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Collective action in multilevel water governance and management: variation by scale and problem type

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Abstract

A set of water decision scenarios in the western U.S. provided examples about how collective action varies by scale and type of water management problem. Once problem scales exceed the microwatershed level, it is difficult for individuals to represent themselves and they must express their choices through representatives. Empowerment to make collective decisions is highest at local scales where consequences of resource decisions are borne by those who are empowered. As the scale increases, the conflicting priorities and impacts among multipurpose water issues become difficult to sort out and more formal decision approaches are needed. Findings from the cases show how empowerment falls off in different ways as scale increases, with more empowerment for planning problems and less for problems of infrastructure development and much less for regulatory actions. By showing how collective action varies by scale and problem type, insight is gained into both the governance and management of water. Clear identification of roles and responsibilities in contextual explanations of water problems at different scales can improve understanding of the reforms needed in management and governance.

Keywords: Collective action; Watersheds; River basins; Scale; Decision scenarios; Roles and responsibilities

1. Need for collective action in water management

The many demands for water create connections with other policy arenas and challenges to its management (Lenton, 2014). Effective collective action is required to resolve the many inherent conflicts that arise in balancing these multiple uses of water to meet the needs of society and the environment. The need for collective action is evident in issues ranging from equitable financing of urban water infrastructure to finding peaceful solutions to problems of water justice in lower-income rural areas. It is important because rising levels of conflict in problems such as water scarcity, pollution and habitat show that top-down command-and-control solutions have limited potential to resolve the tough multi-faceted issues that arise.

Collective action is an important mechanism required to achieve effective water governance, especially to respond to its connector attribute, which is expressed often to explain

complex water management challenges (Edelenbos, Bressers, & Scholten, 2013; Falkenmark, 2013). In a comprehensive review of water economics, the importance of collective action was explained by Hanemann (2006), who wrote that finding a workable mechanism for it to address water issues has ". . . become the subject of vast literature in economics, political science, sociology and game theory." As the processes for integrated water management develop, experiments with it can show how it requires different approaches for the scales and problem types discussed here.

While general notions are a starting point for discussion, a unified perspective is lacking about how collective action should occur across the many types of water problems at different spatial and governance scales. A common framework for how it should occur across these scenarios might help clarify roles and responsibilities and improve explanations of the multi-disciplinary practice field of water management and its governance. The main challenges are that water governance and water management are broad concepts subject to different explanations and collective action implies levels of agreement about courses of action that are difficult to achieve among stakeholder conflicts. Therefore, ambiguous definitions and inherent conflicts make collective action in water management difficult to explain.

Perceptions about the practice of water management extend from technical interpretations about water infrastructure to broad concepts of integrated water resources management (IWRM; Global Water Partnership, 2017). Savenije and Hoekstra (2017) explained that "People from different backgrounds seldom have the same idea about what water resources management implies." They concluded that water resources management is a diffuse field that includes "the whole set of scientific, technical, institutional, managerial, legal, and operational activities required to plan, develop, operate, and manage water resources." Similarly, Lenton (2014) explained that water management is difficult due to the "innumerable interconnections among water, energy, food, health, policy, the environment, climate, culture, social welfare, history, economics and politics, to name a few, and all operating on scales ranging from the local to the global."

If a boundary could be drawn around the water sector and its connections with other sectors disregarded, its management challenges would be clearer, but water professionals do not agree about the scope of it. Water governance is also interpreted in different ways, with topics ranging from empowerment of local water users to regulation of large and well-financed water companies. Collective action occurs across this spectrum from direct negotiations of a few persons to broad scenarios of governance involving groups and representatives. As it does, the spatial extent of water problems creates increasing scales of watershed systems and governance levels, and problem types range from well-defined technical problems to complex integrated issues involving multiple sectors and issues.

The concepts of water management and governance used here are based on the explanations in (Grigg, 2010), where both involve policy, planning and control functions, but at different levels. Water governance is the control mechanism over water management, which is the mechanism that organizes, directs and controls water and its infrastructure. The main distinction between water governance and water management lies in the control function. Water management controls the resource to meet the needs of society and the environment, and water

governance controls water management to make sure it does its job. These concepts are at a level that applies specifically to common water problems and do not deal with larger issues.

The many scenarios requiring collective action demonstrate the inherent complexity of water management itself, and they underscore how marshalling successful approaches to it comprises the major challenge facing water governance today. The challenge is embedded in many resource issues that were studied by Ostrom (1990) and colleagues, who were seeking models of successful collective action among resource issues that were far less complex than most water management issues. Thus, finding approaches that work across scenarios to unraveling water management conflicts and dilemmas is important work for water managers and policy makers.

The paper offers an analysis of how collective action occurs among different types of water management problems at different scales. Given the diversity of views on the topic and the ambiguous definitions involved, the paper cannot provide definitive models of much-discussed issues such as participation, empowerment, and decision processes, but it is able to advance real-world examples of how these occur at different scales and in different management scenarios.

The discussion begins by probing the question, "given the multi-faceted nature of water management, can required forms of collective action be related to recurring situations with similar watershed and governance scales?" Spatial scale is described by water accounting units as nested systems of watersheds of increasing size and governance scale is explained by levels and scopes of activities. A second question is, "can archetypes of water management scenarios be assembled to prove how required approaches to collective action fit patterns that are determined by problem types and scales?" To probe these questions, a few water management archetypes are assembled for purposes of analysis. A spectrum of participation is used to provide a framework to explain degrees of collective action. The data base for examples is from a system of watersheds and river basins in the western United States where experiences and scenarios are mirrored in other watershed systems.

The analysis illustrates how different forms of collective action occur in the diverse decisions scenarios that occur in water management and governance. How collective action takes place depends, of course, on the decisions and pivotal events that occur during the processes of water resources management. The framework through these processes occur continues to evolve and broaden as water professionals grapple with many connected societal issues.

2. Water resources management and governance

The disciplines of water resources management and governance span diverse types of problems that are hard to classify because water issues are interconnected with issues in other arenas. Is the central issue of water management the allocation of resources, or is it about coordinating multiple purposes such as handling wastewater, generating hydropower, and mitigating flood damages, as well as providing water supply? Participants from disciplines such as engineering, law, or economics will see it differently, but there are areas of consensus.

One area of consensus is about allocating the values inherent in using water. In writing about the unique attributes of the problem of water, Hanemann (2006) explained: "The generic problem of water is one of matching demand with supply, of ensuring that there is water of a suitable quality at the right location and the right time, and at a cost that people can afford and are willing to pay." While this explanation seems to focus on use of the resource, the concept can be extended to deriving other values from the handling of water, such as protecting people from being damaged by it.

A simple focus on allocating water blurs the clarity of water management in two ways. One is that satisfying demand for water (and its resource values) involves more than handling the wet resource and extends to related functions such as building infrastructure and organizing public services. This illustrates the connector attribute of water management, where the inherent mixture of functions makes it difficult to quantify costs and benefits involving public and private good attributes affecting multiple sectors. The phrase "water resources" serves well to explain how the connector attribute of water provides values that are derived in multiple sectors from its use, availability, and even avoidance of too much of it. The other way that the clarity of water management is blurred is that the accounting stance for valuing water uses varies by spatial and governance scales, which makes it difficult to know who benefits and who pays and to identify the incentive structures.

As an example of how water management involves more than resource allocation, consider the widely-reported water issues of lack of access to water and sanitation among residents of low-income countries. These involve water management, but they deal even more with social issues such as poverty and the organization of public services. As another example, consider water scarcity in irrigated regions. Finding more water may be an option, but measures such as charging schemes and adapting to scarce water may be more important. Finally, consider how flood loss prevention deals with land use and community resilience as much as it does with the management of water.

These complexities lead to a continually-expanding scope of understanding about water management as a discipline and to a much greater emphasis on water governance than in the past. In the U.S. the discipline focused initially on planning of water resources infrastructure systems and later it focused on sustaining environmental resources (Clawson, 1981; Griffin, 2012; Renne, 1950). As it addressed more topics, engineers sought to organize it as a sub-discipline and the American Society of Civil Engineers has created a designation of certified water resources engineers who are to be ". . . leaders serving society in advancing sustainable management of the world's water" (American Academy of Water Resource Engineers, 2017). Reaching beyond such technical approaches, the international community began to focus on water management at the 1972 United Nations Mar del Plata conference and again during the 1990s when the concept of IWRM emerged (Global Water Partnership, 2017; Grigg, 2014). Now the links of water management to sectors of development are recognized more completely (Falkenmark, Jägerskog, & Schneider, 2014; Thalmeinerova & Downey, 2014). As water management evolved as a discipline, the emphasis on participation through the democratic political process has also increased (Priscoli, 2004).

These continually-evolving concepts show water's role as a connector of issues rather than a single independent issue in itself. This leads to an explanation of water management

as a multi-level discipline that is founded on technical issues of handling water and extending broadly upward in complexity to address water's many connections with issues of other sectors. A current example can be found in ongoing discussions about the nexus among water-energy-food issues (German Federal Government, 2017).

The transition from water management to water governance involves an upward move from the realm of action to the realm of setting policy, enabling organizational capacity and imposing regulatory controls. Governance is such a broad concept that it must be applied with context in mind if it is to be understood well. Much of the current water governance literature is about how it connects to the development dialogue (Water Governance Facility, 2017), but the analysis here deals with a more specific question of how collective action occurs within it at different scales.

3. Problem types

To identify a range of problem types for this analysis, a set of case studies from a previous study was used (Grigg, 2015a, 2015b). The previous study drew from several sources to create a set of sixteen problem archetypes that recurred within the many case studies that were evaluated. Of the archetypes, five broad categories can be used to span their range (Table 1). Most of the sixteen were in the category shown for planning as a coordination tool, a result that reflected the missions of the groups publishing the cases, such as the Global Water Partnership (2017).

These problem types occur in the socio-political-technical arena (planning and coordination, building infrastructure and establishing services) and in the legal arena (allocating rights and operating regulatory programs). Other classifiers could be used, such as water supply versus wastewater, surface water versus groundwater, water quantity versus water

Table 1
Five archetypes of water management

Planning to coordinate water resource uses	The problem-solving process for change in watersheds. It might refer to coordination for conflict resolution or determining plans of action to improve or develop resources.
Allocating the right to use water resources	Judicial or administrative decisions such as water rights, permits, compacts or other agreements about division of water use entitlements.
Infrastructure development	Planning, construction, and operation of water infrastructure, whether owned by one entity or jointly by multiple entities.
Water-related services establishment	Utility or water district services that are planned, implemented and operated. The focus is on business or operating plans.
Regulatory programs	Regulatory programs for water use, water quality, health, environment, or safety. Normally, regulations are set by policy, and operating programs involve administering and enforcing them.

quality problems, among others. A further merger of the categories into three groups is made later to facilitate a focused analysis. These three groups are: planning and conflict resolution, developing infrastructure, and regulating water use and management.

4. Spatial and governance scale in water management

Scale factors in water management involve sizes of watersheds and governance systems. By mapping the problem categories according to them, clear distinctions begin to emerge in how decisions are made.

Watershed scales are amenable to clear classification because they can be delineated with spatial tools and a widely-accepted classification of them has been developed in the U.S. (US Natural Resources Conservation Service, 2014). In it, six levels of scale extend from about 40 square miles upwards to regions comprising several states. The smallest scale of the subwatershed at an average of 40 square miles is about the size of a typical U.S. city of 150,000 in population. To illustrate aspects of collective action in water management, two smaller scales have been added as shown below in Table 2 below.

When added to watershed scales, governance scales introduce the additional dimension of how decisions are made relative to size and scope of area and jurisdiction. Within the diverse forms of governance, there is today a great deal of discussion about how collective action and participation should occur in public decision forums. Much of the discussion focuses on how to marshal effective collaboration and in a recent special issue of the journal Public Administration Review the editors explained how collaborative public management is required to solve problems that transcend single organizations and require multi-sector relationships active involvement of citizens (O'Leary, Gerard, & Bingham, 2006). In the same issue, Fung (2006) explained how public participation can be defined by who participates, how participants communicate and make decisions and how discussions are linked with policy or public action.

Governance scales measure vertical authorities and scopes of authority. Seven levels of these were identified by Fiorino (2014), including four in a direct line through global, national, state-provincial and local levels. Three others are added to provide coordination

Table 2
Classification of U.S. watershed scales and governance levels

Name	Level	Avg. area, Sq. mi.	Case watersheds	Governance levels
Region	1	177,580	Missouri River	State-national
Subregion	2	16,800	Platte River	State-provincial
Basin	3	10,596	South Platte River	Local-state
Subbasin	4	700	Poudre River	Local-state
Watershed	5	227	Poudre tributary	Local-state
Subwatershed	6	40	Urban basin	Local
Microwatershed	7	1	Subdivision	Local
Site	8	0.1	Neighborhood	Local

among coordinating authorities at local-state, state-national, and national-global levels. For water management, these correspond to regional water districts, interstate water compact organizations, and international water treaty organizations, which are essential mediating institutions in handling integration issues (Grigg, 2010, 2015a, 2015b). Fitting water management scenarios to governance level has been recognized as an important policy issue, and the idea of subsidiarity has evolved as a popular concept, where certain functions seem to fit best at certain governance levels (Benson & Jordan, 2014).

Table 2 associates governance scales with spatial scales as defined in the U.S. watershed classification system. Most spatial scales fall either between major units of government or at the local level of governance. The classification system is for U.S. conditions and in other nations larger watersheds might be rated as national level and large multinational basins would reach to the national-global level of governance. To aid in later discussion of cases, the case watersheds are shown, from the Missouri River down to a few building sites.

5. Collective action from participation to empowerment

The general notion of collective action is that it occurs when people work together to solve common problems. However, levels of influence in it vary widely from low-power participation to high-power decision authority. When collective action occurs through organized authorities it takes the form of participation in governance, and each of the seven governance scales described earlier will involve diverse mechanisms for different problem scenarios and scales. For example, local matters can involve hearings and committees where individual citizens can participate actively, but at the state-provincial level, hearings are more formal and channeled into sector groups, such as for water quality planning. National level collective action can only occur through representatives, where individual citizens and groups can exercise influence through the political process. At the global level, collective action can only be expressed through national representatives.

The intervening governance levels offer similar opportunities for collective action. Regional water districts may sponsor congresses of their stakeholders, as well as to have their views channeled through board members. Interstate and international water organizations are not amenable to collective action by individual participants and must operate through formal governance representatives.

No matter the scale, collective action in water management occurs along a spectrum from person-to-person negotiations to levels with many participants who work through representatives, either elected or appointed. The different points on this spectrum involve varying degrees of social networking, which takes on increasing importance as social media and networking channels facilitate group actions. At smaller scales social networking makes it possible to marshal supporters for collective action, even if no face-to-face meetings are involved. At larger scales it can organize high degrees of inputs to influence water policy and decisions, even when water management work is by representatives or panels of representatives, such as a negotiating panel made up of selected legislators.

The degrees of collective action have been studied to develop a spectrum of participation by levels of authority, leading to a "Ladder of Public Participation" (Arnstein, 1969).

Table 3
Levels in the Spectrum of Public Participation

Level	Public participation goal	Promise
Inform	Provide balanced and objective information to assist in understanding.	Keep public informed.
Consult	Obtain public feedback on analysis, alternatives and/or decisions.	Keep public informed, listen to and acknowledge inputs, provide feedback.
Involve	Work directly with public to ensure that inputs are considered.	Ensure that inputs are directly reflected in plans and provide feedback.
Collaborate	Partner with public in development of alternatives and preferred solutions.	Incorporate inputs to maximum extent possible.
Empower	Place final decision making in hands of the public.	Implement what public decides.

Building on the concept, the International Association for Public Participation created a Spectrum of Public Participation with levels from high to low power (Co-Intelligence Institute, 2017; International Association for Public Participation, 2017). Its five levels are paraphrased in Table 3, where each level has a goal to show the intent and a promise to express a commitment to the participants.

In this present study, this spectrum was used to assign levels of public participation to the scale-dependent management processes discussed in the case examples that follow. The categories of "collaborate" and "involve" were merged to add to the clarity of the examples. While the spectrum does not explicitly explain the variable of numbers of people involved, it is obvious that the more people who participate in discussion of an issue, the less power each individual will have in reaching a decision. This variability is important in explaining how participation varies with spatial and governance levels.

6. Case study of western U.S. watersheds

A system of watersheds and river basins in the western United States (Figure 1) was used to exemplify the variation of collective action mechanisms by scale and problem types. The headwaters are in the Cache La Poudre basin in Northern Colorado, which discharges into the South Platte River and then to the North Platte to become the Platte River in Nebraska. The Platte flows into the Missouri River, which is part of the Mississippi River system (Figure 1). The smallest scales are not shown but are within the city of Fort Collins, which is in the Poudre Basin.

Selected examples of problems to illustrate experience and participation with these watersheds were extracted from studies by the City of Fort Collins, State of Colorado, Colorado Water Resources Research Institute, and U.S. Army Corps of Engineers. Scenarios in other watershed systems are similar, as shown by comparison with case studies in (Grigg, 2015a, 2015b).

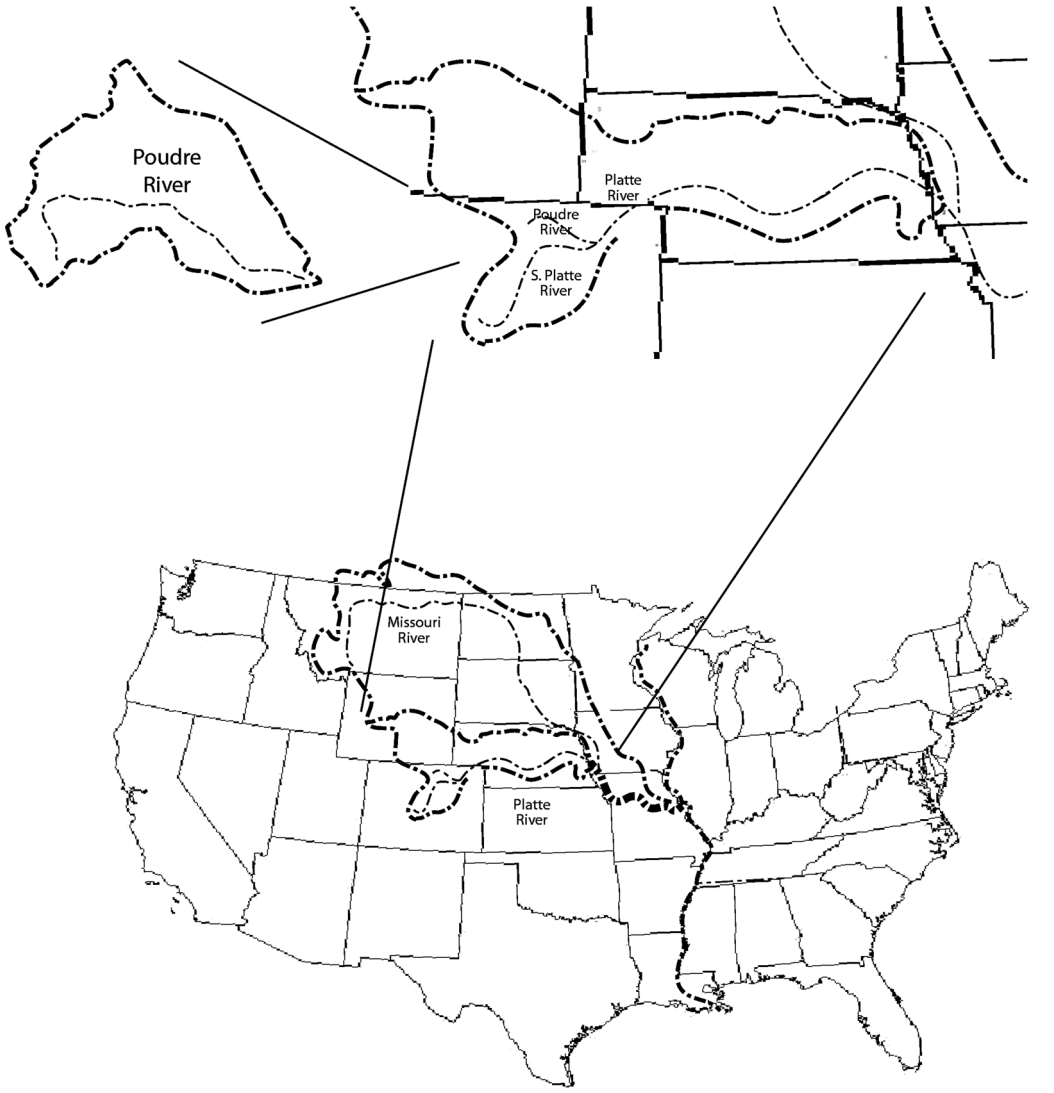

Figure 1. System of example watersheds for the study

The seven watershed scales and five problem types discussed earlier were used to formulate some 35 scenarios. Scale level 8 was not used so as to reduce the detail. However, while collective action at this scale does not involve major issues of organized water management, some actions there illustrate neighbor-to-neighbor problem-solving. Some of the case scenarios were used more than once so that the number of cases cited is reduced to seventeen. Table 4 lists them and provides short titles and key references.

Table 5 presents an overview of how these examples distribute themselves among the seven watershed scales and five problem types. These are then discussed in more detail in Table 6.

Table 4
Key references for the water management scenarios

Example case	Level	Reference
Missouri River reservoir system	1	(U.S. Army Corps of Engineers, 2017b)
Operation of reservoir system	1	(U.S. Army Corps of Engineers, 2017c)
Planning in Missouri River basin	1	(Missouri Inter-agency Basin Committee, 1969)
Platte River Recovery program	2	(Platte River Recovery Implementation Program, 2017)
Water compacts between states	2	(Colorado Water Conservation Board, 2017b)
Planning of Two Forks reservoir	3	(Grigg, 1996)
Roundtables in S. Platte basin	3	(Colorado Water Conservation Board, 2017a)
State water management systems	3	(Colorado Department of Public Health & Environment, 2017)
Water rights allocation	3	(Colorado Judicial Branch, 2017)
Operations of conservancy district	4	(Northern Water, 2017)
Poudre Water Users Association	4	(Fischer, Brown, Bartlett & Gunn, PC., 2017)
Reservoir planning	4	(U.S. Army Corps of Engineers, 2017a)
City water supply policy	5	(City of Fort Collins, 2017a)
City-wide water utility systems	5	(City of Fort Collins, 2017b)
Water utility regulation	5	(Colorado Department of Public Health & Environment, 2017)
Water-trading: cities and farms	5	(City of Fort Collins, 2017c)
Irrigation system operation	6	(New Cache La Poudre Irrigating Company, 2017)
Non-point source controls	6	(City of Fort Collins, 2017d 42)
Stormwater planning	6	(City of Fort Collins, 2017e)

Table 5
Overview of case examples by scale and problem type

Scale/Process	Planning	Allocation	Infrastructure	Services	Regulation
Microwatershed Small urban basin	Stormwater planning	Irrigation system operation	Stormwater infrastructure	Maintenance of stormwater systems	Non-point source regulation
Subwatershed Urban basin	Stormwater planning	Irrigation system operation	Stormwater infrastructure	Maintenance of stormwater systems	Non-point source regulation
Watershed Poudre tributary	City-wide water supply policy	Water-trading: cities and farms	City-wide utility systems	City-wide water utility systems	Water utility regulation
Subbasin Poudre River	Reservoir planning-coordination	Poudre Water Users Association	Reservoir planning	Operations of conservancy district	Non-point source regulation
Basin S. Platte River	Roundtables in South Platte basin	Water rights allocation	Planning of Two Forks reservoir	None at this scale NA	State water management systems
Subregion Platte River	None at this scale NA	Water compacts between states	None at this scale NA	None at this scale NA	Platte River Recovery program
Region Missouri River	Planning in Missouri River basin	Missouri River reservoir system	Missouri River reservoir system	Operation of reservoir system	None at this scale NA

Table 6(a-e) illustrates how collective action occurs in these examples and provides notes on the problem types and levels of collective action based on the spectrum explained earlier. While one level of participation is noted for each case, the situations often involve more complex patterns of involvement, such as when some participants have more power than others. No attempt is made here to analyze these because the focus is to illustrate how the predominant forms of collective action vary with scale and problem type.

Table 6a
Examples of collective action in planning and coordination problems

Level	Examples	Participation
7 Microwatershed	Stormwater planning and problem-solving in neighborhoods and parts of the city. Hearings are held but the utility makes decisions. Participants are likely to know each other.	Involve
6 Subwatershed	Same as microwatershed, but participants are less likely to know each other.	Involve
5 Watershed	City-wide water supply policy development. Involves representatives on city panels and public hearings. Policy is made by elected City Council.	Involve
4 Subbasin	Reservoir planning and coordination in Poudre Basin. Hearings are held but it is difficult to reach consensus. Environmental impact statements are used.	Consult
3 Basin	Roundtables in the South Platte basin. Representatives suggest policies and planning studies.	Involve
2 Subregion	NA. Platte River involves three states, which do not currently work on joint plans. Legal activities predominate.	
1 Region	Planning in Missouri River basin. Past studies were conducted. Participation was by representatives.	Consult

Table 6b
Examples of collective action in resource allocation problems

Level	Examples	Participation
7 Microwatershed	Irrigation system operation. Water-trading occurs on a person-to-person basis or within an irrigation company.	Empower
6 Subwatershed	Irrigation system operation. Water-trading might occur person-to-person or within an irrigation company.	Empower
5 Watershed	Water-trading between cities and farms. Irrigation shareholders are involved, but not city stakeholders.	Involve
4 Subbasin	Poudre Water Users Association coordinates informal water allocations within the basin and the water commissioner respects their decisions.	Empower
3 Basin	Water rights allocation through the Division Water Court. Stakeholders are notified and can object.	Consult
2 Subregion	Water compacts between states are mechanisms for state-to-state water allocation.	Inform
1 Region	Missouri River reservoir system. No compact in force but operation of river by COE is de facto allocation mechanism.	Inform

Table 6c
Examples of collective action in infrastructure development problems

Level	Examples	Participation
7 Microwatershed	Neighborhood storm drainage systems are planned and the utility makes decisions.	Involve
6 Subwatershed	Same as microwatershed but involvement becomes more formal as the area increases.	Involve
5 Watershed	City-wide water utility systems are developed with advice of representatives on panels. Hearings are conducted.	Involve
4 Subbasin	Reservoir planning. Proposed reservoirs in Poudre Basin are under development, but difficult to reach consensus.	Consult
3 Basin	Reservoir planning of Two Forks reservoir in South Platte basin. Permit was evaluated but vetoed by the USEPA.	Consult
2 Subregion	NA. Infrastructure is considered either basin or region level.	
1 Region	Missouri River reservoir system was built decades ago. Any new infrastructure would include consultation through representatives.	Consult

Table 6d
Examples of collective action in establishment of services

Level	Examples	Participation
7 Microwatershed	Maintenance of stormwater systems. People are consulted and the utility responds. In a homeowner association decisions are made collectively.	Involve
6 Subwatershed	Same as microwatershed.	Involve
5 Watershed	City-wide water utility systems. Once water utility services are established the utility responds to customer inputs.	Involve
4 Subbasin	Operations of conservancy district. Northern Water provides water delivery services. Water users and organizations are consulted.	Consult
3 Basin	NA. No services organization operates at this scale.	
2 Subregion	NA. No services organization operates at this scale.	
1 Region	Operation of reservoir system. Corps operates reservoirs for navigation and flood control as a service. Consultation through representatives in annual planning.	Consult

Table 6e
Examples of collective action in regulatory problems

Level	Examples	Participation
7 Microwatershed	Nonpoint source controls.	Consult
6 Subwatershed	Nonpoint source controls.	Consult
5 Watershed	Water utility regulation. Once rules and permits are issued, there is little room for adjustment based on consultation.	Inform
4 Subbasin	NA. Regulation does not occur specifically at this multi-state scale.	
3 Basin	State water management systems. Once rules and permits are issued, there is little room for consultation. In standard-setting there could be consultation.	Inform
2 Subregion	Platte River Recovery program was a unique mixture of collective involvement, regulation, and political actions via representatives. Public hearings also occurred.	Involve
1 Region	NA. Regulation does not occur directly at this scale.	

7. Analysis of the cases

By extracting from the examples in Table 6 the levels of participation can be summarized (Table 7). It is apparent that scale affects the possibilities for collective action in somewhat predictable ways. After all, an important reason for representative government is to select people to speak for groups because once you pass a certain size in a group, it is no longer possible to work with everyone. In terms of water management, we see board members of irrigation organizations or elected city council members making decisions on behalf of their constituents. This passage from direct decision making to representatives occurs at small spatial and governance scales. Once these scales reach beyond a certain size, then it becomes a matter of representatives of representatives making decisions, such as when water policy makers decide on behalf of cities, counties and other stakeholder groups.

As noted earlier, the principal categories of problems introduced were collapsed into three to provide a clear delineation between planning to resolve issues, committing to infrastructure projects, and making regulatory decisions. These problem types show clearly how collective action can occur in different scenarios because it is much different for a group of people to make recommendations about a long term plan versus but making a definite decision about proceeding with a costly infrastructure project or taking a regulatory action.

Table 7 provides information to summarize the levels of participation by problem types and scales. It explains how power levels diminish quickly with scale for most problem types, and how planning activities offer the most possibility for meaningful participation.

With these differences in view, a framework to illustrate how levels of participation vary with scale and problem type can be created (Figure 2). This conceptual display

Table 7
Spectrum of participation by problem types and scale

Level	Participation by problem type and scale
Empower	Empowered participation is evident in small scale actions such as water-sharing among mutual irrigation ditch company users and in the larger scale coordination of actions among members of the Poudre Water Users Association. This level is made possible because the consequences of the collective decisions are confined to the people involved.
Involve	At small scales stormwater planning can involve citizens directly. Water trading among cities and ditch companies can occur at the watershed and subbasin levels but through representatives and individuals are not empowered to make decisions. City water supply policy and implementation are developed with involvement of citizens and committees and utilities respond to customer involvement. The planning roundtables operate at a statewide level. The Platte River Recovery program was a unique case of involvement at different levels.
Consult	Consultation involves formal procedures, usually for reservoir planning, regulatory standard-setting, and annual operations planning such as the Corps reservoir system and water users of the Northern Water system. Water rights actions through the court system involve formal consultation through notices and objections.
Inform	For regulatory actions and large scale compact issues the mechanism of informing stakeholders is the norm. This occurs because of the legal nature of the processes and the fact that the policies and rules have already been set.

illustrates how planning problems with emphasis on people working together to solve joint resource-allocation issues can involve more empowerment at smaller scales than infrastructure problems, which involve entities working together to plan, construct, and operate infrastructure facilities. Regulatory problems involving legal or quasi-legal actions to regulate the actions of others can involve little collective action, even at small scales.

The diagram shows how watershed and governance scales align and how population increases with scale. It also shows how beyond the micro-watershed level collective action of people is usually voiced by appointed or elected representatives. One the action is beyond the watershed level, the representatives must themselves be represented by representatives. For example, Colorado has 65 state representatives for its some 5.5 million people or about 85,000 people per representative. On the average, this population is at the upper end of the watershed scale and at the lower end of the subbasin scale, where water collective action begins to involve representatives-of-representatives.

8. Conclusions

Ultimately, collective action in water management is about levels of empowerment, just as it is in other public issues. Water has unique attributes as a connector that complicate processes of participation in decision making. These unique attributes are especially evident as scale increases and across different types of management problems, where distinct differences in participation occur in problem types of planning and coordination,

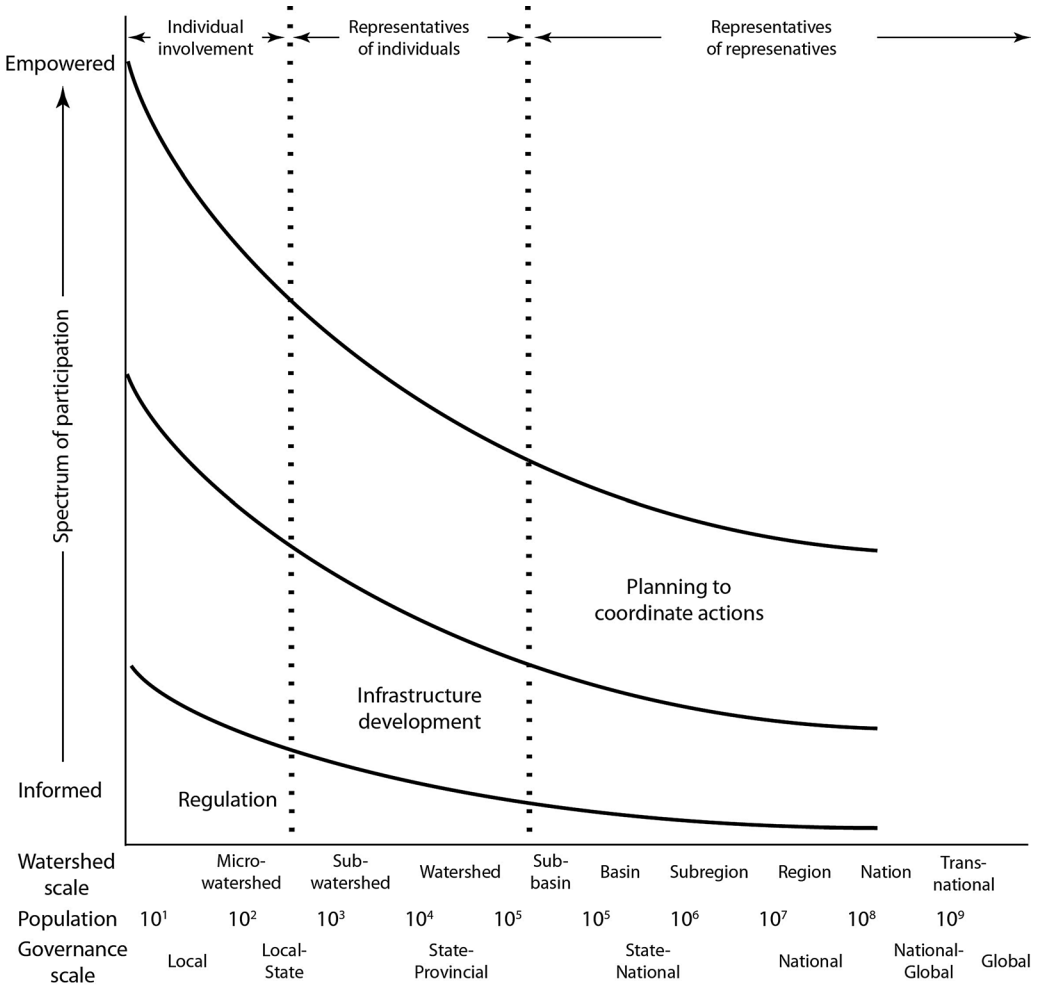

Figure 2. Conceptual display of participation levels by scale

infrastructure development, and regulation. Planning and policy development are more amenable to empowerment than those that involve commitment of resources and regulatory controls on actions. Planning for joint problem-solving at smaller scales is especially amenable to collective action to work out conflicts among individuals. Participation can also be facilitated at somewhat larger scales to create long range plans with tentative decisions. Planning involves less formal commitments, infrastructure involves firmer commitment of resources, and regulation is about enforcing rules that are already made.

As with other issues, the increasing numbers of people involved at larger scales and the confusion that comes with too many dissonant voices necessitate that collective actions occur through representatives rather than among individuals. As the scale increases, the

number of conflicting priorities and goals among multipurpose water issues become difficult to sort out and more formal approaches are needed to reach decisions.

The possibilities for empowerment to make collective decisions at smaller scales involve local resources such as shared management of an irrigation system where the impacts of the decisions are felt mainly by those who are empowered. The work of Ostrom (1990) focused at these smaller scale systems with shared resources and she recognized that more studies were needed to reach conclusions about multilevel, polycentric systems in specific social-ecological settings. The examples cited here are illustrative of these more complex problems.

As scales increase, participation at the level of "involvement" falls off quickly for all problem types and participation occurs mostly at the "inform" or "consult" levels. Changes in modes of participation occur at points of discrete changes in scale where governance authorities also shift, such as from the city to watershed levels. Once the number of people involved grows beyond a certain point and person-to-person work is no longer possible, collective action through representatives is required. This is consistent with the work of Olson (1971), who explained that "unless the number of individuals is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational self-interested individuals will not act to achieve their common or group interest."

Other than with small scale problem sets, the only decision process that reached the "involve" level was state water quality management planning. This occurs because the search for a workable water quality management strategy requires answers to complex problems that are not amenable to command-and-control solutions, such as control of nonpoint sources of pollution from cities, agriculture, and open spaces.

The fact that little direct collective action occurs at larger scales can be explained by the large numbers and conflicting interests of the participants, which give rise to the need for representative governance and trends toward judicial action in conflict resolution. Given the levels of conflict involved, many quasi-judicial scenarios are not amenable to collective action in the same sense that a court does not decide cases on the basis of public opinion.

The many complex scenarios of collective action in water management are difficult to generalize because as water connects many elements of human and natural systems it draws in many combinations of issues. By showing how collective action varies by scale and problem type, insight is provided about both the governance and management of water. It is clear that scenarios of water management and governance involve such wide ranges of problems and scales that situations should be explained in context to promote understanding. Discussion of generalized resource management concepts such as conflicts between public and private goods can benefit from the context of specific examples such as those cited. Policy concepts such as subsidiarity to devolve authority to the lowest possible levels have merit but cannot be applied as blunt instruments. Also, collective action problems such as the one illustrated by the Tragedy of the Commons story are limited in their abilities to explain the complexities of different types of water issues as scales increase. Clear identification of roles and responsibilities in contextual explanations of water problems at different scales can improve understanding of the reforms needed in management and governance.

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