

Wet Roots? — A groundwater mapping case study at Bourke

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Knowledge of where a water table sits beneath a soil profile is crucial for irrigated crop production. Groundwater, under the right conditions can be of benefit to plants. This is because they can derive substantial water at depths up to 2.6 metres.

But excessive exposure to groundwater can be detrimental. This is the case if the water table is saline, where it leads to potentially large losses — both economically and environmentally.

Measuring water table depth is inherently expensive and time consuming. This is primarily due to the cost of installation of the measuring devices, known as piezometers.

As a result, the number of piezometers is usually limited (often kilometres apart), meaning groundwater information is often sparse and the variation of water table depth between measurement sites is unknown. Areas that may be at risk of groundwater-related problems such as salinity can go unnoticed until visible signs become evident on the land surface or crop itself.

This article demonstrates the results of a jointly funded research project (CRDC and Natural Heritage Trust) being carried out at the University of New South Wales in association with the Bourke Irrigators' Association.

It shows how traditional methods (limited piezometer readings) can be enhanced by using a combination of remotely sensed and ground based data to predict groundwater depth.

The study site covers approximately 300 square kilometres of irrigated and dryland country in the Bourke Irrigation District (BID) where groundwater management is crucial due to the highly saline water table.

Data collection

Initially an electromagnetic induction survey was undertaken across the BID using an EM34 instrument. From these measurements, 50 core loca-

tions were chosen and drilled to a depth of 12 metres. The depth at which the profile became saturated was recorded. Of the 50 cores taken, 27 had a water table depth between five and 12 metres whilst the remaining 23 cores did not reach the water table.

To enhance the EM34 survey data collected, ancillary remotely sensed data was acquired from other sources. This included additional EM data (EM38), Landsat Thematic Mapper (TM) data (bands two and three) and Digital Terrain Model (DTM) information.

From all this information, a regression relationship was developed to enable estimates of water table depth at each site where ancillary data was collected.

Figure 1 shows the prediction map of water table depth across the BID. Water table depth is set to the benchmark Australian Height Datum (AHD), allowing relative differences in groundwater height to be seen across the study area.

The land surface for most of the study area is between 101–106 meters AHD. This means that under current conditions, the water table at the time of sampling

would in most cases not have interacted with crop roots (for example cotton and wheat).

The exceptions to this are several areas adjacent to many of the water storages across the BID. In these areas where the water table height is greater than 98 metres (that is red shaded areas) soil salinisation has been problematic.

It is also worth noting that while water tables are elevated beneath the irrigated regions, there does not appear to be any significant groundwater mound extending away from the irrigated regions. This means that effects from salinisation should be largely on-farm.

The accuracy of the predictions was assessed by calculating the root mean square error (RMSE) of the predictions. This value is a measure of how different on average each prediction made at each of the 27 sites was from the data collected at this site. The closer the value is to zero the better the score.

It was found that when using the ancillary data, RMSE was 70 cm. This is an 87 per cent improvement in prediction accuracy when compared to the traditional method of only using piezometer measurements.

This method of prediction offers benefits to natural resource management with regard to both cost and accuracy. It gives an estimate of water table depth at a very high resolution (every 100 metres), which allows for even isolated areas of high water table to be identified before visible signs of stress appear.

But it must be noted that this method offers only a “snapshot” of groundwater conditions. It is not suited to ongoing monitoring but rather to get an understanding of overall hydrological conditions and areas that may require further investigations or further monitoring equipment to be installed.

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FIGURE 1: Predicted water table depth using DTM, EM and Landsat information

