APRIL 2022 (NEWSLETTER IV)

TE WHAKAHEKE O TE WAI

A quarterly newsletter for stakeholders of the TWOTW Research Programme

Wairau River, Marlborough (Uwe Morgenstern, GNS Science)

FROM THE PROGRAMME LEADERS

Catherine Moore and Uwe Morgenstern

Kia ora and welcome to our fourth update for the TWOTW research programme. The aim of this update is to keep our stakeholders and collaborators informed of project progress and activities being undertaken.

In this newsletter we are excited to introduce our postgraduate students from the University of Canterbury and Victoria University of Wellington. The students provide an insight into their whakapapa and the range of exciting topics they are researching within the TOWTW programme. In February we held the annual Science Advisory Panel (SAP) workshop (online). Each workstream provided a technical presentation followed by opportunities for a question and answer session, and general discussion topics. We have prepared a short summary of each workstream which is presented in the SAP section of the newsletter. As we head into the second quarter of 2022 and Autumn the team is excited to continue the momentum on our research.

Over the last months, our water age and chemistry tracer programme has been extremely busy to achieve a large sampling coverage during this year's baseflow season. Despite still being under the spell of a few COVID restrictions, we managed to get most of the work underway. We covered the Greater Wellington region to fill knowledge gaps not covered by historic data sets, including the Kapiti Coast, Wairarapa, and the Hutt Valley with excellent coverage from six new multilevel wells to obtain conceptual understanding of groundwater dynamics in 3D. In February 2022, together with Marlborough District Council, we performed a successful radon sampling campaign in the Wairau River, covering nearly its entire length, to obtain information on where the river loses water into, and gains water from the gravel system. Currently we are sampling Northland, Waikato, Auckland, and Bay of Plenty.

Ngā mihi, Cath and Uwe.

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RADON SAMPLING: MARLBOROUGH

In the first week of February 2022 we performed a successful sampling campaign in the Wairau River, covering nearly its entire length, between the coast and Dip Flat. Together with Marlborough District Council (MDC) we collected 140 radon samples to identify where the river interacts with the groundwater system, losing or gaining water. We found a very complex groundwater system discharging into the Wairau River in its lower reaches, where the confining layer is relatively thin and obtained liquefaction damage following the 2016 Kaikoura earthquake. Up to now, very little was known about the natural discharge of the Wairau aquifer - an essential parameter for water resource management. This work is part of a collaboration between MDC, and GNS' groundwater SSIF programme to establish new techniques for water resource management, and the MBIE Endeavour programme Te Whakaheke o Te Wai to produce national understanding of groundwater - surface water interactions.

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SCIENCE ADVISORY PANEL WORKSHOP

The Science Advisory Panel workshop was held on 22 February via MS Teams online. Attendees included members of the TWOTW research programme and panelists from Regional Councils, Universities, iwi, central government, and research organisations. The following summaries have been prepared based on presentations provided at the workshop. Following the presentations, an open discussion was held between the programme members and the panel members.

National Modelling

The national modelling component of TWOTW is developing a national scale groundwater model platform that incorporates nationally consistent datasets and methods for describing model uncertainty. The models developed within this platform utilise MODFLOW 6 software to provide a consistent starting point for finer scale models, suitable for addressing specific (local and regional) questions. Information gained from finer scale models can be used to inform the national scale model and/or finer scale models in areas with sparse data. Recent focus on building and interrogating the Wairau Plains model is now shifting to the Heretaunga Plains model. The impacts of heterogeneity on travel time of groundwater will be further explored.

Meta-modelling

The meta-modelling workstream uses two different meta-modeling (statistical and data-driven) techniques to predict groundwater age from hydrochemistry data and also from a set of widely available physical variables. The aim is to identify rapid modelling methods for predicting groundwater age in areas where groundwater age measurements are not available. Recently, the team has been focusing on the transferability of the meta-modelling techniques to new areas. This includes assessing how well the model developed for the Heretaunga Plains performs in the Wairau Plains region, and then in other coastal regions. A detailed summary of the meta-modelling workstream was provided in the October newsletter - so check there for further technical information.

Source Protection Zone (SPZ) modelling

Source protection zone modelling is required to protect a groundwater supply, such as that used for drinking water. SPZ modelling in heterogeneous aquifers has limitations associated with unknowns in physical hydrogeology and/or modelling aspects (e.g., lithology, geostatistical scaling, parameterisation, modelling constraints for calibration, modelling approaches, solution uniqueness, and boundary conditions). The workstream uses two case studies to explore SPZ modelling. The Heretaunga Plains (Hawke's Bay) is used to explore the impact of nearby boundary conditions and large/small surface water boundaries, and the West Melton (Canterbury) example is used to explore relatively deep wells that require a large vertical delineation. These case studies were selected due to the need for a reliable SPZ modelling and relatively good availability of required data. The focus is on the youngest water reaching the well (e.g., important for drinking water). Upscaling of small-scale heterogeneity is designed to ensure that rapid transport pathways are represented in field scale models. A series of different lithological characterisation schemes and different methods of calibration targets and parameterisations have been explored to date. Initial results are currently being examined in greater detail, including implications of model scale and ease of use and applicability.

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NIWA sampling/modelling

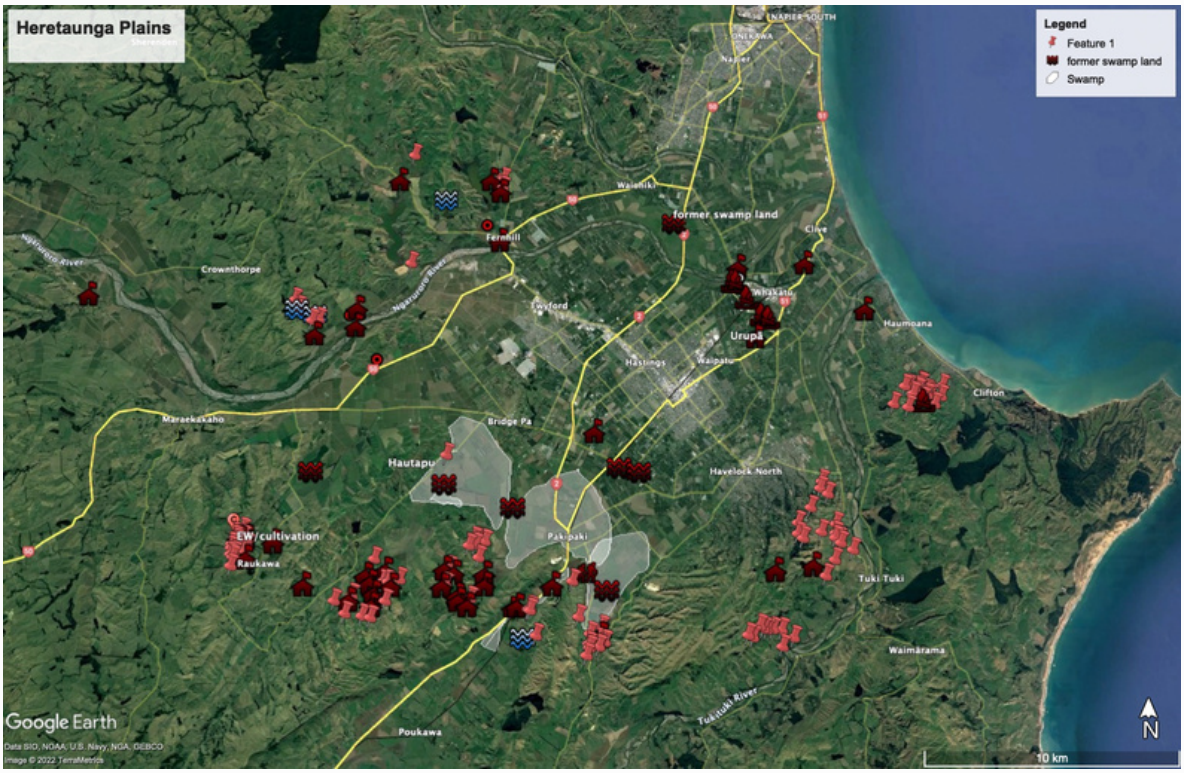
Seasonal cycles of precipitation isotopes can be used to calculate water age metrics such as catchment transit time. This method is most effective for water bodies where the mean residence time of water is low (young water). There is difficulty when trying to calculate the amplitude of river water and precipitation over a mountainous country such as New Zealand. To address this, NIWA have undertaken four years of sampling precipitation isotopes at 58 sites across New Zealand. This data will be used to improve existing precipitation models to better represent amplitude and seasonal cycles by combining model development with increases in sampling. Initial results indicate very low amplitudes on the West Coast (showing less promising results), but very high amplitudes on the East Coast (showing more promising results). Work has begun on coding a new precipitation isotope model. The aim is that when the model is complete, water age metrics can be calculated across national river monitoring sites.

Isotope sampling

The focus of the isotope workstream has recently moved from the Heretaunga Plains to a more national coverage. The workstream is using data collected over the past 60 years in combination with original data collected specifically to fill in data gaps. A groundwater - surface water interaction survey of the Wairau River, Marlborough was undertaken in February and additional isotope sampling has been undertaken in Wellington, Northland, Waikato, Auckland, and Bay of Plenty Regions.

Vision Mātauranga

Work is now focusing on the Google Earth mapping of historical sites and water sources in Hawke's Bay, relevant to the project (see below map). In addition, there has been planning for publications and other outputs in partnership with the whānau of Bridge Pā. A numerical model is also being developed for the Bridge Pā area to support the exploration of local community concerns, and discussions around restoration possibilities.



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INTRODUCING OUR TEAM: STUDENTS

In each newsletter we will be gradually introducing members of our team. For this newsletter we have asked our postgraduate students to introduce themselves - they tell us about their whakapapa and research within the TWOTW programme.

Alyssa Thomas

Ko Manaia te maunga
Ko Whangārei-Terenga-Paraoa te moana
Ko Ngātiwai te iwi
Ko Patuharakeke te hapū
Ko Takahiwai te marae
Ko Rangiora te whare tupuna
Ko Pirihi tōku whānau
Ko Alyssa tōku ingoa

My name is Alyssa Thomas, I am currently doing a Master's of Indigenous Studies at Te Herenga Waka/Victoria University Wellington, in partnership with Te Whakaheke o Te Wai. I finished my undergraduate studies at the end of 2021, a Bachelor of Science in Geography, Development Studies and Māori Studies. I am stoked to be working on the GNS/TWOTW project; regarding groundwater and freshwater aquifers, and how oral histories reflect healthy waterways and interests of resource management. The focus group for this research will be with my whānau in Takahiwai – my special place!

Willow Milligan

Willow is undertaking a Masters of Arts in Māori Studies at Te Kawa a Māui, Victoria Univeristy, Wellington. His thesis is exploring the opportunities for successfully weaving together Mōhua mātauranga Māori and Western Science for the protection and enhancement of Te Waikoropupū Springs, a significant wāhi tapu in Te Tauihu (top of the South Island). He is currently proposing to carry out a historical health assessment of the puna (spring), collaboratively working alongside local iwi to analyse the effectiveness of this approach in relation to establishing future restoration strategies for Te Waikoropupū and other freshwater ecosystems in the rohe (wider area).

Tara Fostner

I am a PhD student at the Waterways Centre for Freshwater Management, University of Canterbury. My research focus is on investigating methods for assessing the 'baseline' (pre-European) conditions of a groundwater-surface water system incorporating indigenous records of natural conditions. Impacts on water resources are often quantified based on an assumed pre-development groundwater-surface water condition, however, baseline conditions are often constrained by lack of data as they pre-date monitoring periods. Understanding the Pre-European groundwater-surface water conditions is a critical consideration when investigating impacts on water resources that affect indigenous populations. This research aims to explore methods of untangling the potential stressors (eg. drainage developments, increased abstractions, etc) of European settlement in a highly developed catchment using numerical modelling techniques and the inclusion of indigenous knowledge to reconstruct baseline conditions. Not only will this project develop new science to underpin the management of integrated groundwater and surface water systems, but it will have flow on effects by providing a more comprehensive understanding of pre-development baseline conditions in a water resource system.

Oscar Arnold

My name is Oscar and I'm very grateful to have won the GNS Te Whakaheke o Te Wai scholarship to research iwi perspectives on groundwater - I'll be studying this to fulfill the Honours year in a Masters of Māori Studies. This is a huge topic, so my research will focus on the Wahi Ngaro between Mātauranga Māori and Western science, and will use groundwater to facilitate a cross-cultural conversation. The Wahi Ngaro interface will be an important pillar for my research. My positionality is situated within a Wahi Ngaro of sorts, I grew up biculturally - my mum is from India, my dad was born in the UK and I learnt Spanish in Australia - I grew up between different cultural contexts. Furthermore, groundwater itself lies within a Wahi Ngaro, an unseen realm. I hope to explore the potential held between te ao Māori and te ao Pākeha perspectives to reveal how collaboration can improve the management of groundwater. I think this cross-cultural collaboration is critical for decision making in Aotearoa more broadly, and especially in the face of climate change. As the impacts of climate change continue to develop, groundwater is likely to be impacted significantly. Both cultures place an emphasis on groundwater so I'm intrigued to see how both worldviews frame, approach, manage and relate to groundwater. The areas of convergence and divergence between both worldviews in relation to groundwater has already been, and will continue to be, a really interesting component of the research. I'm excited to see where this research will lead and feel like I will learn so much. Thank you for the opportunity to be involved in this research.

TWOTW PROGRAMME SUMMARY

Te Whakaheke o Te Wai (TWOTW) is a five-year research programme funded by MBIE's Endeavour Fund and led by GNS Science. Multiple national and international organisations and stakeholders are involved in the collaboration. Primary collaborators of the research programme include NIWA, ESR, Te Tai Whenua O Heretaunga, Victoria University of Wellington, and Watermark Numerical Computing. Hawke's Bay Regional Council support the major case study area, the Heretaunga Plains. Other regional councils and organisations also contribute to the research project, including with co-funding.

The TWOTW programme aims to better support water management based on improved understanding and integration of flow sources, pathways, water travel time, and cultural knowledge and values in New Zealand. The research is underpinned by the concept and defining of 'Te Whakaheke o Te Wai' of groundwater throughout the main catchments and aquifers in New Zealand. The 'Te Whakaheke o Te Wai' of groundwater - our largest freshwater resource - is largely unknown, yet stakeholders recognise that this knowledge is urgently needed to protect and sustainably manage groundwater and the rivers and streams it feeds. Outputs from this research are to provide decision-makers with much needed knowledge for improved water management at national, catchment, and local scales. Outputs from the research will be publicly available and benefit people and institutions involved in water management.

The programme is currently developing the world's first nationally continuous maps of groundwater age, origin and flow paths. A technical foundation of the research project is the development of new modelling technologies. This project builds on the current knowledge and implementation of data assimilation and uncertainty quantification commonly expected and often required in modelling projects. This research is evolving modelling capability from simply understanding uncertainty (which is now generally accepted in modelling), to the design of novel models with an ability to reduce that uncertainty. This includes combining mātauranga Māori and mōhiotanga Māori with aquifer models to reduce this uncertainty. This is a unique combination of western science and indigenous knowledge that demonstrates the importance of combining the two knowledge systems. New stochastic approaches for source protection zone modelling (SPZ) are also being developed.