Joint Select Committee XXX

Responses to Questions on Notice, CSIRO

Peter Stone, June 6 2014

Groundwater prospectivity

Three basins in northern Australia have high groundwater development potential (over 100GL/yr) and two have moderate potential (10-100 GL/yr) but outside these basins the potential is very limited.

Prospectivity of groundwater for irrigation in northern Australia has been examined by CSIRO in its *Northern Australia Land and Water Science Review, 2009* and more recently in *Mosaic irrigation for the northern Australian beef industry: an assessment of sustainability and potential* (2013).

Both studies involved desktop assessments of existing survey data applied at large geographic scale. Given these limitations, our assessment of groundwater prospectivity can best be described as a guide to the potential for irrigation based on renewable (annually replenished) groundwater resources. More detailed studies recently completed at smaller scale indicate that the large scale assessments mentioned above, and from which data is provided below, may underestimate the volume of renewable groundwater available irrigation and other purposes.

Groundwater prospectivity mapping for irrigation reported in *Mosaic irrigation for the northern Australian beef industry: an assessment of sustainability and potential* (2013) [excerpted from p. 43] showed the following spatial distribution of significant opportunities:

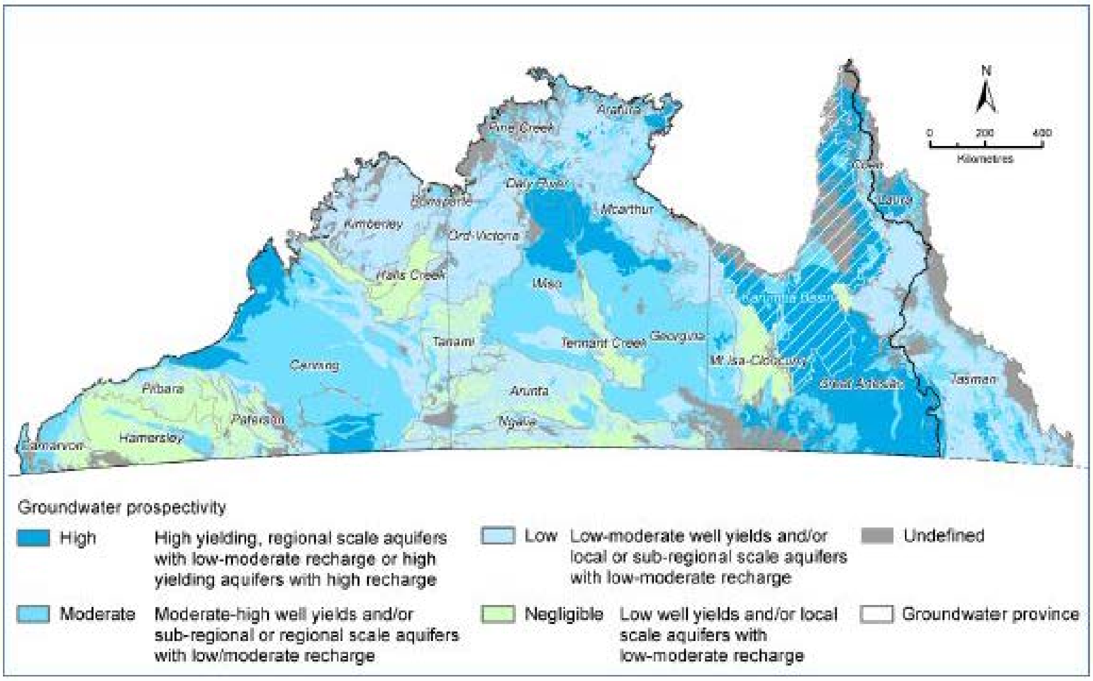

Figure 3.11. Revised map of groundwater prospectivity in northern Australia. Blue tones indicate the degree of prospectivity. White hatching indicates areas where the more developed Karumba Basin overlies the Great Artesian Basin. The prospectivity of the Karumba Basin is not shown.

The spatial variability of estimated prospectivity is summarised in Table 4.2. (excerpted from the same report). Areas of high estimated prospectivity include parts of the Daly, Wiso, Georgina, and

Canning basins, which are consistent with past studies such as the NALWSR (Cresswell *et al.* 2009). Outside of these regions, the development potential of the majority of groundwater resources in northern Australia is low to negligible, *i.e.* less than 10 GL per year of extractable water.

Table 4.1. Estimated annual groundwater availability from northern Australia at the intra-basin scale.

	Groundwater resource	**Development potential**	**Estimated available extraction (GL/y)**
(1)	Daly, Wiso and Georgina basins (central)*	high	> 100
(2)	Canning Basin (coastal)#	high	> 100
(3)	Great Artesian Basin	high	> 100
(4)	Daly, Wiso and Georgina basins, excluding (1) %	moderate	10 - 100
(5)	Canning Basin, excluding (2) ^	moderate	10 - 100
(6)	Other groundwater resources	low	< 10

*refers to the area encompassing the southern region of the Daly Basin and the northern regions of both the Wiso and Georgina basins; #refers to the area of the Canning Basin located less than 100km from the coast; %refers to the combined area of the Daly, Wiso and Georgina basins excluding (1); ^refers to the area of the Canning Basin located more than 100km from the coast

References

Mosaic irrigation for the northern Australian beef industry: an assessment of sustainability and potential. Technical Report. A.C. Grice, Ian Watson and Peter Stone, 23 December 2013.

Northern Australia Land and Water Science Review, 2009. CSIRO, 2009.

The potential for managed aquifer recharge in northern Australia

MAR is a proven technology with many benefits. It is likely that only a small proportion of the area of Northern Australia is suitable for MAR, but its potential in locations where it is suitable could be significant.

- Managed aquifer recharge (MAR) is defined as the purposeful recharge of water to aquifers for subsequent recovery or for environmental benefit.
- There are a variety of forms of MAR that can replenish shallow unconfined aquifers suitable for agriculture, and also deeper aquifers that provide for livestock, industrial, and town water supplies. Terrain and hydrogeology determine the most efficient form of MAR for use in any particular location.
- Where there are suitable soils and aquifers MAR may have significantly lower capital costs than dams, and lower levelised costs for water supplied.
- MAR has lower evaporation losses than surface water storage, which may enhance the capacity to endure drought in areas of low or highly variable rainfall. MAR need not be the sole water storage solution in any particular environment, but can complement and supplement surface water storage.
- Existing large dams in Australia lose 8,000 GL water annually through evaporation (Hostetler 2007). Dams and farm storages in northern Australia are subject to high evaporation rates and frequently occur in areas with low relief, often enabling only shallow water storages. For these reasons, proportional evaporative losses of stored water in northern Australia are higher than those in southern Australia; 25% annual losses will be common.
- The benefits of MAR over surface water storage increase as factors leading to evaporative loss increase, such as high evaporation rates or highly variable rainfall.
- The benefits of MAR also often increase as groundwater use increases because it can be used to replenish depleted aquifers. By this means it can protect riparian vegetation and groundwater dependent ecosystems, prevent sea water intrusion and freshen groundwater quality in brackish aquifers that could otherwise not be used for water supply.
- By significantly reducing the need for surface dams, MAR can reduce issues associated with open water such as incidence of insect, disease and algae problems.
- It is likely that only a small proportion of the area of Northern Australia is suitable for MAR, but its potential in locations where it is suitable could be significant.
- Much but not all of the data required to evaluate the prospects for MAR in northern Australia exist but have not been used to purposefully identify opportunities for MAR at the spatial scale required to scope specific MAR projects.
- The suitability of aquifers to receive water for MAR is widely spatially variable. Aquifers in northern Australia take a variety of forms. They can be localised or extensive, and they vary in their proximity to sources of water with volumes and quality suitable for enabling MAR, such as those associated with mines or energy operations that produce surplus water, wastewater treatment plants or rivers.
- Similarly, aquifers suitable for MAR will vary in the extent to which they are located near suitable demand for water, as dictated by the availability and extent of soils suitable for agriculture, or businesses or communities with water needs of defined quality and volume.
- Prognoses for MAR opportunities vary, (e.g. Northern Australia Sustainable Yields (CSIRO 2009) and Hostetler (2007)), in part because of differences in the scale at which investigations have been undertaken and variance in the assumptions required by incomplete data.
- Australia, through CSIRO and others, has access to the skills required to develop prospective target sites for MAR, and to then produce concept designs for facilities, to assist investigations and approvals, and to monitor and report their economic, hydrologic, environmental, health and social performance.
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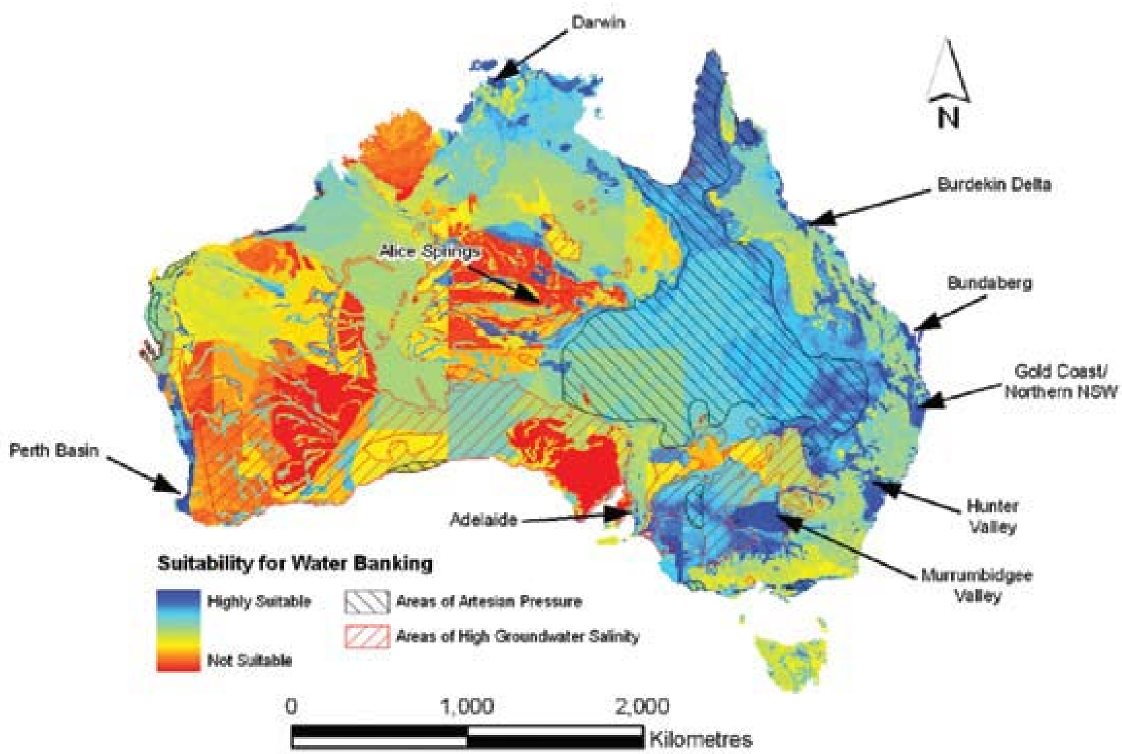


- Figure 1. An example of a map that is claimed to represent suitability for water banking across Australia. The blue areas are thought to be relatively more suitable for water banking than the red areas (Hostetler 2007). Note that specific MAR opportunities can only be identified at a smaller spatial scale than was used in this mapping exercise. For instance, red areas may contain highly suitable sites and blue areas may contain large areas that are not suitable. In addition, note that this map was constructed by lumping attributes that may favour and oppose the likelihood of successful MAR projects. This map demonstrates that opportunities for MAR vary spatially but it should not be used as a screening tool to limit selection of prospective MAR sites.

- A network of Australian private companies formed under the Water Industry Alliance, called MAR-Hub has all the capabilities for investigations, detailed design, construction, provisioning of components and control systems, through to production, installation and maintenance of high efficiency irrigation systems.
- A small number of demonstration projects would be likely to speed adoption of MAR. The challenge is not to decide whether MAR is possible – it is a proven approach to water storage – but to identify the locations where it is the most cost-effective method for matching water supply and demand. This does not require new science, but the application of existing knowledge to incompletely characterised geographies.
- CSIRO is able to provide further detail on the steps that would be required to hasten and expand use of MAR in northern Australia.

References

CSIRO (2009) Summary report from the Northern Australia Sustainable Yields Project http://www.csiro.au/Portals/Publications/Research--Reports/NASY-Summary-report.aspx

Hostetler, S. (2007). Water Banking. Science for Decision Makers. Aust. Govt. Dept of Agriculture, Fisheries and Forestry, Bureau of Rural Sciences, 12p.

The irrigation potential of the Great Artesian Basin

The Great Artesian Basin is large, complex and slow so a single statement about its suitability is not possible. We can say that the slow rates of recharge mean ongoing irrigation on a large scale is unlikely to be feasible.

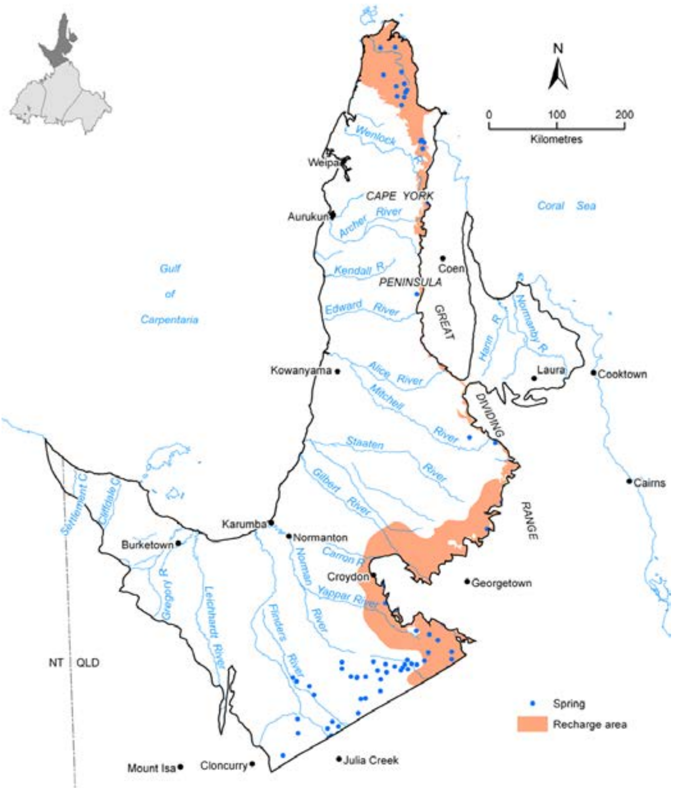
- A water budget describes the amount of groundwater inflow and outflow. For a complex groundwater system – such as the Great Artesian Basin – there could be several different components for inflow and outflow.
- The large volume of the GAB is less important than its low recharge rate in determining its value as an irrigation source
- The generally low rates of recharge means that ongoing irrigation from the GAB is unlikely to be possible on a large scale
- The Carpentaria region comprises a series of stacked qaqifers present onshore and beneath the Gulf of Carpentaria.
- Three major aquifer systems are present in the Carpentaria Basin and the overlying Karumba Basin. These include the Gilbert River Formation, the Normanton Formation and the shallower Bulimba-Wyaaba-Claraville aquifers.
- Reliable data are limited in the Carpentaria basin, and the amount of data is insufficient to produce a series of detailed, reliable regional groundwater level maps.
- This lack of data means there are not accurate estimates of the water budget components.
- Groundwater recharge to the Gilbert River Formation is about 432 GL/year, but this value is not known for certain. Surface water stores of more than twice this volume are possible in similar areas. Consequently, available evidence suggests that in most locations large scale irrigation is more likely to occur through use of surface water than GAB water.
- 

Figure 2 The Carpentaria region showing selected rivers, springs and recharge areas for Great Artesian Basin aquifers excluding the Laura Basin (unmapped)

- Groundwater extraction from water bores drilled in the Gilbert River Formation is estimated to be 64 GL/year.

- In addition to the aquifers of the Gilbert River Formation, groundwater recharge and discharge occur in the shallower aquifers of the Normanton Formation and Karumba Basin). The combination of these shallower groundwater resources and groundwater from the deeper Gilbert River Formation provides baseflow to many of the rivers in the Carpentaria region. Based on streamflow data from a study undertaken in the 1990s, the total amount of baseflow is estimated to be about 630 GL/year, which is assumed to originate from springs that are discharging groundwater from the Gilbert River Formation and shallower aquifers of the Normanton Formation and Karumba Basin.

- There is considerable evidence that extraction from the Great Artesian Basin lowers groundwater pressure which, reduces the capacity to extract water from the basin to a greater extent than implied by the extraction of water alone.

- It is likely that there will be relatively small areas (thousands rather than tens of thousands of hectares) of land that could be sustain ongoing irrigated using water from the Great Artesian Basin

Reference.

Smerdon BD, Welsh WD and Ransley TR (eds) (2012) Water resource assessment for the Carpentaria region. A report to the Australian Government from the CSIRO Great Artesian Basin Water Resource Assessment. CSIRO Water for a Healthy Country Flagship, Australia. http://www.csiro.au/en/Organisation-Structure/Flagships/Water-for-a-Healthy-Country-Flagship/Sustainable-Yields-Projects/Great-Artesian-Basin-Assessment/Technical-Reports.aspx