River Restoration

Project 6.7: Developing an Environmental Flow Methodology

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Introduction

Increased understanding of the ecological importance of temporal environmental variation has led to a concern that many regulated rivers lack the natural variations in flow required to maintain pre-regulation communities. Many of the existing environmental flow methods fail to adequately address this concern.

Project objectives

This project developed a new approach to characterising flow variations for environmental flow studies using knowledge of the influence of flow events on biological and geomorphic processes. This approach has the advantage that ecological benefits of the environmental flow are clearly articulated, available knowledge is included in the development of flow recommendations and the method accounts for the natural dynamism in flow-related ecosystem processes by using the natural flow regime as a template for the environmental flow regime.

Project outcomes

The primary output from this project is the Flow Events Method for evaluating alternate environmental flow management scenarios. The project also investigated strategies for sampling hydraulic habitat in rivers. Hydraulic surveys are an integral component of many environmental flow and habitat studies. Yet despite their importance, there is rarely any consideration given to the number or location of cross-sections required to adequately sample conditions at the various spatial scales from reach to catchment. This work provided evidence that use of a sub-sample from a length of stream, namely a representative reach, is a valid approach to field sampling with the capacity to represent hydraulic variability of the stream length to a reasonable degree of statistical accuracy (α=5%).

A procedure for establishing the number of cross-sections required to represent variability within a sub-reach was also developed. Variability at a catchment-scale was explored, using an alternative method that treats the stream as a continuous function. It was shown that for 10km lengths of stream, that interval sampling from a continuous function had potential to improve upon current approaches to either inferring or sampling hydraulic conditions at the catchment scale.

Whilst sampling strategies will address the need to capture longitudinal variability in hydraulic habitat conditions, hydraulic models are required to represent variations in hydraulic conditions

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with discharge. In some studies, insufficient data is available to apply the traditional approach of using one dimensional backwater calculations. An alternative is to use at-a-station hydraulic geometry relations. At-a-station models commonly take the form of power-law functions relating surface width, mean depth or mean velocity at a single cross-section to discharge and model parameters are fitted to observations of these hydraulic variables at two or more discharges. In habitat studies, the distribution of hydraulic parameters over a reach may be of more interest than values at a single cross-section. This project examined reach hydraulic geometry models for the average and coefficient of variation of seven cross-sectional hydraulic properties. Hydraulic geometry parameters were fitted for 17 stream reaches. Using these fitted parameters, a model was developed to predict reach hydraulic geometry parameters from a single reach survey. This model could provide a useful tool for examining variations in hydraulic characteristics between reaches throughout a catchment or region.

Whilst many studies have investigated methods for determining environmental flow requirements, few have investigated how these environmental flows should be delivered. Linking environmental flow dam release rules to environmental variables has potential to link the flow variability of a regulated stream to the environmental forces acting on the catchment. In this project, a technique was developed to examine a range of release rules related to tributary inflows and rainfall, and optimise these with respect to total water release volumes and other criteria. In particular, the use of gauged tributary inflows as a trigger for release events was investigated. A hydrological model, which represented dam release rules, was run for a range of rule parameters, within a parameter space. The results showed that multiple strategies may be capable of achieving environmental flow targets but that some of these may be more robust in the face of climate variability than others. Significant water savings can result from the use of the technique. The technique was applied to environmental flows targets in the Thomson River catchment, Victoria.

Application of the research

The Flow Events Method has been applied in the following Victorian rivers under contract to Department of Sustainability and Environment,Victoria:

- Broken River
- Loddon River
- Thomson River
- Goulburn River

These applications were carried out in collaboration with the CRC for Freshwater Ecology, EarthTech Pty Ltd and other consultants. The method proved effective in providing a defensible environmental flow assessment which was accepted by community and management groups. The method is now included as part of the Victorian statewide method. The results of the Goulburn River environmental flow study will be used in the development of an environmental flow module for the Goulburn Development Project during 2005.

This project also provided an analysis of unseasonal surplus flows in the Barmah-Millewa Forest. Increased flexibility in the operation of the water system was investigated as a tool to reduce the likelihood of unseasonal surplus flows. The project team also investigated efficient operating rules for water resources systems to meet environmental targets in the Thomson River and Lerderderg River.

This research is being extended in the current CRC for Catchment Hydrology projects (2003-2006) with the development of the River Analysis Package (RAP) which can be used to apply the Flow Events Method (see www.toolkit.net.au/rap). Flow-ecology models used in environmental flow studies are being evaluated as part of a joint project between the CRCs for Catchment Hydrology and Freshwater Ecology (see www.catchment.crc.org.au/riverrestoration).

For further information

A report on environmental flow analysis based on this research project will be published by the CRC for Catchment Hydrology during 2004. The Flow Events Method is described in:

Stewardson, M.J. and Gippel, C.J. (2003). Incorporating flow variability into environmental flow regimes using the flow events method. River Research and Applications 19: 459-472.

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Other publications produced as part of this project are:

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