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River basin organization performance indicators: application to the Delaware River basin commission

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Abstract

This paper reports the development of performance indicators of a river basin management organization's ability to undertake integrated water resources management, and applies them to a US basin organization: a river basin commission. Integrated water resources management (IWRM) and integrated river basin management (IRBM) are defined, in the context of international and US advances in IWRM and IRBM. A suite of good governance factors was assembled from the reviews of consultants' practical experiences in river basin management, peer-reviewed literature, government reports and policy statements, and reports of river basin management practice. A list of impediments to the implementation of IRBM was also assembled. These sources were used as the data set to develop 115 indicators of best practice in IRBM; these indicators were grouped into ten categories: coordinated decision-making, responsive decision-making, goals and goal shift, financial sustainability, organizational design, role of law, training and capacity building, information and research, accountability and monitoring, private and public sector roles. This paper reports the results of a facilitated workshop with the Delaware River Basin Commission's staff and stakeholders to apply the indicators to their setting. The outcome of the workshop was a self-assessment tool for performance evaluation, involving triaging the basin organization situation, checking performance against 20 performance benchmarks and using 63 performance indicators for basin commission settings. The paper concludes with a discussion of the issues surrounding the application of the performance indicators to other US basins and commissions.

Keywords: Integrated river basin management; Integrated water resources management; Performance indicators; River basin organizations

1. Introduction

1.1. Purpose and structure

This paper reports the development of indicators of IWRM performance by river basin organizations (RBOs). The indicators refer to several aspects of decision-making about natural resources management

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across different scales (whole of basin and sub-basins). The indicators also act as signposts for effective basin management, guiding RBOs towards more effective management.

The IWRM performance indicators were developed to provide RBOs with tangible measures of management effectiveness, based on international best practice. The indicators were derived from the opinions of experts engaged in professional practice of water resources management and from peer-reviewed literature. The methods used to derive the indicators are discussed in more detail below.

This paper begins by reviewing international experiences in IWRM and IRBM, including historical and recent US experiences in river basin management, to provide a context for the application of generic indicators to a specific American RBO. The paper then describes the methods used to develop and apply key performance indicators(KPIs) of IWRM to a US river basin organization (the Delaware River Basin Commission), and concludes by examining constraints and opportunities to apply the indicators to this and other US basin organizations and basin initiatives.

1.2. Integrated water resources management and integrated river basin management

IWRM is an approach to water resources management which uses an adaptive, coordinated approach to decision-making about natural resources management. It is cross-sectoral, inclusive and participatory, seeking broad stakeholder involvement in decisions about the management, development and use of water management, to achieve multiple purposes; it is a preferred method of implementing ecologically sustainable development based on the Dublin principles of water management (Global Water Partnership Technical Advisory Committee, 2000). IWRM is strategic, focusing on what needs to be done first, rather than on the use of all-embracing efforts (Mitchell, 1987).

Several conceptualizations of the integrated approach have been articulated and they focus on collaborative, interactive processes amongst stakeholders for strategic decision-making (Mitchell, 1987; Born & Sonzogni, 1995; Viessman, 1996; Grigg, 1998; Margerum & Born, 2002). In the water sector, the concepts of IWRM and IRBM continue to be refined; they have been widely endorsed by agencies, academics and not for profit organizations (Burton, 1986; Rogers, 1993; UNESCAP, 1995; Viessman, 1996; Stakhiv, 1999; Global Water Partnership Technical Advisory Committee, 2000; Born & Genskow, 2001; Cardwell *et al.*, 2004; Hooper, 2005).

IWRM evolved from seminal work in flood management (White, 1970) and in local land and water management in watersheds and river basin management in the 1970s and 1980s (Shih & Meier, 1972; Allee *et al.*, 1975; Mitchell, 1980; Lang, 1986). While it is not a new concept, recent conceptual refinements have clarified the approach and promoted it internationally (Global Water Partnership Technical Advisory Committee, 2000; Jønch-Clausen & Fugl, 2001). Mitchell & Hollick (1993) considered five 'building blocks' form the framework for integrated land and water management (Box 1). Bellamy *et al.* (1999) recognised processes based on the integration of community involvement, technical knowledge, and organizational structure and policy objectives. These processes were echoed by Viessman (1996) who observed that though some state-based water planning in the US is based on integrated approaches, no system exists to guarantee it will occur. Grigg (1998) recognized five dimensions of process which are needed to implement IWRM: dealing with competing uses, addressing local and regional concerns, balancing water quality and quantity, coordinating intergovernmental concerns, and maintaining coordination.

IRBM is a subset of IWRM: it is IWRM at the basin scale and is defined in many ways, according to the purpose and context. One definition which captures the focus of collaborative management is:

Box 1. Building blocks of integrated land and water resources management (Adapted from Mitchell & Hollick (1993)).

1. **Use of a Systems Approach** in which attention is directed towards both natural and human systems, their component parts, and the interrelationships among those parts.
2. **Use of a Strategic Approach** in which attention is directed to key, not all, issues and variables identified through consultation with stakeholders and to linkages among the key issues and variables.
3. **Use of a Stakeholder Approach** in which it is recognized that citizens and non-government groups should be able to participate in decisions about resource management
4. **Use of a Partnership Approach** in which state governments, local governments, and non-government organizations and individuals each have a role, requiring common objective setting, definition of roles and responsibilities, and conflict resolution mechanisms.
5. **Use of a Balanced Approach** in which concerns for economic development are weighed against ecosystem protection, and satisfying social norms and values.

'an integrated and coordinated approach to the planning and management of natural resources of a river basin, one that encourages stakeholders to consider a wide array of social and environmental interconnections, in a catchment/watershed context' (Hooper, 2005).

IRBM works by bringing together stakeholders, people who have a 'stake' (a bargaining position) in a river basin, in a process to manage collaboratively the activities and impacts or resource use. Stakeholders include government entities at national, state and local level, community organizations, environmental and indigenous peoples' groups, businesses, industry organizations, and other organizations and individuals with a water interest. Other definitions of IRBM emphasize water resources planning procedures and poverty reduction, such as that of (Barrow, 1998) who argued that river basin management plans, if they used an IWRM approach, used decisions to maximize water use efficiency as one of the primary goals of water resources management. The aim was to improved livelihoods and sustaining water use for future generations. This goal is prescriptive but not necessarily that of all basin organizations nor settings.

There is now widespread international use of IWRM, evidenced in many water organizations (Box 2, available online at http://www.iwaponline.com/wp/111.pdf).

There is disagreement of what both IWRM and IRBM mean, with criticisms of the prevailing Eurocentric approach in some of the international initiatives listed in Box 2 (available online at http://www.iwaponline.com/wp/111.pdf) which emphasize process above substance. Delli Priscoli, for example, writes:

"If IWRM, as expressed by GWP means environment, then they should say so more clearly. I have asked questions, such as … Was the Tennessee Valley Authority an example of IWRM? Is the Columbia Basin an example of IWRM? Are the 308 Master Plans authorized in the 1920s and undertaken on every major river in the US over 60 years—IWRM. What is the relation between IWRM and Master Plans? Can you talk of IWRM without talking about dams and storage? Can you talk of

IWRM and its contribution to development, wealth generation and growth, without talking about dams and structures?"

(Priscoli, 2006; a fuller version of this quote is available online at http://www.iwaponline.com/wp/111.pdf)

There is also a growing distinction between what IWRM means in the South and what it means in the North (Global Water Partnership Technical Advisory Committee, 2000; Pigram, 2001; Shah *et al.*, 2004; Schulze, 2007), although the distinction is more difficult to distinguish in emerging economies. There are fundamental differences in governance, hydrology, demography and levels of economic development and capacity to manage water by governments. Pigram (2001) recognized considerable problems in importing the process-oriented, technical approach to water and river basin management from the North to Southern basins, and calls for stronger South–South exchange of experience and planning capability. He suggested this be done by building bridges between water managers and water-using sectors in emerging nations of the developing world, and benchmarking process of successful South–South transfers.

Despite these differences, IWRM practical experience has evolved. While many studies emphasize the high degree of complexity of decision-making required for effective management, others focus on ongoing problems with conceptualization and definition, while others still emphasize the organizational and behavioral constraints and the importance of institutional context to implementation (Blackmore, 1993; Van Zyl, 1995; Hooper, 1997; Jønch-Clausen & Fugl, 2001; Global Water Partnership, 2003; Stakhiv, 2003; Cardwell *et al.*, 2004; Grigg, 2008).

River basins and groundwater provinces are logical applications of IWRM over large regions due to the interrelationships between surface water and groundwater resources, and between human needs and ecosystem functioning. There is considerable justification both in the US and in international arenas for the support of river basins as the operational focus of IWRM (Priscoli, 1976; Schilling, 1998; Turton *et al.*, 2001; Anonymous, 2002; Cassar, 2003; Priscoli, 2005). For example, 'IWRM and the Basin Management Theme,' an agreement reached at the 3rd World Water Forum in Kyoto, Japan, in 2003, stated that:

"the key issue confronting most countries today is that of effective governance, improved capacity and adequate financing to address the increasing challenge of satisfying human and environmental requirements for water. We face a governance crisis, rather than a water crisis. Water governance is about putting IWRM with river and lake basin management and public participation as critically important elements, into practice" (Anonymous, 2003).

Two international agreements use an integrated approach at the basin level. The Helsinki Convention on Transboundary Watercourses and International Lakes (Council of the European Union, 1995) established a strong institutional framework for international agreements on river basin management, by means of bilateral and multilateral agreements for the introduction of harmonized policies, programs and strategies to protect transboundary waters. Similarly, the European Water Framework Directive recognized river basins as the locus for implementing the Directive (Chave, 2001). Both initiatives embed the integrated approach in national programs of natural resources management.

The integrated approach to basin management is fraught with difficulties—limited political support, challenges in international collaboration, complex governance, the application of technologies,

information exchange, and vacillating degrees of funding. This complex meta-problem (Box 3, available online at http://www.iwaponline.com/wp/111.pdf) is similar to that of US watershed management as characterized by Naiman (1992). There are significant constraints to implementation, resulting in calls for improving and expanding knowledge of the IWRM approach using adaptive management techniques involving collaboration, risk assessment and risk management (Lee, 1993; Sabatier *et al.*, 2005; Hooper & Lant, 2007).

Experiences in IWRM and IRBM beyond the USA are varied. In South Africa, a major effort in water sector reform commenced in 1994 to address previous inequities and provision of freshwater, with the introduction of the National Water Act (1998). Since then, there have been concerns that the far reaching legislation of the National Water Act was too ambitious, due in part to different interpretations of what is meant by IWRM (Ashton *et al.*, 2006). The integrated approach is encapsulated in the Act, one which enables an institutional environment to enable integrated catchment management. The experience illustrates the unique way in which South Africa addresses key issues facing emerging economies, including rural water supply problems (beyond mainstem river discharge management), water poverty (provision of potable water) and international impacts of climate change in emerging economies (Schulze, 2007). Yet there are concerns that despite positive progress in early efforts, much remains to be done, including the need for increasing awareness, translating motivation into action with a focus on 'people-centred' management and environmental sustainability, political commitment, and a need for leaders to champions an integrated approach (Van Zyl, 1995).

- The Australian experience precedes much of what has happened in Europe and other countries except the USA. The integrated approach was championed in Australia by Burton who first articulated this approach through catchment and floodplain management proposals in New South Wales (Burton, 1984, 1985, 1986, 1988). The early emphasis was on coordinated land and water management at the valley scale, and led to the first legislation in Australia at the state scale (New South Wales, in 1989), refocusing catchment management activities in conservation trusts in New South Wales and whole of valley floodplain management schemes in Victoria (Mitchell & Pigram, 1988; Stone, 1989). However, what is more widely known is the development of Murray–Darling basin activities with the establishment of the Murray–Darling Basin Commission in the mid-1980s. The Murray–Darling experience was built on the need to improve inter-state water sharing and address salinity problems. The cornerstone was the Natural Resources Management Strategy which enabled local action to be coupled with national and state government efforts, by harnessing 'Communities of Common Concern', which enabled the implementation of on-ground works and measures which were largely the responsibility of individuals and communities (Blackmore, 1995). This was supported by a basin-wide funding program, with about 40% of funding allocated to research and 60% to in-ground works. The overall structure for basin management (interstate commission, Community Advisory Committee, funding formulae) has been modified and adapted through time and some regard this adaptability as its strength (Kemper *et al.*, 2005). Recent Australian experience in integrated catchment management has varied with calls for coordination at the national level (AACM International & Centre for Water Policy Research, 1995), with the broad agenda of IWRM now well entrenched in government policy at both state and national levels (Hooper, 2005). Recent studies, however, suggest the integrated approach may have stalled if not failed in New South Wales, for example, by providing local water management committees with responsibility but not power to

create water-sharing plans (Bell & Park, 2006), and the inability of governments to move water reform based on IWRM into core government processes:

"In 20 years working in this field I have seldom seen any serious effort to deal with institutional blockages to major water reform. Throughout the nation there are hierarchies of town and regional planning, land, water, vegetation and estuarine management, as well as agency and local government arrangements to deal with a vista of water-related issues, many of which have been left in place over decades... As a consequence, most of these arrangements do not, and will not, simply atrophy under the assault of new reforms. There must be a conscious effort to dismantle the past at the same time as planning for the future" (Former Head, NSW Healthy Rivers Commission; Crawford, 2007).

- Asian experiences in IWRM and basin management are widespread and vary significantly from region to region. The following examples provide a limited sample of that experience and highlight some of the advances and challenges to IWRM in that extensive region. In the international Mekong Basin, the Mekong River Commission monitors water usage to ensure that actual diversions are within agreed rules for a particular project and that environmental flow obligations are being met (World Bank, 2006). Experience suggests that integration of basin water management at this large scale is fraught with problems of national agendas which frequently over-ride international collaboration, and governance subsequently ends in obfuscation or even stalemate (Chenoweth *et al.*, 2001; Hirsch & Jensen, 2006). Experience in the Tarim Basin in western China suggests progress in one Chinese province resulted from the use of updated regulations which require 'fair and reasonable' water sharing amongst economic partners, as well as a reasonable water share to protect the basin's environment, using a quota system (World Bank, 2006).

These experiences suggest the need to develop solutions *in situ*, relevant to a specific river basin setting and not imported from elsewhere, even though generic coordination principles may apply. One way to do this is to identify specific actions, institutional arrangements and procedures in existing settings which can be used to improve governance, find evidence of the use of these actions, arrangements and procedures, measure their values over time and at different scales, repeat (to authenticate) these measurements, then tie the outcomes of performance review to the improvement of the social, economic and ecological conditions of basins.

1.3. US experiences in IWRM and IRBM[1]

1.3.1. Historical background. US experience reveals a long history of federal and State water activities and basin endeavors.

River basin management techniques in the early and mid-twentieth Century were successful in delivering water supplies, navigable rivers, hydro-electricity and recreation benefits. The Progressive Movement and Conservationism (1901–1920) era, hallmarked by the symbolic conservation leadership of President Roosevelt, witnessed the rise of multi-objective planning and management of

[1] A detailed discussion of US experiences in IWRM and IRBM is available online at http://www.iwaponline.com/wp/111.pdf.

land and water resources in many US basins, focusing on river system use for hydro-electric power, navigation, flood control and irrigation. The Federal Power Commission was created in 1920 and acted as an investigation, licensing authority and manager of surplus power generated from federal dams.

During this part of the 1930s, integrated river basin planning emerged, supported by a rigorous system of economic analysis of federal water resources projects, and established by Title I of the Flood Control Act (1936). This led to widespread use of new cost-benefit analyses coupled to consideration of the social benefits resulting from economic development of regional USA.

The current situation reveals widespread local watershed management efforts rather than whole-of-basin management. Some basin management organizations, such as the Delaware River Basin Commission, remain from earlier Title II days. The rise of the local watershed as the management focus reflects the strong and widespread support for a decentralized system, from which the US arose, a system whereby States' rights and sovereignty over water was preferred to federal intervention. This suggests that grass roots watershed management may precipitate the re-emergence of basin-wide initiatives, as the need for a whole-of-basin approach is realized, although the prospects of 'cobbling together' numerous local watershed initiatives into a basin planning process would create chaos rather than efficiency. This need was recognized in US legalisation as early as the 1920s, in which a broader view of efficiency (then 'conservation') was used than that of today (Priscoli, 2006).

The current US experience demonstrates the federal and State preference for decentralization over federal control and interference. The Federal Government has become the facilitator of local action (through funding programs) while States retain strong sovereignty over water.

River basin management in the USA preceded the international developments in IWRM in the latter part of the 20th Century discussed earlier in this paper. Much has been learned from this profound and lengthy US basin experience, and procedures to improve participation by RBOs have been well articulated in the past and are now receiving renewed attention (Priscoli, 1976; AWRA, 2005). The concern is that other demands are now pressing on the land and water resources and there are increasing calls for basin management to provide resolution of current and predicted conflicts in water resources utilization, including: reconciling contradictory water policies; coordination of programs and agencies; use of water needs assessment and market-based approaches to water management; and basin-level organizations to plan, conserve and protect local waters (AWRA, 2007). Currently, new societal goals for rivers are emerging, including environmental flows, increased access to freshwater supplies and refurbishment of ageing infrastructure and shifting use from agricultural to urban use. The Missouri River Basin, for example, is one basin where these conflicts are apparent, and there are (poorly answered) calls for an adaptive approach to river basins management (National Science Council, 2002).

The challenge in the United States and elsewhere is to implement IRBM, using an adaptive approach, one that tests management options, refines those options based on past experiences and seeks and tests new alternatives. In this context, there is a need to develop indicators which measure IWRM performance.

1.4. Measuring organizational performance

There have been few attempts to identify indicators of the effectiveness of organizations who use an IWRM approach. Recent studies point to the role of organizational behavior and the use of benchmarking (Walmsley *et al.*, 2001; Makin *et al.*, 2004). They point to the need for indicators which

can be used as tools to identify the strengths and weaknesses of the management decisions of organizations, in this case natural resources management organizations. In this way, indicators act as 'signposts' to flag issues so that decision-makers can improve organizational behavior. In this study, indicators flag where effort can be made for continuous improvement in the management systems of river basins. They are also valuable diagnostics of the behavior of the institutional arrangements for basin-scale natural resources management if there is no formal river basin organization, such as a basin commission, authority or trust. The managers of river basin organizations can use indicators to help answer performance questions such as:

- what is the state and the condition of our resource management organization?
- what have we achieved with respect to our organizational objectives?
- in which directions are we heading?
- what needs to be done to improve our performance?

The paradigms of IWRM/IRBM and organizational performance, offer a framework for improving river basin governance, where the term 'governance' is taken to be the decision-making processes in river basin management across all sectors and scales. One way to improve natural resources management at the basin scale is to identify specific actions, institutional arrangements and procedures which will improve governance, find evidence of the use of these actions, arrangements and procedures, measure their values over time and at different scales, repeat these measurements, then tie the outcomes of this performance review to the improvement of the social, economic and ecological conditions of basins.

The last step is beyond the scope of this paper, but is flagged here as an area where further research is required. The result of IRBM in any basin will be reflected, at varying times and at spatial scales, in the biophysical and social and economic indicators of that basin. They are often presented in 'State of the Environment' Reports or 'Report Cards of Basin Health'. The challenge is to demonstrate the degree and extent to which these environmental conditions change as a result of actions undertaken by an RBO, specifically in its river basin management plans, strategies and programs.

2. Derivation of universal river basin organization performance indicators for IWRM

2.1. Methods

The methods used to develop performance indicators involved the use of content analysis and expert opinion to capture prior experiences from which indicators were developed. Content analysis is a technique which is used to analyze and capture the meanings of text. This was applied to publications which include best practice attributes and implementation constraints of IRBM.

In the study reported here, 'expert opinion' is recognized as a critical element in the knowledge of good practice. This technique, capturing excellence from expert opinion, is a tried method of informing water policy, governance and management (Schoenberger, 1991; Desmond, 2004; Saleth & Dinar, 2004). Expert opinion was captured from water sector leaders using interview techniques in workshops (Schoenberger, 1991), again to identify best practice attributes and implementation constraints. The latter method has been used effectively to evaluate water sector performance (Saleth & Dinar, 1999) but poses methodological challenges. Desmond (2004: 268) notes that, "an elite set of actors where power

differentials [exist] can affect access and cooperation. This becomes more acute when the elite actors are struggling to build a particular discursive and material reality for their sector in the midst of social and political contestation".

These features characterize the contentious field of IRBM. They can affect both the quality of access and quality of information exchanged. These issues were addressed by using a purposive sample of leaders in river basin commissions, leading water sector consultants and basin stakeholders and government agency staff. Workshops comprised members of the Delaware River Basin Commission, the Interstate Commission on the Potomac River Basin, the Columbia Basin Treaty, the Environmental Protection Agency, the US Army Corps of Engineers, the World Bank and the Interstate Commission on Water Policy. In all, 42 people attended the workshops or were interviewed separately. These organizations were taken to be a deliberate but not an all-inclusive sample of those involved in basin management in the USA.

Data were therefore collected from these sources:

(1) a review of the literature for the period 1970 to present using the databases of ISI Web of Knowledge/Web of Science, GeoRef, Geobase and Water Resources Abstracts. The literature resulted in a limited number of analytical experiences in river basin management and river basin organization performance indicators, despite 305 references found on 'river basin management'. The majority of the analytical experience literature was concerned with implementation constraints;
(2) a review of experiences of practitioners, consultants, basin managers and water resources managers in the field. These practitioners published material in a variety of forms, including web-based documentation, agency reports and professional journals;
(3) a review of previous experiences in developing evaluation frameworks for Australian catchment management by CSIRO; and lessons learned from large scale restoration projects in the USA, published by a not-for-profit organization (http://www.nemw.org/restoration_charts.htm. Accessed November, 2005);
(4) structured and unstructured discussions with UNESCO Hydrology, Environment, Life and Policy program staff in Paris in 2005 and at an international water policy and law conference in Dundee, Scotland, regarding the efficacy of the then proposed study; and with staff of the US Army Corps of Engineers' Institute of Water Resources during the study.

2.2. Results

'Best Practice' is used as an embracing term. It refers to what is considered by basin stakeholders (water resource managers, research scientists, academicians, politicians and non-government organizations) as the range of management practices which will result most likely in sustainable development outcomes. This means that the practices are economically viable, politically and socially acceptable, scientifically sound and administratively possible. Best practices do not disadvantage stakeholders because of lack of access, or equity issues. They work best when they are culturally attuned to the needs of those who will implement them in a basin setting, and are developed in the context of the realities of the administrative and political systems of that location.

Considerable research and consultancy practice, noticeably occurring over the last decade, highlights the 'ways forward' to implement IRBM. These are collectively termed 'best practice' and are listed in

Table 1. A second group of parameters was also considered: those factors which contribute to restricting the implementation of IRBM (Table 2). The best practice attributes and the implementation constraints relate primarily to management processes. They are not presented in any order in these tables. Table 3 lists the sources of best practice and implementation constraints. Tables 1–3 are available online at http://www.iwaponline.com/wp/111.pdf.

The best practice attributes and implementation constraints were reviewed and synthesized to avoid overlap. A list of universal indicators was then assembled, containing 115 indicators (Table 4, available online at http://www.iwaponline.com/wp/111.pdf) which were grouped into ten categories:

(1) coordinated decision-making—the use of coordination mechanisms between and within agencies and basin organizations; consensus-based decision making; links between local water institutions and a basin organization; how relevant sectoral interests are engaged;
(2) responsive decision-making—decision processes which adapt to new knowledge and new conditions; promote efficiency; value cross-sectoral dialogue; promote best practices;
(3) goals and goal shift—evidence of the use of an integrated approach to the water resources management paradigm;
(4) financial sustainability—evidence of ongoing financial support, cost sharing, transparency, innovative water pricing and demand management;
(5) organizational design—the use of democratic processes; evidence of stable international agreements, national policy; use of organizational structures which fit basin needs and avoid fragmentation;
(6) role of law—the existence of laws which support river basin management; laws characterized by strong and flexible arrangements;
(7) training and capacity building—the use of ongoing training and capacity building of staff relevant to basin needs;
(8) information and research—the existence of a knowledge system to aid decision-making, protocols to share information, and a culture of research–knowledge links;
(9) accountability and monitoring—evidence that basin organizations are accountable to constituent governments and citizens; use of transparent reporting mechanisms;
(10) private and public sector roles—evidence of stakeholder participation; clear specification of roles of private and public sector.

This grouping does not imply an order of importance, but it is axiomatic that there is an emphasis on coordination, within current legal structures and organizational arrangements for water resources management in any setting.

3. Application of universal river basin performance indicators to a us river basin commission

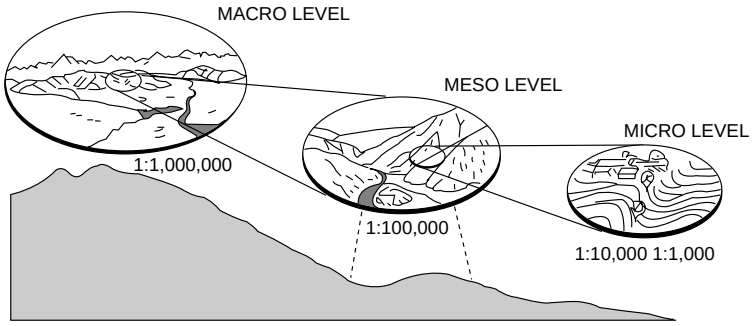
3.1. Challenges in applying universal indicators to US river basins

The next stage of this work was to apply the universal indicators to a specific basin setting in the USA. This involved collecting the input of referents in basin management and identifying application options. The referents included experts in water resources management at the US Army Corps of

Engineers' Institute of Water Resources, members of existing US basin commissions, academicians, and not-for profit organizations. The membership of these referents is reflected, but not confined to the organizations listed in Table 4. Once again the expert informant method discussed above was used to capture essential information which frames the policy setting for river basin management in the USA. This input came through a series of unstructured interviews and meetings with these referent people and organizations.

Several challenges were identified regarding the application of the universal indicators to US conditions. The challenges are listed and discussed below, followed by the application to the Delaware River Basin Commission. The challenges included:

1. *Disagreements on what is IWRM.* There is lack of agreement of what is meant by the term 'IWRM' in the USA. As Stakhiv (2003) points out, 'disintegrated' water resources management characterizes the American water scene. While substantial progress has been made in major water development projects and water quality management initiatives through the 20th Century, coordination at the basin scale is lacking. There is a policy vacuum, limited dialogue and interagency coordination, and concerns about the future of managing America's river basins (Loucks, 2003; AWRA, 2005; Howe, 2005; Jacobs, 2005; Vigmostad *et al.*, 2005).
2. *What is the 'best size' for basin governance?* There is a focus on coordination in the USA at the local watershed level, and substantial national efforts over the last decades have led to the widespread adoption of the 'watershed approach' (Kenney, 1997). The challenge, then, is to specify what the most appropriate size is for effective basin management: is it macro-scale (arbitrary size of at least 100,000 km^2) rather than meso- or micro-scale applications? Macro-scale processes identify broad management solutions and will have hard to measure outcomes, but will provide a valuable scale for decisions on public sector water resources investments. Smaller sized, sub-basin management (river valleys, large watersheds) are useful, but will be unlikely to pick-up the transboundary issues (competing jurisdictions) of the larger scale applications. Very small watersheds (say, $< 100\ km^2$) are inappropriate to basin-scale management design but will illustrate local governance successes and failures. Figure 1 illustrates a template for the division of river basins into different scales of governance. The Delaware River Basin Commission (35,066 km^2), which was chosen for the application of the universal indicators in this study, is a meso-scale basin.
3. *Non-unified water policy doctrine.* Two pervasive water property rights' doctrines exist in the USA: prior appropriation (Western) and riparian water rights (Eastern). These doctrines create different property rights regimes, interpretation of water laws and entitlements, and opportunities for water trading. The challenge is to create indicators appropriate to both conditions. There is an opportunity to create IWRM performance indicators relevant to either doctrine regime, and so recognize the existing conditions.
4. *State advocacy and the politicization of basin governance.* River basin organizations have tended to fade from the agenda of water resources politics and administration in the USA. The previous (Title II) river basin commissions have been dissolved and there is concern that basin initiatives represent covert attempts to increase federal power. The substantial challenge is to recognize the supremacy role, which pervades water policy dialogues, of State water rights over federal rights, and to translate that into an effective form of IRBM and into effective styles of basin organization to suit the water demands of the 21st Century.



	Macro level	*Meso level*	*Micro level*
Natural system and resources	Part of a geographical zone such as a river basin or different ecological zones	Regional or local ecological resource system	Areas with relatively uniform ecological conditions
Mapping scale	> 1:1,000,000	1:100,000–1:500,000	1:10,000 1:1,000
Mapping unit[1]	Provinces	Land systems	Land units, land facets
	National level	*Regional level*	*Local level and individual*
Level of decision-making	Highest political decision-making, international agreements	Province, State, District, Territory	Village, cooperative to farm, factory forest; individual
IRBM organisation	International commission	Intra-national/state basin commission/ authority/ association	Local land and water management group
IRBM document	International agreement	River basin management plan	Land and water management plan, Storm water management plan

Fig. 1. Scales, mapping, decision making, organizations and documents in integrated river basin management (Source: adapted from Newson (1992) and Hooper (2005)).

5. *Few basin organizations.* There are a limited number of basin organizations in the USA today, following the demise of Title II basin commissions during the Reagan administration. They range from more formalized basin organizations such as river basin commissions, to those operating under treaty arrangements, to less formal arrangements such as joint initiatives of State government agencies, basin research programs, and basin lobby groups. Elsewhere, international agreements (such as the Columbia Basin Treaty) and interstate compacts (such as the Delaware Basin Compact) exist. The challenge is that there is no national river basin organization agenda, mandate or procedures, nor are there initiatives to reinstate basin organizations.

3.2. Application to the Delaware River basin Commission

The Delaware River Basin Commission (DRBC) in eastern USA was chosen to apply the universal basin organization performance indicators. The RBO demonstrates classic features of a mature RBO: a demonstrated history of experience and achievement in river basin management, clearly identified roles and responsibilities, evidence of use of an IWRM approach, with a strong interstate component (which illustrates cross-boundary conflict management) and is based on a compact (a common US institutional

arrangement for shared waters). The DRBC was established in 1961 as a compact commission with multi-purpose functions. Principle 5 of DRBC's 2004 Water Resources Plan endorses integrated management.

The purpose of the application was to identify those indicators deemed most relevant to such an interstate basin organization. This was achieved by a structured workshop with senior executives and planning staff of the DRBC. The staff identified 64 indicators drawn from the universal indicators. The results are listed in Table 5 and can be cross-referenced to Table 4. The indicators were chosen as those tagged 'most relevant' and 'relevant' in the workshop. The indicators were then assembled into 8 categories, and 20 performance benchmarks were developed (also listed in Table 5, available online at http://www.iwaponline.com/wp/111.pdf). The basin commission can use a simple Excel-style spreadsheet to:

record evidence of the indicator on a 'yes/no/perhaps' basis;

record the source of evidence (for example, from reports, reviews, meeting outcome statements, evaluations, feedback from staff and stakeholders, and others);

rank each indicator according to a self-assessment procedure, according to an arbitrary maturity rating scale of 'Poor', 'Fair', 'Well-developed' and 'Excellent'.

This checklist style of presentation allows replicability for use in other river basin commissions.

4. Discussion of results

4.1. Use of generic indicators

The majority of indicators in Table 5 require evidence of the existence and efficacy of each indicator. Suggested data sets include river basin management plans, performance reviews, annual reports, internal reviews and ex-post project assessments. A second data set, undertaken simultaneously, is to workshop each indicator to develop scores of achievement for each item. However, more work is needed to streamline this approach to define the values in large group settings, rather than simple voting (as it would take too long), clarification of scores (what does 'fair', 'good', 'excellent' mean with respect to maturity of performance?) and how the results of data collection will be used in basin organizations. There is also the need to ensure the meaning of these scores is comparable when RBOs seek scores from their stakeholders and those to whom they report. Thus, three sets of scores can be used to compare and contrast the perceptions of performance.

Self-assessed approaches are problematic as they suffer from a lack of transparency: self-reporting tends to over-inflate experience but it provides an initial response and can be used to identify gains and losses, and can be compared with the responses from basin stakeholders and those to whom basin organizations report. It is suggested that the use of this template be undertaken cautiously and that a triage of the setting be undertaken prior to the use of the checklist. Furthermore, users may wish to develop numerical responses to the maturity weightings and develop their own meanings of the degree of implementation/achievement meant by the descriptive terms, to ensure consistency between users and through time. The checklist provides a useful 'first cut' of achievement and should be qualified each time it is used in internal performance reviews. Similarly, users could develop their own 'poor' to 'excellent' rankings of the twenty benchmarks identified in this study (Table 5, available online at http://www.iwaponline.com/wp/111.pdf).

4.2. Issues in applying indicators to other US basins

The approach developed in this study is essentially a self-assessment tool. There is an opportunity to use the results through time in a basin to demonstrate improvements and limitations but there are dangers in extrapolating results beyond that basin. There is also value in RBOs using this tool to report frequently to their stakeholders on basin governance improvements, as part of a larger 'report card' of basin ecosystem health.

Several issues need to be considered when applying the approach developed in this paper to other US basins:

- there are strong political moves to assert States' rights in water management, so any basin-level management which suggests Federal initiatives to force the States to work together may be seen as federal intervention, and will over-ride States' rights in water management. This works against collaborative basin management;
- at the national scale, basin management is fragmentary with no overall national policy guidelines nor administrative leadership, so inter-basin comparison of performance will not be made within a national framework;
- over at least the last two decades, there has been increasing decentralization of watershed management to local levels; few basin organizations exists, and those that do are experiencing decreasing federal government support. This implies that the application of performance indicators would most likely be self-funded, and this is a challenge to current basin organizations;
- water and watershed management is issue-based: addressing critical local issues such as water pollution, floodplain management, cleanups and others. Performance indicators in a basin will therefore need to be selected carefully to ensure local issues are addressed;
- the leading national agency for watershed management, The Environmental Protection Agency, created a highly developed system of categorizing watershed management initiatives and developed total maximum daily load (TMDL) measures which establish specific correctional actions in watershed management. There is an opportunity to link TMDL driven performance indicators at a basin level to the developed in this paper.

These issues limit both the immediate development of a national approach to river basin management and the use of the indicators developed in this study. Any inter-basin comparison of performance against a 'national IWRM standard', as expressed in benchmarks and as a subset of the 115 performance indicators (Table 5, see http://www.iwaponline.com/wp/111.pdf), will be flawed. Further work will be required to develop site-/basin-specific procedures.

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