



Predicting Catchment Behaviour

Project 1.1: Development of a Catchment Modelling Toolkit

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Introduction

The Catchment Modelling Toolkit (www.toolkit.net.au) is a new and innovative direction in the arena of modelling to predict catchment behaviour. It represents a significant step forward over existing alternatives and, as it develops further over coming years, will provide an expanding set of flexible tools to support the sustainable management of Australia's land and water resources. The tools and information available from the Toolkit web site represent the accumulated advances of years of work commencing in 1999 and continuing beyond the CRC for Catchment Hydrology research activities of 2003-2006.

The application of the Toolkit concept and products to catchment management provides a flexible approach to catchment modelling. Models are created by fitting together model parts (modules) so that modelling solutions are tailored to management problems. Additionally, commonly grouped modules are developed and deployed as specific applications to meet particular industry needs. As an example of this process, a prototype whole-of-catchment modelling system, called the EMSS (Environmental Management Support System) was applied to the five Focus Catchments, primarily through the land and water management agencies who are parties to the CRC for Catchment Hydrology. Dealing with the limitations of the EMSS – such as fixed model formulations and structures – provided valuable information for the CRC in developing a suite of more flexible management tools and modelling methods.

Research focus

The Catchment Modelling Toolkit was born from extensive review and research. Over the period 2000-2002 a substantial research effort was undertaken in this project to investigate:

- the feasibility of such a concept,
- the toolkit-type approaches that existed at that time in research and application fields,
- the modelling needs of the land and water industry, and
- the kinds of software science required to make the Toolkit a success.

Traditionally, models related to the prediction of catchment behaviour have been developed to deal with specific research problems or locations, and were developed in times when modern software engineering practice was in its infancy. This resulted in a legacy of models with a high diversity of operational features (eg data formatting, time stepping, spatial structure, and parameter input), despite often strong similarities in problem focus, data requirements and output interpretation. Further, models were often developed and used without relevant protocols for





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testing and comparison, documentation, calibration and validation, and verification and peer review. Modern catchment management requires that policy development, planning and intervention be undertaken in an integrated fashion with consideration given to physical, ecological, economic and social systems. Integrated catchment modelling offers managers some support in meeting these needs, although the range of different languages, platforms, and design approaches used in existing models means that integrated modelling can not be done by simply plugging together existing models.

Benefits of a Catchment Modelling Toolkit

The solution to these problems was found to be development of a modelling Toolkit, consisting of a model development system, or 'environment', and underpinned by a methodological framework that covered not only module design and specification, but also relevant protocols for development, testing, deployment and support. A range of toolkit-style approaches with modelling environments and associated methodological frameworks have been developed over the past 10-15 years, including the Tarsier and ICMS systems used by CRC for Catchment Hydrology researchers. A benefit of these kinds of approach is that researchers and modellers can spend more time on core development, and less or no time on peripherals such as data management and visualisation. Other benefits include a common software operational paradigm and a consistent delivery approach for a suite of catchment management related software programs.

- Establishment of the Catchment Modelling Toolkit, supported by such a methodological framework, offers benefits that include
- Availability of an advanced integrated modelling environment (called TIME) to support development and deployment of the Toolkit tools;
- Provision of model design and deployment systems for ready incorporation of newly developed models into the Toolkit;
- A method for provision of a suite of models, in a readily useable format, to CRC for Catchment Hydrology parties and others;
- Development of commonly accepted protocols for effectively describing, designing, documenting and deploying new and existing models for the prediction of catchment behaviour;
- A strong conceptual structure, incorporating appropriate software engineering principles, to support the catchment prediction needs that increasingly encompass hydrological, meteorological, economic, ecological and social systems, and
- Demonstration of the ability, through use of the Toolkit, to integrate a variety of models that permit holistic analyses of catchment function and decision making across multiple issues

Outcome

Using these protocols and methodological framework, the Catchment Modelling Toolkit provided a primary vehicle for achieving the CRC for Catchment Hydrology mission; "to deliver to resource managers the capability to assess the hydrologic impact of land- use and water-management decisions at whole-of-catchment scale". Through this project, the vision and foundation for the Toolkit has been established providing direction for the integration of the CRC research activities from 2003-2006.