River and catchment restoration prioritisation tools

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Abstract

Catchment managers of all forms are increasingly required to use informed and scientifically rigorous decision making processes for river and catchment restoration activities. Decision making is required at a range of geographic scales from whole of catchment to specific sites. As the demand for funding and resources for such restoration activities is inevitably in excess of what is available, prioritization of investment and best value issues become critical needs. The eWater CRC has initiated a major program to revise and develop tools to assist these decision making processes. The tools would be suited to organizations with a wide range of responsibilities for policy, strategic planning and on-ground outcomes. Due to its diverse and integrative nature, the Restoration project has very strong links with other eWater products. Equally links with research and industry organizations outside of the eWater family are to be established and used.

Keywords

Catchment modelling, ecological prediction, natural resource management

Introduction

Natural resource management (NRM) tends to be carried out at two distinct scales: catchment or regional scale where broad priority issues for management are defined and, sub-catchment scale where hotspots are identified. From here NRM tends to be focused at a very local scale, usually a reach of stream rarely more than several hundred metres in length. This second scale is really a scale of 'doing'; the operational scale of implementing stream management. The key audiences for these two scales can also be quite different, the catchment planning scale audience is usually the agencies that fund catchment works such as federal, state, local government and regional NRM groups. The audience for the reach scale planning is usually those actually doing the work, landholders and regional NRM groups. The river and catchment restoration related products being developed by the eWater CRC are similarly designed based on the combination of the spatial scale of the problem and the operational constraints of the user (Figure 1).

Catchment planning scale
At the catchment planning scale there are two key tools under development, 1) the Catchment Planning Tool and 2) the Asset Prioritisation Tool.

Catchment Planning Tool (CPT)
At the catchment scale it is important to be able to simultaneously assess and communicate several alternative NRM scenarios that may have a range of benefits. There are several tools that do part of the job, for example, catchment modelling frameworks such as e2 (Argent *et al.*, 2005) can be used to model sediment and nutrient generation rates under alternative land uses, the ecological response modelling framework (Marsh *et al.*, in these proceedings) can be used to quantify the ecological response to flow change, expert panels can be used to assess the relative merits of different flow scenarios and tools such as multi-criteria analysis can be used for aggregate ranking of different options (Figure 2). The CPT will integrate all of these tools in a single interface. That is, users can define NRM scenarios, these scenarios are then delivered to a catchment model which in turn is used to predict the sediment and nutrient loads from the alternative land or alternate water use scenarios. These flow, sediment or nutrient inputs generated from the scenarios can then be automatically used to predict and compare a quantitative habitat change or ecological responses to each of the scenarios. The quantification habitat change or ecological response uses the

ecological response modelling framework. The pre-selected prioritisation and aggregation of responses as developed by an expert panel can account for the social and environmental weighting of the relative importance of a range of ecological consequences. Hence the resulting output from the CPT integrates changes in water quality and quantity predictions from whole of catchment models with quantitative models of habitat change or ecological response to allow those changes to be presented in terms of their ecological consequences. The CPT will also have provision to account for social input by providing a mechanism to weight the responses. The key advance contributed by the CPT is to bring together several natural resource management techniques in a single platform to provide an integrated picture of the likely response of individual organisms or collective groups/gilds or processes anywhere in the catchment to a specific scenario, and then to allow interactive scenario evaluation. This coupling of physical process models with ecological prediction will allow NRM agencies to explore the sensitivity of the riverine ecosystem to NRM strategies.

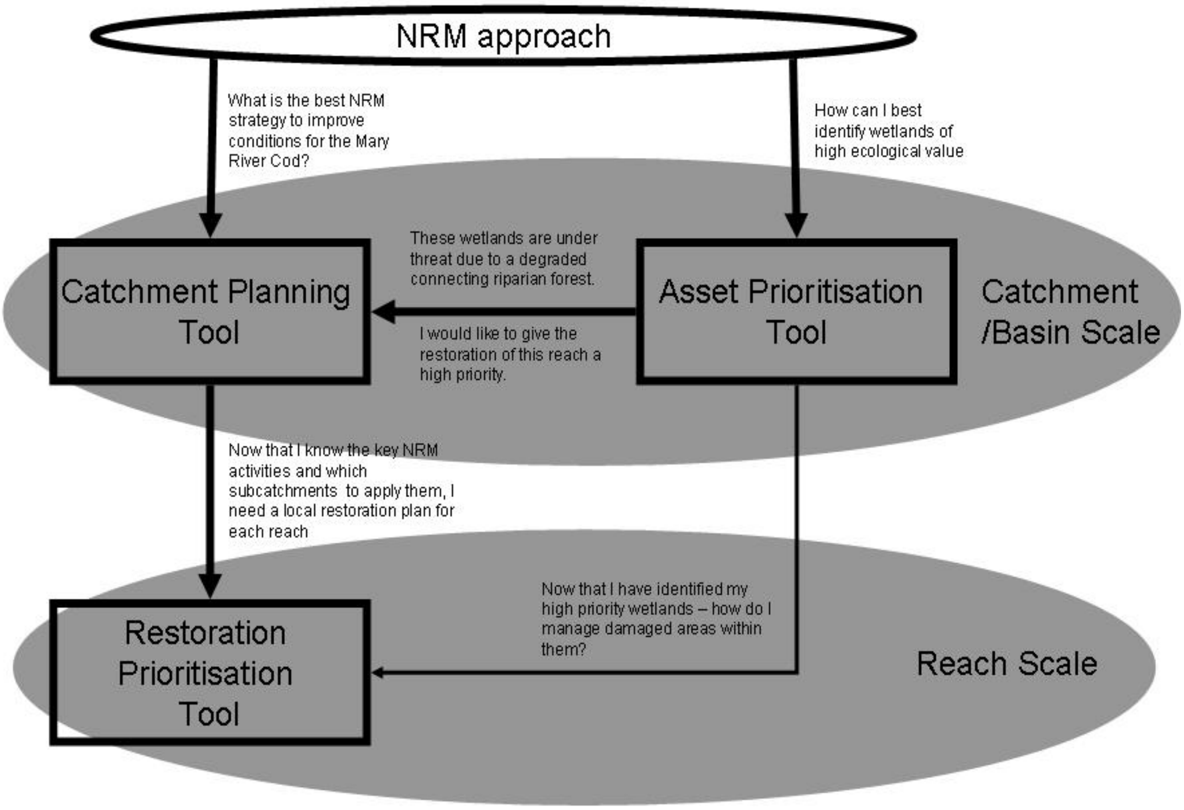

Figure 1. Three key tools of the River and Catchment Restoration program are based on spatial scale and user needs.

The CPT will use the components of the catchment modelling framework 'WaterCast' (Jordan *et al.*, in these proceedings) for modelling sediment and nutrient generation, and as such the capacity of the catchment modelling components of CPT will be upgraded with each improvement in the modelling capacity of the WaterCast framework. The WaterCast framework is developed from the e2 catchment modelling framework which allows for a range of hydrological and sediment and nutrient generation and transport models which allow a catchment model to be tailored to a specific catchment. Whilst the framework is essentially complete, only a small number of sediment and nutrient generation and routing models are currently published within the framework. More sophisticated sediment and nutrient generation and routing models are being developed by eWater CRC for inclusion within WaterCast (Jordan *et al.*, in these proceedings).

The CPT will use the ecological response modelling (ERM) framework for ecological prediction. This framework is based on a database of quantitative models used to predict ecological responses or habitat change to different NRM and flow strategies. For example, a NRM scenario that results in a dramatic decrease in downstream delivery of sediment as predicted by WaterCast may have a positive impact on the potential habitat area available for benthic organisms that live in coarse grained substrate because the smothering effect of fine sediment has been reduced. The ERM framework can currently use rating curve or habitat preference curve models and any numerical formula for predicting ecological response and it is being expanded under the eWater program to include the capacity to handle more complicated network style modelling approaches such as Artificial Neural Network and Bayesian belief Network modelling approaches. Hence the ecological prediction capabilities of the CPT will not be limited by the program's capacity to handle complex and novel understandings of ecological process. We currently have a robust understanding of many critical ecosystem processes but there is no clear mechanism to connect this understanding with physical process models other than on an ad hoc basis. The CPT will provide the capacity to complete the NRM process by linking land and water management directly with ecological consequence.

A complication of being able to simultaneously compute the ecological consequences for many organisms or processes using a range of alternate modelling techniques creates a problem of how to summarise this wealth of information into a form that can be used effectively fro NRM. The RiVERS tool developed by the Victorian Department of Sustainability and Environment will be investigated in respect to providing the basis for the integration interface.

The key focus of the CPT will be the interface development, especially the ability to visualise the relative merits of alternative scenarios, this will be in the form of catchment based maps with users able to interactively visualise the spatial influence of different prioritisation activities.

As well as being able to run different NRM and water management scenarios, the CPT will permit the storage of spatial information, in this way it will be a useful GIS style tool for storing and accessing information. These layers of spatial information will be an integral component of a key module of the CPT, the Asset Prioritisation Tool (APT).

Asset Prioritisation Tool (APT)

The APT aims to optimise investments or water allocations given a set of targets for ecological assets. This can either be achieved by getting protection targets or to allocate rehabilitation measures. These two areas overlap and will share some data layers; rehabilitation works may be designed such that they support high value conservation areas that may be under threat from degrading processes. An example could be a high value conservation area in the estuary as identified by the Asset Prioritisation Tool. Under the Catchment Planning Tool, rehabilitation activities in the upper catchment may be designed with a high priority given to reducing sediment and nutrient loads to the estuary effectively protecting the high value asset.

The early version of the Asset Prioritisation Tool will not have a time stepping capability, but it will have the capacity for users to consider alternate scenarios. The APT combines spatial layers deemed relevant to defining areas of high conservation value. For example the layers may include wetland areas greater than 0.5 ha, reaches of stream where flow modification is less than a 30% change from natural and a spatial layer of weed distribution. After setting protection (asset) targets (i.e. 'protect all 15 native fish species in the region' or 'include 10% of each wetland type') , the Asset Prioritisation Tool can guide the user through the combination of these layers to produce output layers of high conservation value areas, and areas which are at risk. By combining the APT and CPT tools, NRM managers can optimise investments for maintaining or restoring ecological assets.

The APT is based on using the available spatial data to allocate three basic values to each parcel of land:

- Irreplaceability: What is the conservation value of the river and its catchment and the organisms and habitats within?
- Condition: What is the condition of the catchment (in broad scale terms)?
- Vulnerability: How is the condition likely to change without intervention?

The APT is being designed with a focus on aquatic biodiversity assets, but the principles could be applied to other assets.

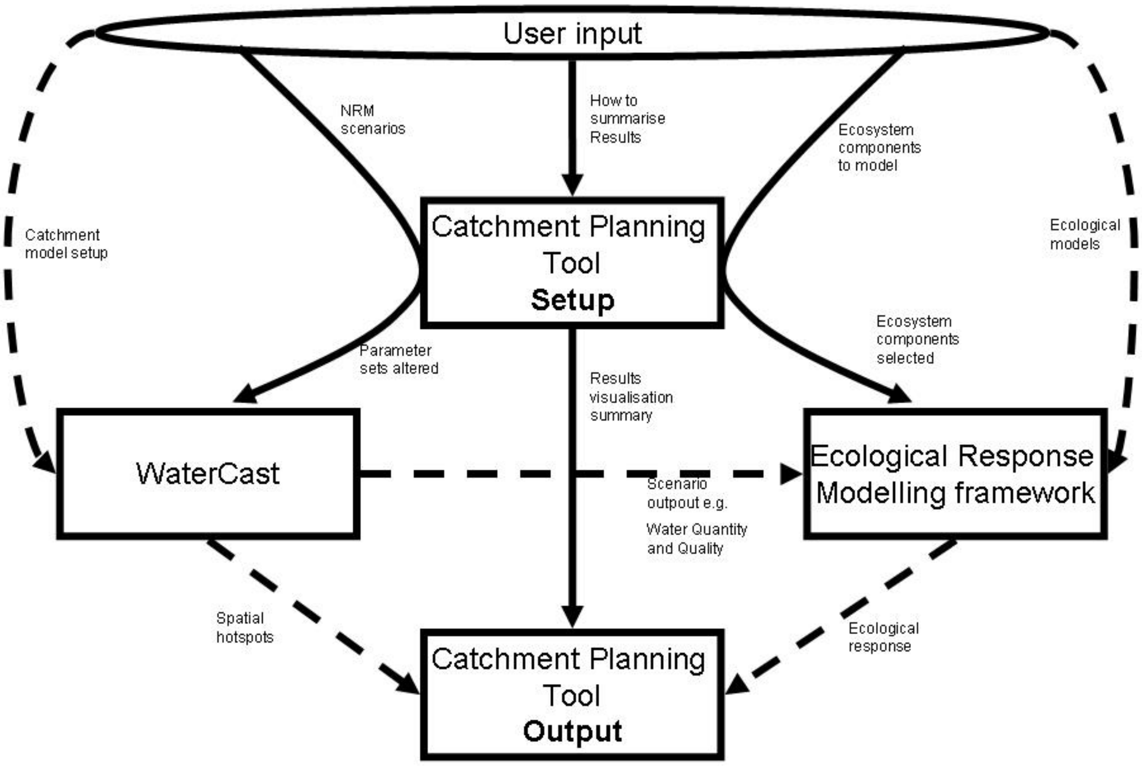

Figure 2. The Catchment Planning Tool integrates across existing tools.

Restoration Prioritisation Tool (RPT)
Once broad scale catchment planing has been established through the CPT and APT, the task of implementing on ground works to realise the value of NRM investments requires a different set of tools. The RPT is to be used by those who design and implement restoration programs, for example the technical staff of NRM organisations and potentially the trained members of community groups that are charged with prioritising and implementing restoration activities. The RPT would be used as a means of evaluating the specific placement of conservation and restoration activities on a reach and property scale.

The first area of the RPT to be developed will be the technical support repository. There is an enormous volume of technical guidance material available for NRM. There are many local, state, regional and international stream management handbooks and guidelines (e.g. Heaton *et al.,* 2002, FISRWG, 1998, Bennett, *et al.,* 2002, Brooks *et al.,* 2006, Rutherfurd *et al.,* 2000, Dixon *et al.,* 2006). The key challenge for RPT is to provide a mechanism to deliver this valuable information to the stream practitioners. This group is often characterised by enthusiastic landholders that do not necessarily have an extensive background in stream management and are unfamiliar with previous literature or networks of experience. Rather than generate another technical manual of how to undertake on-ground works, the RPT will focus on delivering this knowledge base of existing information. This will essentially be a compilation of existing content presented in an online searchable format. Once the initial structure and early version has been developed, the authors of additional information can simply contribute it to the knowledge base. The intent here is a growing electronic repository to of literature, guidelines, manuals, case studies, tools, stories, restoration strategies, tips and tricks. The knowledge base would provide detailed information for the construction of instream works such as fish habitat structures, erosion control techniques, revegetation techniques, fencing and off-stream water alternatives.

A second subsequent area that may be developed within the RPT is in the area of Environmental Water Allocation decision support. There are several initiatives currently underway in this area, and the CPT will also provide some guidance in this area. Hence a review of the needs and capacity in the environmental water decision support will be undertaken midway through the project.

Conclusion

The Portfolio of tools being developed by eWater CRC under the River and Catchment Restoration portfolio will build on existing resources and help to present the content of those existing resources in a manner that is more operationally useful for CRC partner organisations. There is a great deal of stream restoration expertise and published information available locally and internationally. This program hopes to support the continued development of the stream restoration field by developing more effective mechanisms to deliver the available knowledge to partner organisations.

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