Managed aquifer recharge for improved water productivity

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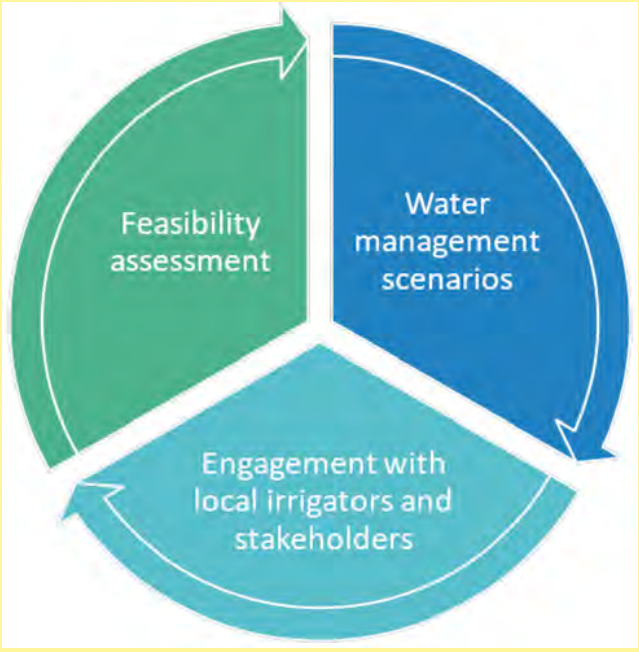
WITH an uncertain future climate and the potential for further policy changes to water entitlements, water security has become a key limiting factor in the profitability of the irrigated cotton industry. Managed Aquifer Recharge (MAR) is the purposeful recharge of aquifers using surface water, which can be extracted when required, and has been proposed as a potential strategy to increase water security.

MAR systems offer an option to store surplus surface water underground and therefore avoid evaporative losses that can be experienced when storing water above ground. This 'extra' water can be used to even out the peaks and troughs, leading to greater security and certainty in irrigated cropping. But MAR systems can be expensive to implement and are also subject to technical and financial uncertainties such as aquifer recharge and recovery rates and costs. While MAR has been undertaken in some capacity since the 1960s, it remains a low presence in regional scale irrigated agriculture.

The 'Feasibility study of managed aquifer recharge for improved water productivity for Australian cotton production' project is investigating the potential to implement MAR at a regional scale in key irrigated cotton growing regions of Australia. The first region the research team from the Australian National University and the University of Sydney considered is the Murrumbidgee River system, with particular focus on Coleambally Irrigation Co-operative Limited Area of Operations (CICL AO), referred in this article as the Coleambally Irrigation Area (CIA).

The broad approach taken was to scope the most promising opportunities ("scenarios") for MAR in the CIA, test and refine them with the local stakeholder working group (including irrigators, industry representatives, environmental managers, water managers), drawing on evidence from a feasibility assessment conducted in parallel. This article provides an overview of the process implemented in the Coleambally case study.

FIGURE 1: Parallel components of the MAR feasibility project



Coleambally Case Study

The Coleambally Irrigation District (CID) is located south of Griffith in the middle of the Murrumbidgee Valley. Coleambally Irrigation Co-operative Limited (CICL) has 295 members and provides irrigation and drainage services to about 500 farms across the area. Irrigators within the area predominately operate row cropping enterprises utilising general security surface water entitlement and groundwater bores, producing a mix of summer (mainly cotton and corn) and winter (mainly wheat and canola) crops. There is little unutilised consumptive water, and surface water entitlements in the CICL licence have been decreasing since the mid-2000s. In times of low annual allocation, and without the capacity to invest in on-farm infrastructure or purchase high-cost water, some CICL members use the water market to sell their remaining water allocation. In this context, the interest of CICL in MAR is whether it can offer some value to members in terms of making more water available during times of low allocation.

The mid-Murrumbidgee valley was selected for a project case study as prior publications (e.g. Khan et al 2008) had indicated the potential feasibility of MAR within the region. The CIA was chosen as the focus for more intensive investigation of the potential feasibility of MAR given the interest of the CICL in the project and as an irrigation corporation it should be better placed to be an early adopter of MAR than individual member irrigators. Analyses to assess the potential feasibility of MAR in the district included interviews with local stakeholders, desktop review of scientific, government and other literature, analysis of existing spatial data, financial analyses, discussions with the Steering Committee and the Murrumbidgee stakeholder group, and discussions with MDBA and NSW government representatives.

The feasibility assessment facilitated the identification and evaluation of three MAR scenarios highlighted promising opportunities for MAR in the irrigation district:

- Don't miss a drop: Capture and banking of water during wet years;
- Storing water for community sustainability: Using stored water in a way that benefits everyone; and
- Integrated groundwater and surface water delivery: Using MAR to complement conjunctive use.

The scenarios were developed iteratively with feedback provided by the stakeholder group which enabled us to refine the feasibility assessments and to provide recommendations for MAR pilot(s) in the Coleambally areas or the Mid-Murrumbidgee valley. Each scenario is backed up by evidence from analyses against each of the seven criteria for the feasibility of MAR (Table 1).

TABLE 1: Feasibility assessment criteria	
Demand for water	Is there demand for more water, or a greater water security? Who wants the water and when?
Water availability	Is water available to be banked underground (e.g. unused surface water shares, surface water traded in when prices are low)?
Technical feasibility	Is there space in the aquifer systems to store surface water for drier times? How can the water be recharged, stored and extracted?
Financial viability	Financial viability and profitability of MAR schemes are influenced by many factors including the MAR type, water source, infiltration and recovery rates, groundwater depth, water markets, crop prices and yields, groundwater pumping costs
Environmental risks	Are there any significant effects on water quality & quantity (positive or negative)? What are the consequential impacts of any change on farm land and ecosystems?
Social acceptability	Is it a socially acceptable option to irrigators, stakeholders and the wider community? What are people's values, knowledge and beliefs about MAR? Do they perceive risks about its implementation in their region?
Governance arrangement	Are the legislative and policy settings appropriate to support a MAR system? If not, how would they need to be changed?

Source: Ticehurst and Curtis, 2017.

Key learnings

The feasibility + scenario framework: Framing the Coleambally research using the seven feasibility criteria enables us to take a whole-of-system view of MAR and assess the potential barriers and facilitators in operating the MAR, and to suggest how future pilot projects could be run. Scenarios allow us to focus on the information needed to decide whether to take the next step towards MAR implementation or not.

Water availability: Despite little unutilised consumptive water, there are opportunities to capture what volume of entitlements are not used or to rethink how the current volumes are used and managed within a scheme to provide outcomes to irrigators and community.

Financial viability: Our analysis of the estimated range in costs to construct and operate a Managed Aquifer Recharge (MAR) scheme in rural areas of Australia suggest a general range from $95 per ML recovered (for schemes with low cost infiltration basin, 100 per cent recovery rate, and a groundwater pumping cost of $33 per ML) to $800 per ML. The upper range is comparable to peaks in the surface water trade prices. Generally, MAR seems financially feasible for cotton growers, if it is strategically managed for drought reserves but less so as a regular seasonal storage option when surface water costs are cheaper than the lowest estimate of MAR costs.

Technical feasibility: Our analysis, based on soil and aquifer characteristics of the area, identified three possible MAR schemes: infiltration into low salinity area; infiltration/injection into a saline aquifer to form a freshwater lens; and, injection into a deep aquifer. Monitoring plans were also explored, with particular focus on using the over 700 piezometers already present in the area.

Governance arrangements: MDBA notes that recovery of recharged water should avoid double counting. MAR policies are not yet in place in NSW or Queensland, which is an opportunity to ensure rules play to the strengths of MAR while minimising associated risks. Pilots for recharge and monitoring can already go ahead with current regulatory frameworks, and are needed to build confidence and expertise.

Our project work going forward

The intended outcomes of this project are to:

- Inform cotton irrigators and industry advisors whether MAR offers an opportunity to increase water security, sustainability and consequential industry value in the case study areas;
- Provide cotton irrigators and industry advisors insight into any early identified obstacles in the implementation of MAR, specified across all facets (i.e. financial, economic, technical, legislative, social and environmental), that will enable timely, cost-effective choices about investments to be made;
- Collate and integrate existing socio-economic, hydrogeological and governance knowledge, data and information in the case study areas; and,
- Develop a framework and methods, from these case studies, that can be applied elsewhere.

We are now finalising the Coleambally case study and the next stage of the CRDC project will shift to our second case study in the Namoi catchment (remotely to start with until Covid-19 is tamed!).

Beyond the scope of this project, we recommend that a pilot MAR scheme be undertaken in the CIA. A low-cost pilot project consisting of retrofitted bores or small scale infiltration basins would provide invaluable practical experience in the planning, construction and operation of a MAR scheme within the Murray Darling Basin, whilst improving the understanding of local hydrogeology as it relates to MAR, and providing a vehicle to collaboratively design legal frameworks for the recovery and use of consumptive water. Such a pilot would enable irrigation corporations within the mid-Murrumbidgee valley to evaluate the feasibility and value of MAR at a regional scale. We are investigating opportunities to embed such a pilot scheme within a new research project.

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This work is funded by the Cotton Research & Development Corporation (CRDC). We appreciate the time and contributions made by local irrigators and stakeholders (especially the team from CICL), the project Steering Committee and personnel from NSW DPIE and MDBA.

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