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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Water & environment

Evaluating aquatic ecosystem services

A manual and framework to evaluate aquatic ecosystem services has successfully been developed through support from the WRC.

Support for the evaluation of aquatic ecosystems services

A new product in the form of a Framework and Manual has been developed to guide practitioners in the evaluation of aquatic ecosystem services. Such an evaluation is needed to establish Resource Directed Measures (RDM) for the protection of water resources in any Water Management Area (WMA) or subsidiary catchment. The product integrates a complex set of disciplines, approaches and methods and is documented in four parts.

Part 1 provides an introduction to and overview of the Framework and Part 2 focuses on the Manual itself. Parts 3 and 4 complement the first two by, respectively, reporting on case studies involving the use of the product and providing supplementary information that serves as a background to the approaches employed.

Evaluation of ecosystems services in the context of RDM

The crux of the RDM, and the basis of water resource management in South Africa, is the determination of a Management Class (MC) which prescribes what the quality and overall health of the water resource should be. MCs are determined using the Water Resource Classification System (WRCS), which classifies water resources in terms of Class I (Minimally used), Class II (Moderately used) and Class III (Heavily used). Based on the MC for each significant water resource, the Reserve and the resource quality objectives (RQOs) for that water resource are prescribed.

A water resource invariably produces a bundle of aquatic ecosystem services. Such services could include fresh water, water purification, natural hazard alleviation, aesthetic services and several others. When a MC changes (usually as a result of policy implementation or implementation of a water use project), it is likely that the bundle of aquatic ecosystem services would also change, with some benefits increasing and other benefits decreasing.

Benefits vary depending on the nature of the resource and the nature of its use; ecosystem services provided will, therefore, vary from case to case. Such variations in benefits would affect various beneficiary groups and produce a number of trade-offs.

The WRCS outlines the implications of different MCs, which are linked to specific water resource management scenarios in the case of specific resources, thus facilitating informed decision-making about trade-offs.

The Framework and Manual explore how these scenarios, and their associated trade-offs, should be evaluated.

The Framework and Manual

A key consideration in the development of the Framework has been integration with other existing frameworks, approaches and methodologies in the RDM domain and related disciplines. This helps to prevent duplication of effort, minimises the development of new and complex approaches and methodologies, and integrates with existing analyses and processes. Features of the Framework are the adoption of best practices with regard to Reserve determination and WRCS processes, the definition and classification of ecosystem services, and the focus on economic valuation (including environmental economic valuation).

Addressing the problem of linking the ecological classification of a resource (which follows from the Reserve

determination and WRCS processes) and the economic value of its ecosystem services has led to the adoption of the following key approaches:

- An ***ecosystem approach***, involving application of the Millennium Ecosystems Assessment (MA) framework for defining the benefits (i.e. ecosystem services) yielded by the ecosystem; and
- A ***comparative risk assessment (CRA) methodology*** to develop the causal chains linking ecological production to the defined ecosystem services.

Inherent in the ***ecosystem approach*** is the understanding that socio-ecological systems are complex and dynamic. Management interventions would thus be based on incomplete knowledge or understanding of ecosystem functioning, have unforeseen feedbacks over the long term, be insufficient for coping with continuous change and future shocks, and be unable to account for all the social, economic and ecological influences at multiple scales.

Methodologies that take all these characteristics of socio-ecological systems into account (such as ***comparative risk assessment***) hold greater potential for identifying and adapting management approaches that increase a system's resilience and adaptive capacity and set the system on a more sustainable trajectory.

The Framework for the evaluation of ecosystem services

By following the four-phased approach described below, the Framework accommodates the above considerations in a logical way and ensures a systematic means of evaluating the changes in ecological category of aquatic ecosystems that result from different water management scenarios.

Phase 1, the systems analysis, defines the system that is subject to enquiry, assembles all relevant and valid scientific information about the system, and describes the management scenarios which provide the options for water resources management and water infrastructure operations.

Phase 2, the assessment of ecological change, initially takes place in a workshop environment, where domain experts evaluate the agreed-upon scenarios in terms of their feasibility and reach agreement on the scenarios being reasonable and suitably different to allow a range of management options and consequences to be explored.

Chains of causality that exist between ecosystem assets (and the drivers that impact upon them) and ecosystem services (and the benefits derived from them) are defined and quantified through the selection and measurement of appropriate indicators. These chains of causality then form the bases for the development of production functions for each ecosystem service.

Phase 3, valuation of ecosystem services, integrates the production functions developed in Phase 2 into socio-economic demand functions. The wide variety of valuation techniques that exist for estimating demand are discussed in detail in the associated Manual.

Phase 4, the evaluation of trade-offs, compares the different water resource management scenarios using the combined outputs of Phases 2 and 3. The set of trade-offs of costs and benefits associated with the different scenarios are evaluated through cost-benefit analyses (CBA). The CBA informs two types of decision-making: (a) whether a particular scenario is worthy of being pursued; and (b) where more than one scenario option is available, which of these are the more beneficial. A particular management scenario or activity is worthwhile if the net present social value is positive. The more beneficial options have higher net present social values.

The Manual for valuing ecosystem services

The Manual describes the detailed tasks within each phase of the Framework. It is based on best scientific knowledge reported in recent national and international literature and gives full consideration to the complex adaptive social-ecological systems that deliver ecosystem services. It proposes comparative risk assessment as a useful tool in prioritising risks to ecosystem service provision, and as a means of scaling down to the requisite simplicity.

Available methodologies and techniques are evaluated in an objective manner and in recognition of the process being a stepping stone in the continued pathway of learning around ecosystem service valuation. The Manual also adopts a pragmatic approach which encourages practitioners in learning and adaptive analyses. Finally, it considers the aquatic ecosystem services benefits accruing to all beneficiaries, while accommodating a public participation process.

Conclusion

The Framework and Manual can be used with any assessment of ecosystem services in all aquatic ecosystems (i.e. in rivers, wetlands, groundwater, estuaries or marine environments). This research product serves to support the WRCS and provides guidance on the integration of the current Reserve determination process with the WRCS. It also

provides a causal description and understanding of aquatic ecosystems, the ecosystem services they support and the effects of water resource management on these.

It clarifies the valuation of ecosystem services delivered by aquatic ecosystems for RDM and provides for best practice whilst avoiding being overly prescriptive. In addition, the Manual allows for desktop, rapid, intermediate or comprehensive studies that are consistent with the requirements of the WRCS.

It has to be recognised that every water management scenario, applied to different river systems, will have unique environmental effects which have to be quantified in a diligent manner, following the guidelines of this Framework and Manual.

Through the development of this Framework and Manual, a number of opportunities worthy of further exploration have been identified.

These include:

- Collation of evidence of the linkages between biodiversity, ecosystem change and ecosystem service delivery, that are specific, or applicable, to southern African aquatic ecosystems. This would provide a source of information for production functions and models of ecosystems services with different levels of complexity for different levels of Reserve determination.
- Exploration of risk terminology as a basis for dialogue in the management of the allocation and use of water resources. Such research would develop insights into the strategic management of dialogue in complex decision-making contexts and the importance of this for sustaining water resources in a dynamic and uncertain global environment.
- Linking of aquatic ecosystem services evaluation with collateral decisions in the domains of biodiversity and land management. This would offer efficiency gains through minimising redundancy in the evaluations as well as supporting necessary meta-analysis.

As the WRCS is implemented, one would expect trade-offs to be continually changing. The Framework proposed here has to be continually assessed and improved, where necessary, to adapt to the changing environment.

Further reading:
To obtain the report, ***Framework and manual for the evaluation of aquatic ecosystems services for the resource directed measures*** (**WRC Report No. TT 462/10**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.