Managing the Link between Ground and Surface Water

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ABSTRACT: Groundwater and surface water are interconnected and interchangeable resources in many regions of Australia. Connectivity refers to flows between water resources located above ground (surface water) and below ground (groundwater). This connectivity can have significant implications for both water availability and quality, and presents major challenges for water managers and policy makers in Australia. Understanding and managing the linkage between groundwater and surface water is critical if Australia's water resources are to be sustainably managed. Assessing these links is difficult and complex but necessary in managing water scarcity, allocation and water quality in Australia.

While our understanding of the link between groundwater and surface water resources has increased significantly in recent times, there remains a concern that many water management plans still do not fully account for stream-aquifer connectivity. This is particularly the case for the impact on surface water availability of increased groundwater use. In response, an adaptive management framework supported by a web-based information resource, the Connected Water website (www.connectedwater.gov.au), has been developed to support national water reforms. The framework and the website has been designed to help water managers, water authorities, policy makers, catchment groups, industry groups and others to learn more about evolving water management priorities and requirements to facilitate coordinated responses. The framework can be applied at any scale from a project to a catchment through to the national perspective.

This paper will provide an overview about the Connected Water Framework, its adaptive management approach and the assessment and management tools accessible through the associated website www.connectedwater.gov.au.

INTRODUCTION

Groundwater and surface water are interconnected and interchangeable resources in many regions of Australia. This connectivity can have significant implications for both water availability and quality, and presents major challenges for water managers and policy makers in Australia. Understanding the connectivity between surface water and groundwater is critical if Australia's water resources are to be sustainably managed.

Increasing demand for water and a decline in the availability of surface water has seen significant growth in groundwater extraction in Australia. Independent management of groundwater and surface water means that there is a risk of allocating the same water twice. Discharge of fresh groundwater into a stream is critical for surface water users and aquatic ecosystems during the low-flow period. Pumping from an aquifer near a river can dramatically change the amount of this baseflow to the stream. In contrast, if the groundwater is salty or contaminated, increased groundwater discharge can have a negative effect on surface water quality. Hence, effective management of water quantity and quality issues requires an understanding of these surface water-groundwater interactions.

AN ADAPTIVE MANAGEMENT FRAMEWORK FOR CONNECTED GROUNDWATER-SURFACE WATER RESOURCES

An adaptive management framework for connected groundwater and surface water resources has been developed to support national water reform (Figure 1). The framework aims to provide a consistent national approach to conjunctive water management in Australia in line with the principles of the National Water Initiative (www.nwc.gov.au/nwi/index.cfm).

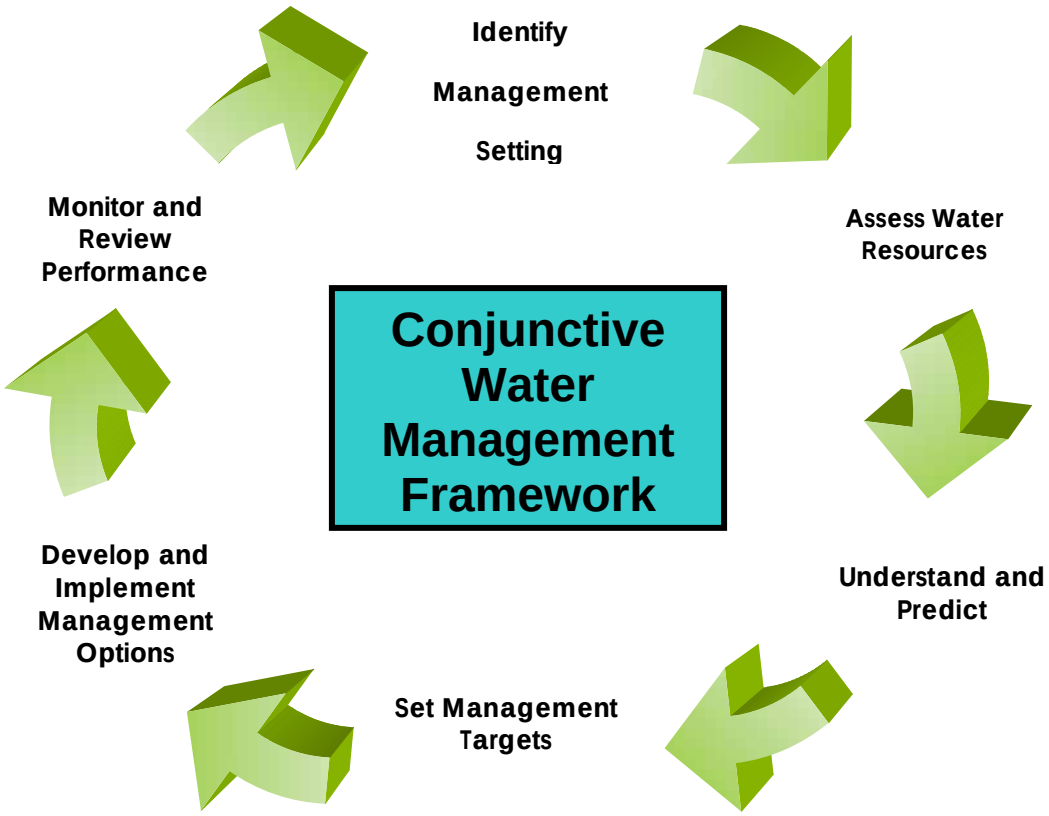

Figure 1: An adaptive management framework for connected groundwater-surface water resources in Australia

The framework is designed to help water managers, water authorities, policy makers, catchment groups, industry groups and others to learn more about evolving water management priorities and requirements to facilitate coordinated responses.

This framework provides a context within which existing groundwater and surface water management can be integrated and provides social, environmental and economic outcomes across industries and regions. The framework is comprised of six toolboxes structured within a generic adaptive management cycle (Figure 1). Each of the toolboxes is designed to house 'tools' in the form of water management methods or guides. Tools represent different options available at that point of the management cycle.

TOOLS TO ASSESS CONNECTIVITY

Assessing groundwater-surface water interactions is often complex and difficult. However, there are a range of tools available to assess the nature and degree of connectivity. These tools can

be defined in terms of: spatial scale, temporal scale, cost, ease of use, advantages, limitations, and application. A summary of these tools is presented in Table 1. Detailed information on various tools can also be accessed through the Connected Water website (www.connectedwater.gov.au).

MANAGEMENT OPTIONS

There are a range of policy and on-ground investment options available for implementing a conjunctive water management approach. The management options are:

Policy Options

- **Licencing and Allocation -** total water accounting, linking of management plans, coordinated embargoes, tiered access, triggers and thresholds
- **Water Trading -** compatible licences, cost structures, infrastructure capacity and ownership
- **Management Zones -** stream buffer zones
- **Risk Management -** aquifers as drought reserves, coordinating groundwater-surface water storages, using climate predictions
- **Land Use Planning -** salinity mitigation, water quality protection

Investment Options

- **Water banking -** aquifer storage and recovery (ASR), infiltration ponds, underground dams, recharge releases
- **Water treatment -** bank filtration, dune filtration, soil aquifer treatment
- **Water interception -** salt interception schemes
- **Water supplementing -** streamflow augmentation, water provision for groundwater dependent ecosystems (GDEs)

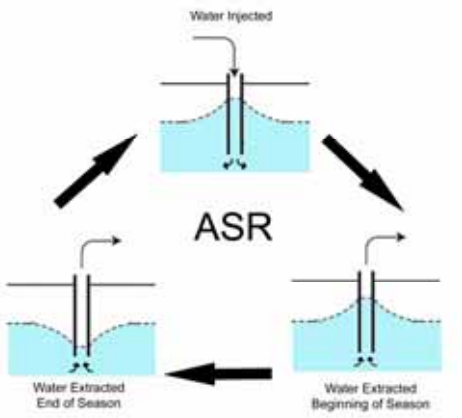

Figure 2: Aquifer storage and recovery

CONNECTED WATER WEBSITE

The Connected Water website contains information on groundwater and surface water connectivity issues for policy makers, water managers and catchment groups.

Log on to the Connected Water website (www.connectedwater.gov.au) to find out:

How does groundwater interact with surface water?

Why should groundwater and surface water be managed conjunctively?
How connectivity can be assessed?
What tools are available to assess and manage connectivity?
What are the policy implications for managing connected systems as one resource?

Key features of the website:

- Information on conjunctive water management policy
- Tools to assess stream-aquifer connectivity
- Latest national and international case study reports
- Extensive reference database with over 1,500 entries to search and download
- Comprehensive glossary of groundwater and surface water terminology
- Colourful photo gallery
- Additional groundwater/surface water web links

How can I obtain more information?

For further information visit www.connectedwater.gov.au or contact us at connectedwater@brs.gov.au

Table 1. Summary of tools to assess groundwater-surface water connectivity

Tools	Scale	Cost	Ease of Use	Comment
Hydrographic analysis Processing of time-series stream flow monitoring to define baseflow (groundwater discharge) component	Intermediate to regional	Low	Easy	Commonly applied method for unregulated Australian catchments
Hydrogeological mapping Mapping of groundwater systems including flowpaths, groundwater quality, aquifer structure and properties and geomorphology	Intermediate to Regional	Medium to High	Moderate to Difficult	Groundwater flow system, surface geological and hydrogeological mapping is available at a coarse scale for most groundwater management regions across Australia
Modelling Simulation of water flow regime around streams using mathematical equations	Catchment to river reach	Low to High	Moderate to Difficult	Requires data from other methods for calibration. Surface water models are commonly developed in isolation to groundwater models
Geophysical survey Use of a range of remote sensing technologies that are useful for mapping hotspots and landscape parameters that indicate connectivity	Stream reach to catchment	Medium	Moderate to Difficult	Opportunities may exist to use geophysical data collected for other purposes eg. mineral exploration. Satellite imagery is commercially available, some free in public domain
Seepage measurement Direct measurement of water flow between stream and aquifer at specific points	Site specific	Low to Medium	Easy	Main application to date in Australia has been investigating leakage from irrigation channels or studying aquatic ecosystems
Artificial tracers Monitoring movement of introduced tracers such as fluorescent dye	Stream reach to site	Medium	Moderate	Not routinely applied in connectivity studies in Australia. Overseas focus is on karstic aquifers or investigations of contaminated sites
Hydrochemical and environmental tracers Use of the chemical constituents of water (such as major cations, anions, stable isotopes, radon and chlorofluorocarbon) to track water flow	Stream reach to catchment	Medium to High	Moderate to Difficult	Commonly used in Australia in connectivity studies to identify the sources of recharge and groundwater inputs to streams
Temperature Measurements of variations in stream and sediment temperatures as ‘tracers’ to identify gaining and losing reaches	Site specific	Low	Easy to Moderate	Limited examples of being applied to study groundwater-surface water interaction in Australia to date

Hydrometric analysis Measurement of hydraulic gradient between aquifer and surface water feature and the hydraulic conductivity of the intervening aquifer material	Catchment to reach to site specific	Low to Medium	Easy to Moderate	Comparison of stream levels with nearby groundwater levels commonly used to define seepage direction
Water budgets Use of river reach water balances to define seepage component	Catchment to river reach	Low to Medium	Easy to Moderate	Need to quantify stream inputs and outputs such as diversions and extractions. Some examples using the available stream flow gauging data