Department of Science, Information Technology and Innovation

Queensland Shallowest Watertable Aquifer Mapping Method

A method for providing baseline mapping of the shallowest watertable aquifers in Queensland

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Document history

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1 Introduction

Groundwater is an important resource in Australia representing up to 17 per cent of currently accessible water resources (National Water Commission 2012). The sustainable use and management of this finite resource remains a challenge for governments. Despite being a poorly understood resource, groundwater plays an important ecological role in directly and indirectly sustaining a range of aquatic and terrestrial ecosystems.

The 2004 Intergovernmental Agreement on a National Water Initiative commits all Australian jurisdictions to provide water for the environment in groundwater management and planning. A fundamental requirement for ensuring consideration of groundwater for the environment is the capacity to identify the extent and nature of the shallowest groundwater at a scale appropriate for use in management and planning processes. In Queensland, groundwater management and planning processes occur primarily at the catchment scale.

In 2012 the Australian Government funded the development of a National Atlas of Groundwater Dependent Ecosystems and co-funded, with the Queensland Government, the Queensland GDE Mapping Project. The Queensland GDE Mapping Project developed a new catchment scale mapping method (GDE mapping method) based on a consultative process that integrates expert local knowledge of landscapes (and the ecosystems within them) with detailed spatial data sets in a geographic information system (GIS) (Department of Science, Information Technology and Innovation 2015).

During the implementation of the GDE mapping method valuable local expert knowledge was captured on the extent and properties of potential shallow watertable aquifers. The development of the shallowest watertable aquifer mapping (as described in this document) is intended to complement existing Queensland GDE mapping and provide valuable additional information about the extent and properties of shallow watertable aquifers.

1.1 Document purpose

The purpose of this document is to provide details on the method for mapping the extent and properties of the shallowest watertable aquifers that has been successfully applied across a diverse range of Queensland's landscapes, including identification of limitations and an assessment of accuracy.

This document should be read alongside the Queensland Groundwater Dependent Ecosystem Mapping Method (Department of Science, Information Technology and Innovation 2015).

1.2 Mapping outcomes

Shallowest watertable aquifer mapping supports the following outcomes:

- Provides an information resource for natural resource management and planning processes, including use by water planners in the management of groundwater for the environment;
- Informs the assessment of the impact of proposed developments on groundwater resources;
- Provides an information resource for education and communication about groundwater, their extent, and their properties;
- Guides research into groundwater resources; and
- Guides investment of natural resource management funding.

2 Framework to map shallowest watertable aquifers

Shallowest watertable aquifer mapping in Queensland comprehensively maps the extent and properties of the shallowest watertable aquifer. The shallowest watertable aquifer mapping method is derived from the GDE mapping method framework (Department of Science, Information Technology and Innovation 2015). During implementation of the GDE mapping method framework, local expert information on the extent and properties of the shallowest watertable aquifer is captured. While this knowledge is used to develop GDE mapping (as describe in Department of Science, Information Technology and Innovation 2015) this information can also be synthesised independently to develop complementary shallowest watertable aquifer mapping.

2.1 Shallowest watertable aquifer mapping method framework

The Queensland GDE mapping method (and hence the shallowest watertable aquifer mapping method) uses an iterative, heuristic approach that synthesises multidisciplinary local expert knowledge. This knowledge is integrated with relevant spatial data in a GIS. The method further adopts an approach to expert elicitation called ‘walking the landscape’ (Department of Environment and Heritage Protection 2012). Walking the landscape is a systematic and transparent consultative process that captures and integrates local expert knowledge with the best available spatial data to produce a comprehensive integrated mapping product that includes mapping, pictorial conceptual models and supporting information. This local expert knowledge includes information on the extent and properties of the shallowest watertable aquifer.

The GDE mapping method framework is divided into five stages containing a total 15 steps:

1. Development of mapping rule-sets and pictorial conceptual models: steps 1-3;
2. Development of draft GDE products: steps 4-6;
3. Refinement: steps 7-11;
4. Product testing: step 12; and
5. Finalisation and product release: steps 13-15.

The following subsections build on the GDE mapping method framework to detail the development of the shallowest watertable aquifer mapping. Further information on each stage and component steps of the GDE mapping method can be found in the ‘Queensland Groundwater Dependent Ecosystem Mapping Method: A method for providing baseline mapping of groundwater dependent ecosystems in Queensland’ (Department of Science, Information Technology and Innovation 2015).

GDE Mapping Method Stage 1: Development of mapping rule-sets and pictorial conceptual models

Stage 1 of the Queensland GDE mapping method utilises the walking the landscape approach to systematically capture and synthesise existing knowledge (step 1), available spatial data (step 2), and local expert knowledge of landscapes (step 3). The relevance of each step within stage 1 for mapping shallowest watertable aquifers is explained below.

- The review of existing knowledge (step 1) captures information on the current level of conceptual understanding of groundwater presence in the landscape.
- The compilation of available baseline spatial data sets (step 2) supports the development of draft shallowest watertable aquifer mapping data and provides an indication of the potential detail of any such mapping.
- During the technical workshop (step 3) a facilitator (moving systematically through each catchment) asks experts to identify the approximate areas of potential shallow watertable aquifers and therefore, potential GDEs.
  - Pictorial conceptual models developed in technical workshops (step 3a) are simplified representations of the conditions controlling groundwater presence and expression at a range of scales (e.g. specific sites, local areas, regions, etc.). Pictorial conceptual models illustrate how groundwater moves through a catchment, any available information on the depth to groundwater, and the likely location of groundwater recharge and discharge.
  - Mapping rule-sets developed in technical workshops (step 3b) describe the drivers and processes that delineate where GDEs are, or are likely to be, groundwater dependent when applied to spatial data sets through GIS analysis. The first component of these mapping rule-sets involves the delineation of the extent of shallow watertable aquifers.
  - Expert assessment of available spatial data sets to implement mapping rule-sets (step 3c) includes assessment of available spatial data to support the delineation of the extent of shallow watertable aquifers.

GDE Mapping Method Stage 2: Development of draft mapping products

In stage 2 of the Queensland GDE mapping method, a draft set of integrated GDE products are developed including pictorial conceptual models (step 4), mapping rule-sets (step 5), and mapping data (step 6). The relevance of each step within stage 2 for mapping shallowest watertable aquifers is explained below.

- Hand-drawn pictorial conceptual models from step 3a are digitised and refined using specialised software (step 4). The integration of multiple pictorial conceptual models is driven by similarities (such as similar landscapes, processes and conditions controlling groundwater presence and expression).
- Mapping rule-sets developed at the technical workshop (step 3b) are further developed to ensure logical consistency between mapping rule-sets and ensure that the implementation process is efficient (step 5).
- The GIS analysis process (step 6) uses specialised software to apply mapping rule-sets (step 5) and develop mapping data that delineates ecosystems that are potentially groundwater dependent. During this GIS analysis process, data sets with polygon (i.e. area) geometries are developed that delineate the extent of shallowest watertable aquifers.

GDE Mapping Method Stage 3: Refinement

Stage 3 of the Queensland GDE mapping method iteratively refines the developed draft GDE products (stage 2), repeating component steps from stage 2 until expert consensus indicates that the products accurately reflect their current knowledge of the landscape. Stage 3 consists of optional field validation and technical review. This stage is critical to ensure that the generated products are fit for their intended purpose and are accepted by local experts. The relevance of each step within stage 3 for mapping shallowest watertable aquifers is explained below.

- The completion of optional field validation (step 7) provides information on the extent and expression of groundwater within a landscape.
- A technical review workshop(s) (step 8) reviews draft GDE mapping products developed in stage 2. This includes review of the extent and properties of the shallowest watertable aquifer against local expert's understanding of the landscape.
- Refinement of pictorial conceptual models (step 9) focuses on rectifying any omissions or inaccuracies identified during the technical review workshop in step 8. This includes any omissions or inaccuracies in the extent or properties of shallowest watertable aquifer.
- Refinement of mapping rule-sets (step 10) focuses on rectifying any omissions or inaccuracies identified during the technical review workshop in step 8. This includes any omissions or inaccuracies in the extent or properties of shallowest watertable aquifer.
- Refinement of GDE mapping data (step 11) is based on refinements to pictorial conceptual models (step 9) and mapping rule-sets (step 10). This may include refinements to the extent or properties of shallowest watertable aquifer.

GDE Mapping Method Stage 4: Product testing

After the refinement process (stage 3), product testing is conducted with a wide range of stakeholders including experts from government, natural resource management groups, and universities. Product testing forms part of the quality assurance process and also tests the functionality of the intended delivery mechanism. The relevance of each step within stage 4 for mapping shallowest watertable aquifers is explained below.

- A closed release of the suite of GDE mapping products (step 12) includes the release of the draft mapping data set ‘Extent and properties of the shallowest watertable aquifer’. The focus of this product testing, as identified in the terms of reference provided to reviewers, is the identification of errors in the mapping products and testing the usability of the proposed delivery mechanism.

GDE Mapping Method Stage 5: Finalisation and product release

Stage five balances the feedback received during the quality assurance process (stage four) with the resource requirements to implement those suggestions. All mapping products including shallowest watertable aquifer mapping data is an approximation and will be updated over time as data and knowledge improve. Any identified errors from stage 4 should be corrected but feedback of a conceptual nature may need to be addressed in later iterations of mapping products.

- Alongside the finalisation of a set of GDE mapping products (step 13), a final shallowest watertable aquifer mapping product is produced consisting of the completion of any minor alterations as identified in stage 4.
- Alongside the integration of a final set of GDE mapping products with existing products (step 14), a final shallowest watertable aquifer mapping product is integrated with existing products. The shallowest watertable aquifer mapping data is then individually versioned and released through available delivery mechanisms.
- Future updates to GDE products are recommended reflecting the dynamism of ecosystems, our rapidly evolving understanding of groundwater and ecosystem interaction, and improvements in available spatial data sets. This includes future updates to the complementary shallowest watertable aquifer mapping product.

2.2 Method limitations

Availability of spatial and non-spatial data

The detail of shallowest watertable aquifer mapping is determined by the scale and extent of available data sets on which the mapping is based and the detail captured during expert elicitation (step 3). Where key baseline data sets are limited, the detail and accuracy of maps generated will inherit these limitations. As underlying baseline data sets are improved and more information becomes available the detail and accuracy of GDE maps generated should improve.

Mapping rule-sets

The development of mapping rule-sets often involves the extrapolation of knowledge from one well-known locality to other areas that are similar in functionally relevant ways. The process of transferring knowledge between areas is beneficial in identifying shallow watertable aquifers in areas where less research has been conducted. However, a shortage of local expert knowledge may result in some specific shallow watertable aquifers not being mapped. The application of generic mapping rule-sets to various landscapes is likely to result in either the under- or over-estimation of shallowest watertable aquifer extent.

Since mapping rule-sets are limited in application to specific landscapes there will be differences in the way shallowest watertable aquifers have been identified between and within regions. These differences should reflect variations in landscape processes between different regions, and will also depend on the knowledge of experts used in the identification process. This may result in some inconsistencies between mapping rule-sets applied to adjacent landscapes or adjacent regions and therefore visible discontinuities at the borders of adjacent mapping products. As mapping is reviewed, underlying data sets are improved and more information becomes available, these differences should diminish.

3 Products

3.1 Mapping

Shallowest watertable aquifer mapping data is presented as one spatial data set: ‘Extent and properties of the shallowest watertable aquifer (polygons)’. Metadata is provided to accompany the spatial data set.

3.2 Supporting documentation

Queensland Shallowest Watertable Aquifer Mapping Method

This method outlined in this document describes the overall process which has been used to map the extent and properties of the shallowest watertable aquifers.

Queensland Shallowest Watertable Aquifer Technical Mapping Specifications

Technical mapping specifications are produced describing the implementation of the method in each region of Queensland, ‘Queensland Shallowest Watertable Aquifer Technical Mapping Specifications: Module # Region A’.

User support guides

User guide are available on Wetland*Info* to assist people using the suite of GDE mapping products:

- Mapping background; and
- Glossary of technical terms.

4 References

Department of Environment and Heritage Protection (2012), *Walking the landscape- a whole-of-system framework for understanding and mapping environmental processes and values*, Queensland Government, Brisbane.

Department of Science, Information Technology and Innovation (2015), *Queensland Groundwater Dependent Ecosystem Mapping Method: A method for providing baseline mapping of groundwater dependent ecosystems in Queensland (April 2015 Version 1.1)*, Queensland Government, Brisbane.

National Water Commission (2012), *Groundwater Essentials*, National Water Commission, Canberra.