



Final Report

Catchment & Environment Series | Cotton Research & Development Corporation

FINAL REPORT 2006

Part 1 - Summary Details

CRDC Project Number: ANU8C **OR Cotton CRC Project Number:**

Project Title: Development of a Decision Support System in the Gwydir and Namoi valleys - Understanding surface-groundwater interactions in the Namoi River

Project Commencement Date: 01/09/02 **Project Completion Date:** 30/09/06

CRDC Program: Catchment & Environment **OR CRC Program:** - Please Select One -

Part 2 – Contact Details

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Part 3 – Final Report Guide (due 31 October 2006)

Background

1. Outline the background to the project.

Water reforms implemented by the NSW State government are likely to have considerable impacts both on current water users and the environment. In many areas reliable information on the magnitude and direction of impacts on farm profits, industries and the environment of these changes is not available. Lack of such information makes it difficult for the trade-offs between economic and environmental outcomes of different policy options, as well as for the impact on various industries and water users groups, to be fully considered. In many cases this will lead to suboptimal decision making, where decisions do not lead to the outcomes expected, and greater uncertainty for resource users and managers, thereby affecting their ability to plan.

This project complements a second project (ANU7C) which focused on developing a decision support system which is accessible to industry representatives and state government agency staff for considering the impact of various water allocation policies on water users and the environments of the Namoi and Gwydir River catchments. This project developed understanding of the linkages between surface and groundwater systems in the Namoi river basin and developed a modelling approach for estimating the effect of groundwater extractions on surface water flows.

Objectives

2. List the project objectives and the extent to which these have been achieved.

Project objectives were:

- Develop an understanding of the interactions between surface and groundwater in the Namoi river basin;
- Develop a simple modelling approach suitable for use in an integrated assessment model to assess the impact of groundwater extractions on surface water flows.

Both these objectives have been met. The student has undertaken a comprehensive classification of surface water-groundwater interactions in the Namoi River basin and has successfully developed a relatively simple approach to modelling these interactions that allows estimation of the impacts of groundwater extraction on surface water flows.

Methods

3. Detail the methodology and justify the methodology used. Include any discoveries in methods that may benefit other related research.

Two main methods were used in the project:

- Analysis of existing data sets including bore and stream hydrographs, using a range of techniques. Base flow filtering was used in conjunction with statistical and observational analysis to determine the nature of interactions between groundwater and surface water systems.
- A conceptual hydrological model, IHACRES_GW was developed. This approach builds on the existing IHACRES surface water model to allow the effects of groundwater extractions on baseflows to be estimated. This model is an innovative method of analysis which allows for analysis of daily data necessary to consider interactions in ephemeral systems. This approach is likely to be further developed in a project being conducted as part of the Cotton Catchment

Communities CRC. In particular it is planned to be used in conjunction with more traditional groundwater flow models to estimate the magnitude of surface-groundwater interactions.

Results

4. Detail and discuss the results for each objective including the statistical analysis of results.

A full description of project results can be found in Ivkovic (2006). A brief summary is provided here:

- River reaches in the Namoi river basin were characterised according to three levels of information: presence of hydraulic connection; dominant direction of aquifer flux; and, the potential for groundwater extraction to impact on river flows. Most of the upper reaches and tributaries of the Namoi were found to be connected systems. The lower Namoi and some areas of the Cox's creek system were found to be disconnected.
- Application of the IHACRES_GW model to the Cox's creek catchment has been able to show that the estimated sustainable yields of 7,200 ML for zone 2 and 18,600 ML/yr for the combined zone 2 and zone 9, covering the entire Cox's creek catchment are likely to have significant impacts on surface water resources in the area. The lower limit in zone 2 is likely to reduce baseflows by 6,000 ML/yr and lead to slower recoveries of the river system following drought periods. The model shows that for extraction rates greater than 9,000 ML/yr the groundwater and surface water systems would be permanently disconnected. It suggests that a limit of between 7,000 and 8,000 ML/yr across the whole subcatchment (including both zone 2 and zone 9) would be most appropriate.

Outcomes

5. Describe how the project's outputs will contribute to the planned outcomes identified in the project application. Describe the planned outcomes achieved to date.

Planned outcomes were developed for the broader project (ANU7C) These have been reported against in the final report for this project.

6. Please describe any:-
 - a) other information developed from research (eg discoveries in methodology, equipment design, etc.); and
 The IHACRES_GW model is a significant advance in the modelling of connected surface water groundwater systems. A full description is given in Ivkovic (2006).

Conclusion

7. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. What are the take home messages?

The work shows that current sustainable groundwater yields identified using detailed groundwater flow models are likely to be too great and need to be re-evaluated. These were assessed in the Cox's creek catchment. In this catchment current allocations are likely to lead to permanent disconnection between surface water and groundwater systems. In particular the ability of the river system to recover following droughts is compromised. The modelling shows that a limit of between 7000 and 8000 ML/year is more appropriate for the entire Cox's creek subcatchment (zone 2 and zone 9). A higher limit will lead to a permanent disconnect between river and groundwater systems that will have substantial impacts on river water users downstream including the environment. Similar results can be expected in other catchments and a more detailed assessment should be undertaken of sustainable yields in these areas.

Extension Opportunities

8. Detail a plan for the activities or other steps that may be taken:
 - (a) for the future presentation and dissemination of the project outcomes.
Several journal articles are planned and one is in an advanced state of development.
 - (b) for future research.
The project methods have been further applied by an honours student at ANU and will also be further developed as part of a CCC CRC project between University of Sydney, ANU and UTS.

8. A. List the publications arising from the research project and/or a publication plan.
(NB: Where possible, please provide a copy of any publication/s)

Published works:

Ivkovic, K.M.J. (2006). Modelling Groundwater-River Interactions for Assessing Water Allocation Options, PhD thesis, The Australian National University (submitted).

Ivkovic, K. M., B. F. W. Croke, et al. (2005). The Development of a Simple Model to Investigate the Impact of Groundwater Extraction on River Flows in the Namoi Catchment, NSW Australia. 'Where waters meet' - NZHS-IAH-NSSSS Conference, Auckland, New Zealand.

Ivkovic, K. M., R. Letcher, et al. (2004). Groundwater-River Interactions in the Namoi Catchment, NSW and their implications for water allocation. 9th Murray-Darling Basin Groundwater Workshop, Bendigo Victoria.

Ivkovic, K. M., R. A. Letcher, et al. (2005). Investigating the Impact of Groundwater Extraction on River Flows in the Namoi Catchment, NSW Australia. International Workshop, From Data Gathering and Groundwater Modelling to Integrated Management, Alicante, Spain, International Association of Hydrogeologists.

Ivkovic, K. M., R. A. Letcher, et al. (2005). A framework for characterising groundwater and surface water interactions: A case study for the Namoi catchment, NSW. 29th Hydrology and Water Symposium, Water Capital, Canberra Australia.

Publication under review:

Ivkovic, K.M., Letcher, R.A., and Croke, B.F.W. (under review). The use of a simple surface water-groundwater interaction model to inform water management, The Australian Journal of Earth Sciences.

Part 4 – Final Report Executive Summary

Allocations of river and groundwater have been traditionally treated separately in Australia and many other parts of the world even though in many regions groundwater and river systems are hydraulically connected. Groundwater extractions in areas where river systems are hydraulically connected can cause substantial impacts to river flows particularly base flows or low flows, which are considered to be ecologically important. Traditional groundwater modelling approaches tend to be undertaken on time scales of weeks or months which are not sufficient to demonstrate the impacts of groundwater extractions in many river systems, particularly where flows are ephemeral. This research considers the impacts of groundwater extraction on surface water flows using a simple conceptual modelling approach called IHACRES_GW. The Cox's creek catchment in the Namoi river basin, Australia is used as a case study. The research effectively demonstrates that groundwater extractions are having significant impacts on baseflows in this area and that current policies will not be effective in reducing these impacts. The research also demonstrates the potential of such an approach to be used in conjunction with traditional groundwater models when setting allocation limits and considering sustainable groundwater yields.

The application of the IHACRES_GW model in the Cox's Creek subcatchment demonstrated that groundwater extraction affects the frequency, timing and magnitude of baseflow events, and that the impacts vary not only as a consequence of the extraction rates and other losses to groundwater storage, but also according to the groundwater recharge rates. The legacy that historical rates of extraction have on overall groundwater storage volumes and associated baseflow discharges is a function of the net recharge to the exploited aquifer system versus loss as a consequence of extraction and other groundwater losses. It can take decades or longer to recharge aquifers to pre-drought storage levels if groundwater resources have been heavily and/or overly exploited. Conversely, during wetter climatic periods, particularly when associated with flooding and increased groundwater recharge, groundwater storages may be replenished within a relatively short time. Although groundwater recharge rates are not required for estimating sustainable pumping rates, they are critical for an accurate assessment of groundwater-river interactions and sustainability assessments.

Application of the IHACRES_GW model to the Cox's creek catchment has been able to show that the estimated sustainable yields of 7,200 ML for zone 2 and 18,600 ML/yr for the combined zone 2 and zone 9, covering the entire Cox's creek catchment are likely to have significant impacts on surface water resources in the area. The lower limit in zone 2 is likely to reduce baseflows by 6,000 ML/yr and lead to slower recoveries of the river system following drought periods. The model shows that for extraction rates greater than 9,000 ML/yr the groundwater and surface water systems would be permanently disconnected. It suggests that a limit of between 7,000 and 8,000 ML/yr across the whole subcatchment (including both zone 2 and zone 9) would be most appropriate.

If results of this research were to be adopted by government the outcomes for irrigation industries are likely to be variable. In some areas this could mean reduced groundwater allocations, particularly during dry periods, although this is likely to be offset in other parts of the industry by increased surface water availability and improved capacity of the river system to recover from drought. It is possible that some impacts could be offset by allowing greater surface water access, although the nature of impacts from such a scheme would need to be tested.