Summary Report

Water Quality In The Daly River
A multi-disciplinary management approach

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Salinity & Water
AUSTRALIA

May 2006

Report WRD18/2006D

CHARLES DARWIN UNIVERSITY

CSIRO Land and Water

Northern Territory Government
Department of Natural Resources Environment and the Arts

BIBLIOGRAPHIC REFERENCE: Wilson, D., Cook, P, Hutley, L., Tickell, S. and Jolly, P., (2006), Water Quality in the Daly River – A multi-disciplinary management approach. Northern Territory Department of Natural Resources the Environment and the Arts, Technical Report No. 18/2006D

ISBN: 1 920772 35 9

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Cover photo: Daly River at Oolloo Crossing

National Action Plan for Salinity and Water Quality

Summary Report

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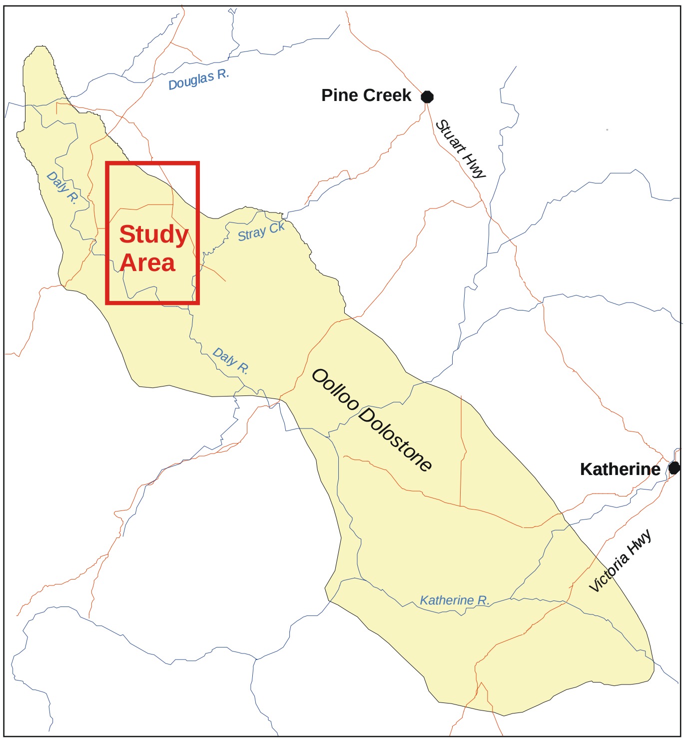
Main Findings

- Native woodlands use more water than native and improved pastures.
- Recharge increases significantly following clearing, probably by at least a factor of two.
- Spring flow to the rivers will increase in proportion to the increase in recharge. There will be an immediate increase in spring flow when the additional recharge reaches the aquifer. The actual water recharged (and any contaminants it might contain) will however not discharge to the river for decades.
- Two mechanisms of recharge are identified; diffuse and bypass flow. Rapid recharge through sinkholes or macro-pores is considered to be the most likely mechanisms for bypass flow.
- Beneath native woodlands recharge is estimated to be made up approximately 30% diffuse recharge and 70% bypass flow. The proportions may be reversed beneath cleared land because bypass flow should remain the same.



Background

The Daly River flows all year round. River flows are sourced from springs, largely from the Oolloo Dolostone aquifer. The water quality and the amount of spring flow are critical to river health and will affect river water quality and impact water-dependent ecosystems. The lack of knowledge on the relationship between land clearing, recharge and spring flows was the main reason for initiating this project. Scientists from Charles Darwin University, CSIRO Land & Water and the Northern Territory Government took part in the study. A diverse range of disciplines were applied to the problem including soil water dynamics, vegetation hydrology, canopy micro-meteorology, applied ecology, hydrochemistry and hydrogeology.

Aims

The aim of this project was to predict the effects of land clearing on groundwater recharge to the Oolloo aquifer and therefore to spring flows in the Daly River.
The current work attempted to understand the physical processes related to recharge. This will provide further scientific basis for the development of land and water management practices and assist in preventing adverse impacts on the ecosystems sustained by spring flows into the Daly River.

Limitations

A one year study should not be the basis of management recommendations. Rather, this report indicates the potentially significant consequences of land clearing. Further work is required to develop and test hypotheses using several years of data.

Methods

Two approaches were used to estimate recharge; surface water balance and subsurface water chemistry methods. Each looked at different parts of the water cycle

- The surface water balance, involved field measurements of, rainfall, evapotranspiration and soil moisture. It attempts to account for all the inputs and outputs of water to a body of soil, over a specified time. Recharge was estimated as the difference between rainfall and the sum of evapotranspiration, the change in soil moisture storage and estimated runoff. Two sites were monitored, one in natural woodland and one on cleared land, under native pasture. Recharge was then estimated on a daily and an annual basis. The results from this method apply to a single wet season.

- Subsurface water chemistry was used to infer rates of water movement and flow processes. Recharge was estimated using the chloride mass balance method (see "Chloride Mass Balance" below) applied to deep soil samples and to groundwater samples, but also considered differences in soil moisture beneath native vegetation and cleared land, and a range of other chemical indicators of recharge processes. These techniques provide an average recharge value over a number of years.

The surface water balance method was operated at only a single site under each land use, whereas the subsurface water chemistry method was applied to four deep soil cores obtained beneath native vegetation and four beneath cleared land.

A computer model of the groundwater system was then made to determine the effects of changes to recharge caused by land clearing on groundwater levels and on spring flows in the Daly River.

CHLORIDE MASS BALANCE

This technique involves the measurement of the chloride concentrations in rainwater, soil water and in groundwater. Chloride is relatively inert. Other minerals dissolved in water can react with the atmosphere, soil or rock, making them less valuable as tracers. Few rocks contain chloride so the method assumes that all chloride present was brought into the catchment in rain. All rain contains minute amounts of chloride ultimately derived from the sea.

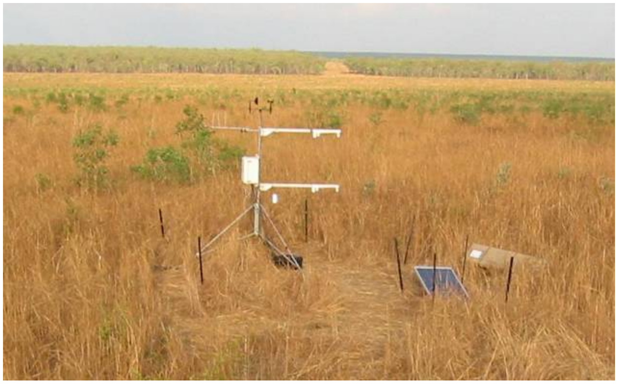
When rain falls on the ground and seeps into the soil, evaporation and plants use up some of the water, leaving the chloride behind. Soil water and groundwater therefore always have a higher chloride concentration than the rain water. Over a long period, equilibrium is reached between the amount of chloride entering and discharging from an aquifer. Recharge can be estimated by multiplying the ratio of chloride concentrations in rain and groundwater by the amount of rain.

EXPERIMENTAL TECHNIQUES

Eddy covariance tower at the uncleared site. It was used to determination evapotranspiration.

Deep soil cores used for soil moisture, chloride and matric potential measurements.

Bowen Ratio station at the cleared site, also used to determination evapotranspiration.



Collecting groundwater samples to measure the CFC content.

DALY RIVER AREA

Daly River at Oolloo Crossing

Picking melons, Douglas / Daly area

A spring emerging from a gravel bank on the Daly River.

RESULTS

PLANT WATER USE

Water balance results indicate that evapotranspiration is much reduced over recently cleared land relative to native savanna. For the period of measurement, 13 September 2005 to 2 March 2006, evapotranspiration rates from native and cleared land were estimated to be approximately 510 mm and 260 mm respectively. Rainfall over this period was 1058 mm. There is evidence that the native trees were accessing soil water down to depths of at least six metres. Grasses on the other hand can only use water shallower than 20 to 30 cm.

RECHARGE, UNCLEARED Vs CLEARED

When the first storm events of the build-up (October-November) occurred, rain fell onto dry soil profiles under native vegetation and onto a relatively wet profile at the cleared site. On cleared land, any water draining to 0.3 m depth is unlikely to be accessed by grass roots and could potentially become recharge to groundwater.

Recharge estimates using both surface water balance and subsurface water chemistry both indicate higher values beneath cleared compared to uncleared areas. Following clearing, recharge increases by a factor or two or more. Groundwater modelling suggests that a realistic value is from two to four times the pre-clearing recharge rate.

TYPES OF RECHARGE

At the onset of the project recharge was presumed to be dominantly diffuse. However several observations suggest that recharge beneath native vegetation is dominated by bypass flow and not slow movement through soil horizons. The most likely mechanism for this is via sinkholes and or macro-pores (cracks and root holes in the soil). Sinkholes are not a prominent feature of the landscape over the Oolloo Dolostone and only a few are open to the surface. Small depressions probably caused by the collapse of solution cavities (caves) at depth are however common. Recharge could occur through these features especially where the soil is thin.

The water chemistry was used to estimate that recharge over uncleared land is made up of approximately 30% diffuse recharge and 70% bypass recharge. The proportions may be reversed beneath cleared land because bypass flow should remain the same. Bypass recharge therefore appears to be a major recharge pathway. This is significant because that type of recharge occurs more rapidly than diffuse recharge and so increases the potential for contamination of the groundwater and hence the river from nitrates and agricultural chemicals. The shorter the time that recharge takes, the less the opportunity for contaminants to degrade.

SPRING FLOWS

Springs along the Daly River are the main discharge point for groundwater of the Oolloo aquifer. A major consequence of land clearing will be an increase in groundwater recharge. The delay between clearing and the additional recharge reaching the aquifer will be of the order of a few years or less. Spring flow to the rivers will increase in proportion to the increase in recharge. There will be an immediate increase in spring flow following the increase in recharge, however the actual water recharged will not discharge to the river for decades.

DRYLAND SALINITY

Dryland salinity has resulted from land clearing in many areas of southern Australia. Recharge estimates from this study suggest that clearing over the Oolloo aquifer will result in a watertable rise. Several factors however make it unlikely that salinity will be a widespread problem here: (i) the amount of salt stored in the ground is very low in comparison to areas where salinity currently occurs; (ii) the incised river and high hydraulic conductivity of the aquifer should promote drainage to the river.

Although dryland salinity is unlikely to be a major issue, the increased recharge due to clearing will raise groundwater levels, typically around one to two metres. Low lying areas may experience waterlogging for longer periods than they did before clearing. Widespread clearing could result in further waterlogging of low lying areas, impacting crop or pasture growth on cleared sites.

IRRIGATION

The replacement of native woodlands with pasture will result in an increase in groundwater recharge and a corresponding increase in spring discharge to the Daly River. Pumping groundwater for irrigation has the opposite effect and will result in reduced spring flows. To some extent, these effects may counteract each other, although the composite effect of both processes of the water balance and on flows to the Daly River will depend upon the location of cleared areas, and on the location of pumping centres and the periods and volumes of extraction.

Under the present regime of groundwater pumping, end of dry season river flows would be greater than they would be if no clearing had taken place. A further increase in pumping might also be possible without reducing river flows, although the locations of pumping centres relative to important spring flows would need to be examined. Groundwater modelling is essential to determine the balance between recharge, groundwater pumping for irrigation and spring flows to the river.

TECHNICAL TERMS

AQUIFER: A water bearing layer of rock that will yield usable amounts of water. Water can be held in fractures, cavities or spaces between sand grains.

DRYLAND SALINITY: The process where salts are mobilised by rising watertables and can adversely affect plant growth and soil structure.

EVAPOTRANSPIRATION: The use of water by plants and from evaporation from the soil.

GROUNDWATER: Water stored beneath the ground in the zone that is fully saturated.

RECHARGE: Replenishment to an aquifer due to infiltration of rain. Recharge can also occur from water seeping through beds of rivers, lakes and swamps.

SATURATED ZONE: The subsurface zone in which all the openings are full of water.

UNSATURATED ZONE: The subsurface zone usually starting at ground level, that contains both air and water.

WATERLOGGING: The process where the watertable rises to within the root zone. Plant growth and access can be affected.

WATERTABLE: The surface between the saturated and unsaturated zones.

CD_ROM

The accompanying CD is designed for use on the Windows operating system, Windows 95 or higher.
It should auto-run when inserted in the cd drive. If it fails to do so navigate to the file “Daly_WQ.exe” and double click it.

The CD contains the following reports in Adobe Acrobat format:

- The technical report
- The groundwater modelling report
- The report on the deep coring
- The summary report