

Mapping aquifers from the air to secure water for the future

An ambitious project in Hawke's Bay has seen experts take to the air to map water under the ground in Aotearoa New Zealand's biggest ever aquifer mapping project. This forms part of a wider groundwater work programme that includes national aquifer characterisation and advancing groundwater numerical modelling methodologies. GNS Science has partnered with Hawke's Bay Regional Council on the multi-year initiative that will help to protect the region's underground freshwater resources for future generations. This project builds on many years of previous groundwater research, including SSIF funding and the MBIE-funded '*Smart Aquifer Characterisation*' Research Programme, that allowed us to socialise the concept and technology to council staff, as well as working with them on planning and different funding options.

New Zealand's largest export-earning sectors (tourism and land-based industries) rely on fresh water, with irrigation from groundwater alone contributing about \$2 billion to the economy annually. Forty percent of New Zealanders rely on fresh groundwater for their drinking water, and yet up to 40% of our fresh water catchments face significant shortages and contamination. This results in significant costs and disruption to remedy. Groundwater is also critical to sustain our aquatic ecosystems and cultural values such as 'mahinga kai', as 80% of our annual river flows come from groundwater.

Our research in this area aligns to a number of relevant international, national and sectoral commitments, strategies and goals, including the National Policy Statement for Freshwater Management, the National Drinking Water Standards and the New Zealand Living Standards Framework.

Our aim is to map, measure, and model New Zealand's major aquifers to improve the characterisation, measurement, mapping and dynamic modelling of New Zealand's groundwater systems. The knowledge we gain can be applied to sustain and improve the social, environmental and cultural values of the nation's aquifers. Through our *National aquifer characterisation by system* project we are developing advanced groundwater maps in both 2D and 3D, with mapping taking place not by region, but by groundwater system, with the goal of seamless characterisation from the local to the national scale. Through our *Advanced Framework for Groundwater Modelling* project we are developing optimised decision-making tools in an advanced framework that can be more easily applied by regional councils and rolled out nationally. Outputs will be applicable to a diverse range of users including policy-makers, planners, water managers, and hydrogeologists.

What we have been doing

Through previous SSIF/core and contestable programmes, GNS has been contributing towards these objectives for 10+ years. Over the past two years, GNS's research efforts (both through our SSIF programmes and other linked contestable and commercial work programmes, such as the MfE Groundwater Atlas) have contributed to a national top-down approach of all coastal aquifer systems in New Zealand in terms of fluxes, geometry, classification; and 3D classification regarding depth to basement rocks.

Central to the Hawke's Bay project is the Danish airborne electromagnetic survey technique known as SkyTEM, which can cover large areas of ground quickly and cost effectively to provide high levels of detail on the subsurface.

The SkyTEM technology provides a 3D view of the subsurface to a depth of about 300 m – a bit like getting a scan of the aquifers. It is sensitive to rock type, porosity, permeability, clay content, moisture content, and properties of the water – all of which help in understanding aquifers and contributes to our mapping and characterisation of aquifers.

In early 2020, data for the project was collected by a specially equipped helicopter using flight lines that were about 200 m apart. Areas covered were the Heretaunga Plains, the Ruataniwha Plains, and the Otane and Poukawa Basins.

We worked closely with the Regional Council to plan the project and liaised with specialist contractors to ensure the surveys were fit for purpose and the data was of a high standard. This included working closely with the Regional Council's Communications team to plan and develop material for the community, including flyers, webpage FAQs, daily Facebook updates, engagement with equestrian communities, a kick-off event with government officials, newsletter updates, radio and internet adverts. There was a positive response from the community in terms of the transparency and level of timely information provided.

Increasing capability

Although our scientists have significant experience with other electromagnetic methods, this is the first time SkyTEM data has been processed within Aotearoa New Zealand. The technique and equipment were developed by Aarhus University HydroGeophysics Group in Denmark, and GNS Science has partnered with the University to provide training, investing in the capability development of our scientists, and also for quality assurance on the processing and modelling of the data.

Benefit to NZ

We are making the processed data available to the Council in phases over the next two years, and much of it will be publicly available. In the next year, we will also work with the Council to drill several boreholes in the aquifers for scientific measurements that will be used to ground-truth the data and make the end result more robust. The final year of the project will include updating the Council's groundwater modelling tools in the Heretaunga Plains with this information.

The collected data and derived models will be a long-term asset for the Regional Council to support their freshwater management objectives.

The SkyTEM technique is increasingly being used worldwide to address groundwater management issues. Its use in Aotearoa New Zealand is largely due to GNS Science working with regional councils to communicate its value.

Other councils are expected to follow the lead of Hawke's Bay Regional Council and use it to gain better images and models of the aquifers in their region to support sustainable freshwater management.

The large scale of the Hawke's Bay project was made possible through the support of the Government's Provincial Growth Fund (PGF) (50%), the Regional Council (56%) and MBIE SSIF

funding (14%). The SSIF funding in this project allowed us to extend the interpretation and modelling on the data collected. Through the SSIF funding for this project we were also able to leverage the equivalent additional funding from the PGF, which enabled us to extend the fly over areas for data collection to include the Poukawa and Otane Basins. The datasets collected on this project will be used long-term in Groundwater SSIF programmes to look at topics such as advancing numerical groundwater modelling and characterisation of aquifers.

End-user Commentary

“SkyTEM and the 3D Aquifer Mapping project is a major part of our critical water security programme in Hawke’s Bay, and it wouldn’t be happening without the impetus and support from GNS Science.”

Dr Jeff Smith
Manager Science, Hawke’s Bay Regional Council