

Strategic Analysis Paper

5 October 2017

The Use and Management of Ancient Water in Northern Australia

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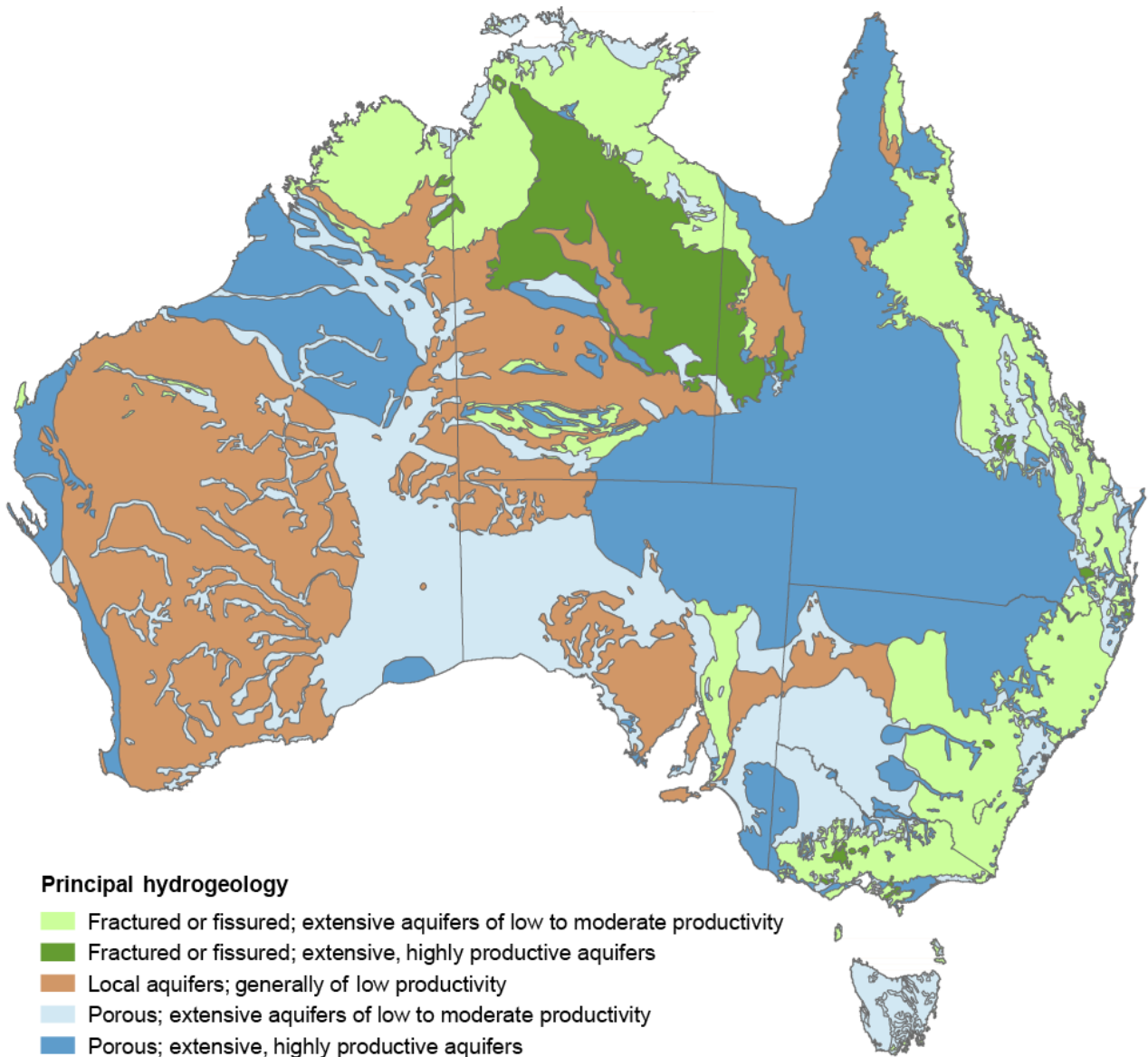
Key Points

- Northern Australia contains three major subterranean water systems, with one each in Queensland, Western Australia and the Northern Territory. Each of these systems is unique.
- The viability of an aquifer depends on how frequently it can be recharged – and there is evidence that significant natural recharge events for some aquifers only occur on a timescale of millennia.
- Ancient aquifers not only supply water for industry and towns, but they are also crucial for supporting biodiversity and have high cultural values that date back tens of thousands of years.
- In central Australia, any water used is a net loss from an aquifer system that last saw significant recharge thousands of years ago. The management of this resource is yet to achieve the necessary careful exploitation for long-term sustainability.
- Groundwater resource management across northern Australia must consider very localised aspects of aquifer characterisation and use, while still being able to fall under cross-jurisdictional policies such as the National Water Initiative.

Summary

In northern Australia, three major hydrogeological systems are listed as being highly productive: the Canning Basin in Western Australia, the Great Artesian Basin in Queensland and the Daly Basin in the Northern Territory. Each of these systems is unique and, as such, needs to be managed in ways that consider local aquifer characteristics while ensuring compliance with state and national regulatory frameworks. The [National Water Initiative \(NWI\) of 2004](#) requires that States compile water allocation plans which, in turn, require sufficient levels of understanding of these aquifers. In some cases, such as in the Pilbara region of

Western Australia, the [water allocation plan](#) does not take into account all forms of water extraction while, in other cases, the net flow of water from aquifers is well understood but is not sustainable over the long term. The characterisation of aquifers, their interconnectedness, and how they affect surface water resources and Groundwater Dependent Ecosystems (GDEs) is a major step in gauging sustainability and scope for development. Ultimately, however, the viability of an aquifer depends on how frequently it can be recharged – and there is evidence that significant natural recharge events for some aquifers only occur on a timescale of millennia. In the following analysis, examples will be given from just some of the major users of water from aquifers in northern Australia to demonstrate different levels of knowledge around aquifers and management practices.



Analysis

There are several methods of characterising groundwater sources. From above, massive volumes of sub-surface water can be found by [measuring fluctuations in gravity via satellite](#), or [airborne electromagnetic \(AEM\) surveys](#) that can be carried out by planes or helicopters using specialist equipment. More detailed information about the size and shape of an aquifer will require the drilling of exploratory wells. Information

about how water flows through an aquifer, and how often it is recharged, can be inferred through calculating the age distribution of water from several samples, by measuring the concentrations of various environmental ‘tracers’ such as radioisotopes. Carbon-14 is a naturally occurring tracer that can be used to determine the specific age of water when it is between 200 and 30,000 years, which is a process more commonly known as carbon-dating. For water that is less than approximately sixty years old, [trace amounts of synthetic or radioactive contaminants can be used](#). Concentrations of chloro-fluorocarbons in the atmosphere increased from the 1950s and peaked in the 1990s, as did sulphur hexafluoride. The presence of a radioactive isotope of Hydrogen called Tritium in a groundwater sample indicates that it is attributable to rainfall that occurred since the 1960s when nuclear weapon testing substantially increased atmospheric concentrations of this isotope.

The Alice Springs Water Supply

The Alice Springs water supply in central Australia, and much of its surrounds, is taken from the Mereenie aquifer system; a sequence of sandstones in the Amadeus basin, which consists of water that is somewhere between 10,000 and 30,000 years old. A [water balance for the Amadeus basin](#), compiled as part of the 2005 water resource strategy, indicates that all extraction from the aquifer is a net loss of water since any natural inflows are approximately cancelled out by evapotranspiration and outflow to other parts of the aquifer. In 1978, [chemical analysis of water from the Mereenie sandstone](#) suggested that distinct volumes of water within the aquifer were attributable to separate recharge events that occurred thousands of years apart. A 1999 study inferred that the deepest water in the Amadeus Basin aquifer system could have been up to 400,000 years old, based on estimated total volume and inferred transit times for water within it.

A [Managed Aquifer Recharge \(MAR\)](#) site at Alice Springs re-introduces treated wastewater to the ‘[outer farm basin](#)’ (an alluvial aquifer that is underlain by an ancient buried river valley). The volume of water that was recharged at the site was around 1.5 million cubic metres (1,500 ML) over three years between 2011 and 2014. This volume of recharge represents, very roughly, about seven percent per year of the amount of water extracted from the Mereenie sandstone aquifer system.

Aquifer Extraction in the Pilbara

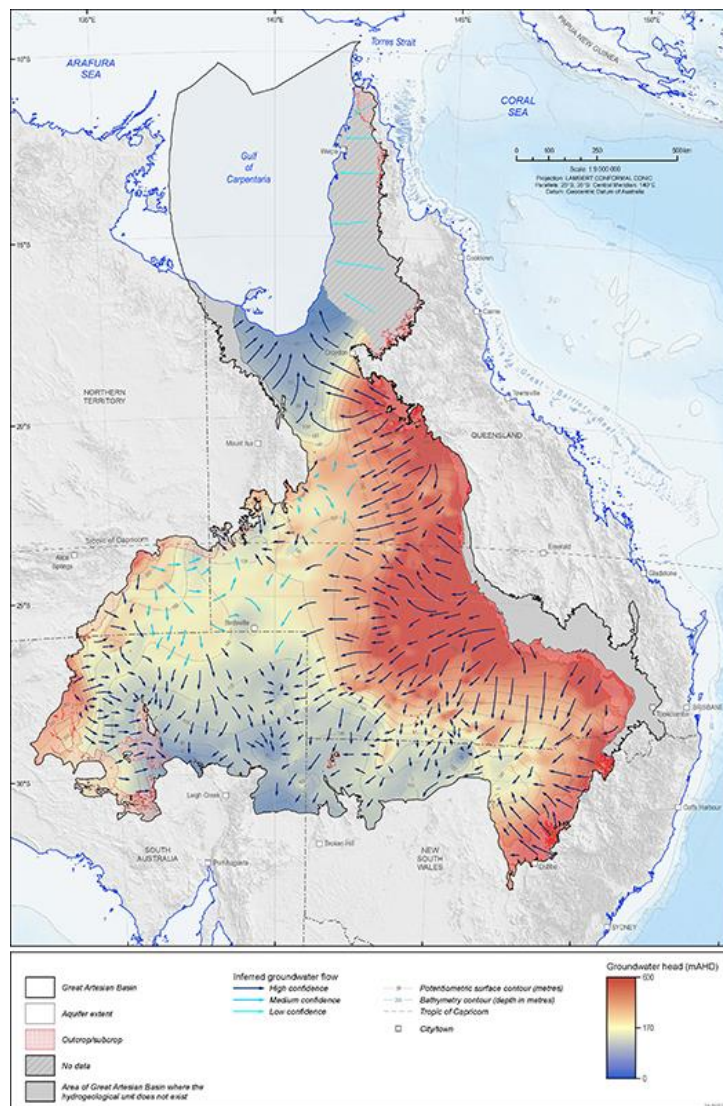
In the Pilbara region of Western Australia, the 2013 groundwater allocation plan set a total allocation limit for all target groundwater resources of 90,500 ML/yr (or 90.5 GL/yr). The allocation plan, however, does not set limits for water extraction from fractured rock aquifers by mining operations – which was [estimated to be around 550 GL](#) in 2015. This extraction is mostly for dewatering purposes, whereby the water table is locally lowered to allow access to mineral ore and is licensed on a case by case basis due to irregularities in the characteristics of the individual aquifers where mines operate. While licensing guidelines do encourage the use of excess dewater for consumption by third parties (such as for town water supplies or irrigation), or for recharge to an aquifer, it is still allowable for excess water to be discharged to other surface water bodies like rivers or lakes. Water age distributions from wells near a mine-site in the Pilbara indicated that recharge events were [separated by hundreds](#) of years, with an upper age estimation of some water of up to 13,000 years. While aquifers in the Pilbara are recharged more frequently than those in central Australia, a biodiversity survey from 2002-05 found that stygofauna – [which are mostly tiny crustaceans that live in groundwater](#) – are [endemic to the region](#) but are also under threat from high levels of groundwater extraction.

In 2015, a [report to the Western Australian Department of Water](#) made further recommendations as to specific areas of land that showed potential for irrigated agriculture using excess mine dewater and called for further investigation. The Pilbara Hinterland Agricultural Development Initiative was [launched in 2013](#) by

the Department of Agriculture and Food Western Australia to investigate the potential for irrigated agriculture in the Pilbara region using excess mine dewater as well as other in-situ sources. The project included starting up and running a 150 Ha irrigation trial site that sourced water that was excess from a nearby mine-site. In 2016, [operations at the mine-site were suspended](#), which highlighted the risk associated with relying on mine operations for a water supply.

Water from the Great Artesian Basin

The Great Artesian Basin underlies about a fifth of the country and is estimated to hold [nearly 65,000 million megalitres](#) (about 130,000 Sydney Harbours, or about 850 times [the volume of water extracted from the environment in Australia in the financial year 2014-15](#)). It is estimated that some water in deep sections of the basin in southern Queensland [may be in the order of a million years old](#), based on groundwater tracer data that was gathered for use in a 2015 Atlas of the Great Artesian Basin published by Geoscience Australia.



The 2013 [Great Artesian Basin Water Resource Assessment](#) by the CSIRO made predictions about groundwater levels throughout the basin over the next fifty years, using different modelling scenarios for future climate and assumptions about development. In the [northern part of the basin](#) (north of the Flinders River in Queensland, where groundwater flows towards the Gulf of Carpentaria) water is forecast to either remain at similar levels or increase, based on a 'median future climate' scenario and expected levels of groundwater development. In the [south-western region of the basin](#), where the water eventually flows from

recharge zones on the eastern side of the basin, levels are generally predicted to drop. A [supporting technical document for the assessment](#), however, lists some of the assumptions that underpin these forecasts: namely that water bores continue to flow at 2011 licensed rates until 2070, that bores for stock watering see reduced flows due to more efficient use, and that water extraction through petroleum wells continues at 2010 levels.

Conclusion

Northern Australian groundwater management must address significant challenges. Each aquifer is fundamentally different and management arrangements must be tailored to individual aquifer characteristics. Water use is also central to management plans and the needs of pastoralists, mining, heavy industry and households require different management strategies. Cross-jurisdictional compliance, such as the NWI, an additional layer of complexity. The examples presented in this paper practically demonstrate the challenges this presents.

In central Australia, any water used is a net loss from an aquifer system that last saw significant recharge thousands of years ago. The management of this resource can only aspire to careful exploitation rather than long-term sustainability.

In the Pilbara region of Western Australia there is an opportunity to make use of substantial volumes of water for agricultural development. It would appear, however, that there is little in the way of unified regulation or analysis of the effects of groundwater extraction in the region. In 2011, researchers from the CSIRO Tropical Ecosystems Research Centre in Darwin [published a summary of interviews conducted with Aboriginal people and organisations in the Pilbara](#). A common feature of the interviews was that there had been a 'general drying out of the country'; an observation that cannot be quantified when all the significant groundwater extraction is licensed on a case-by-case basis with seemingly little monitoring or regulation of cumulative effects.

The hydrogeological characteristics of the Great Artesian Basin are now relatively well understood. The model of the basin constructed by a CSIRO water resource assessment provides a powerful tool for understanding the effects of resource management practices. The assumptions about future extraction from aquifers, however, need to be better aligned with proposed growth in population, irrigated agriculture and use by the mining and oil and gas sectors.

Ancient aquifers not only supply water for industry and towns. They are also crucial for supporting biodiversity and have high cultural values that date back tens of thousands of years. Accelerated development in the north, as was earmarked by a [2015 Government White Paper](#), may well be relying on groundwater sources that are already known to have limited capacities for additional allocation of water.

Any opinions or views expressed in this paper are those of the individual author, unless stated to be those of Future Directions International.