Australian Government

Cotton Research and Development Corporation

Annual, Progress and Final Reports

Part 1 - Summary Details **REPORTS**

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number:		**ANU7C**
Annual Report:	☐	Due 30-September
Progress Report:	☐	Due 31-January
Final Report:	☒	Due 30-September (or within 3 months of completion of project)

Project Title: Development of a Decision Support System in the Gwydir and Namoi valleys

Project Commencement Date: 01/09/02 **Project Completion Date:** 31/08/2005 (28 Feb 2006 for ANU8C)

Research Program: 2 Integrated Natural Resource Management

Part 2 – Contact Details

Administrator: Ms Susan Cuddy

Organisation: ICAM, ANU

Postal Address: ICAM, Building 48a, SRES, The Australian National University, Canberra

Ph: 02 6125 3568 **Fax:** 02 6125 8395 **E-mail:** susan.cuddy@anu.edu.au

Principal Researcher: Dr Rebecca Letcher

Organisation: ICAM, ANU

Postal Address: ICAM, Building 48a, SRES, The Australian National University, Canberra

Ph: 02 6125 8132 **Fax:** 02 6125 8395 **E-mail:** rebecca.letcher@anu.edu.au

Supervisor: Professor Tony Jakeman

Organisation: The Australian National University

Postal Address: ICAM, Building 48a, SRES, The Australian National University, Canberra

Ph: 02 6125 4742 **Fax:** 02 6125 8395 **E-mail:** tony.jakeman@anu.edu.au

Researcher 2 (Name & position of additional researcher or supervisor).

Organisation:

Postal Address:

Ph: **Fax:** **E-mail:**

Signature of Research Provider Representative: 

Part 3.3 – Final Reports (due 3 months after completion of project)

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 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 work builds on a previous project (a PhD project funded through an APA and CSIRO top-up scholarship) in which a regional scale integrated economic-hydrologic modelling framework was developed for considering water allocation in the Namoi River catchment. Feedback from State Government Agency and industry representatives at the end of this previous project indicated that there was considerable interest in further developing this prototype so that it could be used by decision makers and other catchment stakeholders for considering economic and environmental trade-offs associated with a variety of management issues in the catchment.

This project aimed to complete the prototype previously developed in the Namoi so that it is acceptable to local stakeholders, and then to apply this completed framework to the Gwydir river catchment.

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

The project aimed to develop regional scale (Namoi and Gwydir valleys) decision support systems that

- are capable of considering spatial impacts on irrigated agriculture (economic) as well as on streamflow resulting from changes to policies in any of the 3 water systems (unregulated, regulated an groundwater) in the Namoi or Gwydir catchments
- are relatively accessible to staff at regional DLWC, NSW Agriculture offices and to members of CMB's and RMC's (note that due to restructuring etc over the last three years these are now DNR, DPI and CMA's). It should be able to demonstrate both pre-run and new scenarios 'live' in meetings.
- are not a 'black box' and that affords an opportunity for government agency staff, industry representatives and other stakeholders to comment on underlying assumptions etc.

These aims have all been met. The project has delivered two DSS, one for the Namoi and one for the Gwydir (referred to as the Water Allocation Decision Support System or WAdss), which can show spatially explicit economic and flow impacts resulting from changes to water access, water allocation and water pricing in any of the three water systems (unregulated, regulated an groundwater). These DSS are capable of being run live in meetings (run-time ~ 4 minutes) and demonstrating pre-run scenarios. They have been successfully tested in a workshop situation with CMA representatives, irrigators and State Government Agency Staff. These DSS were developed with a high level of input from local stakeholder including government, CMA representatives and irrigators. This input included a Project Steering Committee, interviews and software workshops. As such, every reasonable action has been undertaken to ensure that they are accessible, that

the assumptions behind them are clear and that stakeholders have had adequate opportunities to feedback into their design.

3. Detail the methodology and justify the methodology used.

This project used an integrated assessment methodology to develop a DSS for each of the Namoi and Gwydir catchments. Integrated assessment is a discipline that takes a holistic, problem-oriented approach to scientific assessment. Natural resource management involves trade-offs between complex and often interrelated social, economic and environmental system changes. This complexity lends itself to the use of integrated, and often model based, assessment approaches. These approaches differ from traditional, disciplinary model based approaches in that the breadth of issues (and disciplines) considered is often much greater, and the complexity of the model developed is driven by the problem focus rather than by the disciplinary bias of the modellers involved. The need for integrated assessment was supported by Parson and Fisher-Vanden (1997), who state 'it is plausible that most useful assessment is integrated to some degree, since few real policy issues or decisions can be fully advised by drawing on the knowledge of a single research community'. A growing body of literature exists on the development of such approaches for considering issues such as climate change and catchment management (see for example Dowlatabadi, 1995; CIESIN, 1995; Janssen and Goldworthy, 1996; McKinney et al., 1999; Mendelsohn and Rosenbeg, 1994; Park and Seaton, 1996; Ravetz, 1997; Risbey et al., 1995; Rothman and Robinson, 1997; Timmermunn and Munn, 1997; Villa and Costanza, 2000; Yarnal, 1998; Weyant et al., 1995; Jakeman and Letcher, 2003; Walters and Holling, 1990; Hagmann et al., 2002; Lovell et al., 2002; Gottret and White, 2001; Benbasat and Gass, 2002; Holling, 1978; Walters, 1986). These approaches are, however, still in a relatively early stage of development. This project and lessons from the approach applied have added to the discipline of integrated assessment (see Letcher et al., 2004; Letcher and Jakeman, 2003; Jakeman and Letcher, 2003; Letcher et al., in press). The latter references also provide more detail on the methodology of the project, including the model components.

4. Detail and discuss the results including the statistical analysis of results.

The results from this project relate more to the development of the software and the experiences of users at workshops with this software and approach than to specific model results. To date 14 copies of the software have been distributed through workshops. Each attendee at these workshops was also asked to fill in a questionnaire after they had had a chance to become familiar with the software and ask questions about how it worked and its assumptions etc. The following briefly summarises their responses to this questionnaire:

- When asked about whether the model would be useful for considering water allocation management issues in the future, all respondents answered yes.
- Respondents were asked to outline issues the model should be used to consider. Many different issues were raised but common issues were the review of water sharing plans, macro water plans, ECA and other water sharing arrangements, trade decisions and potential purchases of water for the environment.
- All respondents found the workshop useful.
- There is demand for other impacts such as salinity or vegetation changes to be built into the system over time.
- Workshop participants were asked to identify limitations of the system. Those identified included the need to keep the system simple so that non-modellers can run scenarios, bugs in the software and the need to ensure that the system is robust to a broad range of computers etc., as well as difficulties with ensuring realistic data assumptions in the system. These potential limitations were also discussed with the group and some strategies for dealing with them identified.

5. **Provide a conclusion as to research outcomes compared with objectives. What are the "take home messages"?**

This project aimed to develop DSS for water allocation that were accessible, transferable and able to demonstrate trade-offs between economic and hydrological impacts spatially and temporally across a catchment. These objectives have been met as was demonstrated at two recent workshops held in Narrabri and Moree where a mix of irrigation representatives, CMA staff, researchers and government agency staff were trained in the use of the model. These users were able to explore scenarios live in the workshop situation as well as new results from pre-run scenarios. Overall these two groups concluded that the models were accessible and able to show types of impacts (economic and hydrologic) that have not been so easily explored in the past. The groups both seemed quite comfortable with the software and expressed interest in ensuring these DSS are taken up by planning processes in the Namoi and Gwydir catchments. A strategy for this uptake was also discussed. The groups identified areas where the software could be improved or further development could take place, but also seemed comfortable with the current capacity of the system. Take home messages from this project and from the recent workshops are:

- The importance of the process by which models are developed cannot be underestimated. A high level of communication between researchers and stakeholders is required for these types of policy models to have any chance of succeeding. Resources need to be made available to facilitate this level of communication in project design. Otherwise projects may as well not be funded, as they are quite likely to produce unusable and/or unadopted models that benefit only researchers.

- Ongoing development and 'ownership' of the model should not necessarily be vested in researchers in the long run. It is important to get the software up and running and ensure that sufficient science goes into model development that research groups are engaged and bring their enthusiasm to the model development process. However when it comes to using the model for 'real world' decisions the model is best used and maintained by local groups vested with either power to make decisions or for whom decisions are being made. In the case of the Namoi and Gwydir WAdss this means that while the research group may maintain an active interest in the model, including improving the science or interface over time, local groups such as consultants, CMA or government agency staff must now take responsibility for maintaining the model, ensuring data are accurate and accepted by the community, and that the model is used in an appropriate manner. This provides a real opportunity for better dialogue to develop between catchment managers and irrigators and for more appropriate use of models in the decision making process. The WAdss should now be embedded in a process whereby, before decisions are made using model results, a process of soliciting feedback on model assumptions is facilitated by a group such as the CMA. This message came out very strongly from both workshops.

6. **Detail how your research has addressed the Corporation's three Outputs - Economic, Environmental and Social?**

The project will enhance the sustainability of natural resource use by providing a tool to decision makers which will enable better resource management decisions through improved understanding of the impact and effectiveness of water allocation policies. This tool will provide important information on environmental and economic trade-offs at the whole of catchment scale as well as for sub-regions. Improved information on the impact of catchment wide policies on the cotton industry in these catchments will lead to a better understanding of these impacts, and it is hoped the creation of policies which have smaller economic impacts on the industry and individual cotton growers in these catchments with greater environmental benefit. In addition allowing stakeholders such as

irrigators input into the development of this type of policy model, and providing an avenue for communication between the irrigation community and catchment policy makers such as CMA's and State government Agencies, can lead to substantial social benefits. This communication can lead to better understanding of the objectives and constraints facing these different groups and better coordination of activities to achieve each of their goals. In the long run this will help to maintain viable regional communities through reduced adverse impacts of resource management decisions and greater certainty for resource users and managers, as well as greater community acceptance of management actions. These improved decisions should lead to enhanced sustainability outcomes for the catchment as a whole, and increased profitability for the industry and the communities which rely on it.

7. **Provide a summary of the project ensuring the following areas are addressed:**

a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.)

The project has led to the development of a generic software tool which can be applied to any catchment to consider water allocation (with at most minimal code changes to represent new situations). This software has also been implemented in the Namoi and Gwydir catchments and has been distributed under license for these applications. The software is distributed as freeware.

b) other information developed from research (eg discoveries in methodology, equipment design, etc.)

The project has substantially advanced the science of integrated assessment. Substantial interest has been expressed by research groups in Australia, Europe, Asia, Africa and North and South America in the approach and model developed. The model is currently being reapplied in a catchment in Zimbabwe as part of a PhD student project. Other applications have also been proposed but as far have not been fully developed. Lessons from the project have also been published and have been taken up by a variety of research groups, including some European Union 5th and 6th framework projects. The project has been part of a larger body of work which has created many research spin-offs including an ARC project investigating sensitivity and uncertainty analysis of integrated models, numerous student projects on a very broad range of topics including hydroecological indicators, modelling of wetland flooding, an application of prospect theory to modelling farmer decision making and uncertainty analysis of subcomponents of the system.

c) are changes to the Intellectual Property register required?

Not at this time. A licence agreement has been developed with which the software is distributed. This is necessary to meet the requirements of ANU's sublicense agreement with CSIRO for ICMS. It is also desirable to create appropriate expectations of the software and to outline the process for reapplication of the software by third parties. A copy of this license agreement has been provided electronically.

8. **Detail a plan for the activities or other steps that may be taken:**

(a) to further develop or to exploit the project technology.

There is a possibility to pursue development and exploit existing technology along three main lines:

- Enhancing the existing software and making these enhancements available to the Namoi and Gwydir applications as well as to any future new applications. Desirable enhancements identified at the workshops were:
    - Allowing for explicit trades especially between unregulated subcatchments in the interface. This is relatively simple and involves mostly a straightforward redesign of this page of the interface.
    - Allowing for adaptive environmental water, translucency, transparency and the design of Environmental Contingency Allowances (ECA). This is more complex and involves both changes to the underlying model as well as the interface.
    - Allowing for greater flexibility in supplementary share trading. This involves small and relatively simple changes to the model code but significant changes to the interface.
    - Allowing for impacts on end-of-system flows to be demonstrated in the interface. This needs to be better specified but is likely to involve changes to the interface as well as to the model code.
- Reapplying the software to new catchments such as the Macquarie River Basin, the Condamine-Balonne system or catchments in Queensland or other states.
- Creating a stand-alone application for the Peel River system and using this as part of the Water Sharing Plan process which will be undertaken early next year. This would provide an opportunity to trial the new 'ownership model' and also to trial the use of the software in a CMA facilitated feedback process.

These options have come from discussions with workshop participants. Option 3 is being considered by the CMA and DNR. I feel this is the most immediate option, and would ideally be undertaken before additional investment is made in the software. This would essentially test the capacity of the system to be used by these stakeholders in a Water Sharing process. Option 1 may be facilitated through multiple mechanisms. Were a new catchment application to be identified (Option 2) then many of these could be undertaken as part of this application. Otherwise it would be possible to seek some funding and/or undertake some of these changes in cooperation with other funding sources. The Cotton CRC has expressed some interest in new applications of the software. My feeling is that these may be desirable but should not be committed to for 6-12 months to allow a better appreciation of likely adoption of the system to be formed.

(b) for the future presentation and dissemination of the project outcomes.

The project will continue to be presented at international conferences. This includes presentation of aspects of the DSS design at the upcoming MODSIM conference to be held in Melbourne (paper attached) as well as presentation of the software to a group of DSS developers and other researchers and research users at the IEMSS conference to be held in Vermont next June.

I also plan to hold a workshop/information session sometime in January or February with staff in Sydney head-office of DNR. This will follow the format of previous workshops held in Narrabri and Moree.

I would be keen to publicise the research and results through other media including local newspapers etc but would like to make sure that this fits well within plans for publicity with CRDC and the Cotton RDC. In particular I feel it would be best to have identified

more clearly the next steps in model development and adoption before this kind of dissemination is undertaken to ensure unrealistic expectations of future work are not set-up.

(c) for future research.

There are many potential avenues for research that have been identified arising from this project. Some of these have already been scoped and funding sought, others are still in the ideas stage. The main options for research are:

- development of a wetland flooding model to estimate the impact of flows reaching the wetland and their likely environmental benefits. A prototype model was developed as part of an ANU Masters project. Development of a fully functional model is being undertaken as a PhD project funded by the Cotton CRC.
- Linking impacts on flows to 'river health' outcomes. An honours student has already undertaken a project looking at hydroecological flow indicators. This work could potentially be refined and used in future versions of the model to enhance the environmental impact analysis.
- Improving the links between surface and groundwater systems in the model. This work is part of a CRDC funded project ANU 8C funded in conjunction with this project. This will be incorporated into the system sometime next year. Further research into this area is also planned through the Cotton CRC in a project involving ANU and the University of Sydney.
- Improved representation of farmer decision making. Two small undergraduate student projects have already been undertaken on this topic and have produced interesting results. There is the potential to fund a PhD or possibly even an honours student to look further into this issue.
- Sensitivity and uncertainty analysis of the model. Two honours projects have already been undertaken looking at the sensitivity of subcomponents of the models developed in this study. A further vacation scholar project is currently being undertaken to investigate the sensitivity of the whole system to parameter uncertainty. In addition a research group from the UK has expressed interest in investigating the model in this way. This area of research could potentially support a PhD project or further smaller projects.

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

Croke, B. F. W., Letcher, R. A., and Jakeman, A. J. (in press). "Development of a flow network for the Namoi River Basin, Australia." *Journal of Hydrology*.

Croke, B.F.W., Letcher, R.A, Ticehurst, J.L., Norton, J.P., Newham, L.T.H. and Jakeman, A.J. (in press). "Integrated assessment of water resources: Australian experiences", Water Resources Management.

Jakeman, A. J., and Letcher, R. A. (2003). "Integrated Assessment and Modelling: Features, Principles and Examples for Catchment Management." *Environmental Modelling and Software*, 18: 491-501.

Letcher, R.A. (2005). "Implementation of a water allocation decision support system in the Namoi and Gwydir valleys", *Proceedings of the International Congress on Modelling and Simulation (MODSIM05)*, 12-15 December 2005, Melbourne Australia.

Letcher, R., and Jakeman, A. J. (2003). "Application of an Adaptive Method for Integrated Assessment of Water Allocation Issues in the Namoi River Catchment, Australia." *Integrated Assessment*, 4(2): 73-89.

Letcher, R. A., and Aluwihare, P. "Development of a Decision Support System for the Namoi and Gwydir Valleys." *Proceedings of the International Congress on Modelling and Simulation*, Townsville Australia, pp. 1649-1654.

Letcher, R. A., Jakeman, A. J., and Croke, B. F. W. "A Generalised Conceptual Framework for Integrated Assessment Modelling of Water Allocation Issues." *International Environmental Modelling and Software Society (iEMSs) Conference*, University of Osnabruck, Germany, pp.433-438.

Letcher, R. A., Jakeman, A. J., and Croke, B. F. W. (2004). "Model development for integrated assessment of water allocation options." *Water Resources Research*, 40: W05502.

Letcher, R.A. (2005) "Namoi Water Allocation Decision Support System (WAdss): User Manual", iCAM Technical Report 2005/36.

Letcher, R.A. (2005) "Gwydir Water Allocation Decision Support System (WAdss): User Manual", iCAM Technical Report 2005/37.

ANU 8C (which is closely linked to this project) has also led to the following publications:

Ivkovic, K. M., Croke, B. F. W., Letcher, R. A., and Evans, W. R. "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., Letcher, R., and Croke, B. F. "Groundwater-River Interactions in the Namoi Catchment, NSW and their implications for water allocation." 9th Murray-Darling Basin Groundwater Workshop, Bendigo Victoria, 8pp.

Ivkovic, K. M., Letcher, R. A., and Croke, B. F. W. "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.

Ivkovic, K. M., Letcher, R. A., Croke, B. F. W., Evans, W. R., and Stauffacher, M. "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.

The following publications are also currently planned:

- Short Communication paper for Environmental Modelling and Software detailing the WAdss software design and interface.
- A paper on the policy implication arising out of results from the two models. Probably submitted to the Journal of Environmental Management or Water Resources Research.
- A paper describing application of the software and method to the Namoi and one for the Gwydir. Possibly written as two companion papers. To be submitted to Ecological Modelling or Environmental Modelling and Software.
- A paper describing results from the sensitivity analysis of the Gwydir model. I will try to submit this to Water Resources Research in the first instance.
- A paper describing results of a sensitivity analysis of the Namoi model. I may submit this to either Water Resources Research or Agricultural Systems.

- A more detailed model on the economic component model and analysis of results from this for various options. Probably submitted to Australian Journal of Agricultural and Resource Economics or the equivalent American journal.

I am attempting to write first drafts of much of this material over the next few months. After this I will successively improve and submit papers over the next 12 -18 months.

10. Have you developed any online resources and what is the website address?

Information on the project and updates of model documentation etc are available from the ICAM website. The address is:

http://icam.anu.edu.au/html/water_allocation.html

11. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. Where possible include a statement of the costs and potential benefits to the Australian cotton industry or the Australian community.

The project has provided the cotton industry an opportunity to be involved from the ground up in the development of a model which is likely to be used to formulate water sharing policy over the next few years. This is very important given the experiences of many industry representatives in the last round of water sharing plan development. So long as the WAdss is embedded in a process whereby irrigators are able to engage in finalising model assumptions (such as areas laid out to irrigation, storage volumes etc) before the model is used for informing policy processes such as the review of water sharing plans, I feel confident that the WAdss will help overcome many of the difficulties in negotiating appropriate outcomes and in communication more generally experienced in the last water sharing plan round. While this will not necessarily mean that decisions made will not impact on the industry, it will mean that the industry will be able to ensure that these impacts are adequately represented and considered in the policy process. Potential win-win solutions that create environmental benefit at the least economic cost will also be able to be identified and explicitly considered by the process. This can only benefit the industry in the long-run.

REFERENCES

Benbasat, J. A. and Gass, C. L. (2002) Reflections on integration, interaction, and community: the Science One program and beyond Conservation Ecology, 5, 26.

CIESIN (1995), Thematic Guide to Integrated Assessment Modeling of Climate Change [online], Consortium for International Earth Science Information Network University Center, Michegan, http://sedac.ciesin.org/mva/iamcc.tg/TCHP.html.

Dowlatabadi, H. (1995) Integrated assessment models of climate change: an incomplete overview Energy Policy, 23, 289-296.

Gottret, M. A. V. N. and White, D. (2001) Assessing the impact of Integrated Natural Resource Mnaagement: challenges and experiences Conservation Ecology, 5, 17.

Hagmann, J., Chuma, E., Murwira, K., Connolly, M. and Ficarelli, P. (2002) Success factors in integrated natural resource management R&D: lessons from practice Conservation Ecology, 5, 29.

Holling, C. S. (1978) Adaptive environmental assessment and management, Wiley, Chichester.

Jakeman, A. J. and Letcher, R. A. (2003) Integrated Assessment and Modelling: Features, Principles and Examples for Catchment Management Environmental Modelling and Software, 18, 491-501.

Janssen, W. and Goldworthy, P. (1996) Multidiscplinary research for natural resource management: conceptual and practical implications Agricultural Systems, 51, 259-279.

Letcher, R. A., Croke, B. F. and Jakeman, A. J. (in press) Development of a flow network for the Namoi River Basin, Australia, Journal of Hydrology.

Letcher, R. A., and Jakeman, A. J. (2003). Application of an Adaptive Method for Integrated Assessment of Water Allocation Issues in the Namoi River Catchment, Australia, Integrated Assessment, 4(2), 73-89.

Letcher, R. A., Jakeman, A. J., and Croke, B. F. W. (2004). "Model development for integrated assessment of water allocation options." *Water Resources Research*, 40: W05502.

Lovell, C., Mandondo, A. and Moriarty, P. (2002) The question of scale in Integrated Natural Resource Management Conservation Ecology, 5, 25.

McKinney, D. C., Cai, X., Rosegrant, M. W., Ringler, C. and Scott, C. A. (1999) Modeling water resources management at the basin level: Review and future directions, SWIM Paper 6, International Water Management Institute, Colombo, Sri Lanka.

Mendelsohn, R. and Rosenbeg, N. J. (1994) Framework for integrated assessments of global warming impacts Climatic Change, 28, 15-44.

Park, J. and Seaton, R. A. F. (1996) Integrative research and sustainable agriculture Agricultural Systems, 50, 81-100.

Parson, E. A. and Fisher-Vanden, K. (1997) Integrated assessment models of global climate change Annual Review of Energy and the Environment, 22, 589-628.

Ravetz, J. R. (1997) Integrated Environmental Assessment Forum: developing guidelines for "good practice", ULYSSES, Darmstadt University of Technology.

Risbey, J., Kandlikar, M. and Patwardhan, A. (1995) In Thematic Guide to Integrated Assessment Modeling of Climate Change[online](Ed, CIESIN) Consortium for International Earth Science Information Network University Center, Michegan.

Rothman, D. S. and Robinson, J. B. (1997) Growing pains: a conceptual framework for considering integrated assessments Environmental monitoring and assessment, 46, 23-43.

Timmermunn, P. and Munn, R., .E. (1997) The tiger in the dining room: designing and evaluating integrated assessments of atmospheric change Environmental Modelling and Assessment, 46, 45-58.

Villa, F. and Costanza, R. (2000) Design of multi-paradigm integrating modelling tools for ecological research, Environmental Modelling and Software, 15:169-177.

Walters, C. J. (1986) Adaptive management of renewable resources, Macmillan publishing, New York.

Walters, C. J. and Holling, C. S. (1990) Large-scale management experiments and learning by doing Ecology, 71, 2060-2068.

Weatherford, G. D. (1990), Vol. Paper No. 5 University of Colorado, Boulder, Natural Resources Law Centre Western Water Policy Project Discussion Series.

Weyant, J., Davidson, O., Dowlatabadi, H., Edmonds, J., Brubb, M., Parson, E. A., Richels, R., Rotmans, J., Shukla, P. R., Tol, R. S. J., Cline, W. and Fankhauser, S. (1995) Integrated Assessment of Climate Change: an overview and comparison of approaches and results, In Climate Change 1995: Economic and Social Dimensions (Eds, Bruce, J. P., Lee, H. and Martes, E.F.) Cambridge University Press, Cambridge.

Yarnal, B. (1998) Integrated regional assessment and climate change impacts in river basins Climate Research, 11, 65-74.

Part 4 – Final Report Executive Summary

Water allocation and access arrangements affect the livelihoods and well-being of a diverse range of water users, including irrigators and the environment. Increasing pressures on surface and groundwater resources have seen a shift in water management towards decision processes that attempt to represent the interests of these diverse groups. Decision makers are increasingly being asked to take account of trade-offs between different users of water so as to make fair, equitable and/or efficient decisions that achieve a balance of social, economic and environmental outcomes.

In NSW, changes to water allocations and access, through the design and implementation of Water Sharing Plans, involved negotiation between stakeholders representing many different interests and concerns. A key gap identified by many stakeholders involved in these negotiations was open access to integrated, scientifically sound and generally agreed upon information on the socioeconomic trade-offs likely to result from changes in access, allocation and pricing. In addition, estimates of impacts on the flow regime and on river health are also required. The Water Allocation Decision Support System (WAdss) has been developed and applied to two NSW catchments, the Namoi and Gwydir River catchments, for considering the trade-offs between environmental and socioeconomic outcomes resulting from changes in water allocation, access and pricing in the unregulated and regulated surface water systems and the groundwater system of these catchments.

The WAdss has been developed to be used in a workshop situation, allowing for analysis of a library of pre-run scenarios, sharing of scenarios between users, and creation of new scenarios live in meetings and workshops. It also allows for reports to be generated which can be accessed from outside the system. The system has been tested in workshops situations with a broad range of potential users and found to have potential for considering water allocation issues.

Development of the WAdss has involved substantial stakeholder involvement. This has been aimed at giving stakeholders a greater sense of ownership of the models, results and WAdss, by incorporating their comments and ideas into the system. It was also important for obtaining information and data necessary for ground-truthing or calibrating the models in the system and for increasing the awareness of stakeholder groups of the existence of WAdss, its potential uses and limitations.

Overall the development process of the WAdss has been successful, given the maintained engagement of stakeholders in its development and support for its continued use and development. Initial development of the WAdss is complete. The WAdss is now moving into an adoption, extension and reapplication phase. Success in this phase will depend on the maintained engagement of stakeholders, and the enthusiasm and input of researchers or other champions within Agencies or Catchment Management Authorities. With this support and adoption of the system by these groups for policy and planning processes it is hoped that the WAdss will lead to greater communication between irrigators and catchment management authorities and the development of policy options that lead to improved environmental outcomes at the least cost to production. The WAdss provides an important opportunity to incorporate the opinions and knowledge of irrigators in the water allocation decision making process and debate.

The potential of WAdss for use in other catchments and for incorporating the investigation of other issues (wetland ecology, salinity, vegetation change) is very high. WAdss has the framework and the analytic tools to examine trade-offs in these cases.