Investigation into the effects of extended dry periods on ground water dynamics and stream salt loads in NSW.

Christopher McCulloch  
New South Wales Department of Primary Industries, Orange, Australia  
E-mail: chris.mcculloch@dpi.nsw.gov.au

Justin Hughes  
New South Wales Department of Primary Industries, Orange, Australia  
E-mail: justin.hughes@dpi.nsw.gov.au

Russell Crosbie  
New South Wales Department of Primary Industries, Orange, Australia  
E-mail: russell.crosbie@dpi.nsw.gov.au

David Mitchell  
New South Wales Department of Primary Industries, Orange, Australia  
E-mail: david.mitchell@dpi.nsw.gov.au

ABSTRACT: The dynamics of local ground water systems at four sites in the Lachlan and Macquarie River catchment areas have been measured to quantify the change in groundwater levels over time as well as the salt movement in the local streams. The four sites; Avoca, Boorowa, Brays Flat Creek, and Sloanes Creek are all affected by dry-land salinity and are first order catchments contributing to the Murray Darling catchment. At the four sites a range of measurements have been underway to record the dynamics of the local groundwater and surface water systems, as well the local climatic conditions. These include measurements from networks of piezometers, stream flow monitoring stations and climate stations including measurement of the Bowen ratio. The Boorowa and Avoca sites have had significant changes in landuse during the study period. These changes have included a move away from annual cropping to perennial pastures and the planting of tree belts. The Sloanes Creek and Brays Flat Creek sites have remained under the same landuse, primarily perennial pasture and annual cropping throughout the monitoring period. The sites have experienced lower than average rainfalls during the period reported on here, due to the extended dry period affecting NSW. This paper looks at the effects the reduced rainfall has had on groundwater levels and the effects this has inturn had on the stream hydrology of the catchments. The effects of landuse changes are also discussed in this paper, as the groundwater levels have dropped substantially since their implementation. The use of residual mass rainfall curves and the use of the HARTT method have provided some conclusions as to the processes taking place in these four study catchments.

INTRODUCTION

The NSW Department of Primary Industries projects “Key Sites” and “Sustainable Grazing on Saline Lands” have been making investigations into water balance in several salt effected catchments in the Murray-Darling basin. These projects have focused on various aspects of the water balance in the study catchments; these include Groundwater dynamics and their effect on the hydrology of the catchment. Statistical analysis of groundwater data will be used here to define climatic effects on groundwater dynamics.

SITE DESCRIPTION

The Catchments looked at in this study are located at Avoca, Boorowa, Bray’s Flat and Sloanes Creek in central NSW.

In all the sites groundwater levels are currently monitored with the use of logging capacitance water level units at time intervals ranging from 15 minutes to 1 hour which add to historical data from dip readings.
Avoca,
The Avoca study site is located 15km from Young, NSW. The catchment groundwater is being monitored by 18 piezometers and 2 stream gauges that monitor water moving out of the catchment. Landuse changes have been established from cropping to planting of trees and perennial pasture.

Bray’s flat,
The Bray’s Flat Creek catchment is located 14kms from the town of Manildra, NSW. It is a head water catchment for the “Mandagery Creek”. The Mandagery Creek flows into the Lachlan River.

The Catchment is 750 hectares; with native vegetation on the steeper slopes at the top of the catchment where as the remainder of the catchment is dominated by winter cropping in rotation with perennial and annual pastures, grown in conjunction with areas of permanent pasture. Study at this site uses a network of 41 piezometers to provide groundwater data in conjunction with 3 stream gauging sites.

Boorowa,
The Catchment studied at Boorowa, NSW is 120 hectares in size. In the past winter cropping in rotation with pastures was the dominant land use in the catchment; however the land use has changed to perennial pasture, and grazing management has changed in conjunction with the incorporation of tree belts. At this site a network of 21 piezometers provides groundwater data in conjunction with a stream gauge site.

Sloanes Creek,
The Sloanes Creek catchment is located 35km south of Wellington NSW and is 700 hectares in size. Sloanes Creek is tributary of the Bell River.

The land use is mixed cropping and pasture with Canola and Wheat being the main crops and the pastures dominated by Lucerne and Phalaris. There are some planted tree belts located within the catchment. Study at this site started mid 2002 and continues, during this time a network of 32 piezometers have provided groundwater data in conjunction with 3 stream gauging sites.

RESULTS, METHODS AND DISCUSSION

Rainfall:
Rainfall data has been collected from the four sites being monitored for this study, this data in conjunction with data obtained from the Queensland Department of Natural Resources Data Drill (Jeffery et al, 2001) web site (http://www.bom.gov.au/silo) has been studied in correlation with groundwater data and stream flow data to gauge the effects rainfall has.

When the rainfall data is examined using the “Residual Mass Curve” method (Prabodh Das, 2005) observations of the overall pattern of rainfall can be drawn. The shape of the curve shows periods where the rainfall has been either periodically higher or lower than the average for the studied period. Stages of the curve that are rising would reflect “wetter” periods and falling stages of the curve show the inverse, where “drier” periods were being experienced.

Ground Water Level:
Ground water measurements are a vital source of information about the hydrological factors affecting catchments including recharge, storage and discharge (Taylor et al, 2001). The ground water level (GWL) for the sites has been drawn from the monitoring of several piezometer networks that are located across the studied areas.

In order to draw conclusions about groundwater trends the data recorded from groundwater monitoring and rainfall records has to be compared. However to gain a better perspective on groundwater dynamics rainfall fluctuations and groundwater trends over time have to be compensated for. The HARTT (Ferdowsian 2001) method (equation 1) is used here for that purpose. The HARTT method uses the residual rainfall described above and the lag between rainfall and groundwater dynamics to define a correlation between climate and groundwater movement.

\[
\text{Depth}_i = k_0 + k_1 \times \text{AMRR}_{i-L} + k_2 \times t
\] (1)

Table 1 shows the results of the HARTT analysis and linear regression showing the correlations between groundwater level and climate at a 95% confidence level. The GWL in relation to residual rainfall can be seen in figure 1.

Avoca
It can be seen in Table 1 that at the Avoca site that both time and rainfall are statistically
significant to changes in groundwater level. Hence in an average rainfall year groundwater would continue to fall. The fall in groundwater could be attributed to the tree plantings at the site accessing groundwater.

**Brays Flat**

The data from Brays Flat analysed here is from a piezometer located at the scald site in the catchment. The results in Table 1 can be depicted as suggesting that on the scald time trends have no significant effect on groundwater however rainfall displays a slight significants to groundwater dynamics. Suggesting that the climate conditions have a small effect on the groundwater, at this site it is most likely that geographical conditions are the major contributing factor to ground water dynamics.

**Boorowa**

For the analysis at Boorowa the data was divided into pre-treatment and post-treatment to describe effect landuse changes may have had.

It is shown in Table 1 that during the pre-treatment period climate was a significant factor in groundwater dynamics, however when the post-treatment data is analysed we can see that climate becomes insignificantly correlated to groundwater levels. During this period; time is shown to be significantly effecting groundwater. This effect coincides with a period where grazing management changes have taken place and where perennial pastures are using soil water more efficiently resulting in reduced drainage.

**Sloanes Creek**

As with Brays Flat the groundwater data analysed here is from the scald area of the catchment, this site is located just upstream of a large geological constriction that forces groundwater to surface. This may be the reason that time and not rainfall has been found to contribute significantly to groundwater dynamics.

**CONCLUSIONS**

In order to draw correlations between groundwater dynamics and climatic conditions such as rainfall, different trends in time and climate have to be compensated for. For this application the HARTT method has been used to try and draw conclusions as to whether groundwater dynamics at sites that are being monitored are being effected by rainfall and the drought period that is currently being experienced in NSW.

The HARTT method provides a good tool for this purpose however integrity of results may be compromised by factors such as length of time series and geological and geographic characteristics of the monitored sites.

Where base flow contributes to stream flow this tool could also be used to say whether rainfall has an effect on groundwater which inturn may affect stream salt loads.

**ACKNOWLEDGMENTS**

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**REFERENCE**


Figure 1: Groundwater levels and Residual Rainfall curves.