An Integrated Catchment Management System for the Namoi Basin

Presentation to Namoi River Management Committee
28 June 1999

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Introduction

CSIRO is developing a computer tool for building and delivering environmental Decision Support Systems (DSS) for catchment management. This tool is called ICMS[1]. The purpose of the development of an ICMS for the Namoi is to trial and demonstrate the ICMS software. To this end the Namoi is the major case study within the ICMS project.

Objectives

The primary objective is to provide the Namoi River Management Committee (NRMC) with a DSS for exploring some of the likely impacts of management actions and change on the physical condition of the Namoi Basin, particularly the water quality of its stream network. It will do this by integrating models of catchment processes developed for the Basin by ICAM⊕, CSIRO, and others.

Specific objectives are:

- to integrate into one package a suite of models which describe some of the physical processes within the Namoi;
- to develop a framework within which socio-economic, as well as physical and biological, consequences of change (and no change) can be explored.

Products

The proposed product is not a production DSS. However, it is hoped that the final product, called the ***Namoi ICMS***, will contain sufficient models and assessment tools to allow the NRMC to explore the impacts of a pre-determined set of change scenarios on the flow, sediment, contaminant (phosphorus, salt and others) transport and movement through the Namoi System.

Schedule

It is proposed that development and delivery has 4 phases. Phases 1 and 2 will deliver a working DSS by the end of September 1999. This will contain models (see next section), data, change scenarios and DSS enquiry and analysis tools. Phase 3 then focuses on extending the presentation and interpretation capabilities and can be delivered by end of March 2000. Phase 4 is the handover stage. The details of this stage will depend on the needs and requirements of the NRMC.

Physical Models

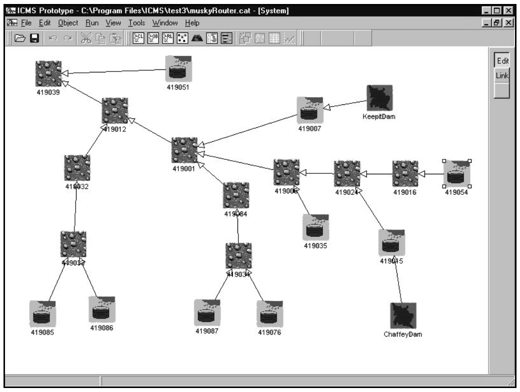
The core of the DSS will be a suite of models which predict the delivery of flow, salinity, sediment and phosphorus concentrations and loads in response to

- daily climate
- land use management practices including farm dams.

A set of erosion models will be included to provide measures of hazard. In addition, a socioeconomic framework for assessing on-

[1] **ICMS** - Integrated Catchment Management System.

site and off-site effects of management practices and policies will be developed.



Potential Framework for a Socio-Economic Model within ICMS

(Author: Rebecca Letcher, ICAM)

Catchment management issues have economic, social and biophysical aspects. Whilst a catchment management issue such as salinity or eutrophication has an obviously biophysical nature, the causes and effects of these problems may be traced back to social or economic factors in the catchment. Thus to fully consider a catchment management issue requires quantification of not only biophysical factors associated with the issue but also social and economic causes and effects. For this a socioeconomic model would need to be integrated with the biophysical.

The framework of socioeconomic models of catchment behaviour are driven by user needs, and by the issue for which they are required to analyse, to a much greater extent than biophysical catchment models. They are much more dependent on specific factors in the catchment being modelled, such as the type of agriculture present, social and economic trends in the catchment and the extent of non-farm business within the catchment. An economic model that has been developed to address issues of salinity will be very different from one that addresses problems of environmental flows or water quality. Equally the type of model required for a predominantly urban catchment will be very different from a model of a mainly agricultural or rural catchment.

Due to this dependence, the exact form an economic model in ICMS would take cannot be specified without some feedback on the needs of users and the issues which most need to be addressed in the catchment. To illustrate one potential framework for a socioeconomic model in ICMS, the issue of environmental flows will be considered.

1. Case Study Issue: Environmental Flows

Environmental flows consist of a number of different aspects. For the purposes of this case study these have been assumed to predominantly consist of:

- maintaining the natural pattern/variability of flows;
- maintaining natural low flows;
- protecting high flows, especially the first flushing flow after a prolonged dry period.

The expected environmental benefits from improved environmental flows include[2]:

- improved water quality and reduced algal blooms;
- healthier ecosystems and wetlands, with more natural inundation of floodplains and wetlands and improved in-stream habitat for native flora and fauna;
- increased bank stability and reduced slumping with healthier in-stream and riparian vegetation;
- discouragement of alien pest species such as carp;
- increased water supply reliability to downstream water users, such as residents of Walgett and downstream agricultural users.

[2] Adapted from 'Proposed interim environmental objectives for NSW waters: Namoi catchment', NSW EPA, October 1997.

1.1 Policy Options

Nancarrow *et al.* (1998) conducted surveys of stakeholders with different backgrounds within the Namoi catchment on their perceptions of the causes of environmental flow problems within the catchment and their suggested policies for improving environmental flows. These suggestions include:

- reduced off-allocation pumping by irrigators;
- reduced urban residential water consumption;
- switch to more water efficient crop types;
- use grey water or urban water effluent for irrigation;
- fewer releases from dams with storage of water on-farm;
- maintaining present farm production with less water than currently;
- taking or buying back sleeper licences;
- disallowing the carryover of unused water allocations to the following year, possibly buying back unused allocations from irrigators;
- removing some irrigation licences permanently or possibly removing a proportion of all licences;
- allow irrigators to store winter flows on-farm for summer use.

An economic model would allow these policy options (and others) to be simulated to test their effectiveness in improving environmental flows and their impact on stakeholders within the community. For the purposes of this case study it can be assumed that some combination of these policies would be applied to achieve given changes in environmental flows.

In the example of environmental flows the potential consequences of policy initiatives can be divided into consequences to <u>irrigators</u>, to <u>other agriculture</u>, to <u>urban water users</u> and changes to <u>off-site benefits</u>.

1.2 Impacts

Irrigators

Some of the potential impacts on irrigators of implementing the policy changes suggested are:

- income lost through reduced of changed production;
- costs of implementing alternatives to irrigation (including changing to different crop varieties, changing land management practices);
- changes in production risk due to possible increases in the unreliability of water supply, the switch to more risky crops or the increased variability of farm income;
- changes in on-farm employment as the labour intensiveness of production changes;
- impact on regional cotton industry viability, which will have secondary impacts on the entire regional economy; and
- costs of increasing on-farm storage capacity.

Other Agriculture

Other agricultural producers within the catchment will also be effected by changes in policy. Some of these effects may be:

- increases in farming risk and losses in farm income due to lost sleeper licences (this may be partially offset by compensation if this is offered);
- possible improved productivity and other benefits, particularly to downstream users.
- Impact of changes in commodity prices.

Urban Water Users

The possible impacts on urban water users include:

- changes in water demand behaviour;
- changes in the price of water and the total bill faced by water users (the cost of water to townspeople may increase);
- changes in the cost of town water supply, including increases due to increased maintenance and repair of infrastructure, and decreases due to reduced water treatment costs with improvements in water quality and delays in building future supply increments;
- changes in the expected costs of risks to town water supply. For upstream communities excess capacity may be reduced, decreasing the amount of water that is available for droughts or major fires, whilst for downstream communities increased environmental flows may increase supply reliability and reduce the risks of running out of water during prolonged dry periods.
- impacts on water dependent non-farm businesses, who may have to reduce water or may be faced with higher production costs due to user pays pricing strategies.

Offsite Benefits

Offsite benefits of increases in environmental flows include:

- increased flow to downstream users which may lead to improved productivity, increased land use options, reduced uncertainty of dry season flows and increased supply reliability to downstream communities;
- improved water quality which may increase recreation and tourism values of streams and rivers, will reduce water treatment costs and reduce the frequency of algal blooms which have negative health impacts on local communities. Improved water quality decreases the costs to all downstream users, urban, industrial and rural.

The policies suggested could be expected to impact most heavily on those without access to alternative water resources or without storages in which to hold water from low impact periods for later use when abstraction may be more damaging to the environment. The policies can also be expected to generate benefits for some users, particularly those in downstream areas where there is currently tension over upstream use.

The effectiveness of these policies will depend on a number of constraints affecting the ability of farmers, businesses and individuals to reduce their water consumption and on the ability of local governments and water supply authorities to augment existing supply arrangements. These constraints include constraints on irrigators, urban water users and local government and water authorities.

1.3 Factors Affecting Structural Change and Resource Allocation

Irrigators

The main constraints on irrigators would be factors which affect their ability or willingness to alter their production or water management practices. These factors include:

- their current availability of off-stream storage capacity. Farmers who currently have excess storage capacity will be able to increase their storage of winter flows or of less frequent releases without incurring significant additional costs.
- land use suitability. Farmers who own land that is suitable to grow a large variety crops will have greater flexibility in their production choices. All farmers will be constrained in their choices by the suitability of their land for different purposes.
- prices of inputs, outputs, and alternative products and related elasticities. These prices will affect the willingness of farmers to change their production choices or their land management practices, and will affect their profitability under different land use options.
- ability to invest in new technology. Farmers who have recently invested in irrigation technology or those who are not able to invest in more water efficient technology may not be willing or able to reduce water consumption through improved technology. This will include the availability of credit given the current debt levels faced by farmers, interest rates and taxes and subsidies on production alternatives.
- availability of alternative water resources. If irrigators are unable to switch to alternative sources or water, such as groundwater or greywater, then this may reduce their ability to respond to changes in surface water policy. The costs of alternatives to irrigation are likely to be greater, and the impact of policies on irrigators profitability is likely to be larger, where alternative water resources are unavailable.
- management skills of the farmer population. Poorly informed farmers are unlikely to be able to make the best water and land management choices for their farms.
- farm resource stocks. These include stocks of land, capital, labour and natural resources such as soil fertility. Farmers' stocks of these resources will limit their production choices and their ability to modify production practices in response to a change in policy.
- Infrastructure refurbishment status and technical efficiency of resource use.

Urban water users

In this case urban water users include residential, commercial (non-farm business) and other users such as schools and parks. The factors constraining the ability of urban water users to change their consumption behaviour include:

- price elasticity of water. This reflects the proportion by which consumption would change with a percentage change in price. In general water is not particularly elastic, that is, it requires a very large increase in price to achieve a fairly small change in consumption behaviour. Some uses of water may be more elastic than others, for example an increase in the price of water may not affect indoor use for showering and drinking, but it may decrease the amount of water that is used on maintaining gardens and lawns. This will constrain the ability of pricing policy to affect water consumption.

- current tariff structure. If water is not currently priced it may not be feasible to begin charging for water. Alternatively, a move to user pays pricing is likely to have a much greater effect on consumption than a change in price once user pays has already been introduced.
- current metering capabilities. If volumetric metering is not currently possible then the cost of introducing meters for all urban water users may outweigh the savings in water consumption.
- size and type of dwelling. Low density housing with large gardens usually require greater water for upkeep than high or medium density housing. Also water users in high density housing are most likely to be using the majority of their water for necessary uses such as drinking or washing, and may be less able to further reduce their water consumption below current levels, while those with large gardens or outdoor areas may be more easily able to reduce their consumption.
- population size and growth rate. These will affect both current and future demands for water.
- compliance with water restrictions. The effectiveness of water restrictions will depend on the rate at which the population complies with restrictions and the ability for these to be policed.
- availability and uptake of water saving schemes and technologies. These may include more water efficient appliances or possibly the use of rainwater tanks. The age and condition of water reticulation infrastructure will also influence urban water use as old, poorly maintained systems will tend to have greater system losses through leaks than well maintained systems.

Other Constraints

Other constraints on the effectiveness of environmental flow policies include:

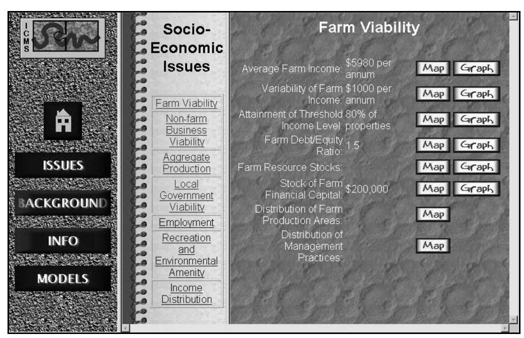
- the availability of technologies and the relative costs of maintenance of environmental flows to businesses, individuals and water supply authorities;
- local water supply authorities ability to invest in new technology and in additional maintenance and repair of existing infrastructure;
- community acceptance of policy initiatives and the ability of local authorities to police policy implementation.

These types of constraints can be specified within an economic model to assess their impact on consumption behaviour. Such a model would require modules for the behaviour of different types of farmers in different areas of the catchment, urban residential water consumption, non-farm business water consumption within the catchment and also for the expenditure of local government and water supply authorities.

The complexity of each of these modules would depend on the situation being modelled. Where non-farm business is not seen as being a major driver of environmental flow problems, or as being one of those groups which is greatly affected by proposed policies, then the non-farm business model would be fairly simple or may possibly not even be included.

Models for irrigation dependent farmers would need to be fairly complex as irrigators are a major user of water in the catchment and as such are likely to be affected by changes to environmental flow policies. As can be seen by the discussion above, irrigation is a major focus of the constraints on policy success. It can also be seen that many of the potential consequences of policies impact on irrigators.

2. Possible Model Structure



To model types of impacts of implementing environmental flow policies discussed above, the socioeconomic framework would require three main components:

- a farm production model;
- urban (non-commercial) water consumption model;
- and a non-farm business model.

The farm model would need to reflect the current distribution of farm types and sizes in the Namoi. However, it is not feasible (or particularly desirable) to model every individual farm within the catchment. Thus the catchment would be divided into characteristic farms which attempt to reflect an average farm for each main farm type in different areas of the catchment.

Boundaries of these farm types are likely to follow boundaries of hydrological and physical features of the catchment. This means that an entire subcatchment, or possibly a smaller area, may be assumed to contain farms of one particular type and size. Thus the model would be able to simulate the impact of reforms on particular types of farms in different areas of the catchment, but not on individual farms. This type of farm model allows the simulation to capture the main budget and resource constraints faced by different types of farmers, without trying to capture the behaviour of individual farmers currently in the catchment.

It would be possible to model urban water consumption using fairly simple empirical models. This would reduce the complexity of the overall socioeconomic model and simplify its data requirements, but would still potentially provide sound estimates of changes in urban water consumption. Many suggested policies do not effect urban water consumption (such as changes to irrigation licences and off-allocation) so the effect of using a fairly simplistic model for this should be minimal. This model should also account for the financial costs of changing outflows on dams and other additional infrastructure costs faced by local government and water supply authorities.

Non-farm business has not been identified as a major source of tension over water allocation in the Namoi catchment. This means that this component may be able to be modelled fairly simply or may even be able to be largely ignored. It might be preferable to use a specific non-farm business model for only the larger industries that are likely to be effected in the catchment, and to include other non-farm business consumption in the urban water use model.

Other factors which may be effected and modelled include the effects on recreation and tourism values of streams and rivers, effects on regional unemployment and the effects on local government viability. Unless these issues are perceived as a major issue connected with changes in environmental flow policies it may be best to signal only the most direct costs, or to model these factors very simply. For example if the biggest impact on regional unemployment is expected to be as a result of changes in on-farm labour, as non-farm businesses are not expected to be greatly effected by policy changes, then it may be best to quantify only changes in on-farm employment using the farm model and use this to indicate changes in regional employment, through the proportion of regional employment that is provided on-farm, rather than providing a complex regional employment model, including off-farm employment.

3. Summary

The design and implementation of a socioeconomic model framework in ICMS would depend on the issues being modelled, and the impacts that users are most interested in assessing. For water quality and quantity issues in the Namoi catchment this would most likely mean that the socioeconomic model would include a fairly complex model of farm production, with more simple models of urban water consumption and non-farm business water consumption. It would also be possible to model the effects of policies on factors such as regional employment, although due to the necessary complexity of such a task, these models would not be included unless it was felt that this would be a major social and economic impact of policy change in the Namoi. Some indication of changes in regional employment would be achieved by modelling changes in labour use in areas that are most effected by policy changes, such as on-farm employment.

The complexity of model components is also reliant on the availability of data to parameterise the model. Detailed data on farm production choices may not be available at the scales required for modelling and may need to be obtained through surveys. Also non-farm businesses are unlikely to provide data on their production choices and profitability due to concerns about confidentiality. Where necessary it may be possible to obtain additional data through surveys but this is a costly procedure in terms of both the time and the monetary cost of running such a survey and analysing the data obtained. For this reason model components should be kept as simple as possible given the accuracy and complexity required by users.

4. Stakeholder Feedback

The types of questions for which feedback from stakeholder groups is required to construct an integrated socioeconomic and biophysical model for catchment management include:

1. What are the main issues you would like addressed in your catchment?
2. Would you be interested in a socioeconomic model which assesses the impacts of environmental flows policies in your catchment (or other resource allocation and sustainability questions)?
3. e.g. For environmental flows, what policies would you be most interested in assessing?
4. Which water users do you feel will be most impacted on by these policies?
5. Which groups will gain the most from these policies?
6. Which social and economic (and biophysical) impacts are you most interested in being assessed?

5. References

EPA (1997) 'Proposed interim environmental objectives for NSW waters: Namoi catchment', NSW EPA, October 1997.

Nancarrow, B.E., Syme, G.J., and McCreddin, J.A. (1998) 'The development of stakeholder principles for defining environmental flows in modified rivers', CSIRO Land and Water Consultancy Report No. 98-25.

Queries

This project is Project CWA20 within the Integration and Adoption Program of the Land and Water Resources Research Corporation (LWRRDC). For further details, contact Susan Cuddy, CSIRO Land and Water, GPO Box 1666, Canberra, ACT 2601, (w) 02 6246 5705, Susan.Cuddy@cbr.clw.csiro.au,