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Review Article

Integrated management of large rivers and their basins

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ABSTRACT

It has become standard practice to refer to any management of rivers and their basins as "integrated". The development and use of the concept reflects a growing appreciation of the complexity of river basins as hydrological, ecological, economic, political and social systems. However, the term "integrated management" is used vaguely, and, although the need for a management approach which considers more than a narrow focus on hydrology or economics is widely recognized, there has been concern that the term is often used as camouflage in an attempt of gain acceptance or funding for a narrowly based project. There has also been discussion about the applicability of river basins as planning units, given that large basins rarely coincide with political units, and the role of, and need for, river basin management organizations. It is clear that the management of water resources and environmental resources generally requires consideration of a broad and increasing range of factors and input from a much wider range of stakeholders than was generally recognized in the past, and a lack of shared objectives as well as both technical and governance challenges inhibit integrated management in many basins. Progress towards integrated management is patchy and it will not be achieved in a single step. Where programs are integrated in name only, that is evidence of incremental progress and even small steps bring benefits.

1. Introduction

The literature on integrated environmental management and rivers is voluminous and the concept has been discussed under a number of different descriptive titles. They include Integrated River Management (IRM) (e.g. Smith et al., 1994), Integrated River Basin Management (IRBM) (e.g. Biswas and Tortajada, 2001; Downs et al., 1991; Kirby and White, 1994), Integrated Water Resources Management (IWRM) (e.g. Biswas et al., 2005; Lenton and Muller, 2009; Lubell and Edelenbos, 2013), Integrated Catchment Management (ICM)(e.g. William, undated), Integrated Watershed Management (IWM) (e.g. Heathcote, 1998), Integrated River Basin Governance (e.g. Hooper, 2005) and Integrated Natural Resource Management (e.g. Campbell and Sayer, 2003). The terminology differs slightly depending on the nationality and specific focus of the author, but they are all addressing a similar set of issues: the need for land and water managers to address a broad set of crosslinked issues and stakeholders. Barrow (1998) produced a classification of approaches under the descriptor "river basin planning and management" which distinguished between single purpose, dual purpose, multipurpose, comprehensive, integrated and holistic approaches.

1.1. Conceptual basis for integrated management

The establishment of the Tennessee Valley Authority (TVA) in 1933 was a clear first attempt at integrated river basin management, aiming at utilizing water resources for social and economic ends (Callahan, 1980). There has been extensive discussion of the TVA model (e.g. Newson 1992;

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Ekbladh, 2002), including debate about the success of the organization in the US (Ezzell, 2002), the political appropriateness of this type of federal involvement in states and the extent to which the model can or should be exported to developing or other developed countries (Newson 1992, Miller and Hirsch, 2003).

The earliest explicit conceptualizations of integrated management were those included in multi-objective planning for water resources in the 1970s (Cohon and Marks, 1973, 1975; USWRC, 1975a,b; Major, 1977). They constituted the first attempt to explicitly consider social, environmental objectives as well as economic objectives in a water resource management framework. The United Nations Water Conference in 1977 identified a wide range of water resources management issues of concern, and developed an action plan which identified the need for real coordination amongst all bodies responsible for investigation, development and management of water resources and suggested that it "may be desirable that provisions concerning water resources management, conservation and protection against pollution be combined in a unitary legal instrument" (Biswas, 1978). The claim by Biswas (2004) that the action plan included integrated water resources management however, is not correct.

Integrated management began to be more broadly recognized and discussed following the Dublin conference which produced a statement (Dublin Statement, 2002) that influenced the subsequent Agenda 21 document produced by the United Nations Conference on Environment and Development held in Rio later the same year (Agenda 21, 2002). The Dublin statement identified four principles: freshwater is (i) a finite and vulnerable resource, essential to sustain life, development and the environment; (ii) water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; (iii) women play a central part in the provision, management and safeguarding of water; and (iv) water has an economic value in all its competing uses and should be recognized as an economic good.

The Rio conference explained integrated water resource management as follows: "Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilization. To this end, water resources have to be protected, taking into account the functioning of aquatic ecosystems and the perenniality of the resource, in order to satisfy and reconcile needs for water in human activities. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems." (Agenda 21, 2002).

The conference identified four principles of which the first is the key in the context of this Journal Issue:

- To promote a dynamic, interactive, iterative and multi-sectoral approach to water resources management, including the identification and protection of potential sources of freshwater supply, that integrates technological, socio-economic, environmental and human health considerations;

The Global Water Partnership published the following definition of Integrated Water Resources Management in 2000: "IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000). This definition has been widely adopted by other agencies (e.g. MRC, 2013). However, the document containing the definition was prepared by a panel of prominent engineers and hydrologists and is ambiguous with respect to ecosystems. It should be interpreted to mean that water resources development should not compromise the sustainability of ecosystems, because they are vital. However, it appears from the discussion in the document that the panel meant that "vital" ecosystems, as distinct from "non-vital" ecosystems, should not be compromised (GWP, 2000). How vital and non-vital ecosystems could be distinguished is not discussed. Biswas (2004) has been quite critical of the definition, arguing that it has little practical resonance.

The concept of integrated management is now widely accepted, and most river basin organizations now explicitly or implicitly incorporate some form of integrated management as a part of their goals. In many countries river basin organizations have been, or are being, established explicitly to address the need for integrated management.

2. Drivers for integrated management

The development of integrated management of rivers and their catchments reflects the increasing human pressure on rivers as well as the growth of technical understanding of how rivers and their catchments work. There has also been a great deal of attention and thought devoted to natural resource governance (e.g. Hooper, 2005; Molle et al., 2009) partly as a response to the need to manage at a range of scales and across jurisdictional boundaries.

2.1. Populations and pressures

When human populations or human demands are small relative to the water or water-based resource, there is little need for management. However, as the demand grows, either because population is growing or because the harvesting or use per capita is increasing, competition and conflicts begin to arise. The first management driver for a river is often a need to manage a particular aspect of the resource. It may be a need to manage a fishery – initially locally and later on a larger scale. It may be a need to manage navigation – to avoid collisions or unsafe shipping, or channel management through markers or dredging. It may be a need to manage water quality, or water extraction.

As population and demand grows there is an increasing need to manage across sectors. A single farmer pumping water for a small crop may have little impact on other river users. However, as the number of farmers, and the area to be irrigated grows, those wanting to extract water for

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