him the NZHS Outstanding Achievement Award this year.

FIELD DAY

Maimai Field Day

Monday 20/2/23, Reefton

The Maimai Field Day on Monday 20 February 2023 was a splendid occasion. It celebrated 50 years of research at the Maimai Experimental Catchment near Reefton, while looking forward to future research at one of the most well-studied experimental catchments in the world. There were nearly 30 attendees, from Crown Research Institutes, universities, Department of Conservation and the Forest Owners Association in New Zealand, and a Canadian/American contingent (three of whom had carried out PhD research at Maimai and one presently so engaged) and two from Germany. Unfortunately, Andy Pearce and Lyndsey Rowe, who were major players in the setting-up and early days at Maimai could not be with us. Tom Dunne from California was also not able to be there.

Attendees gathered for welcome drinks at Dawson's Hotel in Reefton the evening prior. A pleasant evening was had, helping to establish a collegial atmosphere for networking and brainstorming within the group.

Next day we assembled for participant introductions and an overview talk from Jeff McDonnell on the history of research at Maimai and its significance in catchment hydrology.

Acknowledgements to Jeff McDonnell for the photographs

Then we headed into the field. Maimai, so often clothed in clouds and rain, was bathed in sunshine with streams at record lows.

Stop 1 was just out of Reefton looking at an exposure of Old Man Gravel and discussing initial forestry questions driving Maimai research. (McDonnell). Stop 2 was at the Maimai hut: Discussion of native beech forest and early interception studies (McDonnell). We had lunch outside the Maimai hut.

Acknowledgements to Jeff McDonnell for the photographs

Stop 3 was in the upper (0.3 ha) part of M208 catchment with Mosley's pits, where we discussed Mosley's early work and Pearce, Sklash, Stewart, McDonnell results and reinterpretations (McDonnell, Stewart).

Stop 4 was at the Woods and Rowe hillslope of M208 catchment: Discussion of hillslope hydrology and sequencing (McGlynn, Gabrielli, Morgenstern, McDonnell)

Stop 5 was at Powerline Creek: Discussion of scaling relations, catchment complexity, groundwater age (Hauhs, Stewart, McGlynn)

Upon our return to Reefton, we had a group dinner back at Dawson's. Discussion continued long into the night. In the coming months, Jeff McDonnell and his team will generate a website with the Field Day materials and a repository for all the papers that have come out of Maimai (in pdf form).

Mike Stewart

Uwe Morgenstern

ARTICLE

Hoa Pham

Northland Regional Council

Northland 2018-2020 drought: An extreme drought event in modern times (*)

In February 2020 the Northland drought was declared a "Medium Scale Adverse Event" by the New Zealand government and was upgraded in March 2020 to a "Large Scale Adverse Event" that covered the whole of the North Island and some parts of the South Island. Northland Regional Council monitored and assessed drought conditions well before drought was officially recognised in February 2020 by using the NDEWS (**).

Northland meteorological drought lasted for 24 months, from July 2018 to July 2020, which was the second most severe recorded drought (the worst being the 1914-1915 drought).

The 2018-2020 meteorological drought developed from a localised drought in the northern half of the region (Cape Reinga and Kaitaia areas) in July-August 2018 and extended downwards through the rest of the region from December 2018. The drought became a regionwide drought in July 2019, particularly in the north and northeast where "Extremely Dry" conditions occurred. Some relief from dry conditions occurred in December 2018 to February 2019 and September to December 2019 mainly due to several front systems and thunderstorms making landfall over the region. The drought only ended with a severe storm in July 2020.

Throughout this event, from localised to regional drought, the Kaitaia area persisted to be most affected, spending more time in "Extreme Drought" conditions than other areas in Northland.

Responding quickly to meteorological drought, the Northland hydrological drought also persisted between July 2018 and July 2020, which was the worst since records began.

The most severe hydrological (surface water) drought occurred in May-June 2019 and May 2020. The Awanui River recorded the most severe drought conditions for the rivers monitored throughout the region.

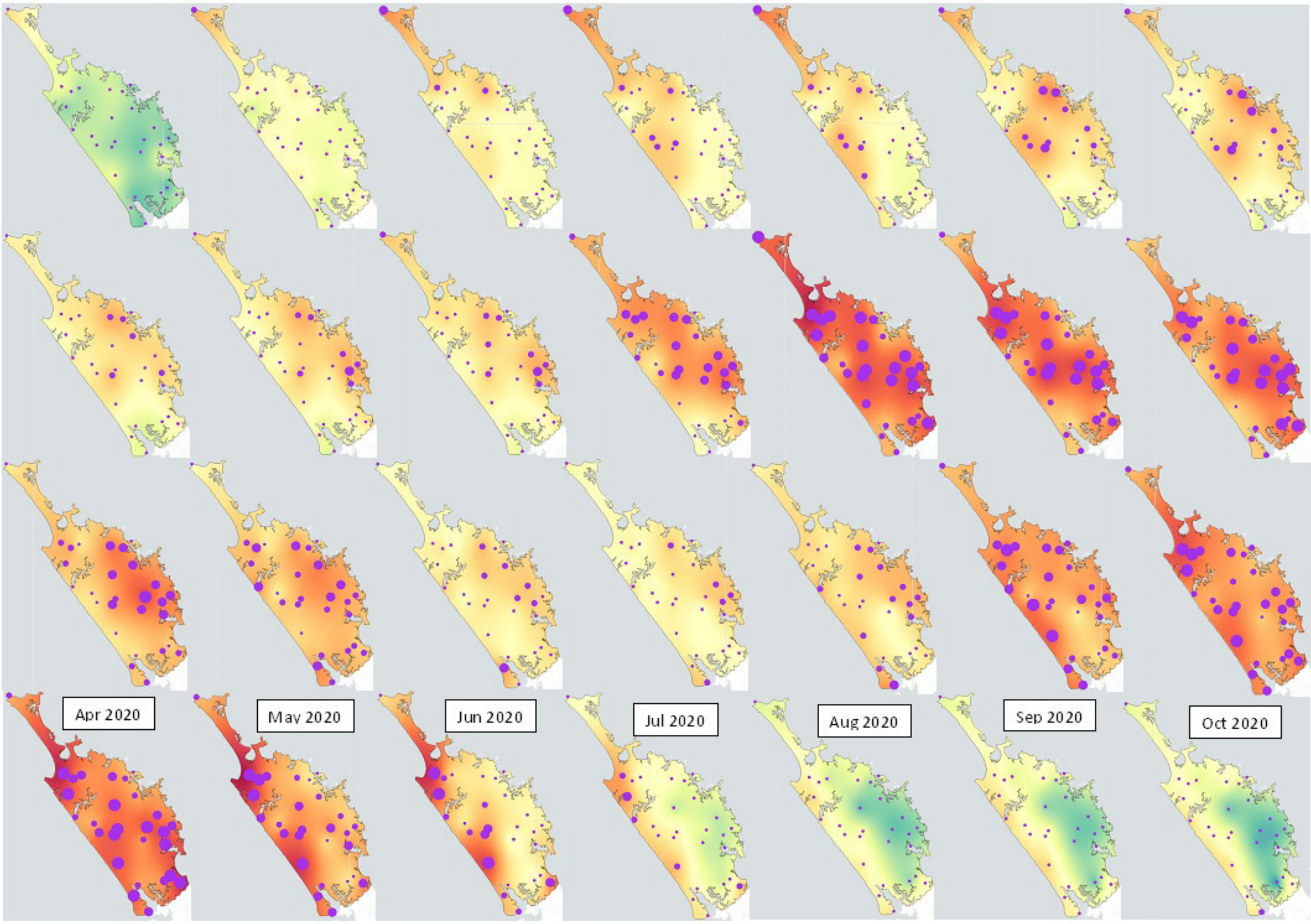
The most severe hydrological (groundwater) drought occurred during the period of February 2019 to March 2020 with very low groundwater levels in most Northland aquifers, with the aquifers in Russell and Ruawai areas recording the most severe drought conditions.

The most severe hydrological (water storage) drought for Wilson water supply dam occurred between December 2018 and December 2019 and maybe beyond (post-2019 dam water level data were unavailable at the time of drought modelling).

A survey of water quality and ecological conditions was conducted at the end of the drought period and results were compared to defined exceedance criteria as an indication of possible impact. At most sites assessed, these bottom lines were not exceeded. However, dissolved oxygen, macrophyte cover, and periphyton weighted composite cover (PWCC) had the highest proportion of sites that failed the defined criteria. It is possible these could be attributed to decreased flow rates, but no direct measurements were taken to show a relationship between flow and these variables.

(*) Kaitaia area was most affected: Extreme low 6-month rainfall during this drought event exceeded its 100-year estimate. One-week mean low flow here exceeded its 100-year estimate.

(**) Northland Regional Council developed the Drought Early System for Northland region (NDEWS). This system was proved to be effective for the region since its operation in 2017.



SPI-6 distribution for July 2018 to July 2020: The severity of meteorological drought is highlighted in orange and red colours for severe and extreme dryness, respectively.

Full report can be found at https://www.nrc.govt.nz/resource-library-summary/research-and-reports/climate-and-weather/drought-research-reports/.

ARTICLE

Hoa Pham

Northland Regional Council

Northland's July 2020 storm: was it a 1-in-500-year event?

After a prolonged drought from July 2018 to June 2020, Northland experienced a severe storm in July 2020 (between 15 to 18 July 2020). This event triggered extremely heavy rainfall and high flood flows in many areas across the region and was widely reported in the media as being a 500-year return period event.

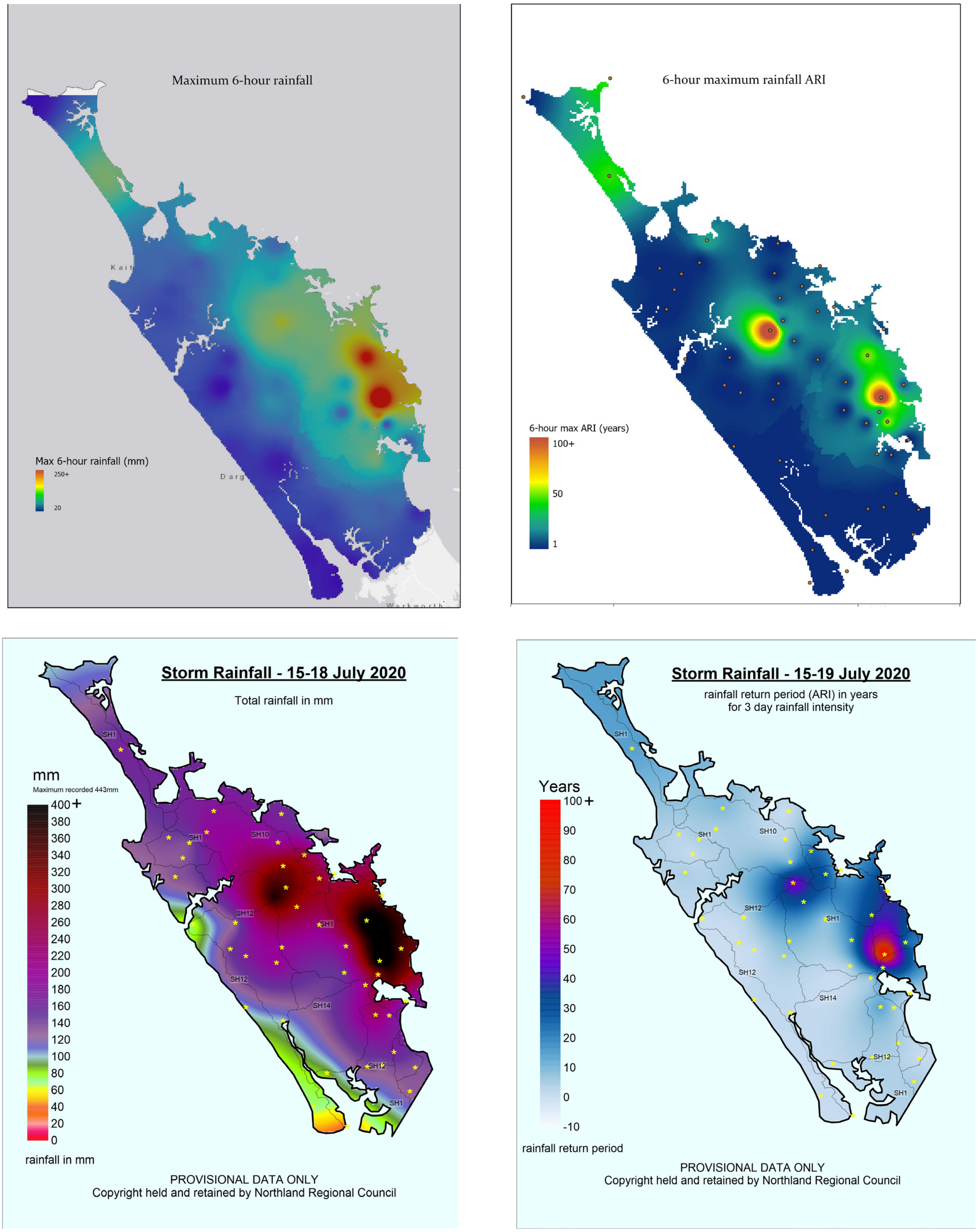
Hopua te Nihotetea retention dam in normal condition and during the July 2020 event.

Storm cells began in Waitangi catchment and later spread throughout the region and became concentrated around Whangārei [**]. Rainfall was most intensified in northern Kaikohe, Waitangi, and Whangārei areas with over 100 mm in 6 hours and over 200 mm in 24 hours. Highest rain intensity was recorded at Kaikohe rain gauge, which exceeded 100-year Average Recurrence Intervals (ARIs) for all short periods (30 minutes to 24 hours). Whangārei area received highest rainfall (over 400 mm) during entire storm period that exceeded the 106-year ARI estimated at Hātea rain gauge.

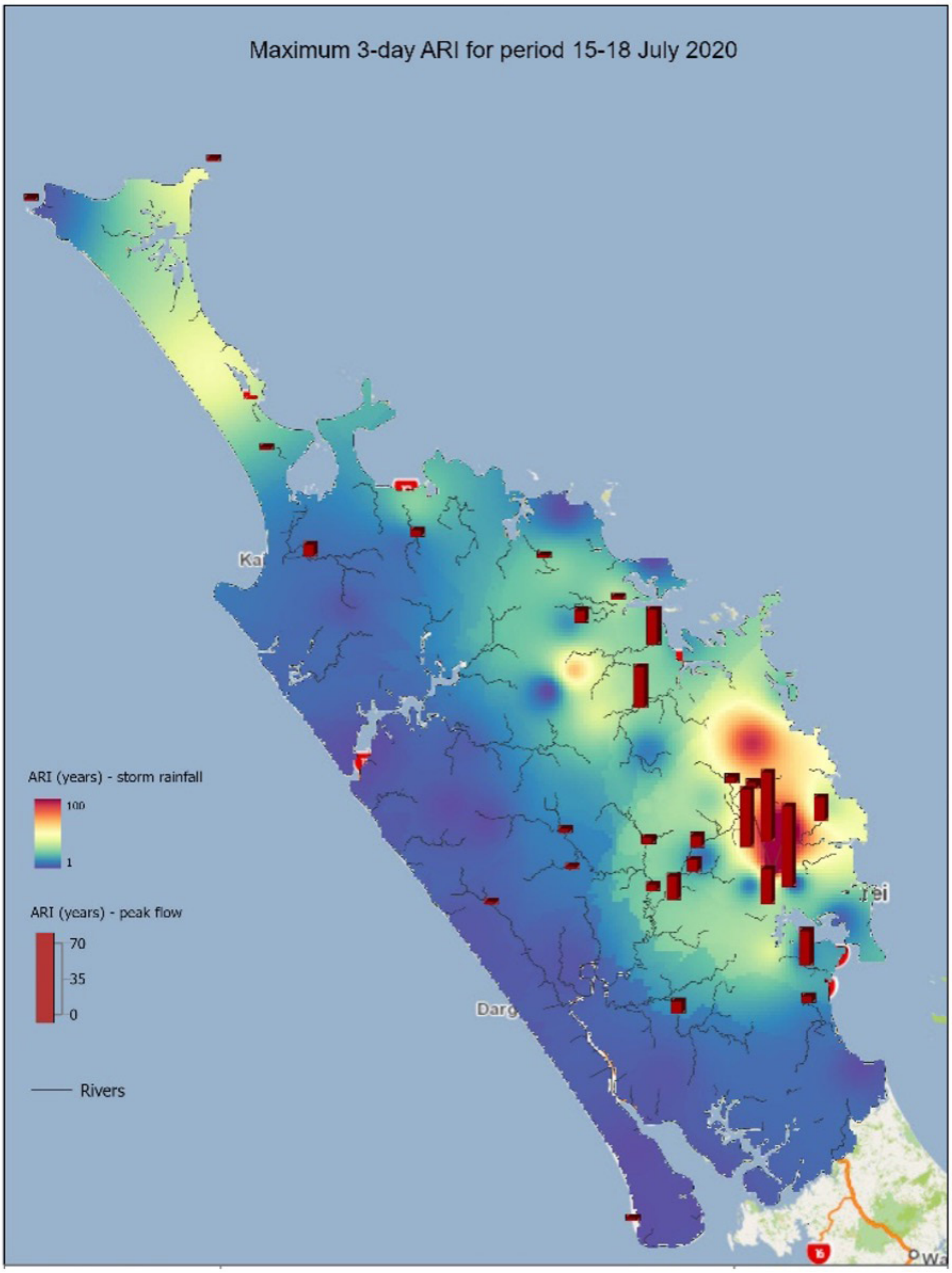
Following the rainfall patterns, flooding was widespread in the east during the storm. Hātea River in Whangārei had highest flows on record; however, this was likely influenced by tide. Actual flood peak flows in Hātea River could be between the 1-in-20-year and 1-in-50-year estimate. This was similar with flood peak flows in Waitangi Rivers. Notably, flood peak flowing through Raumanga Stream into Whangārei CBD was reduced by about 20% due to the operation of Hopua te Nihotetea detention dam.

The July 2020 flood was not preceded by high Standardised Precipitation Index (SPI) but by very extreme short-term rainfalls, and well saturated antecedent soil condition. Compared to historic major floods in July 2007, January 2011 and July 2014, the July 2020 flood was, in general, less severe.

Other notes: Northland weather rain radar detected storm rainfall with similar severity in two areas, north Kaikohe and Whangārei, during the storm event. However, the Northland Regional Council rainfall network only captured the Whangārei severe storm rainfall.



Maximum 6-hour and total 3-day storm rainfall and corresponding ARIs in Northland



Maximum 6-hour and total 3-day storm rainfall and corresponding ARIs in Northland

Full report can be found at https://www.nrc.govt.nz/resource-library-summary/research-and-reports/natural-hazards/july-2020-floods-assessment-report/.

(*) Published media:

- https://www.nzherald.co.nz/nz/once-in-500-year-storm-floods-northland-traps-residents/7LDAUEBPJVEF4XVOUBIGBBL33Q/
- https://www.odt.co.nz/news/national/whangarei-flooding-1-500-year-event
- https://www.nzherald.co.nz/northern-advocate/news/northlands-july-2020-flood-in-photos/EPFAFBRIAGOBLVCVOFSXXB43QQ/

(**) During the storm event, Council monitored real-time storm rainfall by using both Council's rainfall network and Northland weather rain radar.

ARTICLE

Lee Chambers

Mapping the uncertainty of groundwater level rise can support resilience to sea level rise threats

Lee Chambers[1], Brioch Hemmings[1], Simon Cox[1], Catherine Moore[1], Matthew Knowling[2], Kevin Hayley[3], Jens Rekker[4], Frederika Mourot[1], Phil Glassey[1], and Richard Levy[1]

[1] GNS Science, [2] University of Adelaide, [3] Groundwater Solutions Pty. Ltd, [4] Kōmanawa Solutions Ltd

Introduction

According to the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6; https://www.ipcc.ch/assessment-report/ar6/), global mean Sea Level Rise (SLR) is one of the most certain consequences of climate change. A corollary of this projection is the rise in groundwater levels for hydraulically connected aquifer systems at the coastal margin, leading to potential groundwater emergence at the land surface (groundwater flooding). The future economic and social damages of this often poorly characterised natural hazard will be substantial unless appropriate mitigation measures are implemented within defined management timeframes.

Our work

GNS Science has therefore developed a modelling workflow (or framework) to support better informed land-use and infrastructure planning through risk-based decision making (Chambers et al., 2023). Our approach explicitly acknowledges the uncertainty of the groundwater flow model used, and the "deep uncertainty" attached to the IPCC-SLR projections themselves. The resulting groundwater-related projections and associated uncertainty (see e.g., Figure 1) provides valuable insights for planners, resource managers and communities.

Data visualisation tools

To support the various stakeholders of our case study in South Dunedin (i.e., Otago Regional Council, Dunedin City Council, South Dunedin Community), we have also developed a Graphical User Interface (GUI). The GUI serves to better communicate, visualise and demonstrate probabilistic groundwater modelling outputs for decision-making purposes (Figure 1).

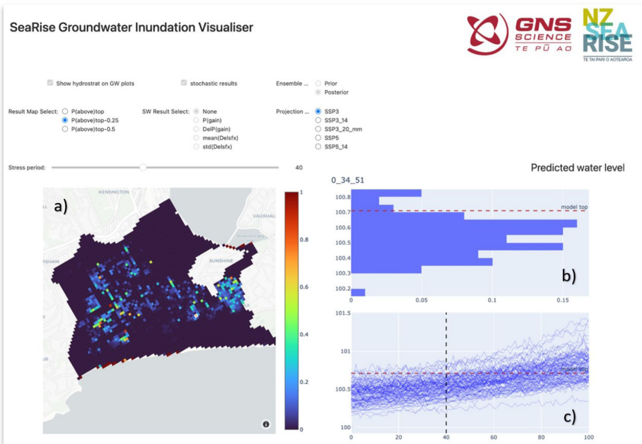


Figure 1. Example screenshot from the South Dunedin GUI demonstrating the transient progression of annual groundwater levels resulting from rising mean sea level for the IPCC-SSP3 scenario. The embedded figures in the GUI show a) the probability of groundwater levels exceeding the model top - 0.25 m for the year 2050, b) the probability of groundwater levels exceeding the model top for an example location in South Dunedin for the year 2050, and c) the transient progression of the probability for rising groundwater levels at the example location. For figures b and c, the x-axis refers to the year of the projection (2010-2110) and the y-axis refers to absolute groundwater levels (in relation to the Otago Metric Datum).

Conclusions and future work

Our approach has attempted to equip decision makers with all the necessary information to determine where groundwater flooding is likely, and where it is not. The rapidity and reproducibility of the coded workflow allows for a wide range of IPPC (or other) scenarios to be tested and mitigation options assessed.

Clearly, rising groundwater levels will present critical infrastructure planning issues long before groundwater emerges at the land surface (e.g., Cox et al. 2020). For example, the planned renovation of old leaky sewer and stormwater pipes for the case study area during the 2030-2050 timeframe (previously acting as a groundwater drainage system) will exacerbate SLR-driven groundwater level rise and flooding. This is because the leaky storm/wastewater networks will no longer be able to accommodate future increases in groundwater flows caused by rising mean sea level. Decision-makers should therefore consider limitations or reductions in drainage flows in future management scenarios of the region, to avoid underestimation of the groundwater flooding hazard.

Acknowledgements

This research was supported by the NZ SeaRise Endeavour programme, funded by the Ministry of Business, Innovation and Employment (MBIE) contract RTVU1705 (https://www.searise.nz/). The case study example development was supported by Otago Regional Council (ORC) and Dunedin City Council (DCC).

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Cox, S. C., Ettema, M. H. J., Mager, S. M., Glassey, P. J., Hornblow, S., and Yeo, S. 2020. Dunedin groundwater monitoring and spatial observations. Lower Hutt (NZ). Q24 GNS Science GNS Science, 86. Report 2020/11. doi:10.21420/AVAJ-EE81

ARTICLE

Daniel Wagenaar, Thomas King & Tim Hawgood

Application of the index velocity method in complex flow conditions

Introduction

The collection of accurate and reliable flow records in open channel flow is dependent on several factors of which a stable stage-discharge relationship is crucial. Flow monitoring site and hydraulic conditions that can impact a stable stage-discharge relationship include an unstable section control, sediment transport, debris, vegetation, off-channel storage, variable backwater effects and unsteady flow conditions (Figure 1).

Variable backwater, off-channel storage and unsteady flow conditions are all hydraulic conditions that can have a significant impact on the stage-discharge relationship and accurate flow calculations. Flood-wave movement, operation of irrigation canals, tidal effects, stream junctions and flood control measures are some examples of both variable backwater and unsteady flow conditions. The effects of the conditions on stage-discharge rating curves are illustrated in Figure 2.

There are number of established methods in defining a stage-discharge rating curve affected by variable backwater, off-channel storage, and unsteady flow conditions. The methods consist of direct measurements, analytical investigation using simplified approaches, modelling using physical-based approaches, the index-velocity method and continuous slope area method. This technical note focuses on the application of the index velocity technique using a bank-mounted acoustic doppler velocity meter, the SonTek SL1500-3G instrument.

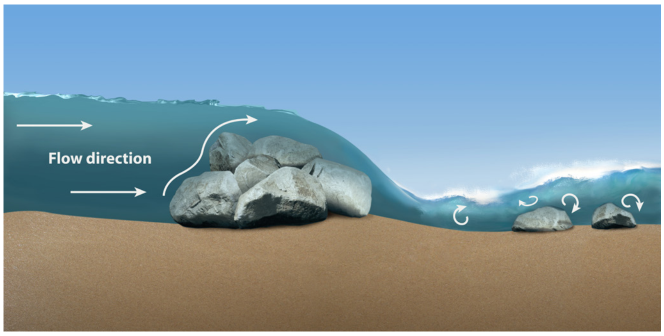

Figure 1. Section Control

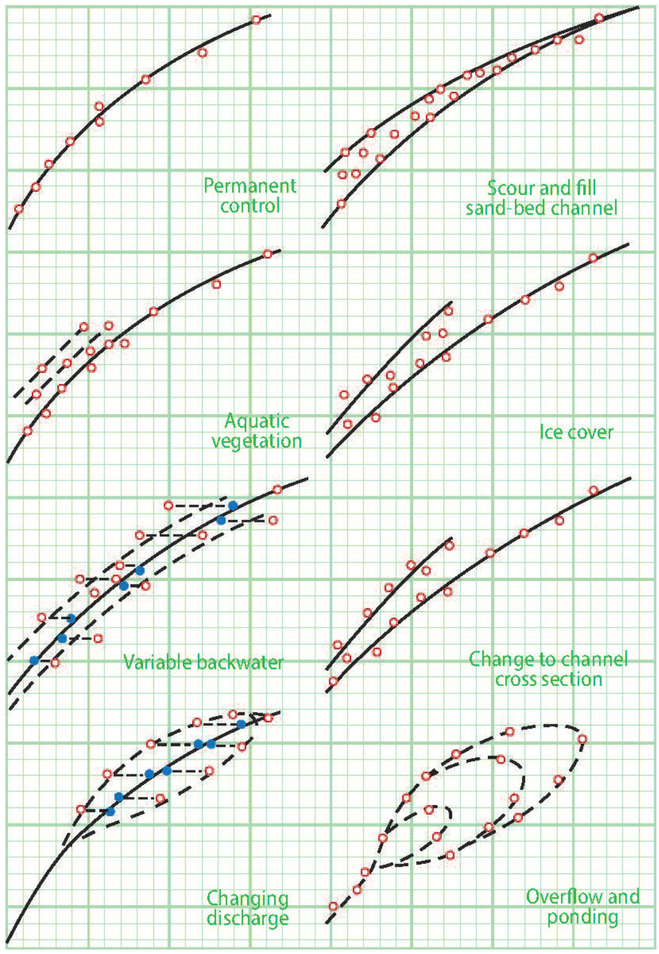

Figure 2. Rating Curves Different Hydraulic Conditions (Adapted from Herschy (2009)

Study Case

The flow monitoring site is situated in a stormwater drain (tributary) shown in Figure 3 for the monitoring of total runoff in the upstream catchment. The tributary discharges into the mainstem of the catchment approximately 1.5km downstream of the flow monitoring site.

Figure 3. Flow Monitoring Site

The site and hydraulic conditions that will affect the development of a traditional stage-discharge relationship at the flow monitoring site consists of variable backwater from the mainstem, off-channel storage on the left bank, backwater due to bridge deck and vegetation. The conditions present at the flow monitoring site were not suitable for development of a traditional stage-discharge relationship and it was decided to develop an index velocity rating using a SonTek SL1500-3G instrument. The instrument was installed in 2021 on the right bank upstream of the bridge at an elevation of 1.2m above the channel bed.

Index Velocity Method

Calculating flow using the index velocity method is different from the traditional stage-discharge rating curve. The index velocity method consists of two ratings, the index velocity rating and stage-area rating, with the output from each rating multiplied to calculate a flow. The index velocity rating is a relationship between the mean-channel velocity and streamwise velocity measured by the SL1500-3G instrument. The stage-area rating is calculated from the cross-section survey of the reference cross section used for the index velocity. The index velocity method is outlined in several published documents listed in the references.

Flow Calculation

Stage Discharge vs Index Velocity

A comparison between the stage-discharge rating and index velocity rating flow hydrographs is provided in Figure 4. The first peak of the index velocity flow hydrograph shows a much steeper rising and falling limb than the stage-discharge flow hydrograph. The flow directly after the peak of the hydrograph reduces to zero due to backwater influences from the mainstem in the catchment during flood events. The bridge deck at flow monitoring site also affects the flow hydrograph of the index velocity compared to stage-discharge.

Figure 4. Comparison Stage Discharge vs Index Velocity Flow

B. Influences

Bridge deck: The bottom of the bridge deck is at 7.8mAHD elevation shown in Figure 8. Flows exceeding 7.8mAHD water elevation will be impacted by the bridge deck shown in Figure 5, resulting in decrease in velocity because of backwater effects caused by orifice / full flow conditions. This flow condition is clearly visible in Figure 4 where a reduction in flow is reported from the SonTek SL1500 instrument.

Figure 5. Bridge Deck at Tributary

Off-channel storage: Off-channel storage is occurring on the left bank just upstream of the monitoring site shown in Figure 6. This can result in unsteady flow conditions resulting in a loop rating. The approach velocity to the monitoring site is also reduced, impacting the stage-discharge relationship.

Figure 6. Off-Channel Storage

Mainstem: The mainstem was in flood at time the stream flow gaugings were performed at the flow monitoring site. The confluence of the tributary and mainstem is located close to the flow monitoring site shown in Figure 7. Any runoff occurring in the mainstem will result in a water level increase (backwater effect) in the tributary.

Figure 7. Mainstem Confluence

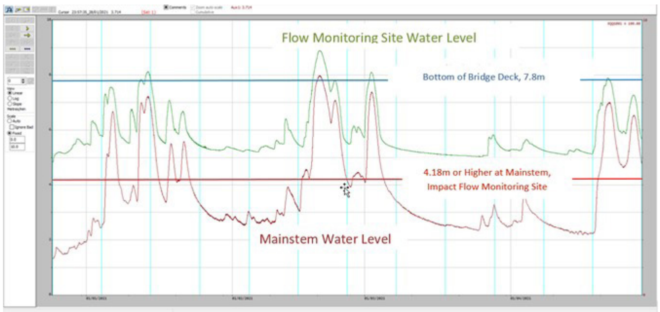

Figure 8. Mainstem Water Level

Conclusion

The proximity of the flow monitoring site in relation to the confluence with the mainstem of the catchment makes it very sensitive to any flow events that may occur in the mainstem. This sensitivity impacts the accuracy of stage-discharge relationship significantly over the entire stage range especially for traditional stage-discharge rating. The flow hydrograph comparison in Figure 4 shows that the traditional stage-discharge rating overestimates the total flow significantly, especially during periods of zero velocity when the backwater effects from the mainstem are most significant.

The index velocity method is designed for these type of flow conditions; however, the final flow calculations are extremely complex as several factors need to be considered to determine the quality and validity of the flow data.

Acknowledgment

Xylem Water Solutions Australia established and operates the flow monitoring site on behalf of Terrain NRM. Funding for the establishment of the flow monitoring site and ongoing development of flow records is provided by Queensland Government Office of the Great Barrier Reef.

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Levesque, V.A., and Oberg, K.A., 2012, Computing discharge using the index velocity method: U.S. Geological Survey Techniques and Methods 3–A23.

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Herschy, R.W., Streamflow Measurement (2009)

UPDATE

Compiled by Maïwenn Herpe

GNS Science update

Photo 1. Gemma Clark

Staffing

Gemma Clark joined GNS' Hydrogeology and Geophysics Team in early February. Gemma completed her MSc at University of Canterbury last year with her thesis focussing on using NDVI remote sensing methods coupled with environmental and stable isotope geochemistry to determine plant and water health around Whakaraupō/ Lyttelton Harbour.

At GNS, Gemma will be working on several projects including the national aquifer mapping project, assisting in the development of models and a project which will focus on how vegetation/ land use cover has changed over time as natural catchment gravel supply has decreased.

Photo 2.Pierre Glynn

Pierre Glynn is currently on his second visit to New Zealand as part of his Royal Society of New Zealand Catalyst Leader Fellowship, hosted by Paul White and GNS Science. Pierre is an Emeritus Scientist with the U.S Geological Survey Science and Decisions Centre and an Affiliated Scholar with the Arizona State University's Consortium for Science, Policy and Outcomes. He also serves as Associate Editor for the Journal Frontiers in Environmental Science (Environmental economics and management section). Pierre's research seeks to advance adaptive management and governance of water resources and environmental issues through improved stakeholder engagements and science/policy tracking. His Fellowship project aims to engage New Zealand communities, iwi and science and policy experts.

His recent publications have addressed topics such as: participatory modelling; value of information and data to decision pathways; the role of biases, heuristics, and beliefs in science, policy, and management; records of engagement and decision-making; water accounting; and the human dimensions of integrated environmental modelling. His Fellowship work brings in the study of narratives and sources of knowledge in the preferences, decisions, and actions of individuals and communities, and the creation of new approaches to track and record science and policy decisions.

For more information and further publications, please contact Pierre Glynn.

National and Rapid Model Building Tools

Developing groundwater models requires pre- and post-processing of significant amounts of spatial and temporal data, often requiring knowledge of specific input and output file structures (e.g., MODFLOW input files) and/or graphical user interfaces (e.g., ModelMuse, Groundwater Vistas) and/or software tools (e.g., FloPy). A robust representation of uncertainty often requires several versions of the model to be built to test the impacts of different model structures (e.g., discretisation, boundary conditions). Repeatability can be difficult to achieve.

As part of the Te Whakaheke o Te Wai project and the Advanced Framework for Groundwater Modelling Project (SSIF), GNS is developing a scripted approach that allows models to be built quickly with minimal user inputs (i.e., just a shapefile of the project area). This approach uses an underlying national dataset to populate default model parameters and produces a model "container" ready for exploration in a highly parameterised context, including creation of ensembles of stochastic parameter values used to quantify uncertainty in model outputs. These ensembles will be available to other projects such as NZWaM, Future Coasts Aotearoa, and regional studies.

The national model database collates aquifer data at the national scale and, combined with the rapid model build scripts, allows users to generate computationally efficient models that simulate groundwater flow in important aquifers. Modelling groundwater flow in steep, low permeability mountainous terrain is often hard to constrain due to the lack of observations and numerical challenges associated with steeply dipping gradients. As such, a filtering algorithm allows users to refine the area(s) to model based on geology and/or slope (e.g., unconsolidated sediment with less than 20% slopes), and represent mountain front recharge using various boundary conditions (Figure 1).

The user will have the option to change the underlying data (e.g., hydrogeology) by simply pointing to the appropriate file(s) (e.g., geotiff, shapefile, lookup table). In a similar fashion, the underlying data will be updated as new information becomes available (e.g., GNS's National Aquifer Characterisation SSIF project, new estimates of recharge, etc). The approach will also provide simple options for changing boundary conditions, discretisation, and model parameters (e.g., scaling hydraulic conductivity). Input and output data can be saved as images and/or rasters. Modellers can use these models as a common starting point for more advanced uncertainty quantification and decision support modelling.

For more information, please contact Wes Kitlasten

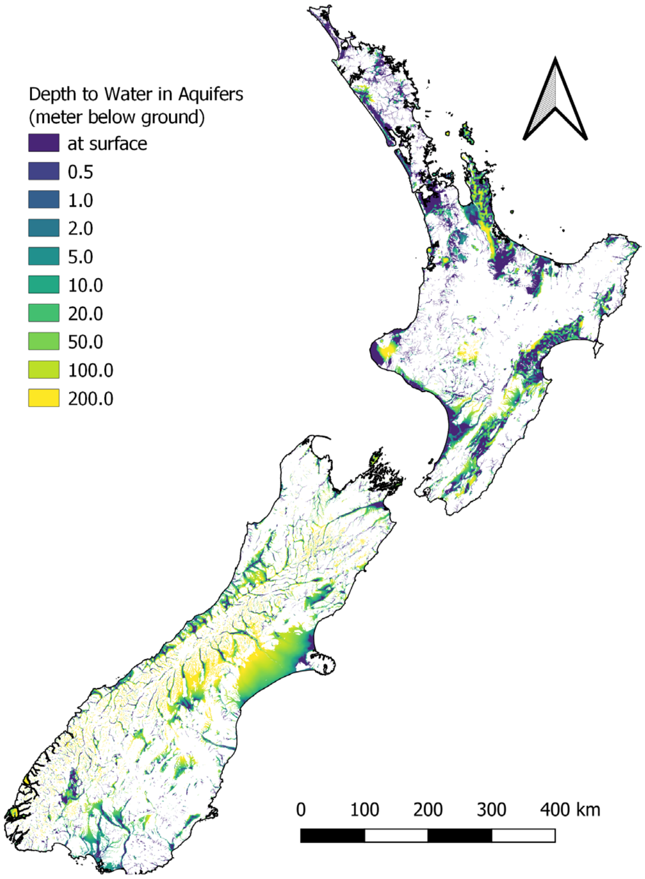


Figure 1. Depth to groundwater for all geologic deposits classified as aquifers at the surface (White et al., 2019) with dark colours showing groundwater near or at the surface and light colours showing areas of deeper groundwater. White areas are not well suited to modelling groundwater, but results are used to inform abstract boundary conditions of smaller models.

White, P.A.; Moreau, M.; Mourot, F.; Rawlinson, Z.J. 2019 (Revised 2022). New Zealand groundwater atlas: hydrogeological-unit map of New Zealand. Lower Hutt (NZ): GNS Science. [86] p. Consultancy Report 2019/144.

Recharge model complexity

The focus of this study is on the implications of recharge model complexity and the additional uncertainty created by 'simplification' errors in a specific groundwater allocation decision context. Understanding the magnitude and timing of recharge fluxes that are due to rainfall percolation provides critical information for any groundwater management programme. Many models are available for the calculation of these recharge fluxes. Some represent significant details of these recharge processes and the spatial heterogeneity of the subsurface, requiring many parameters that cannot be measured nor verified and are computationally expensive. Regardless of how they are modelled, uncertainties of recharge predictions are usually high but must be properly characterised.

Recharge models using simpler representations of the recharge processes and subsurface heterogeneity are often better able to assimilate information from local data but may be accompanied by 'simplification' induced errors. The trade-offs of adopting a simpler rather than a complex recharge model is considered through questions such as, do the simplification induced errors exceed the uncertainties a simpler model is capable of quantifying and reducing through history matching or are these simplification errors insignificant in comparison to the total prediction uncertainty? Answers to these questions are considered separately for different predictions.

This work was contracted by the Department of Water and Environmental Regulation, Western Australia, and we are working in collaboration with CSIRO. For more information, please contact Catherine Moore.

Land use, nutrients and freshwater in the Waihemo/Shag River Valley (North Otago)

Following a groundwater synthesis study (Mourot et al. 2022), which our team produced for Otago Regional Council (ORC) last year (under Envirolink funding), Frederika Mourot was invited to present the results of the study to the Waihemo/Shag Community.

This presentation was part of a full day workshop (Dunback, 28/03/2023; Figure 2) organised by Ben Mackey (ORC Team Leader Land, Science Team) and Benita MacLean (ORC Catchment Advisor, Coastal) to present and discuss the results of recent studies related to land use, nutrients and freshwater quality with the community (see ORC post). Other presentations on nutrient modelling and farm mitigation measures, as well as a farm visit, were also provided by Ravensdown Scientists Will Talbot and Colin Gray and Farm Environmental Consultant Mark Crawford.

The workshop attendees (approximately 20 farmers and landowners) showed a genuine interest in these results, related some aspects to their local knowledge, and indicated their willingness to preserve the freshwater quality in the catchment.

For more information, please contact Frederika Mourot or Ben Mackey.

Figure 2. Engagement with the Waihemo/Shag Community during the Otago Regional Council led workshop on land use, nutrients and freshwater quality (Dunback, North Otago, 28/03/2023).

Mourot F, Coble MA, Moreau M, Herpe M. 2022. Synthesis of the groundwater investigations in the Lower Waihemo/Shag River Valley. Wairakei (NZ): GNS Science. 80 p. Consultancy Report 2022/91

Community engagement at the 2023 Northland Field Days

A team of four GNS Science staff members and three local support iwi members attended the recent Northland Field Days (Dargaville, 2-4 March 2023). This event had not been held for four years due to Covid.

The team offered free nitrate sampling kits and some in-situ nitrate testing using a NICO-TriOS sensor as part of a pilot study on nitrate level in groundwater-sourced drinking-water, called NitrateWATCH. This study follows a recent review of more than 1000 groundwater and surface water samples analysed at GNS over the last decade to infer regional patterns based on water type, land use, geology, soil etc and provides national nitrate statistical data to understand the range and variation of nitrates across New Zealand (Rogers et al. 2023).

Outreach information and activities were also provided with a main focus on groundwater and climate change following the recent Cyclone Gabrielle, which severely affected Northland and the East Coast two weeks prior. This outreach relates to the research undertaken by Frederika Mourot and Estefania Santamaria on climate change and local knowledge to inform more efficient adaptation actions (Mourot, F. 2022).

For more information, please contact Karyne Rogers or Estefania Santamaria

Figure 3. Our engagement team at the Northland Field Days led by Diane Bradshaw (GNS Senior Māori Advisor at GNS), Karyne Rogers (GNS Senior Environmental Scientist), Frederika Mourot (GNS Senior Groundwater Scientist) and Estefania Santamaria (GNS Hydrogeologist), with the support of Lyvia Leaf-Fitzgerald, Haki Toka and Kipi Sarich.

Rogers, K.M., van der Raaij, R., Phillips, A., Stewart M.K. 2023. A national isotope survey to define New Zealand's nitrate contamination sources. Journal of Hydrology, doi: 10.1016/j.jhydrol.2023.129131

Mourot, F. 2022. Indigenous knowledge to underpin climate change adaptation: water management insights from overseas. Oral paper for the Joint conference of the New Zealand Hydrological Society and Meteorological Society of New Zealand. Dunedin, 6th- 9th December 2022.

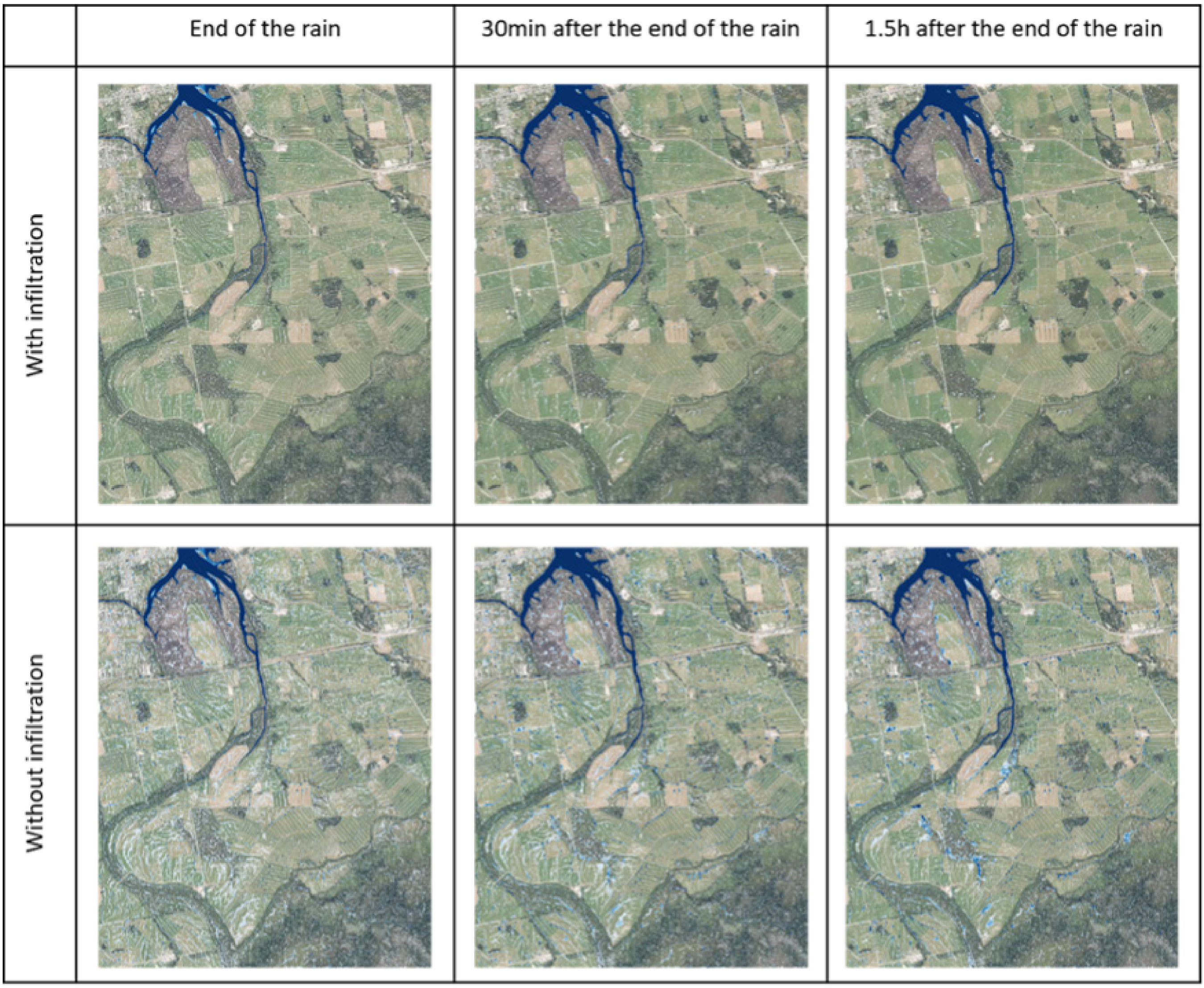
UPDATE

NIWA Update

Compiled by James Griffiths

BG_Flood inundation modelling software

NIWA's open-source flood inundation model, BG_Flood, is nearing version 1, and a group of users from the Pacific Community – Geoscience, Energy and Maritime Division (SPC) met in Wellington as part of the PARTneR project in a joint NIWA & SPC workshop. Cyprien Bosserelle and Alice Harang presented latest improvements in model stability and speed, and new features well-suited for fluvial and pluvial inundation simulation. To complement the rain-on-grid model, a basic ground infiltration model has been added to remove unrealistic ponding. Spatially distributed coefficients, based on the soil properties, ground coverage and antecedent rainfall, are used to model water infiltration before water runoff and continuous infiltration after the beginning of runoff. [Contact cyprien.bosserelle@niwa.co.nz]



Simulation of a 30min-20mm rain on the Lower Orowaiti area with BG_Flood, with and without ground infiltration

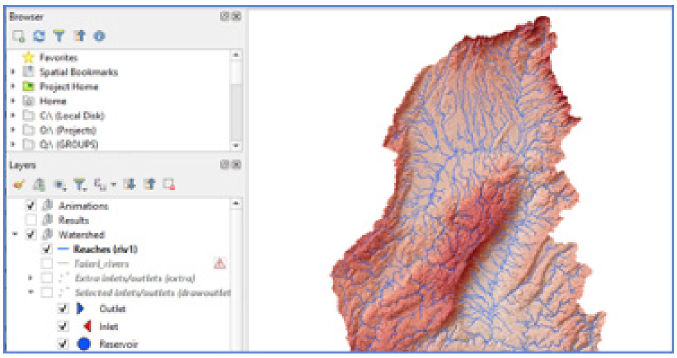
Hydrological training delivered in Samoa

A team from NIWA recently completed in-country field and analytical hydrology training for the Water Resources Division (WRD) of the Samoa Ministry of Natural Resources and Environment (MNRE). The training was delivered as part of Samoa's Pacific Resilience Project (PREP) hydrological monitoring instruments supply and training delivery, which NIWA was contracted by MNRE to provide. Key field hydrological instrument installation and maintenance as well as river/stream flow gauging skills were strengthened through the in-country training. In addition, hydrological data analysis skills using Tideda software and other complementary tools were strengthened (NEON telemetry management system). [Contact: Shaun.williams@niwa.co.nz]

NIWA and Samoa WRD staff (top left); preparing data loggers (top middle); flow gauging (top right); data logger and telemetry maintenance (bottom left); maintaining rain gauge (bottom middle); and groundwater monitoring (bottom right). Photos: M. O'Driscoll, E. Baddock and S. Williams.

Taieri catchment hydrological model

Otago Regional Council (ORC) commissioned NIWA to develop a hydrological model for the Taieri catchment. In response, NIWA developed a Soil and Water Assessment Tool (SWAT) model in partnership with Texas A&M University (SWAT developers). The model was calibrated through history matching at a daily time-step from 1980 to 2020, and the calibrated model was then used to develop naturalised flows and model several future land-water use and climate scenarios. [Contact: channa.rajanayaka@niwa.co.nz]



Mā te haumaru ō nga puna wai - Roadshow and Noho Marae

As part of the Endeavour project Mā te haumaru ō nga puna wai (Increasing flood resilience across Aotearoa), 20–30 practitioners interested in flood modelling gathered at NIWA Christchurch in November. The objective of the event was to bring together stakeholders and members of the research team to open the discussion around the methodology used and the expected delivery of the project.

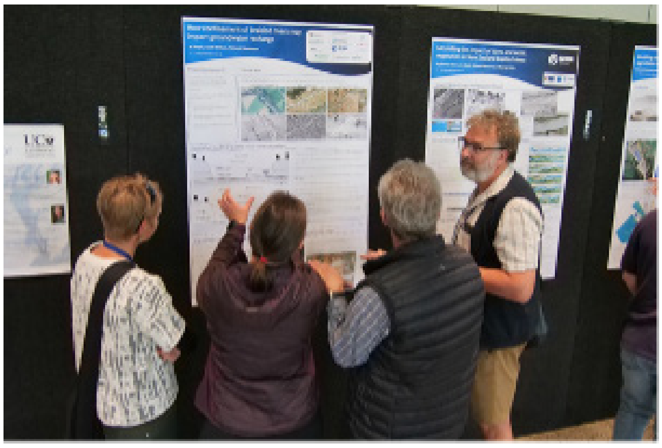
Presentations at the Third Flood Endeavour Science-Practice Roadshow (left); participation in a game of climate change adaptation (centre); and outside the Wairewa Marae (right).

The team were also welcomed to the Wairewa Marae (Banks Peninsula) for their second Noho Marae in late October. Around 40 scientists and stakeholders from NIWA, Manaaki Whenua Landcare Research, The Universities of Waikato, Canterbury, Auckland, WSP and some central and local government representatives gathered from around the country. Central government agencies were also invited to discuss their flood programmes and the potential challenge and alignment needed with the project.

The team also participated in a serious game of decision-making to mitigate the floods and adapt to local flooding as climate change, used as part of the project to open discussion around flood adaptation. The Tangata whenua of Wairewa, part of this project, also presented the story of the marae punctuated by flooding events, and their role as kaitiaki of this land, its rivers and lake and the animal and plants living in the area. [contact emily.lane@niwa.co.nz]

Making Room for Rivers conference

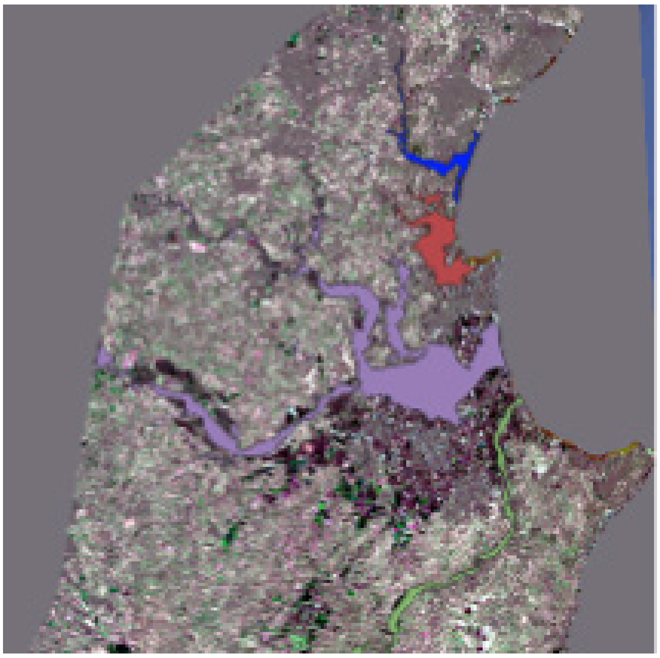
The 2022 Rivers Group Conference in Lower Hutt (9-11 November) featured NIWA's Jo Hoyle as one of three panellists leading a two-hour discussion that concluded the conference. NIWA also had three posters at the conference, which generated a lot of useful discussion. Overall, the conference was considered a resounding success with twice as many attendees as originally planned and a real feeling of momentum generated on the "making room for rivers" topic. [Contact: jo.hoyle@niwa.co.nz]



Presentations at the Third Flood Endeavour Science-Practice Roadshow (left); participation in a game of climate change adaptation (centre); and outside the Wairewa Marae (right).

TC Gabrielle – post-event response

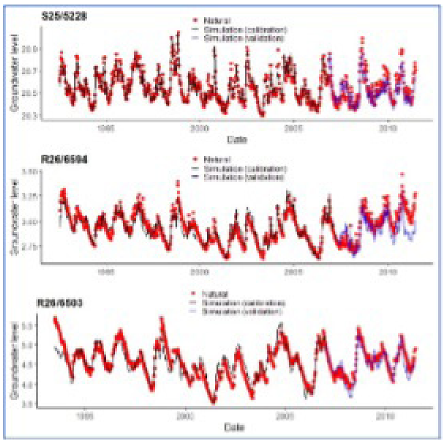
Like many others, NIWA was involved in supporting the recovery efforts after Cyclone Gabrielle. NIWA provided on-the-ground reconnaissance support to University of Canterbury, who flew LiDAR over the main rivers in Hawkes Bay to locate and document stop bank breaches and flooded areas. Teams surveyed the depths, extent and bank breaches of Tutaekuri River flooding upstream of Puketapu and the Ngaruroro region downstream of Fernhill. The data they collected will be used for calibrating hydrodynamic models and LiDAR surveys and in subsequent investigations of flood size, sediment transport, breach mechanisms, insurance losses, risk evaluation and future flood defence design. The Flood Endeavour team has pivoted to produce a map of the flooding in the Hawkes Bay region using the tools they have been developing and preliminary simulations of the event are now under way. [Contact Graeme.smart@niwa.co.nz; jo.hoyle@niwa.co.nz]

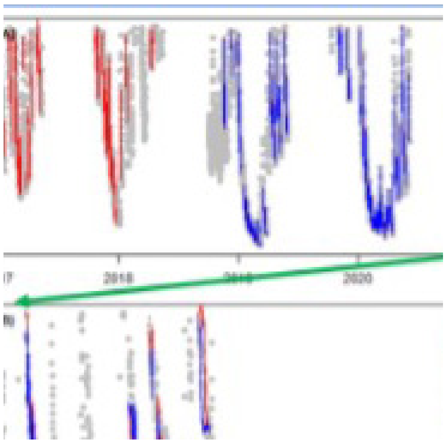


Change detection of flood extent using Sentinel 2 imagery (left); and manual survey of breached stop bank (right).

Anthropogenic impacts on river flow and groundwater levels

Over the past years, within eFlows programme of the Freshwater Centre, NIWA has developed an approach that combines the environmental conceptual modelling with statistical data modelling (including machine learning technique) to model groundwater levels and low flows in the river. This approach has been implemented to study the anthropogenic impacts on groundwater level in Canterbury region, naturalised groundwater level in Greater Wellington region, and impact of hydro-dam and irrigation on low flows in the Wairau River in Marlborough. [Contact jing.yang@niwa.co.nz]





Simulated and observed natural groundwater levels in Greater Wellington (left); and simulated and observed low flow in the Wairau River, Marlborough (right).

UPDATE

Aqualinc Update

New Recruits

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

Jenna Van Housen – Senior Environmental Scientist, we are pleased to welcome Jenna back after a few years on parental leave. Jenna is a water scientist with more than 12 years of experience in conducting investigations that underpin water policy development and in water resource allocation and management.

Nick Dudley Ward – Principal Engineer, Nick has over 25 years of experience as an engineer, scientist, and humanitarian. He has a track record for communicating complex issues with clarity to diverse stakeholders across university, industry, government policy and humanitarian endeavours.

Hunter Pethers-Boak - Environmental Management Consultant. Hunter is a graduate of Environmental Science and Geography and has a postgraduate diploma in Water Resource Management, both from UC. He is joining us after a short-term contract with CCC in their Three Waters asset management team. He specialises in Water Resource Management.

Greg Hatley – Environmental Scientist, after finishing his MSc in Environmental Science with a focus in groundwater microbiology, Greg has since worked in the Biowaste Research Group at ESR on a number of different projects, primarily in the context of waste minimisation and circular economies.

Retiring

After a hugely successful and influential career Neal Borrie has decided it is time to retire.

Neal is an environmental engineer, who has been part of the Aqualinc team from its inception. He has had over 46 years of experience in water and wastewater projects. During his career he has undertaken a wide range of work for central government agencies, regional and local authorities, as well as private industries and businesses.

Neal has been involved with drafting a number of Codes of Practice, Design Standards and Guidelines, especially relating to effluent and waste treatment and discharge.

Projects that Neal has been involved with range from feasibility studies, design reports, environmental impact assessments and contract documentation, through to project implementation. He has worked on projects involving the land treatment of wastewater from industry and municipal sewage treatment plants; the design of irrigation systems for both large community irrigation schemes and individual farm developments; the evaluation of the performance and operation of spray and surface water irrigation systems; and water resource development studies, including catchment water resources and water harvesting developments.

Neal will finish up with Aqualinc at the end of May, we wish him all the best in his no doubt active retirement.

Research Projects

Ararira / LII Catchment Management Plan and Implementation Guide

Andrew Dark and John Bright have been involved in an interdisciplinary team along with EOS Ecology and Cawthron Institute to produce a Catchment Management Plan and Implementation Guide for the Ararira / LII catchment in central Canterbury.

The project has been completed for Living Water (a partnership of Fonterra and Department of Conservation) and has been completed as a co-design process with a Project Team that includes Living Water, Te Taumutu Rūnanga, Selwyn District Council, ECan and the LII Drainage Committee. The catchment contains a land drainage network, maintained by Selwyn District Council, that lowers the water table and makes the area suitable for farming. Current maintenance practices do not recognise the potential habitat value of the drains and have resulted in a cycle of deepening and bank steepening that has resulted in significant sediment inputs.

The Catchment Management Plan "re-imagines" the drainage network as waterways with multiple values, integrating ecological and cultural principles while still retaining the drainage function. A toolbox of solutions, matched to waterway types, has been proposed, drawing from the experience of Living Water's other work on small-scale trials. The Implementation Guide covers key areas that need to be addressed for successful implementation on a catchment scale, including a mix of technical and social aspects.

While the project has been focussed on the Ararira catchment, a secondary aim of the work has been to provide a template for catchment planning and implementation in other lowland catchments with land drainage networks.

The final documents, which were formally presented to Selwyn District Council and Te Taumutu Rūnanga in April, are available here: https://www.livingwater.net.nz/catchment/ararira-lii-river-te-awa-o-araiara/ararira-lii-catchment-water-network-redesign/

Surface Water-Groundwater Interactions

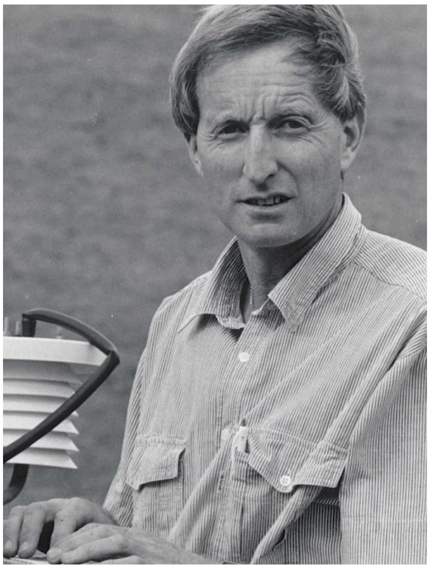
Recently Ross Hector and Julian Weir undertook assessments of surface water-groundwater connections in complex hydrogeology settings. Key to these assessments has been the collection of real-world field data to test the hydrogeological conceptual understanding, guide parameterisation of the analytical solution and cross-check the results.

In one example, we initially completed an aquifer test to quantify aquifer and streambed properties. However, streambed conductance was not able to be quantified within a sensible range using this method, and subsequent analytical assessments then resulted in very large estimates of stream depletion. Therefore, we conducted double-ring infiltrometer tests and stream flow gaugings at multiple sites to better quantify (and constrain) the potential range in bed conductance. This subsequent work narrowed the range in possible streambed hydraulic properties and gave greater confidence in the predicted depletion. This was favourable for both the client and the regional council.

In another example, we installed shallow piezometers adjacent to a stream to measure height differences between the stream's free surface and adjacent groundwater level. These measurements, along with stream flow gain/loss gaugings, also enabled us to quantify the hydraulic properties of the stream bed for subsequent use in an analytical assessment. Prior to this field work, the nearby abstraction bore was deemed highly connected to the stream. The newly collected data resulted in a substantially reduced estimate of hydraulic connection, which again was favourable for managing the resource.

Both of these case studies demonstrate examples where real-world data collection has aided in the realistic assessment of potential effects. Field measurements can help validate and improve models used to inform decision-making. The relatively small investment in field measurements has proven invaluable for aiding the sustainable use of our freshwater resources.

OBITUARY



Remembering Tony Hewitt

Martin Doyle, Tasman District Council

Tony Hewitt, a stalwart of Upper South field hydrology, passed away in February at the too-young age of 72. Tony spent the earlier parts of his hydrological career in the Water and Soil Division of the Ministry of Works and Development (MWD), based in Nelson, and later ventured out to set up his own consulting business.

During the 1970s Tony and the MWD team collected valuable data from across the wider Nelson region, including water resource surveys of the Pelorus, Waimea, Motueka and Buller catchments, capturing the significant 1973 drought in this process. In addition, the Moutere Field Research Centre was established about then, looking mainly at the effect of pine trees on the terrestrial parts of the hydrological cycle. Both these projects were exceptionally valuable, and policy is still being written based on these data. Another notable trance of work from this time was the assessment of hydro potential in the Upper Buller River.

In 1980 Tony became the team leader at Nelson, and he grew the team in size, resources and skill. For that era, the group he built was diverse, and he had a knack of getting the best out of people through measures of trust, encouragement, fun, but also a little stick when needed. He was naturally competitive and field trips often involved tossing gumboots, climbing tall trees, swimming in rivers etc. As a result, the health and safety practices at times might be considered astonishing by modern standards, but no serious harm resulted. When on trips away from home and after work hours (and sometimes during) it wasn't unusual to find yourself hunting, fishing or tramping somewhere, or involved in some other fun activity.

Another knack Tony had was his ability to convince management that we needed various bits of useful equipment. We were given our own tramping packs, various tools, items of non-standard clothing, and even on one occasion, snowshoes (I don't recall these ever being used). Somehow, he managed to source good vehicles not seen elsewhere in the wider MWD. We had a research hut in Kahurangi National Park, and Tony convinced the powers that be of the need to continue its existence, and also found some paint that was particularly useless, to the point we had to spend an extended period in the Cobb Valley every year repainting the hut, and of course hunting and fishing as well.

But it wasn't all just fun. He instilled a duty of care into our data collection, and so improved the

Image above: A newspaper article from the 1990s, showing Tony gauging the Waimea during a drought. Tony gained a lot of satisfaction from gauging rivers throughout his long career.

quality of the data we collected over that era, and of note, was particularly tenacious in his efforts to collect flood gaugings to establish rating curves. It was not unusual to be on a cableway in the middle of a storm at 3 am, with a heavy gauging bomb in the raging water below and spotlights looking upstream for logs. Many rating curves in Tasman/ Nelson are, even now, based on that data. It was similar for drought flows, and a newspaper photo from this era shows Tony gauging the Waimea River with an Ott current meter, one of tens of thousands of gaugings he must have carried out over his career.

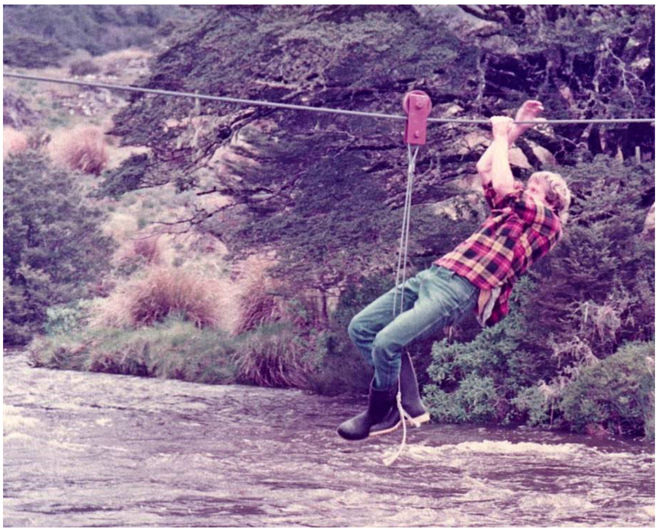
Another of Tony's legacies was the many new Hydrologists he brought into the industry. As mentioned, his interpersonal skills made the job interesting and fun, and he, along with wife Liz, treated staff like family. I feel fortunate to have had that mentorship at an early age – and recall the many things Tony (perhaps unwisely) trusted me to take on – a good example being a lead role in the hydrological study for the Lake Matiri hydro development as a 19-year-old. He allowed me to put my name to the final report, ignoring that he had carry out some major edits... That scheme is a good example of the enduring nature of the work we all do, as it was only several years ago that the Lake Matiri hydro scheme was finally built, with Tony involved in compliance monitoring after its commissioning – a start to finish participation of some 40 years.

In the late 1980s the Water and Soil Division went through a series of changes, ultimately being placed in its new home, NIWA. Tony saw the opportunity to leave and made use of his natural entrepreneurial tendencies in a variety of projects, before setting up his own business "Envirolink", based in Mapua, Tasman. He offered consulting services to the hydrology and monitoring area for over 30 years before selling the business in early 2021 and retiring.

His Envirolink work involved him in many interesting projects, including the feasibility study for the Pike Mine, water quality compliance for the mussel industry throughout the Marlborough Sounds, and other jobs located in great locations – often well into the back blocks. He worked hard and advocated strongly for his clients and was well liked by the many industries he represented. Over this time he continued to bring new staff to the industry, and as before, treated them like family. He continued to foster a positive no-blame culture, a good sign of a confident, trusting leader.

Tony left an enduring legacy through the data he collected, particularly the extremes of droughts and floods, but also through the staff he brought into the industry. He remained passionate about the industry to the end, and never considered hydrology to be work.

He is sorely missed, not least by his wife Liz and daughters Nicola, Leanna and Kristen.



Tony using a 'sweet as' laptop to set up a weather station, not long after setting up Envirolink, his consulting business.

No point in getting wet feet when you can find an alternative way of crossing the river.