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Integrated water resource management, institutional arrangements, and land-use planning

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Abstract. A systems, holistic, or ecosystem approach is often advocated for water management, and has led to the emergence of integrated water resource management, or IWRM. Such an approach can be interpreted as 'comprehensive' or 'integrated', and analysts, planners, and managers need to understand the difference. Edge or boundary problems always are encountered when applying a holistic approach, and design of institutional arrangements cannot eliminate these problems but can minimize them. IWRM often does not have a statutory basis, which can lead to implementation challenges. By linking IWRM to land-use planning and official plans at the local level, IWRM can be given credibility, as well as be systematically connected to land-based issues.

1 Introduction

Integrated water resource management, or IWRM, has emerged as a significant concept since the Earth Summit in 1992, and has more recently been given prominence by the Global Water Partnership (GWP, 2000; 2003).[1] The GWP (2000) defined IWRM as "a process which promotes the coordinated 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."

The GWP definition sets a high standard; it also creates challenges. First, if IWRM promotes the coordination of management initiatives for water, land, and related resources, how are the connections among these resources to be made? Particularly, how are water and land-based systems to be integrated for management purposes? At an operational level, how should or could water management and land use planning be interrelated? Second, what are the implications for the design of institutional arrangements related to public agencies responsible for water and land management, as well as other resources? What framework or approaches can be used to overcome the predisposition of resource-based agencies not to connect with other organizations with shared interests and overlapping responsibilities?

With regard to the challenges outlined above, the purpose here is to alert researchers interested in land-use dynamics to ideas and approaches associated with IWRM. More specifically, the intent is to examine the implications of different interpretations of a systems, ecosystem, or holistic approach related to IWRM, and to consider how

[1] The Global Water Partnership is based on government agencies, public institutions, private companies, professional organizations, and multilateral development agencies committed to the Rio – Dublin principles. The Global Water Partnership was created in 1996 through collaboration among the World Bank, the United Nations Development Program, and the Swedish International Development Agency. The GWP website states that "membership is open to organizations that recognize the Dublin-Rio principles and are involved with issues related to integrated water resources management." The GWP has established a network of regional partnerships in each of Central America, Central and Eastern Europe, Central Asia and Caucasus, China, Eastern Africa, Mediterranean, Pacific, South America, South Asia, Southeast Asia, Southern Africa, and West Africa.

institutional arrangements can be designed to facilitate IWRM. Then, attention turns to how IWRM can benefit from a closer connection to land-use planning. Specialists in land-use dynamics can judge what benefits might accrue to their field through more systematic attention to the insights emerging from work related to IWRM. This is neither a theoretical nor a case-analysis paper. Rather, I pragmatically reflect on insights and lessons drawn from the literature and over three decades of practical experience related to IWRM, in order to share them with specialists in land-use dynamics. However, before addressing the aspects identified above, in the next section attention focuses on the context for IWRM. In other words, what has stimulated the growing interest in this concept, how is it being interpreted, and what are the implications for planning and management?

2 Context for integrated water resource management

Prior to the United Nations Conference on Environment and Development (the Earth Summit) in Rio de Janeiro in June 1992, an International Conference on Water and the Environment occurred during late January 1992 in Dublin. The purpose of the Dublin conference was to identify priority issues related to freshwater, and to recommend actions to address them (International Conference on Water and the Environment, 1992). The ideas and proposals from Dublin were taken to the Earth Summit, and many of the recommendations were subsequently included in Agenda 21, the strategy for sustainable development in the 21st century (Young et al, 1994, page 1).

The Dublin Statement on water and sustainable development, the main output from the conference, emerged from the deliberations of more than 500 people from 114 countries, 28 United Nations agencies and organizations, and 58 nongovernmental and intergovernmental organizations. The preamble asserted that concerted action was needed to reverse trends of overconsumption, pollution, and rising threats both from floods and from droughts. Action needed to come from local, national, and international levels, and four principles were presented to guide future initiatives.

The first principle has been interpreted as a call for 'integrated water resource management', the focus in this paper. This principle stated that

> "Fresh water is a finite and vulnerable resource, essential to sustain life, development and environment. Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or groundwater area."

The first principle emphasized that water problems cannot be treated in isolation, and indeed should be considered in relation to land-based and land-use planning issues. Notwithstanding the observation by Heathcote (1998, page 10) six years later that integrated watershed management was a relatively new concept, this therefore was not a revolutionary principle. For example, the Organisation for Economic Cooperation and Development (OECD, 1989, page 12 – 20) had previously published "guidelines for integration" relative to water management.

Support for a holistic or ecosystem approach has been provided by Born and Sonzogni (1995), Grumbine (1994; 1997), Margerum (1999a), Margerum and Born (1995; 2000), and Slocombe (1993a; 1993b; 1998a; 1998b). Experience in implementing this approach has been documented in Australia (Bellamy and Johnson, 2000; Bellamy et al, 1999; Johnson et al, 1996; Margerum, 1999b; Mitchell and Hollick, 1993; Mitchell and Pigram, 1989; Robinson and Humphries, 1997), Canada (Krantzberg and Houghton, 1996; Mitchell, 1983; Mitchell and Gardner, 1983; Ontario Watershed Planning Implementation Project Management Committee, 1997), the United States

(Born and Sonzogni, 1995); the United States and Canada (Hartig et al, 1998; MacKenzie, 1996), and developing countries (Boehmer et al, 2000).

However, the integration principle also has attracted criticism, such as that by Biswas (2004) and Fitzsimmons (1996; 1998; 1999). Fitzsimmons (1999, page 15) expressed concern because "fog enshrouds the new paradigmists' interpretation of ecosystem management." In his view, nearly all the key terms associated with this 'new paradigm' are controversial within the scientific community and defy verification or objective evaluation. As a result, he maintained that it is a challenge to demonstrate success because it is difficult to demonstrate that goals have been reached. To illustrate, Fitzsimmons (1999, page 25) argued that determining boundaries for ecosystems is usually challenging because there are no generally accepted rules for their identification. More specifically, he argued that there are no generally accepted procedures regarding

> "(1) which spatial variables researchers should consider in formulating ecosystem boundaries, (2) how many variables these same researchers must use when establishing boundaries, (3) how the scientists should meld the individual distributions of variables that they use to depict an ecosystem into a single ecosystem boundary, (4) the scale at which researchers should identify ecosystems, or (5) or how to account for constant change in the distribution of living things ... ."

Biswas (2004, page 249) expressed similar concerns, arguing that, with regard to IWRM, "not only no one has a clear idea as to what exactly this concept means, in operational terms, but also their views of it in terms of what it actually means and involves vary widely." He further argued that IWRM "really is unusable, or un-implementable, in operational terms" (page 250). The implication is that IWRM, as with all concepts, has limitations, and should be used with those in mind.

A different concern was raised by Hooper et al (1999, pages 749 – 750) who observed that too often it seems to be assumed that an integrated approach is desirable. However, in their view, because integration does not occur without costs being incurred, care should be taken when deciding whether or not an integrated approach is appropriate. Staff time and other resources are required to accomplish integration, and those resources are then not available for other needs or tasks. They argued that an often overlooked need was to establish that serious resource scarcity and/or environmental degradation problems were the result of many, interconnected causal factors whose resolution required an integrated approach. In contrast, many situations are characterized by relatively straightforward problems that can be handled effectively by one agency or organization. If such a situation exists, then an integrated approach is unlikely to be needed. On the other hand, if multiple causes exist, or the actions of numerous agencies or participants might work at cross purposes, or could be designed to complement each other, then an integrated approach may be appropriate, and needed.

3 Alternative interpretations of a holistic approach to water management

Many agree that a 'holistic' or 'systems' approach is desirable for resource and environmental management in general (Gerlach and Bengston, 1994; Grumbine, 1994; 1997; Mitchell, 2002, pages 96 – 107; Quinn, 2002; Slocombe 1993a; 1993b; 1998a; 1998b). There is an intuitive appeal to the view that a broad array of variables and their interrelationships should be examined as a system, because many land-based activities have implications for water flows and quality. In addition, water can have significant implications for terrestrial systems, through its capacity to cause flooding, contribute to erosion and salinity, and support wildlife. As a result, an examination of aquatic and terrestrial systems through an integrated approach provides one way to address the dynamics of

interrelated systems, ensuring that critical relationships are recognized and managed. To illustrate, the Collingwood Harbour Remedial Action Plan (RAP) in Ontario reflects such awareness, when noting that

> "the RAP has followed what is known as an 'ecosystem approach.' In short, that philosophy means that whatever remedial actions are taken, they must be consistent with a respect for the entire Collingwood Harbour ecosystem, the animals, plants and people that interact with one another within a shared environment. As a result, wildlife habitat, sources of contaminants beyond the harbour, and land uses that effect water quality, also fall within the RAP's purview" (Collingwood Harbour RAP Team, 1992, page 1).

Over time there have been two basic interpretations of a holistic or systems approach (Downs et al, 1991). The earliest interpretation was usually referred to as *comprehensive*, as in comprehensive river basin planning and management (Mitchell, 1983; Mitchell and Gardner, 1983; Schramm, 1980; Weber, 1964). This interpretation emphasizes that the relevant ecosystem should be defined in the broadest possible way, such as an entire aquifer or river basin, and then one should seek to identify and understand *all* variables and relationships. The second interpretation, which began to emerge in the mid-1980s and was reflected at the Earth Summit, is referred to as *integrative*, as in integrated water resource management (Bellamy et al, 1999; Born and Sonzogni, 1995; Margerum, 1993c; 1993d; Margerum and Born, 1995; 2000; Mitchell, 1986). This interpretation maintains a systems perspective, but is more focused or selective than the comprehensive interpretation. In other words, rather than seeking to examine *all* variables and relationships, the integrated approach focuses on what are considered to be *key* or *selected* variables and relationships. The rationale is that usually a relatively few variables and relationships cause most of the variability in a system, and therefore those are the ones deserving attention. In addition, it is appreciated that not all variables and relationships can be readily manipulated or managed, and so it is prudent to give attention to those contributing significantly to variation in a system, and amenable to intervention by managers.

The emergence of the integrated perspective was a reaction to the weaknesses of the comprehensive interpretation. When the latter has been used, too often the planning processes have taken so long that when a comprehensive river basin or catchment plan was completed events had already swept past it, and the plan was not relevant to current circumstances. This certainly was the case in Canada in the 1970s, so that the concept of an ecosystem or holistic approach, when interpreted as comprehensive river basin planning and management, began to fall into disrepute (Mitchell, 1983; Mitchell and Gardner, 1983). Further concerns associated with comprehensive river basin plans were that they too often generated a large number of unprioritized recommendations, and insufficient attention was given to making the transition from planning to implementation, as the people and agencies responsible for the analysis and the plan were often not those responsible for implementation.

A danger of using an integrated interpretation, as outlined above, is that one or more key variables or relationships might be overlooked. This weakness is a main reason for managers wanting to use a comprehensive interpretation. By considering all variables and relationships, vulnerability or liability from overlooking a key aspect is reduced. To counter this weakness, those espousing an integrated interpretation have argued that at the outset of any planning process it is important to draw upon both scientific/technical understanding *and* local knowledge. In that way, the risk of overlooking a key variable or relationship should be kept manageable.

However, it also is important to recognize that it may not be useful to think of the different interpretations (comprehensive, integrative) as an 'either/or' situation,

in which only one approach should be used. To obtain the benefits of both perspectives or interpretations, analysts and planners can use them in a phased manner. At *normative* and *strategic* levels, it is desirable to think *comprehensively*, when that means striving to identify and consider the broadest array of variables which may be significant for coordinated management of terrestrial and aquatic systems. However, once one moves to *tactical* or *operational* levels, maintaining a comprehensive interpretation can create the difficulties noted above—too long a period of time to complete a poorly focused plan. Therefore, at tactical or operational scales it is desirable to shift to an integrated interpretation, to reduce the variables and relationships to be addressed. If the above blended or hybrid approach is followed, then, as I observed elsewhere,

> "it should be possible to obtain the benefits of a comprehensive approach without becoming so entangled with a complex web of interrelationships that the management exercise literally disappears into a 'black hole', never to re-emerge. In that way, the time required for analysis and planning should be kept to a more reasonable length, and the tighter focus should result in a process which addresses the real needs of managers and users" (Mitchell, 1990, pages 4 – 5).

Table 1 summarizes the strengths and weaknesses of both approaches, and highlights why it is often sensible to use them together.

Another important aspect deserves consideration to ensure that an integrated interpretation leads to positive action. Attention should be given to the way in which an IWRM plan is developed, because at least two basic choices are available. One involves identifying basic goals or directions, along with the initiatives necessary to achieve them. In this regard, individuals and organizations explore how they can contribute to common goals and directions. In the process of exploration, participants have an opportunity to understand where, how, and why their values and interests diverge, and where negotiation is needed to address legitimately different aspirations. For example, in developing its strategy for the Grand River in southwestern Ontario, the Grand River Conservation Authority stated that its "philosophy

Table 1. Strengths and weaknesses of comprehensive and integrated interpretations of a holistic approach.

	Comprehensive	Integrated
Strengths	Considers entire system, parts, and interrelationships	Retains systems perspective, but is more selective and focused
	Broader scope means less likely to overlook significant variables	Greater likelihood of completing analysis in a timely manner
	Most value at normative and strategic levels of planning	Most value at operational and tactical levels of planning
	Emphasizes scientific understanding of ecosystems	Encourages use of both scientific and local knowledge systems
Weaknesses	Implies possibility of understanding entire complex systems, and opportunity to control them through interventions, both of which are improbable	May overlook one or more key variables, which could lead to poorer understanding of ecosystems, and discrediting of analysis and subsequent plan
	Because of broad coverage, may take so long to complete that conditions or context change, making findings less useful	

is that everyone who shares the resources of the Grand River watershed is encouraged to be part of a concerted and collective effort to address watershed issues. The motto 'Share the Resources—Share the Responsibility' has been adopted" (Veale, 2004, page 35).

The other option encourages individuals and organizations to identify their own goals and directions for the future. Then, when they come together, they see whether diverse perspectives can be coordinated. This option has the potential for major difficulty, as it emphasizes efforts to reconcile differences, rather than to identify shared and common interests. The reality is that individuals and agencies do have their own goals and mandates, and it would be unwise to ignore them, or pretend they did not exist. However, to let them determine the context for IWRM is dangerous, as it places the emphasis on differences. Practical experience has shown that effectiveness is usually higher when common goals and objectives are identified along with the general direction to travel to achieve a desirable future, and after having accomplished that to start exploring how individuals or organizations can contribute to their realization.

To summarize, several key aspects need attention regarding IWRM. A holistic approach has been endorsed by many analysts and managers. However, too often this approach is interpreted in a *comprehensive* manner, without critical appreciation for what that implies. By trying to include everything, analysts and managers risk discrediting the holistic or systems approach, by creating expectations that it is possible to understand and control all elements of a system, and by using an approach that usually takes significant time to complete data collection, analysis, and interpretation. The rationale for using an *integrated* instead of a *comprehensive* approach has not been accidental, or the choice by some simply to introduce new jargon. An integrated perspective implies more selectivity than a comprehensive interpretation, while still maintaining the core characteristics of a holistic approach (defining a system, and examining variables and their connections).

4 Implications of edge or boundary problems for institutional arrangements

Serageldin (1995, page 5), based on his experience with the World Bank, commented that water management too often is fragmented among sectors and institutions, with little attention to or regard for conflicts or complementarities among social, economic, and environmental objectives. Multiple agencies have been created for various uses, including irrigation, municipal water supply, power, and transportation, with interactions across sectors in an interdependent 'system' usually ignored or minimized. It is common for issues related to water quantity and quality, and concerns about health and the environment, to be handled separately. Spatial interconnections also are often disregarded, as when individual states or provinces have jurisdiction over water within their territory, but do not consider the consequences when the same water system is shared by a 'downstream' state or province, or even country. Finally, Serageldin commented that domestic, industrial, and commercial water supplies often are provided by local governments that do not coordinate with provincial, state, or national water agencies. The outcome frequently is excessive and unproductive investments, with various organizations making decisions for different uses even though they are focused on the same water system.

Serageldin's identification of a 'silo effect', a term frequently used to characterize or describe the separation of responsibilities among resource-management agencies as well as their inability or unwillingness to consider their mandate relative to those of other organizations, reinforces the rationale for an integrated approach to water

management.[2] It already has been established that many water problems have their origins in land use or other related activity, and vice versa, making it essential for land-use planning to be connected to water planning. The presence of a silo effect, or fragmented responsibilities, from one level of government to another (local, to provincial/state, national, or international), referred to as *vertical fragmentation*, or within one level of government (among different agencies of a government, such as agriculture, forestry, fisheries, water, mining, municipal affairs, or economic development), referred to as *horizontal fragmentation*, provides a strong reason to search for a way to achieve integration through coordination and collaboration.

Both vertical and horizontal fragmentation often occur. Several examples highlight this occurrence. From Australia, the Healthy Rivers Commission of New South Wales (1997, page 27) remarked with reference to management of a catchment in the Sydney metropolitan area that "There is a perception that because 'everyone' is (apparently) responsible, 'no-one' can in fact be *held* responsible." Furthermore, the Commission stated that

> "the problem is rarely a shortage of relevant powers. Powers exist, in multiple agencies and councils, to deal with the majority of the significant issues .... Rather, the problem is that there is no adequately directive framework within which one agency or council feels confident or is encouraged by others *to take the lead in driving through the necessary decisions*. The result is that some critical problems are not being resolved" (page 27).

This situation is not unique to Australia. In Canada a Royal Commission on the Future of the Toronto Waterfront (1992, pages xxi – xxii) concluded that four levels of government in the Toronto area shared jurisdiction and more than 100 agencies shared responsibility for the waterfront. The result was "little effective co-ordination among them. Indeed, in the past the parochial pressures of bureaucracies and representative governments have almost compelled them to be unresponsive to cross-jurisdictional issues. When everyone is in charge, no one is in charge." The outcome described here is the classical negative consequence of a silo effect.

The existence of a silo affect or fragmentation is often very real, and highlights the presence of boundaries or edges between agencies. Indeed, twenty years ago, Eddison (1985, page 149) argued that the major challenges for management are at boundaries or edges, which he defined as situated between states, levels of government, agencies, or divisions within departments. He further argued that aspiring to remove boundary effects through re-organization is futile, as it is not possible to remove boundaries or edges. When restructuring organizations, boundaries or edges are moved, not removed. Each structural option offers advantages and disadvantages, but none is boundary free. He thus concluded that it is essential to devise mechanisms or processes to address the difficulties created by boundary problems.

Two examples illustrate how structural boundaries get changed, but not removed. First, prior to the Stockholm Conference in 1972, many countries created environmental ministries. The rationale was to place all environmental issues in one agency. In Ontario, this led to a Ministry of the Environment to be responsible for all environmental quality issues. From one perspective, this was logical and desirable.

[2] Silos are physical structures used to store grain or other crops. They are designed to ensure the integrity of a crop while in storage, and thus the purpose is to ensure the crop is kept separate from other crops, pests, or other disturbances. In resource and environmental management, the term 'silo effect' is used to describe the separation of functions and authority among different agencies, and the inclination of agencies to protect their functions and authority from possible intrusion by other agencies. Such an approach does not encourage a holistic approach, as each agency is concerned only about what is within its own 'silo', and does not consider possible connections with what other agencies have in their silos.

Air-borne contaminants contributed to pollution of land and water, and land-use activity contributed to water and air pollution. By allocating responsibility for air, land, and water quality management in one ministry, the interconnections among them could theoretically be addressed more systematically. However, from an overall water-management perspective, the logic was less clear. Water-quality issues were allocated to the new Ministry of the Environment, whereas water-quantity issues remained with the Ministry of Natural Resources. Thus, from a water perspective, the hydrological cycle was split in two, which was not logical, especially if a holistic or integrated approach were to be taken.

The second example occurred in the mid-1990s in Canada, as governments strove to incorporate sustainable development into their activities. One initiative at the federal level was to disband the Inland Waters Directorate, and reallocate water specialists throughout the federal public service to work with specialists in forestry, wildlife, fisheries, etc. The idea was to break down the silo effect around water by restructuring and creating divisions focused on sustainable development. The downside to this approach was that people, businesses, or organizations are more likely to believe that they have a water or a land-use problem than a sustainable development problem. As a result of the restructuring to reflect ideas of sustainable development, the federal government's expertise in water became opaque, both externally and internally (Bruce and Mitchell, 1995).

The outcome was referred to as "profound superficiality"—'profound' in that the new arrangement recognized the importance of an ecosystem approach emphasizing attention to the entire system and the linkages among its components, but 'superficial' in the lack of attention to water in all its dimensions—human uses, as an economic driver, as an aquatic environment, and as a key element of the national and global environment. An overriding challenge, therefore, is to determine and achieve appropriate balance between breadth (the ecosystem approach) and depth (the sectoral approach).

If the above ideas are to be addressed in the design of institutional arrangements to facilitate an integrated approach, it is important to be clear about what is meant regarding 'institutional arrangements' (Cortner et al, 1998; Gormley, 1987; Ingram et al, 1984; Mitchell, 1975; Watson et al, 1996; Young, 2002). Young (2002, pages 4 – 5) has provided insightful comments about institutional arrangements by differentiating between "rules in use" and formal specification through contracts and constitutions. Elaborating, Young (2002, page 5) suggested that most analysts of institutional arrangements are

> "comfortable with a point of departure that treats institutions as sets of rules, decision-making procedures, and programs that define social practices, assign roles to the participants in these practices, and guide interactions among the occupants of individual roles. ... Institutions, on this account, must not be confused with organizations construed as material entities with employees, offices, equipment, budgets, and (often) legal personality. In rough and ready terms, organizations ... can be thought of as actors that typically emerge as players whose activities are guided by the rules of the game of institutions in which they participate. Conceptualized in this way, institutions can and do vary widely in terms of a range of dimensions, including functional scope, spatial domain, degree of formalization, stage of development, and interactions with other institutions."

This distinction can be emphasized by noting the difference between what Young refers to as *thin* and *thick* perspectives. In the thin perspective, institutions are systems of rules, decisionmaking procedures, and programs as articulated in formal and explicit statements, including policies, legislation, and regulations. In a thick perspective, all of

the elements associated with the thin perspective are recognized, but, in addition, attention is given to less tangible and implicit norms and standards, including what are generally known to be the 'rules of the game', informal understandings and conventions, and expectations consistent with values and culture. A key aspect is that, whereas the intangible norms and standards typically reflect codified rules and procedures, they normally evolve over time in ways not easy to trace back to their formal and tangible foundations. It is this aspect which highlights the difference between rules on paper and rules in use. The following example from the Fraser River in British Columbia illustrates how understanding of thin and thick dimensions can be used to create an innovative institutional approach to achieve IWRM.

4.1 Fraser River Estuary Management Plan

As noted by McPhee and Wiebe (1986, page 229), the Fraser River estuary dominates the Lower Mainland of British Columbia between Hope on the east, to Vancouver and the Gulf of Georgia on the west. The estuary and associated lands are the major area for economic activity in the province. At the same time, the wetlands in the estuary are essential habitat for migratory wildfowl from three continents. In the mid-1980s, it was becoming clear that this ecosystem was under growing stress. In the words of McPhee and Wiebe (1986, page 230),

> "the Fraser River estuary is a multipurpose resource supporting many activities. However, not all of these activities are compatible with one another. Many times over the past 15 to 20 years, the estuary's ability to continue meeting all the various growing demands has been questioned. Several key issues have predominated: water quality conditions (including toxics), alteration and loss of fish and wildlife habitat, and provision of recreation opportunities."

Against the above context, a joint federal–provincial Fraser River Estuary Study (1982, page 8) recognized that a vision was essential, noting that "What the Fraser needs is an encompassing vision, on where the costs and benefits of multiple use are in balance." It was also recognized that a management program and structure were needed to guide future changes in the estuary so that its natural resource integrity would be preserved and protected, while it also served as a vital economic resource.

To deal with the many interests and stakeholders, the Fraser River Estuary Study (1982, page 36) concluded that a "linked management system provides a framework for interagency cooperation", and this would include "organizational structures, processes and procedures for management and for conflict resolution." The management situation in the estuary involved many decisionmakers, often making decisions on the basis of poor information and in the face of significant uncertainty. It was concluded that understanding of organizational arrangements suggested that "a non-hierarchical, lateral type of structure is advantageous. This would include joint programs, flexible agreements, information systems, and coordinated procedures."

The above elements were deemed essential to deal with the management challenge in the estuary, characterized in the following way:

> "Today management of the estuary is a complex process involving over sixty government agencies including port authorities, water quality agencies, habitat management agencies, municipalities, regional districts, resource agencies, transportation agencies and more. Each of these has responsibility for parts of the estuary, and each has its own approaches to managing its decisions and activities. Each has its own set of policies that may or may not be compatible with those of the others. ... The establishment of such a coordinated program would provide a shared vision for what the estuary should be like in the future. It would provide guidance to all users of the estuary for a cooperative endeavour to achieve common goals.

Without such a management program users would be left more to their separate interests" (Fraser River Estuary Study, 1982, page 38).

The authors of the Fraser River Estuary Study concluded that creation of a new estuary agency was not desirable for several reasons. First, a new agency would require a statutory base, and getting the necessary legislation passed would be difficult if not impossible. Second, a single estuary agency would have administrative challenges in overseeing the various management responsibilities of estuary management. Third, a multiple agency arrangement, once agencies were linked, would create more access points for the public than would a single agency. And, fourth, an estuary agency would not have authority to influence decisions about upland areas which were having a major impact on the estuary. For the above reasons, it was decided not to create a single superagency, but instead to establish a process through which all separate government agencies with responsibilities relevant to the estuary would be joined together for selected activities. More specifically, the Fraser River Estuary Study (1982, page 40 – 31) explained that

"In a 'linked system', management would continue to be entrusted to existing agencies which, to a large extent, would retain their present authority and responsibilities. However, instead of each operating separately, perhaps even in conflict with others, certain key agencies would be asked to cooperate in a joint process designed to improve on the present system but not to replace it. The principle involved is to ensure that agencies work together to achieve a common set of goals .... A linked management system is legally feasible and could be implemented. Under the parliamentary system existing extensive executive and cabinet powers could commit government agencies to a set of estuary management policies. Also, there is considerable legal scope for agreement on procedures and action programs. Such a program is also organizationally feasible but would require a careful program of implementation."

The analysis by the Fraser River Estuary Study focused on how to bring together, or integrate, the different and sometimes conflicting interests, responsibilities, and authority of various stakeholders to work towards a common purpose or vision. Later, McPhee and Wiebe (1986, page 247) observed that, for such a design to be effective in terms of coordination, bargaining, and conflict resolution, "several critical things must occur", including (1) ongoing commitment by those involved at the political as well as at regional and local levels, (2) development of a functional knowledge base, (3) integrated and linked planning by government agencies, and (4) opportunities for the public to identify issues, provide information, and participate in conflict resolution processes. The work by the Fraser River Estuary Study created a foundation for innovations in institutional design which continues today (Dorcey, 2004).

5 Connections among integrated watershed management and land-use planning

It has been argued here that aquatic and terrestrial systems are closely linked, and therefore should be considered together when framing land-use dynamics, or planning for water management. However, there is a further reason why integrated water management is likely to be more effective if linked to land-use planning or to official plans.

Experience has shown that, after considerable time and effort have been allocated to IWRM watershed planning, there often is relatively little action. The principal reason is that frequently the IWRM plan has no obvious 'home' or legal basis, and therefore has low legitimacy. And, even if it does achieve credibility, there is a challenge in achieving implementation because many of the action items have to be taken on by diverse organizations, whether government agencies, private companies, or nongovernment

organizations. Each has to determine how recommendations from the IWRM plan, passed along to it, fit with other responsibilities and priorities. The result is that the IWRM recommendations often have low priority because they are perceived to be someone else's problem or responsibility. Alternatively, if implemented, they are scheduled to fit into the activities and priorities of each agency, rather than with regard to how they should be sequenced as part of an overall, integrated initiative. The outcomes are low effectiveness and efficiency.

A conclusion is that too often the output of IWRM plans becomes an orphan, and suffers the neglect which can accompany such a situation. In this context, it is increasingly being appreciated that IWRM should be conceived, developed, and implemented with explicit connections to other, related initiatives which have credibility thanks to statutory or other policy or administrative bases. This is not unique for IWRM, and is also recognized by those with other interests, ranging from agriculture in Australia (Bellamy and Johnson, 2000), spatial and environmental policies in The Netherlands (de Roo and Miller, 1997), and protected areas in Mexico, the United States, and Canada (Nelson et al, 2003), who are seeking to make connections to land-use and regional planning (Elling, 2000; Prost et al, 1998). The implication is that connecting to statutory-based land-use planning has the potential to improve the effectiveness of IWRM.

Where IWRM has been connected to the statutory base of land-use planning and official plans at the local level, progress can be significant, as the following examples highlight.

5.1 Collingwood Harbour, Ontario

Through the Great Lakes Water Quality Agreement, Canada and the United States designated forty-three Areas of Concern (AOC). Although applying an ecosystem approach to the entire Great Lakes basin was viewed as unrealistic, focusing on selected harbours and their related rivers was considered manageable. Collingwood Harbour, on Georgian Bay, was one of these and was designated as an AOC in 1977.

A Collingwood Harbour Remedial Action Plan was prepared to reduce the excessive phosphorus inputs to the harbour. Key components of the RAP included enhancing the municipal sewage-treatment plant, protecting an existing wetland complex, rehabilitating fish and wildlife habitat, and educating the community. With regard to the wetlands and fish and wildlife habitat, the RAP noted that, "as development proposals come forward, the RAP and PAC [Public Advisory Committee] have recommended that due consideration be given to the creation of a refuge for a wide variety of aquatic life. This will be approached by incorporating the RAP principles into the Official Plan for the Town of Collingwood" (Collingwood Harbour RAP Team, 1992, page 2). This initiative highlights how combining IWRM with a statutorily based official land-use plan facilitated the implementation of principles associated with an ecosystem approach. As a result of the combined initiatives, in 1994, Collingwood was the first of the forty-three AOCs in the Great Lakes to be delisted.

5.2 Don River, Toronto

The Don River flows through the eastern part of Toronto, and had become one of Canada's most degraded urban rivers. At the start of the 21st century the Don River watershed was 80% urbanized, with projections indicating that by 2021 it would be 91% urban. It also was home for 800 000 people, Over 200 years the Don River watershed had experienced pressure from intensifying settlement in three stages: (1) in the late 18th century, settlement occurred in the City of Toronto in the lower watershed and in scattered communities in the upper basin, (2) following the Second World War, suburbanization occurred in the mid-basin, and (3) starting in the early 1980s and continuing, settlement intensified in the headwaters. This settlement degraded or

destroyed aquatic and terrestrial wildlife habitats, polluted surface waters with human sewage, industrial and agricultural chemicals, and petrochemicals, metals, and salt related to road transportation. Urban development exacerbated warmer water temperatures, erosion, and water pollution. The mouth of the Don River, originally a wetland, was filled in, along with other wetlands being reclaimed and springs being lost.

In 1994 the Toronto Region Conservation Authority endorsed the recommendations of the Don Watershed Task Force. The task force had proposed "40 steps to a new Don". Many of the steps were explicitly connected to land-use and regional planning principles and instruments, in order to, for example, reduce the amount of pesticides and fertilizers entering the Don; keep old landfill sites from leaching into groundwater and streams; protect and regenerate lowland forests, meadows, and streamside vegetation; protect and regenerate upland forest habitats; protect and regenerate wetlands; and enhance the network of green corridors linking natural areas. Such initiatives often could be accomplished only by relying on the statutory authority of local municipalities through their official land-use plans. As the task force observed, for real measurable progress towards a healthy watershed to be achieved, the forty steps would have to be "put to work in municipalities and neighbourhoods" (Don Watershed Task Force, 1994).

5.3 Thames 21

The National Rivers Authority, Thames Region (NRA, 1995, page 3) explained that the Environment Agency in Britain was created to facilitate policies on sustainable development. Specifically, the agency is "to take an integrated approach to providing effective environmental protection by working with local planning authorities", and, in that context, "Thames 21 articulates a vision of the water environment. It is supported by a strategy to link land use and water related issues through the land use decision making process."

Using Thames 21 as a framework, the NRA concluded that it could implement various projects by acting on its own. However, the NRA (1995, page 5) also recognized that "working in partnership with other organisations offers increased opportunities for maximizing our effectiveness. The statutory town and country planning system offers a powerful route for promoting NRA policies ... ."

Thames 21 was viewed by the NRA as having three roles. First, as a bridge between the NRA and other organizations, Thames 21 articulates water issues in Regional Planning Guidance (guidelines). Second, it summarized NRA policies which could be promoted through the statutory plan development system. And, third, Thames 21, by highlighting development issues which needed to be addressed, provided a regional context for preparation of Catchment Management Plans. The important connections between water and land-use planning were summarized by NRA (1995, page 5) in the following words:

> "The NRA recognises the advantages of promoting the water environment through the statutory development plan system. 'Thames 21' is an important part in the ongoing dialogue with local authorities in identifying those locations where water related policies need to be more actively pursued.
>
> Participation and partnership between all parties with a stake in the development is seen as an important aspect of this approach. While legislation, land use planning and economic instruments may be the main tools of control, consensus can be a powerful influence for enabling satisfactory development to take place. This is particularly true both of the NRA's relationship with the development plan system and local authorities' participation in the Catchment Planning process."

5.4 Fraser River Basin, British Columbia

The Fraser River Basin Council was created in 1997. Its mandate is to ensure that development decisions in the basin, home for 2.6 million British Columbians, protect and advance economic, environmental, and social sustainability into the future. The population in the basin is expected to reach 4 million people in thirty years, and it is understood that pressure will increase on the natural environment because of such growth.

The Fraser Basin Council has developed a set of sustainability indicators as the basis for a "state of the basin" report. These indicators were prepared through collaboration among the council, governments, and nongovernment, private sector, and community groups. The Fraser Basin Council (2003) recognized that negative impacts from population growth need to be managed through various planning mechanisms and tools. For example, it noted that local governments in urban areas use various regulatory tools to encourage more compact communities to minimize the impacts of urban sprawl. To illustrate, between 1986 and 1996, high-density neighbourhoods contained 80% of the growth in Vancouver, resulting in 62% of residents living in what are defined as compact neighbourhoods by 1996. Other planning tools used to manage growth include Official Community Plans, zoning bylaws, urban containment boundaries, and density bonusing. These various initiatives highlight that progress with implementing an integrated approach in the Fraser River basin has been enhanced by connecting IWRM concepts with land-use planning.

5.5 Multibarrier approach to drinking water safety

In mid-May 2000 the small town of Walkerton, population about 5000, in southwestern Ontario experienced contamination of its water supply system by deadly bacteria, *Escherichia coli* O157:H7, or *E. coli* as it is often called, and *Campylobacter jejuni*. These bacteria can cause bloody diarrhea and sometimes extreme abdominal pain. Seven people died, and more than 2300 became ill. It is not known for sure, but is anticipated that some individuals who became sick, especially children, may have effects for the rest of their lives.

Justice O'Connor (2002a; 2002b) conducted an inquiry into the related events at Walkerton, and in his two-volume report recommended a 'multibarrier approach'. O'Connor (2002b, page 72) concluded the "best way to achieve a healthy public water supply is to put in place multiple barriers that keep water contaminants from reaching people." He observed that five barriers are commonly used in relation to the provision of drinking water: (1) source protection, (2) treatment, (3) distribution-system security, (4) monitoring, and (5) practised responses to adverse conditions. For the first barrier (source protection), he noted that typical approaches include watershed protection plans, upgraded sewage treatment, and choice of water source.

O'Connor (2002b, pages 397 – 398) recommended that the provincial government needed to develop a comprehensive approach to all aspects of drinking water, from source protection to the return of treated wastewater to the environment. He found that fragmentation existed even for specific barriers. For example, with regard to source protection from contamination associated with agriculture, he found that this was effectively carved out of the rest of the province's environmental protection regime and treated differently, as highlighted by frequent exemptions from environmental prohibitions on the basis that a farm activity was 'normal farm practice'. Furthermore, the environmental regulations for farms were the under the purview of the Ministry of Agriculture, Food and Rural Affairs, not the Ministry of Environment. He also noted fragmentation related to drinking water treatment and distribution, when during the Walkerton event there was confusion over the respective roles of the Ministry of

the Environment and the local Medical Officer of Health in responding to adverse test results. As a result, he recommended that the Ministry of Environment be designated as the lead ministry with responsibility for a 'source-to-tap' policy. He also recommended that this ministry have the oversight role for a watershed planning process, to be delivered by the catchment-based Conservation Authorities which work closely with municipalities.

Subsequently, an Ontario Advisory Committee on Watershed-based Source Protection Planning (2003) proposed a watershed-based source-protection framework, and, the following year the Ontario Ministry of the Environment (2004) published a white paper outlining the government's proposed approach. The white paper indicates that for each component of a source protection approach there would be assessment and management phases. The latter would require "a mixture of localized measures, designed to protect individual sources, and wider-ranging measures, designed to protect the larger water resource body", and a need "to coordinate actions in a way that maximizes the protection of public health and the safeguarding of source water quality and quantity over the long term" (Ontario Ministry of the Environment, 2004, pages 6 and 8). Such an approach will require collaboration and coordination among provincial agencies, regional authorities, and local governments, especially related to land-use planning and development controls. This need is well appreciated, and mechanisms will be created to ensure that the watershed planning will be connected to local land-use planning processes.

6 Implications

A holistic approach offers real advantages, but also challenges, to improving understanding of complex systems, whether aquatic or terrestrial. When using a holistic approach, two interpretations—comprehensive and integrated—should be recognized and their differences appreciated. Each interpretation provides benefits, and understanding is most likely to be enhanced if analysis is conducted in a two-step process, beginning with a comprehensive outlook but then evolving to an integrative perspective in order to become more focused.

In conceiving and implementing a holistic approach, we need to recognize that boundary or edge problems will always exist, and that it is not possible to eliminate them by redesigning institutional arrangements, especially structural aspects. At best, structural changes will move or rearrange the boundaries or edges. Thus, it is important to appreciate that boundaries and edges always will be present, and therefore that institutional arrangements should be designed to minimize their negative consequences. This is usually best achieved by establishing processes and mechanisms, and by nurturing organizational cultures and individual attitudes, to encourage the collaboration and coordination required in IWRM. Structural changes on their own will not be adequate.

Because integrated water(shed) plans often do not have a statutory or other basis to provide legitimacy or credibility, an opportunity exists for managers to link or connect such initiatives to land-use planning processes or to official land-use plans which normally have legal or administrative legitimacy. In this manner, understanding about land-use dynamics and procedures can be used in conjunction with insights about aquatic systems. The examples in this paper illustrate that land-use planning processes can systematically assist in the implementation of concepts associated with IWRM. As a result, researchers and practitioners of both IWRM and land-use planning should both work more explicitly to determine how their analyses and professional practice can be used in a complementary manner.

The above 'implications' may appear on the surface to be simple, and indeed they are. However, being simple is not the same as being 'simplistic' or superficial. It is still very common for researchers and practitioners not to differentiate between alternative interpretations of a holistic approach, and to go by default or drift toward a comprehensive interpretation. Similarly, when the desired collaboration and coordination required for integration do not occur, thinking and action too often start with or are confined to altering structural arrangements. Sufficient attention is not usually given to considering a mix of institutional aspects, especially mechanisms and processes needed to handle cross-boundary issues. The 'linked management' system in the Fraser River basin and the multibarrier approach being introduced in Ontario illustrate how a mix of strategies and instruments can be used to complement one another. IWRA and land-use planning specialists too often continue to operate as two solitudes, or in different silos, to the disadvantage of each. If more attention were given to these simple or basic implications, prospects for improved IWRM and land-use planning exist.

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