PAWSEY supercomputing centre

PARTNER INSTITUTION

Curtin University

# WESTERN AUSTRALIA'S WATER SUPPLY
# PROTECTING PERTH'S AQUIFERS


**PROJECT LEADER**
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**SYSTEM**
MAGNUS

**TIME ALLOCATED TO GEOPHYSICAL SUBSURFACE MODELLING AND IMAGING PROJECT** 8,500,000 HOURS
WITH ONLY A FRACTION USED FOR THIS PROJECT

**AREA OF SCIENCE**
HYDROGEOPHYSICS

**APPLICATIONS USED**
MODEM
Mare2DEM
Airbeo

One of Australia's most important – and sometimes most tumultuous – relationships with the natural environment is between the public and its water. In the south west of Western Australia in particular, delivering enough fresh water for a growing population is a pressing challenge when the conditions are drier than ever due to less annual rainfall as a result of climate change.

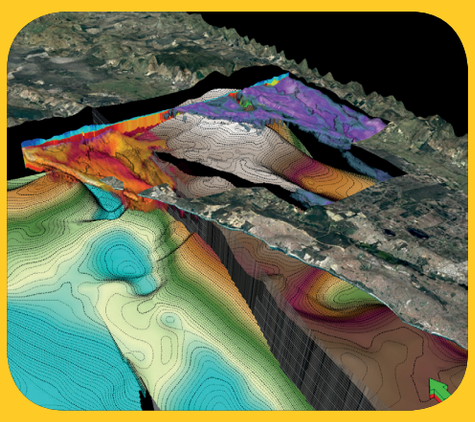
In the capital city of Perth, where around 80 per cent of the State's 2.6 million population live, dams and rivers are all but redundant as water supplies. The answer to date has lay in the vast reserves of water our aquifers hold. But with climate change also impacting aquifer recharge, using these resources now presents its own difficulties for the government as it manages a reliance on over 400 gigalitres of groundwater a year to meet the city's public and private water supply needs.

With the help of Pawsey Supercomputing Centre and its flagship system the Magnus Cray XC40 supercomputer, Professor Brett Harris and his team from Curtin University's Department of Exploration Geophysics have helped create detailed 3-D models of the Perth's groundwater aquifers by sending airborne electromagnetic survey measurements directly to the powerful supercomputer for near-real-time processing of data. These models are important components of innovative government moves to sustain these valuable water resources.

2017

## THE CHALLENGE

Aquifers are complicated hydrogeological structures that may span thousands of square kilometres. There are dynamic shallow aquifers that may be connected to streams and rivers, or play a role in keeping valued lakes and wetlands alive. There are also the older, deeper aquifers, where the groundwater may have remained untouched for tens of thousands of years.
Perth's largest groundwater source the Gnangara system is already one of the best understood systems in the world, but more extensive knowledge is required if the aquifer system is to be managed sustainably in the 21st century. By increasing the understanding of how the different parts of groundwater systems are connected, and where and how water moves through the systems - especially from the superficial aquifer into the deeper aquifers – the government can identify locations and rates for taking groundwater that have less impact on the environment and other water users.
The work also gives government the ability to identify the best locations where water can be put back – replenished or recharged - into the deeper aquifers, to optimise pumping for public scheme supply, and again, to improve environmental outcomes.
To support the State Government's plans for Water Corporation to put in new extraction and aquifer replenishment wells on the Gnangara system, an enormous and detailed 3D picture from surface to more than 2 km below the ground was needed.
To map Perth's complex multi-level aquifer systems, data spanning thousands of square kilometres had to be collected, processed, integrated and converted to information on rock type and groundwater chemistry.
"We had a total of about 100,000 readings, and a couple of hundred simulations had to be run on each reading," Professor Harris said.



Three dimensional distribution of shallow clays extracted from Airborne Electromagnetic data; set above the interpreted basal surface of a major aquifer.

So big, in fact, that the team claim a single CPU processing the data would have taken years. Instead, the team turned to the Magnus supercomputer, which reduced the time required to a matter of hours.

## THE SOLUTION

With the sheer bulk of data being sent back-and-forth, the use of Magnus – one of the Southern hemisphere's most powerful supercomputers – was vital. It allowed Professor Harris and team to spot errors on-the-go, test new ideas and build their 3-D map as quickly as possible.
"It was about using the computing speed and power of Magnus in order to do things that would be completely impossible otherwise," Professor Harris said.
Such a quick turn-around time for processing the electromagnetic survey data ensured the team could integrate data from multiple sources and accurately model the geology of the aquifers.
"Our role in this is building a framework, so when you run the model it will tell you what's going to happen in 50 or 100 years. It might take years to reverse any changes, so getting this big framework right is important," he said.

## OUTCOME

The research has already helped the Department of Water and Environmental Regulation recommend replenishment and abstraction sites based on ability to deliver goals of both maximum redraw and optimum environmental benefits, supporting groundwater levels near lakes, wetlands and areas of seawater intrusion risk. www.watercorportation.com.au/water-supply/ongoing-works/groundwater-replenishment-scheme).
Senior Hydrogeologist for the Department of Water and Environmental Regulation, Doctor Jon-Phillipe Pigois is one of the scientists using this research.
"All of this technical information is going towards the Gnangara groundwater allocation plan. It was last released in 2009, so it's due for an upgrade," Dr Pigois said.
Dr Pigois notes that water replenishment can be highly beneficial if the water is put back into the best possible location for the health of Perth's underground aquifer systems and this type of active management requires detailed knowledge of the entire groundwater system.
"Groundwater replenishment is the 'dam building' of the 21st century. It is accepted in areas like Perth as a better storage option for harvested and recycled water, and helps offset water losses from climate change, evaporation or water use.
"In the case of Gnangara, where the water accessed from the system is an essential component of Perth's public and private water supply, and would require billions of dollars to replace with alternative water supplies, the contributions of this science to getting water use management right and keeping aquifers sustainable, is returning major financial benefits to Western Australians.
The team is now writing code to automate processing and integration of data from many sources so that the electromagnetic readings taken can be instantly inverted to inform groundwater models and ultimately assist in water management decision making.