



# Institutional perspectives on participation and information in water management

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## Abstract

Integrated urban water management — a framework to understand, control, and optimize elements of the urban water infrastructure as an integrated system — is inherently complex. It becomes more complex and challenging, however, when public participation in management institutions is considered. This paper applies a systems perspective to explore institutional arrangements for participation. Our goal is to conceptually organize this complexity and provide starting points for systematic examination of participation in urban water management. The discussion highlights two rationales for engagement with external parties: (1) building support and legitimacy for integrated urban water management; and (2) enabling transformation in the management system. The general institutional framework is then illustrated by a case study of participation and transformation toward more integrated management in the metropolitan area of Atlanta, Georgia.

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## 1. Introduction

Integrated urban water management (IUWM) is a framework to understand, control, and optimize elements of the urban water infrastructure as an integrated system (representative infrastructure elements include wastewater treatment plant(s), sewer network, receiving waterbody, drinking water plant, and source waterbody; Beck, 2004; Meirlaen and Vanrolleghem, 2004; Schütze et al., 1999, 2002). This approach is motivated by the recognition that separate optimization of the elements does not necessarily optimize or enhance the quality of the whole system (Beck, 1976; Hawken et al., 1999; Schütze et al., 1999), and it is has primarily focused on the physical infrastructure (Butler and Schütze, 2004; Meirlaen and Vanrolleghem, 2004; Schütze et al., 1999; Schütze et al., 2001). Integrated water management (IWM) is a related concept requiring

water quantity, water quality, and social dimensions of water resources to be considered simultaneously (Deyle, 1995; Geldof, 1995a,b; Grigg, 1999; Heinzmann and Sarfert, 1995). Integrating technical and organizational aspects of water management creates a system with the characteristics of complex adaptive hierarchical systems (Geldof, 1995a; Patten et al., 2002; see also Holland, 1995). In the case of IWM, Grigg (1999) suggests that the main challenges will be institutional. Here we extend this to IUWM by asking: How can urban water management incorporate or be integrated with the network of actors and institutions that create their socio-political context?

Broadening participation in IUWM is one means of integration with the socio-political context. When considering participation in resource management, however, we must address a series of questions including: (1) participation by whom; (2) in what; (3) when; and (4) to what end (Blumenthal and Jannink, 2000; Chess et al., 2000; Holling, 1978; Korfmacher, 2001; Laird, 1993; Lovell et al., 2002; Perhac, 1998; Rosener, 1978). In this paper we consider institutional

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arrangements for participation and address these questions using a systems perspective. Our goals are to provide a conceptual framework that organizes the complexity introduced by engagement with external parties and to offer starting points for a more systematic examination of participation in urban water management. The first section details the institutional framework for participation in urban water management, starting with a systems view of actors and institutional arrangements in urban water management. The second section discusses the range of parties who may be involved in participatory processes and the ways that involvement may be structured, and the third section addresses benefits that may be gained by engaging external parties. Finally, these general concepts are illustrated by a case study of participation in water management in an urban area with rapidly developing margins (Atlanta, GA).

## 2. Institutional framework for participation in urban water management

Institutions are “...the sets of rules or conventions that govern the process of decision making, the people that make and execute these decisions, and the edifices created to carry out the results” (Gunderson et al., 1995a, p. 497). Institutional frameworks for urban water management overlie natural systems and the multiple resource streams or benefits they provide. They are a part of the social capital required to convert natural capital into human-made capital. Institutions and actors in an IUWM system must address multiple types of water resources and the services they provide. Postel and Carpenter (1997) subdivide the benefits derived from freshwater ecosystems (e.g. lakes, wetlands and rivers) into three broad categories (Table 1). Two categories encompass goods extracted from the systems, while the third accounts for instream services. Goods extracted from aquatic systems include water supplied to the human population for drinking and other uses as well as harvested resources like fish. Instream services include flood control, transportation, recreation, and hydroelectric power generation.

Each benefit can be considered a separate resource stream, each of which may require different quantities and qualities of water in the natural system. Extracting or appropriating one benefit may negatively impact the natural system’s ability to provide other resource streams (Catley-Carlson, 2002; Postel and Carpenter, 1997; Postel et al., 1996). Responsibility for juggling this array of impacts and quantity and quality requirements rests with a range of actors, including natural resource managers, charged with connecting the resource streams to the economic system. As described in the following sections, multiple actors and the institutional arrange-

Table 1

Services provide by rivers, lakes, aquifers and wetlands (modified from Postel and Carpenter, 1997)

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Goods
<i>Water supply</i>
Drinking, cooking, washing and other household uses
Manufacturing, thermoelectric power generation, and other industrial uses
Irrigation of crops, parks, golf courses, etc.
Aquaculture
<i>Supply of goods other than water</i>
Fish
Waterfowl
Clams and mussels
Pelts
Services
<i>Non-extractive or instream benefits</i>
Flood control
Transportation
Recreational swimming, boating, etc.
Pollution dilution and water quality protection
Hydroelectric generation
Bird and wildlife habitat
Soil fertilization
Enhanced property values
Non-user values

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ments that structure their interactions comprise the institutional framework for participation in urban water management.

### 2.1. Actors

In the context of natural resource management, *actors* are, by definition, decision makers. Classical conceptions of decision makers in the urban water arena focus on managers, such as supervisors of municipal water and wastewater authorities and officials with state or federal environmental agencies. These actors make decisions about the production of services, assess consumption and quality of product, and monitor and regulate the condition of source and receiving bodies of water.

In a simple conceptual model of an urban water management system (Fig. 1A), managers can be differentiated based on the resource stream(s) of primary concern. One manager may focus solely on supplying drinking water, while another may be concerned with stormwater management and the assimilative capacity of the receiving stream. Each manager has an activity domain determined by the resource stream(s) of concern, his or her authority to make decisions regarding those resource streams, and inter-relationships between resource streams. The size of activity domains varies and it is possible for domains to overlap. For example, in Lake Sidney Lanier, a reservoir in the southeastern United States, the Georgia Department of Natural Resources is responsible for managing fish populations.

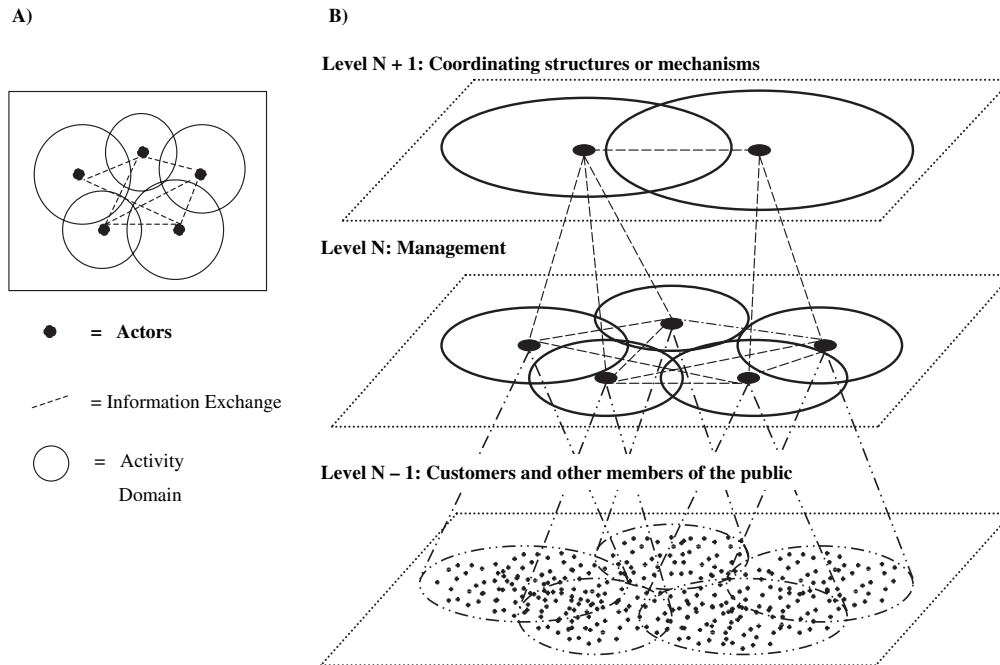


Fig. 1. (A) Simple; and (B) multi-level conceptual models of urban water management. The simple model shows exchanges of information and activity domain overlap in one level of natural resource management, while the multi-level constructs a nested hierarchy of management levels based on types of institutional arrangements.

This domain overlaps with the authority of the United States Army Corps of Engineers to control water releases from the reservoir, which also can impact fish populations. Formal and informal channels of communication and cooperative arrangements facilitate interactions between resource managers across these activity domains.

Sole focus on the management level of activity, however, neglects IUWM's socio-political context. Most fundamentally, it does not include the public as actors (i.e. decision makers). The public includes a variety of individuals who make decisions about utilization of resource streams, including rates and intensity of consumption. Collectively, these individual decisions underlie and are constrained by those of the resource manager. Therefore, the public constitutes a lower level of action in an IUWM hierarchy (Fig. 1B). These actors create demand for the resource goods and services, and provide legitimacy for decisions made at the management level.

The simple model also neglects a higher level of the hierarchy, in which decisions that coordinate managers' activities can be made (Fig. 1B). An avenue for greater integration in urban water management, this is a significant aspect of the management system where it exists, although it can take many different forms (e.g. regional governance structures, interstate commissions, or conjunctive management agencies).

Information exchanges are key elements of our conceptual models of IUWM (Fig. 1). These elements highlight a fundamental challenge in a system with

many actors at different hierarchical levels: couching complex information in ways that intersect with divergent motivations, interests and capacities. Such information can range from raw data to summary statistics to information condensed in a way that ties directly to human values (Schiller et al., 2001).

The measures that actors use to assess resource management effectiveness are of particular interest. Actors will look to different indicators of success depending on factors such as the resource stream(s) of interest, their activity domain, and organizational mission. Indicators of interest to one subset of actors may address management processes or operations measures, such as fecal coliform concentrations in wastewater and stormwater discharges or the nutrient removal efficacy of specific control measures. Other actors may be interested in indicators of ambient conditions and the condition of the resource stock (e.g. fecal coliform levels in a specific waterbody; measures of ecosystem function). Still others are likely to look at more global, use-related measures: Is it safe to swim here? How often do nuisance algal blooms limit recreation use? This mix of disparate measures for evaluation adds another dimension of complexity to the system in which urban water managers operate.

## 2.2. Institutional arrangements

At each level in the urban water management system, institutional arrangements structure activity domains

and interactions among actors. While there is an extensive literature on water resource institutions from differing perspectives, the framework for institutional analysis developed by Elinor Ostrom and colleagues is particularly useful (see Bromley and Feeny, 1992; Burger et al., 2001; Ostrom et al., 1994, 1993; among others).

Ostrom and colleagues define institutional arrangements as rule-sets that direct or constrain actions at multiple, nested levels (Fig. 2; Kiser and Ostrom, 1982; Ostrom, 1986). Each level incorporates situations where choices are made and actions taken. Decisions at the *operational level* determine individual actions, patterns of interaction, and outcomes in the physical world. Decisions at the *collective choice level*, in turn, determine the rule sets or institutional arrangements that govern decisions at the operational levels. Finally, decisions at the *constitutional level* determine the rule sets that direct or constrain actions at the collective choice level. While actions at higher levels bound those at lower levels, actions at the operational level are the ones that directly affect resources and the distribution of outcomes of resource use. Monitoring and assessment information, in turn, provides feedback at the operational level about the distribution of outcomes; this information may also feedback to the collective and constitutional choice levels (Kiser and Ostrom, 1982).

In the urban water management arena, operational rules affect the public’s daily appropriation decisions concerning the use and consumption of resource streams. They also affect production decisions, which are the more technical actions required to extract a product (e.g. production of treated drinking water; Ostrom et al., 1993). At the next level, collective choice rules establish management policies and programs that direct or constrain appropriation and production decisions. Constitutional level rules, in turn, specify governance or collective choice structures. Monitoring and assessment, then, provides feedback on resource status for use by operational actors when making appropriation and production decisions. That feedback may also be used at higher levels in decisions regarding the rules that direct or constrain action at lower levels.

In short, institutional arrangements structure the IUWM hierarchy. As implied in the preceding discussion, these arrangements and the resulting hierarchy of actors are not necessarily static. Management systems can change when a portion of actors shifts from actions at the routine, operational level to the higher collective choice or constitutional levels. This institutional transformation may follow the adaptive cycle introduced by Holling (1986, 1995, 2001). In this cycle, a system passes through a conservative phase terminating in a crisis. This is followed by a creative destruction phase leading

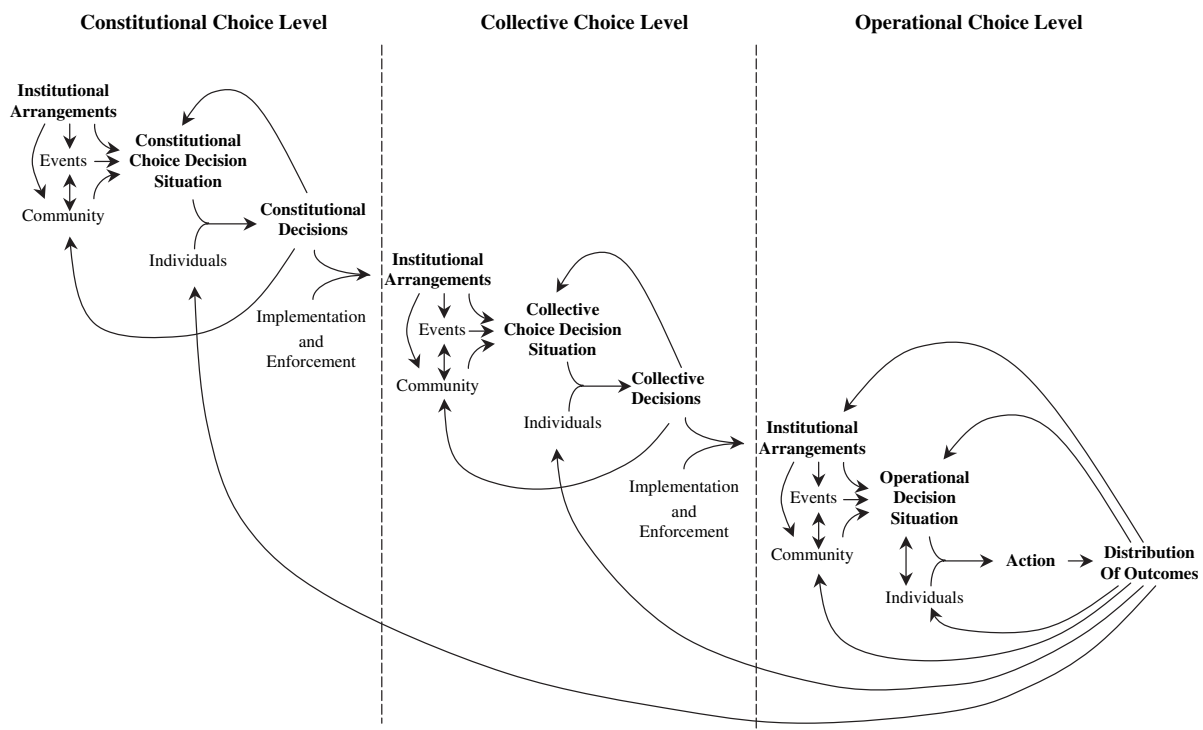


Fig. 2. Levels of action from an institutional perspective (adapted from Sabatier, 1991). Three distinct levels of action can be identified in resource management and use: constitutional, collective, and operational. Individual decisions, which affect the physical world, are made at the operational level and are controlled by institutional arrangements and decisions made at the collective choice level. Constitutional choice decisions, in turn, constrain those of collective choice level.

to reorganization. The cycle completes when the system transforms from its reorganized state with improved resource exploitation back to a new conservative phase. A crisis in the form of sub-optimum outcomes in resource use or other evidence of institutional failure can precipitate a non-routine change in the level of action by operational actors, moving them to action at the higher collective choice or constitutional levels, one condition for development of alternative solutions to common pool resources problems (Ostrom, 1991; Ostrom et al., 1994; Schlager and Blomquist, 2000; Schlager et al., 1994). The non-routine actions may then guide the system through the creative destruction and reorganization phases (Gunderson et al., 1995a).

This framework has been developed through analysis of common pool resources (CPRs), the natural or human-made stocks that generate flows of resource units over time (Ostrom, 2000). Examples include the receiving waterbody in an urban water system, a resource system that provides a flow of services including waste assimilation and recreation among others. CPRs pose substantial management challenges. Traditional models of these challenges predict that, without external control, outcomes will be sub-optimal. These models are often interpreted as directing one of two mutually exclusive solutions: central, bureaucratic management or privatization of the resource (Ostrom, 1991). Both theoretical arguments and empirical studies, however, demonstrate the potential for institutional solutions between these extremes (Blomquist, 1992; Ostrom, 1991; Ostrom et al., 1994). These solutions usually involve some degree of organization among resource users and development of self-governing institutions for specific resources. Such self-organization may generate internal control that is more distributed, a type common in complex systems (Siljak, 1991).

Inherent in this institutional perspective is the recognition that resource management generally, and urban water management specifically, is not simply a technical endeavor. The network of managers is embedded in a complex matrix of tax or rate payers, customers making individual appropriation decisions, and other members of the public. This context creates a participation imperative, in that integration of urban water management will require engaging the public with the goal of, at least, neutrality and, preferably, better informed and more supportive stakeholders.

### 2.3. The 'who' and 'how' of participation

Participatory processes may involve a variety of actors who participate in different ways (Chess et al., 2000; Korfmacher, 2001; Rosener, 1978). A populist view of government argues for direct participation by individuals in processes with relatively open access and limited a priori criteria for participation. Stakeholder

involvement initiatives, in contrast, are based on the principles and institutional philosophy of pluralism (Fiorino, 1988). A pluralist view advocates representative processes involving agents from multiple, competing interests (Blahna and Yonts-Shepard, 1989). This view emphasizes collective action and the shaping of policy through the political competition of interest groups, a perspective generally familiar to resource management agencies (Pritchard and Sanderson, 2001).

Applying these perspectives to the question of participation in urban water management highlights three groups of actors, each with a range of motivation and capacity for participation. Most broadly, participation efforts may be populist in nature, targeting the broad, diffuse *general public* as the pool of consumers and rate/tax payers who fund urban water management and who generally benefit from its results. A variation is to target the *attentive public*, the subset of the general public that, for various reasons, has a sharper interest in water resources and the management agencies that affect them but may not be actively engaged with the issues through participation in organized interest groups (Rainey, 1991).

Finally, the most intensive participation efforts often follow narrower pluralist premises, targeting organized interests or *stakeholders*. Stakeholders can be characterized in one of five ways (Table 2). Most broadly, stakeholder involvement includes those responsible for, affected by, or expert in a particular issue or decision. People who hold multiple perspectives and offer different kinds of knowledge about the issue, including operations managers, other experts, and sectors of the general public, are all potential participants (Hart, 1986).

Different types of stakeholders may not be mutually exclusive. Public officials, for example, may come from agencies that have a stake in the outcome; thus, they are both decision makers and affected parties. It is also important to recognize that stakeholders often come into these forums as 'cooperative antagonists' (Raiffa, 1982). As such, participants recognize their diverse

Table 2  
Potential participants in stakeholder involvement initiatives

Actor description	References
Actors who will be directly impacted; likely to receive benefits or bear costs of a decision	Ozawa (1993), DeLeon (1992)
Interest groups with indirect claims to shared resources	Bonnicksen (1985)
Parties with technical and/or non-technical expertise	Ozawa (1993), Hart (1986), Stewart et al. (1984)
Formal decision makers from agencies with direct responsibility, from peripheral agencies, and from other units of government	McKinney (1990), Bonnicksen (1985)
Actors able to influence implementation of decisions	Thomas (1993), Ryder and Taylor (1993)

interests and agree to work toward common ground, but expect themselves and other participants to be primarily concerned with their own interests (Collins, 1990).

For urban water managers, the key is to recognize that there is a heterogeneous set of external actors whose understanding of IUWM and support for system improvements can be built through engagement. In addition, different modes of participation may be desirable depending on the purposes for engagement (Arnstein, 1969; Blumenthal and Jannink, 2000; Chess et al., 2000; Chess and Purcell, 1999). Purposes of engagement can be conceptualized as a continuum with four nodes that reflect participants’ degree of influence or authority for final decisions (Fig. 3). On the left-hand side of the continuum, participants are peripheral to decision makers. On the right, participants are more closely connected to decision makers. Consultative forums involve a range of parties in structuring problems and identifying potential solutions. Decision making forums, in turn, involve stakeholders including those affected by decisions and those with formal decision making authority in joint, substantive decision making.

The specific structure for a given participatory initiative is framed by rule sets that define institutional arrangements. Of seven distinct types of rule sets (Kiser and Ostrom, 1982; Ostrom, 1986), four are particularly relevant to participation in urban water management: scope rules, authority rules, position rules, and information rules (Table 3). In this context, *scope rules* define the outcomes that may be affected by a participatory initiative. For example, urban water managers may undertake participation with a relatively narrow scope such as operational aspects of a new facility. Alternatively, a participatory effort may have broad scope, addressing an array of issues related to water quality in streams that receive multiple wastewater discharges as well as stormwater runoff. *Authority* and *position rules*, in turn, define the components of a participatory initiative and the participants in each position. Some components may have consultative or decision making authority, with position rules specifying a small number of participants; others may be designed as advisory forums with a large number of participants. Finally,

Table 3  
Typology of rule sets (Ostrom, 1986; Kiser and Ostrom, 1982)

Rule type	Specifications
Position rules	Set of positions in participatory processes and how many participants hold each position
Scope rules	Set of outcomes that may be affected and the external inducements and/or costs assigned to each of these outcomes
Authority rules	Set of actions assigned to a position (i.e. the actions each participant is authorized to take)
Information rules	Channels of communication among participants and the language and form in which communication will take place
Boundary rules	How participants are chosen to hold positions and how participants leave these positions
Aggregation rules	Decision function(s) to be used at a particular decision points
Payoff rules	How benefits and costs are to be distributed to participants in different positions

*information rules* determine the access to various types of information and the forms in which information will be conveyed (e.g. real time monitoring results; quarterly reports with summary measures; reports from subsistence fishers).

It is important to note that these different types of rules are operable in decision situations at each level of action (Kiser and Ostrom, 1982). For a fishery, for example, scope rules at the operational level may delimit the location or time period in which harvesting is allowed (Schlager et al., 1994). Collective choice decisions about management of the same fishery are also delimited by scope rules, which may direct a scope of collective action limited to rules that define acceptable harvest conditions or may be defined more broadly, addressing the rule sets that manage water quality or habitat impacts on the fish population, for example. It is also important to note that overlapping groups of actors may be involved at more than one level. The key difference between levels is not the actors but the rule configurations that constrain or direct action and, for the collective and constitutional choice levels, the rule sets that are the object of potential modification (O’Toole, 1993). Again, depending on the specific rule configurations, collective or constitutional choice situations may involve resource users, a condition

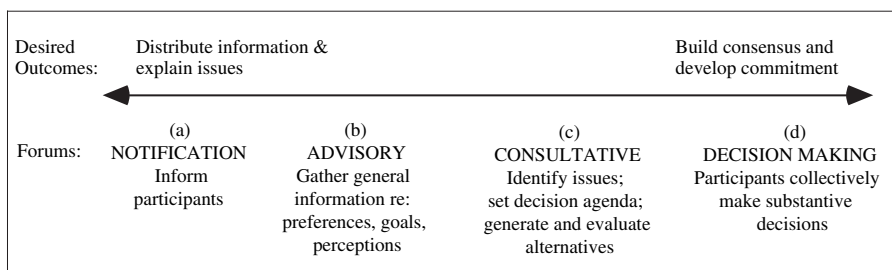


Fig. 3. Continuum of authority for participatory decision making. The reasons to engage outside participants in a decision can be conceptualized as a continuum with four nodes that reflect participants’ degree of influence or authority for final decisions. Participants’ proximity to decision making increases from left to right.

associated with transformation to more effective systems for management and governance of common pool resources (Ostrom, 1991; Ostrom et al., 1994; Schlager and Blomquist, 2000).

#### 2.4. Potential outcomes of participation

Studies of participation in environmental decision making provide evidence of a range of positive outcomes (Cowie, 1999) and one of the most frequently noted provides a starting rationale for broader participation in IUWM: building increased legitimacy and support. This rationale subsumes two types of potential outcomes. The first relates to the perceived credibility of decisions, with participation providing an broader base of information for decision making and a presumptive basis of reasonableness in resultant decisions (Collins, 1990; Durning, 1993; Ryder and Taylor, 1993). The second goes beyond discrete decisions to the more fundamental question of governmental legitimacy. Involving parties beyond traditional decision makers may enhance the legitimacy of the management system itself through collaborative learning, identification of solutions that provide a better fit across the natural and social components of the system, and shared ownership of results (Costanza and Ruth, 1998; Fiorino, 1990; Korfmacher, 2001). As such, broader participation in decision making can enhance the system's present and future decision making capacities (Fischer, 2000).

These outcomes, of course, are not a given. Poorly structured or poorly managed participatory processes are likely to damage the perceived legitimacy and degrade support for resultant decisions or the broader management system. The rule sets that configure participation, in particular, may be defined in a way that decreases the likelihood of positive outcomes from a participatory initiative<sup>1</sup>. Authority and position rules, for example, may limit the breadth of participation to more organized, influential interests, reflecting pluralist biases and undermining the credibility of the process and resultant decision (Durning, 1993). The scope of activity of a participatory initiative, or the authority given to participants, may be misrepresented or defined in a way that does not fit the breadth of participation or the characteristics of the resource system and pending decision(s). Information rules, in turn, can minimize use of local knowledge, resulting in over-reliance on external expertise and limiting the robustness and implementability of decisions (Fischer, 2000).

The institutional framework presented here, incorporating different levels of action and discrete rules sets

operable at each, provides a way to critically assess structures for participation in IUWM. This can be done in post hoc analysis, as indicated in the following case study, or in a design phase prior to a participatory initiative. Questions of interest include the following: What is the scope of the problem or decision at hand, and what is or was the scope of a participatory initiative? Who participates in different components of the participatory structure and with what authority? What information is needed for decision making and how is or was it conveyed to participants? Considering these as design questions, and tailoring the answers to the characteristics of the specific resource-management system and the decision(s) at hand, can increase the likelihood that engagement will lead more informed, supportive stakeholders and increased legitimacy for the management system (Cowie, 1999).

Looking beyond increasing support and legitimacy, we come to a second rationale for broader participation in urban water management: participation can function as a mechanism for management system transformation, potentially fostering more effective institutional arrangements and improved environmental outcomes (Beck et al., 2002; Gunderson et al., 1995b; Holling, 1978). More specifically, does participation contribute to emergence of coordinating mechanisms or structures in an urban water management system? As highlighted by the institutional analysis framework outlined above, engagement of multiple actors can contribute to exactly this sort of institutional change. Following the language introduced by Ostrom and colleagues, if established with sufficient scope and authority, participatory structures can provide a forum for collective choice that directs changes in rule sets at the collective choice or operational levels and thus, changes in the management system and resultant patterns of resource use. Further, such a forum can involve resource users in collective choice decisions regarding governance and resource management, a condition associated with more effective solutions to common pool resource problems (Ostrom, 1991). Different collaborative approaches may result in this type of system transformation including adaptive environmental assessment and management (Gunderson et al., 1995b; Holling, 1978; Lee, 1993; Walters, 1986) and adaptive community learning (Beck et al., 2002).

The two rationales for broader participation are particularly significant in areas where development and increasing water/wastewater demands place growing pressures on the resource-management system. The metropolitan area of Atlanta, Georgia is experiencing just such pressures. Recent participatory initiatives in metro Atlanta, summarized in the next section, provides examples of both alternative structures for participation and the role that participation can play in management system transformation.

<sup>1</sup> It is worth noting that this discussion focuses on the institutional arrangements or structures for participation, neglecting questions related to the dynamics of individual choices and actions within these structures. The latter is an equally rich topic with obvious implications for the outcomes of participation but is beyond the scope of this paper.

### 3. Participation and transformation toward more integrated management in the Atlanta metro area

Over the past two decades, the Atlanta region has been among the fastest growing metropolitan areas in the United States. While the region lies in five major river basins, it relies on the Lake Lanier-Chattahoochee River system for the majority of its water supply; that system also receives a significant portion of the region's wastewater discharge. The Chattahoochee basin upstream of the City of Atlanta is approximately 3761 km<sup>2</sup> and the river is relatively small when it enters the metro area (annual average discharge of roughly 74 m<sup>3</sup>/s at Peachtree Creek). Lake Lanier is a large reservoir in the headwaters of the system (150 km<sup>2</sup>), constructed in the 1950s with hydroelectric production and navigation as designated purposes. Water supply and maintenance of downstream flows for wastewater dilution have since become important uses of the lake. Although the Chattahoochee is one of the smallest rivers serving as the primary source of water among U.S. metro areas (CWI, 2000), storage in Lake Lanier and other reservoirs in the region has supported intensive urbanization, with high rates of development evident today on the periphery of the metro area (Fath and Beck, 2004).

Stresses on the resources of the Lanier-Chattahoochee system have, of course, accompanied intensive development. In recent years, there has been an increased investment in the region's water management infrastructure. This investment has been driven by current and pending water quality problems, by judicial action in response to water quality impairments, and by approaching limits on wastewater treatment capacity (CWI, 2000).

Concurrently, the region has seen increasing attention to participation in urban water management. Participatory initiatives have varied widely, ranging from those focused on allocation of water among states to those addressing watershed contributions to loading from combined sewer overflows. Among recent participatory efforts in the region, three examples are particularly useful in illustrating the rule sets that structure stakeholder participation at operational and collective choice levels as well as nested ecological and social scales (Pritchard and Sanderson, 2001). They also illustrate the role that participation can play in increasing legitimacy of urban water management efforts and as a mechanism of institutional change.

#### 3.1. Participation at the operational level

The first example is the Citizen Advisory Board of the F. Wayne Hill Water Resources Center. It is an example of stakeholder involvement in facility design and operations, including provision of feedback at the operational level via monitoring. The participatory initiative

was undertaken to build a base of more informed and supportive stakeholders<sup>2</sup>. A project of Gwinnett County, the Hill WRC is an advanced wastewater treatment facility with a capacity of 20 million gallons per day. The facility uses high pH lime clarification, granular media filtration, carbon adsorption, membrane filtration, and ozone disinfection in addition to conventional secondary treatment and biological nutrient removal.

Because its design included effluent discharge directly to Lake Lanier, a major regional drinking water source and recreation resource, the facility proved controversial early in the permitting process (Fath and Beck, 2004). The design embodies principles of indirect water reuse. In Georgia, however, that approach has seen only limited implementation, a factor contributing to skepticism about the proposed facility. As part of the subsequent effort to build public support, the Gwinnett County government established a Citizen Advisory Board (CAB) as a quasi-autonomous forum for ongoing or routine stakeholder participation in facility design and management (Table 4).

The formal (i.e. written) rules that structure participation establish a forum with the CAB as the sole component. Positions on the CAB are filled by representatives from four sectors, with the number of participants from each limited to one or two. The Board is charged with disseminating information about the facility, providing feedback to the county, maintaining open communication between the county and the public, and monitoring facility development and operations. Overall, the formal rule sets that structure this forum define it as one with relatively narrow participation and limited, consultative authority – with one significant exception. The Board's responsibility for monitoring and oversight is supported by direct decision making authority for a budget line of \$50,000, a distinctive feature of this example.

Since its inception, the CAB has been quite active, providing substantive consultation during facility design and development. The Board drafted its own bylaws to define measures of project success and specify its interface with county government. During the design phase, the Board toured a comparable facility in another jurisdiction and hired consultants to evaluate alternative treatment technologies. Following the transition from design and development to an operational mode, the Board has remained active with good attendance at

<sup>2</sup> Information presented here is drawn from the Bylaws of the Citizen Advisory Board, available from the Gwinnett County Public Utilities Department, Lawrenceville, Georgia; a presentation by Frank Stephens at the Symposium on Public Perception and Participation in Water Use, August 2001, Washington, DC; and an interview with Frank Stephens, Gwinnett County Public Utilities Department, conducted on December 12, 2001.

monthly meetings and substantive interaction with facility managers.

The Board's exercise of consultative authority, as well as decision authority over a dedicated budget line, is posited in large measure on the information rules that structure this participatory forum. First, county staff is formally charged with responding to specific design questions from the CAB (e.g. why are you using ozone disinfection rather than the cheaper *uv* technology?). Second, CAB members have access to every facet of plant operations, including the authority to take or split samples for independent analysis. Finally, during the permitting process, the county agreed to implement a monitoring program that goes well beyond state and federal requirements. Since plant operations began, monthly monitoring reports and daily monitoring data have been available to CAB members.

To date, the plant has over-performed in comparison with permit limits and Board members have not seen a need for additional information or critical feedback/response. In short, this structure for routine participation at the operational level has made it past design phase negotiations and established on-going exchange and input during normal operations. What might occur if the plant begins to under-perform, however, remains an open question. The record of participation in this example reflects public concern about the risks of a tighter loop between drinking water and wastewater, concerns similar to those identified by Pahl-Wostl (2004). Redundancies in facility design were emphasized as a response to these concerns during design and development. During on-going operations, however, it remains to be seen how such concerns, and use of information to support or refute them, will play out if problems in plant performance are perceived or become evident.

### 3.2. *Non-routine collective choice*

The second example of participation in urban water management in the Atlanta area is the Clean Water Initiative. Formed in 2000 by the Metro Atlanta Chamber of Commerce and the Regional Business Coalition, this initiative is an example of non-routine participation in decisions at the collective choice level<sup>3</sup>. Following the concepts introduced earlier in this paper, the CWI example demonstrates a shift in the level of

action from operational, appropriation decisions to a higher level, focusing on the management structures and policies that direct or constrain those decisions (Fig. 2). Interestingly, the impetus for action at this higher, collective choice level came from *outside* the set of actors formally responsible for urban water management. This example demonstrates self-organization among resource users, a condition for development of alternative solutions to common pool resource problems (see p. 8; Ostrom, 1991; Ostrom et al., 1994; Schlager and Blomquist, 2000), and parallels a mechanism for institutional transformation following Holling's adaptive cycle identified by Gunderson et al. (1995a).

At the outset, the CWI focused on two problem areas: (1) ambient water quality; and (2) wastewater treatment capacity. Water supply was acknowledged as a longer-term concern likely to be addressed in other venues. The formal rules that structured the CWI are summarized in Table 4. This example again has a single component: the CWI Task Force. In comparison with the example described above, however, this structure has a much broader scope. Consistent with that broader scope, the task force has more participants representing a wider array of sectors (including elected officials who were also authorized actors at the constitutional level shown in Fig. 2). Further, it has greater authority because it was convened as a decision making forum with responsibility for recommending changes in management structures and policies to address water quality and wastewater capacity problems.

The informal rules that defined the structure of this participatory forum placed a premium on information exchange as a prelude to decision making. From April to October 2000, staff and task force members gathered and reviewed a large volume of information on current and projected conditions of specific resource streams and the underlying natural system, sources of impacts, and management practices. This material was packaged in nine volumes of presentation materials, with Task Force meetings structured around these volumes. Task Force members used the presentation materials as information resources throughout their deliberations. A corollary information rule emphasized a transparent information base and openness in decision making. Task Force meetings were open and well-publicized, were supplemented by dedicated public input sessions, and presentation materials were made available via the World Wide Web after each meeting. While use of the World Wide Web does not serve as an information resource for members of the general or attentive public with limited Web access, in this case, it did serve as a resource for the broader pool of organized stakeholders with interests in the Task Force's process and decisions.

Presentation materials played a significant role in moving the Task Force discussion forward, emphasizing

<sup>3</sup> Information for this example is drawn from the Final Report of the Clean Water Initiative distributed by the Metro Atlanta Chamber of Commerce, Atlanta, GA and available at <http://www.cleanwater-init.com>; presentations made at meetings of the Clean Water Task Force available at <http://www.cleanwaterinit.com/issues.htm>; a presentation by Kevin Green at the 2001 Georgia Water Resources Conference, March 26–27, 2001, Athens, GA; and an interview with Kevin Green, Metro Atlanta Chamber of Commerce, conducted December 19, 2001.

translation of technical information on resource use and conditions into forms useful to this heterogeneous set of decision makers. Two types of information were seen as particularly useful. The first was an indicator of the condition of the resource stock: a map of waters in the region that violate water quality standards. Over 1000 stream and river miles in the metro Atlanta area do not currently meet water quality standards and many segments are yet to be evaluated. When mapped, this visual seemed compelling to Task Force members, many of whom were scientifically-lay business leaders. The second type of information cited as significant is an indicator of the condition of a specific resource stream: a chart of current wastewater discharges and treatment capacities across the region. This chart and supporting materials showed little excess capacity and demonstrated that, due to the small size and degraded quality of receiving streams, the ability to expand capacity in the near future is limited.

This information highlighted the connections between wastewater capacity, stormwater runoff, and ambient water quality, creating a macro-level picture of the region's water resource problems. This picture clearly demonstrated sub-optimal outcomes in resource use and the inadequacy of status quo institutional arrangements. Participants concluded early in the process that changes in the management system were necessary. After reaching this conclusion, the Task Force developed recommendations for a new, coordinating component of the metro area's water management system. This component was formally established through legislation passed by the Georgia General Assembly and is described below as the third example of participation in urban water management in this region.

### 3.3. Institutionalizing routine collective choice

In 2001, largely following the recommendations of the Clean Water Initiative, the Georgia General Assembly creating the North Metro Georgia Water Planning District (NMGWPD)<sup>4</sup>. Again using the concepts illustrated in Fig. 2, non-routine collective choice by participants in the CWI led to constitutional-level action to institutionalize routine participation at the collective choice level. This example demonstrates a transformation toward more integrated urban water management in this region, implemented through a new

forum for self-governance among resource users (a second condition for development of alternative solutions to common pool resource problems; (Ostrom, 1991; Ostrom et al., 1994).

NMGWPD is charged with coordinated planning for wastewater management, stormwater management, and water supply in a 16-county region. While implementation responsibility rests with local governments, the NMGWPD's plans are expected to largely direct the development of the region's water infrastructure. The formal rules that structure the NMGWPD are summarized in Table 4. This example has a relatively elaborate set of institutional arrangements, consistent with a scope that covers integrated regional planning for stormwater, wastewater, and water supply/conservation. The structure for participation includes eight distinct components, with breadth of participation ranging from 27 on the decision making component to more than 250 participants formally designated in consultative or advisory capacities.

Like the preceding examples, information rules are a significant component of the structure. One element emphasizes distribution of information on resource conditions to the general public. The legislation that established NMGWPD requires that the stormwater, wastewater, and water supply plans each include education and public awareness components, stating that these efforts should be designed to reach 75–90% of the NMGWPD's population in the next 5 years. This element of the NMGWPD's work is expected to include an interactive website organized around the state's 14 major river basins. It is interesting to note that NMGWPD itself lies in portions of only five of these basins. The website, however, is being designed as a statewide resource to emphasize upstream-downstream connections.

Perhaps more significant for the goal of integrated water planning, the legislation also charges NMGWPD with regional cooperation in development of a coordinated water quality monitoring program and regional database. The regional database will include an automated system for measuring and depicting impervious surfaces in the region. Impervious surface measurements are recognized as a key indicator of ambient water quality conditions, and the ability to produce visual representations is seen as a powerful tool for public education and outreach.

Integrated water planning, of course, is not the same as integrated water management, and the NMGWPD's effectiveness may ultimately prove to be limited by a disconnect between planning and operations. In this case, local water and wastewater managers were consulted frequently as the proposed district was developed, and two aspects of the institutional structure are intended to increase the likelihood of implementation at the operational level.

<sup>4</sup> Information for this example is drawn from the 2001 Activities and Progress Report of the North Metro Georgia Water Planning District available at <http://www.northgeorgiawater.org>; Georgia Code §12-5-570 et seq.; the interview with Kevin Green referenced in the preceding note; an interview with Rick Brownlow, Atlanta Regional Commission, conducted December 19, 2001; and an interview with Becky Champion, North Metro Georgia Water Planning District Governing Board member, conducted January 8, 2002.

Table 4  
Selected structures for participation in urban water management in the Atlanta metropolitan region

Position	Participants	Authority
<b>W. Hill Water Resources Center: participation at the operational level</b>		
Citizen Advisory Board	Business: 1	Consultative w/narrow budgetary decision authority
	Environmental NGO: 1	
	Local government: 1	
	Nearby residents: 2	
Scope:	Resource focus: wastewater treatment (single facility)	
	Institutional scope: limited to design and operational level decisions (monitoring and oversight)	
<b>Clean Water Initiative: non-routine collective choice</b>		
CWI Task Force	Business/industry: 21	Decision-making
	State: 5	
	Local government: 8	
	Substate region: 1	
	Non-governmental: 5	
Scope:	Resource focus: water quality and wastewater capacity in a 10-county region	
	Institutional scope: strategies and structures the region should use to address these issues	
<b>North Metro Georgia Water Planning District: institutionalizing routine collective choice</b>		
Governing Board	Local government: 17	Decision-making
	Business/industry: 6	
	Academic: 1	
	Consultant: 2	
	NGO: 1	
Technical Coordinating Committee	Local government: 46	Consultative
	Regional council/auth.: 6	
	Consultant: 2	
Basin Advisory Councils	Multiple sectors: 217 members on 6 separate councils	Consultative or advisory (to be determined)
Scope:	Resource focus: surface water quality and quantity in an 16-county region	
	Institutional scope: develop integrated regional plans for stormwater management, wastewater management and waste supply/conservation.	

First, a Technical Coordinating Committee (TCC), composed primarily of representatives from local water and wastewater utilities and authorities in the region, serves in a consultative capacity (Table 4). To date, the TCC has been actively involved in shaping the NMGWPD's work products and it is expected to make significant contributions to development of the final plans. Not surprising given their firsthand experience, many TCC members recognized the need for better coordination in management of the region's water resources before this became common parlance among local elected officials. While the long-term effect remains to be seen, the TCC's active engagement with the elected officials on the NMGWPD's Governing Board may provide a link between the planning and operational levels that enhances the integration and ability to implement provisions for water supply, stormwater management, and wastewater management.

Second, the state agency that permits water withdrawals and wastewater discharges has an oversight role and the NMGWPD's plans must be consistent with planning standards established by that agency. More importantly, once the plans are completed, consistency with regional plans will be a condition for water withdrawal and wastewater discharge permits granted by the state. In addition, local governments that do not

implement the applicable provisions will be ineligible for state grants and loans.

While an active TCC, oversight by state regulators, and permit consistency with regional plans may provide a link between planning and operational levels, the effectiveness of these provisions remains to be seen. And, three related aspects of the structure may actually impede integration at the operational level: domination of the decision making component by local elected officials, a structure that historically has a poor track record in the Atlanta region; little decision making authority for non-governmental stakeholders; and participation of operational managers in a restricted consultative capacity.

In short, the NMGWPD's ability to accomplish the promise of more integrated water management remains an open question. But, to many of the water managers and external parties that participated in its development, no other alternative was acceptable. Status quo institutional structures were clearly failing. Removing direct water management authority from local governments and vesting greater authority at the state or regional level, however, was not politically tenable. Memoranda of Agreement between local governments might provide an alternative coordinating structure but would probably result in an inconsistent patchwork of

agreements among the more than 100 localities in the region. At this point in the transformation of water management in the Atlanta area, a new coordinating level in the hierarchy was needed, even if limited to a planning capacity. This adaptation occurred through participation in non-routine collective choice and, in turn, institutionalizes routine participation in management of the region's water resources.

#### 4. Discussion

The recent initiatives in the Atlanta metro area illustrate several important aspects of the institutional framework for participation in urban water management. The first is the array of potential structures for participation and the assortment of actors who might participate. The scope in these examples ranges from design and operations of a single facility to integrated planning for a large region. The number of components and breadth of participation range from a single component with very narrow participation to a multi-component structure with nearly 300 authorized participants. As noted above, the different dimensions of participatory structures suggest design considerations for urban water managers as they seek to engage external parties. Applying these design considerations to specific resource-management systems and decision situations can increase the likelihood that the benefits of greater support and legitimacy can be gained from particular participatory initiatives.

A second important aspect of the institutional framework for participation in urban water management is the increasing significance of informational elements. No longer limited to reporting for regulatory compliance, information on operations and outcomes can be a tool with which to build support for more integrated water management. As seen in the Hill WRC example, information on operations and outputs can, at least initially, offset concerns about tightening the loop between wastewater and water supply. At a broader scale, as seen in the other examples, information on conditions of the resource stock and key resource streams can demonstrate the insufficiency of current institutional arrangements and the need for transformation in the management structure.

Finally, the examples demonstrate that engagement with external parties can be a mechanism for institutional change. In the Atlanta case, an intensive participatory initiative led to the emergence of a new level in the management hierarchy. Actors involved in the participatory initiative recognized that current institutional arrangements were yielding sub-optimal or undesirable resource outcomes, with degradation of the resource stock of particular concern. This provided the impetus for self-organizing at the collective choice

level to create a new coordinating structure. Recognition of the undesirable conditions can be interpreted as the crisis required to initiate system transformation in Holling's adaptive cycle. As suggested by Gunderson et al. (1995a), this participation initially emerged outside of the existing management structure.

In complex systems, tension often exists between the constraints imposed by higher levels of organization and self-organizing at lower levels. At the same time, higher level constraints can provide opportunities for improved system control and performance. In the Atlanta case, the new coordinating structure provides a mechanism for broader exchange of information on resource conditions and use, for coordinated planning and, potentially, for coordination of activities at the operational level.

The new structure may provide an opportunity for optimization of the regional water system as a whole, in contrast to the current optimization of individual parts with sub-optimal performance on the regional scale. This opportunity will only be realized, however, if the new NMGWPD can successfully bridge the split between planning and operations and be effective over the entire management life-cycle (Beck, 2004; Blumenthal and Jannink, 2000), a task in which informational elements may have a role. More specifically, the NMGWPD could develop regional measures to assess resource management effectiveness. A common set of outcomes or effectiveness measures, defined at the regional coordinating level, might serve to tailor operational-level activities if the measures are salient and applicable to operational-level actors. How to design and use such measures, potential interactions with other incentives/disincentives at the operational level, and the effect they may ultimately demonstrate in practice are questions that deserve further exploration.

Transformation of management systems like that seen in the Atlanta region is not a frequent occurrence. This leads to the question of what features may be prerequisites for this type of institutional change. From the institutional and system dynamics perspectives, we can identify three conditions that promote transformation in the management system structure (i.e. the network of actors and their spheres of influence). The first is increasing complicatedness at the operational level. Following Allen et al. (2001), when a system becomes too *complicated* at one level in a hierarchy, it must become more *complex* by generating new levels in the hierarchy. By creating this kind of complexity, the system can use its resources more efficiently. As an illustration, consider the metro Atlanta case and contrast the resource requirements of a series of inter-local agreements as a potential coordinating mechanism (transaction costs, in particular) versus the resource requirements of the planning district as a new level in the hierarchy.

The second condition that appears to promote transformation in management systems is information indicating the development of sub-optimal outcomes in resource use or, put differently, evidence of collective institutional failure or crisis. As noted above, this is a key element explaining system transformation using Holling's adaptive cycle. The third, then, is institutional arrangements for non-routine activity at the collective choice level (i.e. the capacity for self-organizing). Under these conditions, one may see a shift in level of action from the operational to the collective choice level. Service providers, other managers, and resource users can be involved in participatory initiatives that serve as a mechanism of institutional change (Cowie, 1999; Schlager and Blomquist, 1996).

In this paper we have suggested that urban water management can be enhanced by greater integration of actors and management institutions, making use of alternate levels in an IUWM hierarchy. At the core, this integration occurs through the creation of new, perhaps differently structured, informational links to facilitate actor collaboration. Similarly, the use of real time control in IUWM (Beck, 2004; Meirlaen and Vanrolleghem, 2004) creates additional informational connections from the physical infrastructure to the management actors and institutions. Benefits can arise from this increased integration or connectedness, but there can be too much of a good thing. Increased connectedness may also introduce additional costs and hidden dangers. While considering integration for urban water management, Beck (2004) notes 'paralysis may eventually set in, as we become captive of too much detail'. From an institutional perspective, there are two primary perils to consider. First, with increasing connections the total system transaction costs may increase. It may take more time and energy to communicate with all of the collaborating actors and integrated elements of urban water infrastructure. Second, with increasing integration the consequence of failure may amplify. The 2003 power blackout in the northeastern United States and the rapid spread of the Internet virus MSBast are striking examples of this kind of danger (Schiesel, 2003). Making it more complicated, the connection topology – how the system is integrated – can alter these risks (Barabási, 2002; Dunne et al., 2002). Ultimately, the costs and benefits of integration in urban water management will need to be evaluated for each system.

Institutions for water management are an important component of IUWM. Consideration of their role in addition to the basic infrastructure (e.g. wastewater treatment plants, sewer networks, source and receiving water bodies, drinking water plants) leads to a more complex understanding of the system of interest. Through the conceptual framework and case studies presented in this paper, we have illustrated how water

management institutions can: (1) work as integrators of disparate components of urban water management; (2) structure participation of a variety of actors; and (3) organize the communication of information between actors and institutions within a nested institutional hierarchy. The case studies also demonstrate the potential for institutional transformation in response to the influence of information and participation at the non-routine collective choice level.

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