

8. Assessing Performance in Polycentric Governance System Interactions

Tomas M. Koontz, Dustin Garrick, Tanya Heikkila, Sergio Villamayor-Tomas

Abstract

This chapter compares insights from our empirical cases of three kinds of interactions: cooperation, conflict and conflict resolution, and competition. The elements of authority, information, and resources affected incentives and interactions differently. Focusing on interactions as a unit of analysis points to a variety of performance criteria that may be appropriate. These criteria for assessing outcomes and processes cannot all be optimized at once, as trade-offs are evident, and different types of interaction are likely to entail different performance combinations. In our case studies, no performance criterion scored high across all cases, and no case performed well across all performance criteria.

The previous three chapters analyzed cooperation, conflict and conflict resolution, and competition. Focusing on one type of interaction at a time allowed for in-depth analysis. In this chapter we synthesize findings across the three chapters to compare how authority, information, and resources affect incentives and interactions. Subsequently we discuss the multi-dimensional concept of performance and describe how each interaction type performs on each performance criterion. We also discuss trade-offs among performance measures.

8.1. The Roles of Authority, Information, Resources for Incentivizing Interaction Types

By comparing across the three types of interactions described in our cases (cooperation, conflict/resolution, competition), we can examine how authority, information, and resources create different incentives by type of interaction. Recall that cooperative interactions are those where multiple centres choose to work together to advance shared goals. To do so they communicate, coordinate, and/or share resources with each other. In conflictual interactions actors disagree about how to provide a good or service, or over the rules, policies or institutions for addressing a governance issue. Conflict resolution involves an agreement or decision where actors no longer engage in conflictual behaviors, or where they are willing to compromise on an issue. Competitive interactions feature a market logic where decision units are pressured to respond to client demands for goods or services.

In the case study on cooperation, we found that key decision centres (the Puget Sound Partnership and Local Integrating Organizations) within the focal action situation (restoring the Puget Sound) lack authority to coerce. Authority outside the focal action situation related to compelling actors to provide clean water and species protection does exist in adjacent action situations, and the actors overlap with actors in the focal action situation. Moreover, such authority in adjacent action situations provides incentives for actors within the focal action situation to come together seeking to cooperate rather than face coercive authority (e.g., to avoid listing of salmon under the Endangered Species Act).

In the Puget Sound case, we found that information flows horizontally among members of independent centres (Local Integrating Organizations) as well as vertically from the independent centre incentivizing actors (the Puget Sound Partnership) to the other independent centres (Local Integrating Organizations).

Resources are a key element for the success of cooperative interactions in the Puget Sound case. Resources are shared at every level to motivate action in line with the resource provider's priorities, from the Puget Sound Partnership establishing Local Integrating Organizations in accordance with the Puget Sound Partnership goals and then incentivizing Local Integrating Organizations to plan in alignment with the Puget Sound Partnership priorities, to Local Integrating Organizations incentivizing local actors to carry out plan recommendations. In the Puget Sound Partnership, funds flowed from government agencies to the Puget Sound Partnership to Local Integrating Organizations to local actors carrying out actions.

The importance of resources to incentivize action depends, in part, on how actors view their odds in adjacent action situations. Many actors in the Puget Sound case believed cooperation via the Puget Sound Partnership would yield greater resources than other ways of interacting, although after several years some of the local groups were questioning this belief.

Our examination of cases of conflict and conflict resolution highlighted that the source of conflict in a polycentric system often stems from both distributed authority and a lack of clarity or agreement on who has authority on specific issues. For instance, in the case of oil and gas conflict, many disputes have centred around questions of whether actors at lower levels of government can extend their authority on certain issues to a statewide scale. In the context of the oil and gas system, certain actors also have high incentives to engage in conflict due to the economic value of the industry, as well as the potential impacts associated with the industry. In other words, the distribution of potential benefits and costs of the good being managed may be important in understanding the different incentives leading to conflict and conflict resolution.

Approaches to mitigate or resolve disputes over authority in the oil and gas example were facilitated by the creation of action situations that encouraged conflict resolution. For example,

in Colorado actors created a Task Force of diverse stakeholders to identify policy options that would give local governments more voice in siting decisions. The Task Force process resulted in the state regulatory commission adopting new rules that expanded local government advice and consent for drilling proposed in urban areas. In other words, actors in Colorado distributed authority among a wider range of interests as a means to resolve conflicts. In the process, information from the different interests could be exchanged more openly. However, it was difficult to sustain information sharing during the conflict resolution processes. This may have been due the fact that the underlying issues driving the conflict persisted, despite conflict resolution efforts. Conversely, in New York, information was seen as key to bringing the conflict to resolution. That is, state actors spent years doing environmental and health impact assessments, which led to the decision to ban fracking.

Our analysis of the cases of competition in polycentric systems in Spain and the US illustrate how information and resources affect the patterns of competition and outcomes in two settings with different levels of centralization and distinct approaches for distributing authority among independent centres: water allocation among irrigation districts in the Ebro river basin (Spain) and water reallocation from irrigation to environmental purposes in the Columbia Basin (US). In both cases, the distribution of authority in water allocation decisions creates a dynamic tension and issues of potential conflict between decentralised self-governance by irrigators and local water users, on the one hand, and institutions to address sectoral competition and the redistribution of water across jurisdictions, on the other.

In the Spanish irrigation project case, a nested governance structure addresses competition for water among irrigators during drought at two levels - within districts (self-governed Water User Associations, i.e., WUAs) and between them (via a project-level second

order organization). Information and resource asymmetries justify the devolution of authority from the river basin organization (RBO) to the second-order organization to generate and disseminate information about water use and demand, and provide mechanisms to reallocate water on a competitive basis, as well as resolve conflicts between farmers and districts.

In the U.S. portion of the Columbia Basin, market-based river restoration involves two inter-related forms of competition: (1) competition among appropriators (water users) and between sectors (irrigation and environmental uses) and (2) competition for resources (funding) by the organisations implementing water acquisition projects to reallocate water from irrigation to environmental purposes. Implementing organisations therefore compete with independent decision-making centres (irrigation districts) for water and with each other for external resources. Both cases illustrate the potential for market mechanisms to address resource competition within local districts.

Across the three case studies in this section, the elements of authority, information, and resources create different incentives for the three types of interactions (see Table 1). For example, in the cooperation case the lack of authority to command compliance led to other elements such as funding resources coming to the fore, while in the conflict case the lack of clarity on who has authority slowed conflict resolution. Information flow varied across the cases: in the cooperation case it flowed vertically and horizontally; in the Colorado fracking case it flowed from many directions in the venues created for open exchanges; in the Spanish competition case it flowed through a key second-order organization.

Table 5: Effects of authority, information, and resources across the cases

	Cooperation in Puget Sound	Conflict and Conflict Resolution in NY and CO Fracking	Competition in the Ebro and Columbia River basins
Authority	Lack of coercive authority led PSP to use information and resources to guide LIO behaviour. Coercive authority in other action arenas, especially endangered species, encouraged some actors to seek cooperation.	Distributed authority and a lack of clarity on who has authority on specific issues challenges timely conflict resolution	Ebro: Management autonomy of WUAs allows them to reallocate water within the district on a competitive basis Columbia: Columbia: Authority over water allocation formally vested in state governments. Irrigation districts control allocation decisions within their boundaries.
Information	Flowed vertically from PSP to LIOs and also horizontally among LIOs. Information was critical in shaping cooperative actions.	Created venues that allow for more open exchange of information can mitigate conflict, but the influence of information on conflict was slow and	Ebro: second-order organization mediated information sharing between WUAs and RBO thus facilitating the organization of water reallocations within the project. Columbia:

		conditioned by other factors	Information asymmetries plagued efforts to reallocate water from agricultural to environmental purposes
Resources	Flowed vertically from PSP to LIOs, and then LIOs further distributed some funds. Resources were a key element in shaping cooperative actions.	Neutral centres of decision-making provided resources for convening conflict resolution dialogue or producing information; but resources were also used strategically to further conflict	Ebro: WUAs funded the maintenance of canals that connect the districts guaranteeing physical feasibility of water reallocations. Columbia: Federal and state funding for environmental water acquisitions were channeled to ‘qualified local entities’ with responsibility for implementation.

Recall as well that within each case, authority, information, and resources interacted with each other. For example, as described in chapter X [cooperation], lack of authority within the focal action arena led the Puget Sound Partnership to turn to information and funding resources which together provided incentives for actors at the local level to create ecosystem recovery plans that fit with regional priorities. As described in chapter Y [conflict], new forms of

authority to address conflict were created, which also ensured resources were available to facilitate information gathering in the conflict resolution processes. At the same time, resources were used to further conflict by enabling key actors to engage in conflict strategies. As described in chapter Z [competition], a clear understanding of the division of labor and thus authority at different levels of decision making (from the basin down to the local levels) facilitated the dissemination of information and articulation of resources to effectively reallocate water rights.

8.2. Performance Criteria across Types of Interactions

Scholars of polycentricity, and governance more generally, have identified a wide range of performance criteria (McGinnis 2011). These can be grouped by outcome and process measures. The primary outcome measure is based on a fundamental question: What results did the system produce? A related outcome measure is whether the results were achieved with efficient use of resources. For some interaction types we can also ask whether results were coherent across system levels. Several process measures of performance focus on how decisions were made and actions were taken. Was the decision making process accountable and representative to those affected? Did the process generate opportunities for learning, adapting, and growing networks for future interactions?

To analyse performance in polycentric governance systems, we recommend attention to the basic building block: interactions. As described in the previous chapters of this section, interactions can be grouped into three general types: cooperation, conflict and conflict resolution, and competition. In fact Ostrom, Tiebout and Warren (1961, p. 838) argued “The performance of a polycentric political system can only be understood and evaluated by reference to the patterns of cooperation, competition, and conflict that may exist among its various units.”

Appropriate performance measures may differ depending on the type of interaction, as we illustrate in our study cases below. It is important to note that not all performance criteria are relevant for every situation. Moreover, when analysts desire multiple criteria, the relative importance of one criterion compared to another is not self-evident. This is especially true when trade-offs exist among different criteria which cannot simultaneously be optimised.

8.2.1. Outcome Performance Measures

One set of performance measures relates to outcomes. These include efficacy, efficiency, and coherence.

8.2.1.1. Efficacy

Efficacy suggests achievement of or movement towards a desired goal. Measuring this in complex social-ecological systems is challenging. It requires baseline data, the ability to control for confounding factors, and long horizons for social and ecological processes that unfold over time (Koontz and Thomas 2006). Aside from these data challenges, what constitutes a “desired goal” depends on one’s perspective. For some, it may mean sustainability of a system to provide long-term societal and environmental benefits. For others, it may mean achieving individual gains. Polycentricity scholars have suggested additional goals, such as maintenance of self-governance habits that allow citizens to avoid tyranny (Marshall 2015; Ostrom, Tiebout, and Warren 1961) and matching citizens’ preferences with goods and services provided (Oakerson 1999).

Efficacy in cooperation can be measured in terms of movement towards goals shared by participants. Were the participants able to find common ground and make progress towards achieving it? While participants retain their individual preferences over goals, efficacy means

the action or decision makes progress on the subset of preferences that overlaps with other participants. For example, local integrating organizations (LIOs) in Puget Sound ecosystem recovery created ecosystem recovery plans that identified priority areas for action that the participants agreed upon, suggesting that the plan as an output achieved some degree of efficacy. But it is too early to tell whether the plans are efficacious in achieving as outcomes these agreed-upon priorities in practice.

In the case of conflict, the measure of efficacy will point in different directions, as two or more stakeholders have conflicting goals. For example, disputes over the appropriate level of government to decide limits to oil and gas development led to different results in New York and Colorado. In New York, the state's ability to ban fracking was praised by environmentalists but disliked by the oil and gas industry. In Colorado, several state-level policy decisions on how to mitigate risks of fracking were agreed upon and forums were created to allow disputing actors to discuss their different positions. However, on one of the hotly disputed issues, that of local authority to ban fracking, the state Supreme Court ruled against local governments. This decision was satisfactory to the industry but many citizen and environmental groups disliked this decision. By definition, conflict resolution means disputing parties come to some agreement, or that an accepted conflict resolution venue makes a decision on the issue. While the outcome may not match either party's preferred position, it could still be efficacious if the outcome or dispute resolution process is accepted by the parties. It also may be more favorable than was the status quo (dispute). However, in a polycentric system, actors with resources and sufficient authority (or standing) may be incentivized by one decision to move the dispute to another venue if the actors are dissatisfied with the outcome. That appears to be the case in Colorado, at least, with the issue of local authority.

Efficacy in competition can be measured as the provision of valued goods or services in the right quantity, quality and timing, i.e., as demanded by users of the good (economists refer to this concept as allocative efficiency). For example, in the case of the Ebro river, competition among irrigation districts served to reallocate water to users who would need it the most and/or make the most valuable use of it in a context of severe scarcity. What “most valuable” use means has been hotly debated by farmers regarding the decision of whether to allocate water on a per hectare or per volume basis. WUAs where farmers cannot afford high irrigation efficiency technologies (“traditional”) favour the former while “modernized” WUAs favour the later. In the Columbia Basin, competition between agricultural and environmental needs spurred reallocation through market-based water transactions, and this reallocation is assumed to have moved the resource to higher-valued uses, at least in terms of paying users.

Ecological economists argue that the demands of paying users are not the only appropriate consideration for efficacy. Rather, non-priced goods such as environmental quality and other ecosystem services should be considered (Pahl-Wostl et al. 2013; Postel and Carpenter 1997; Garrick et al. 2009). In the Columbia Basin, water acquisition programs have established flow targets to determine the quantities and timing of water needed for environmental flows. In this case evaluators judged that the water allocation and timing in the Columbia Basin provided sufficient resources to improve environmental quality. Measuring efficacy in terms of environmental quality is challenging because restoration outcomes are influenced by multiple factors, which means efficacy must account for the complex causal chains linking competition with system level outcomes. As with conflict and conflict resolution, competition limits consensus on the goods and services being delivered. What one actor views as the right quantity, quality, or timing might be disputed by another actor. For example, a river restoration project

may be perceived as effective for environmental flows yet ineffective from the perspective of rural livelihoods and sustainable agriculture. Thus, efficacy is a difficult performance criterion to apply to competition.

8.2.1.2. Efficiency

In simple terms efficiency, or cost-effectiveness, refers to the amount of resources needed to achieve a given result. Efficiency has long been a performance criterion for the provision of goods and services. In the private sector, free market exchanges can increase efficiency if certain conditions are met. In the public sector, polycentric governance systems can bolster efficiency when citizens compare results across different centres and demand efficient use of their tax dollars (Ostrom, Tiebout, and Warren 1961). Polycentric systems also allow centres to enter into agreements with each other to provide goods and services at the most efficient scale (Ostrom et al. 1993). Efficiency is reduced to the extent that actors incur the transaction costs of searching, negotiating, and enforcing agreements.

Cooperation in a polycentric system is characterized by the potential for high transaction costs, reducing efficiency. Compared to a centrally controlled governance structure, cooperation can occur both horizontally and vertically, which gives actors greater possibilities. This can increase search costs and take time to unfold, as actors navigate myriad sources of authority, information, and resources. It can duplicate collaborative interactions, when multiple forums are present to provide the same function in the same location. For example, in the Puget Sound ecosystem recovery case, one of the LIOs includes representatives from several organizations that are themselves collaborative forums. Cooperation can reduce efficient use of resources and

may lead to a zero-sum game of taking resources away from other collaborative forums, as it has done to some extent in Puget Sound recovery efforts (Scott and Thomas 2015).

Conflictual interactions are likely to be inefficient, to the degree that participants expend resources in seeking to prevail. For example, in both the New York and Colorado fracking cases, disputes lasted for several years; moved across multiple decision-making units, including the highest courts in each state; and involved dozens of local government actors, private sector actors, and several state agencies. Of course, given the intense nature of the fracking debate, it is questionable as to whether the inefficiencies observed are generalizable to other types of disputes that may arise in a polycentric system.

Competition is a key means by which centres in a polycentric governance system are pressured to provide public goods and services efficiently (economists refer to this concept as productive efficiency). In the case of the Columbia river, competition between environmental water buyers for funding resources spurred more rigorous due diligence to ensure reallocation projects deliver maximum value for money; however, it also raised the search costs and reporting requirements, creating uncertain consequences for efficiency. In the Ebro river case, the introduction of competition partially led to the concentration of water in the WUAs where irrigation technologies are more efficient and in farms where soil conditions, size and business models make the water most productive. The possibility to reallocate water across districts has also made water accounting within the project more complex; however, the added costs are relatively minor given that the accounting system was already in place.

8.2.1.3. Coherence across levels of the system

In a system of multiple centres, the decisions and actions of some centres may export harm to others, or achieve ends that are detrimental to the system as a whole. The potential for scale mismatches between decision makers and affected actors was described by Ostrom, Tiebout, and Warren (1961) as a rationale for public organizations to reconstitute themselves or interact with other decision centres. Thus, performance measures should include whether the interactions lead to coherence across system levels and decision units.

A foundational premise of cooperation is that centres working together can achieve results that extend beyond the boundaries of an individual centre, to a higher level of the system. This logic has been described by Ostrom (1990) and other polycentricity scholars as “nestedness”. With nestedness, centres at lower levels of a system come together to undertake actions at higher levels of the system, such as coordinating work and designing institutions. In the case of cooperation for Puget Sound ecosystem recovery, the Puget Sound Partnership cooperates with Local Integrating Organizations in an attempt to bridge the overall Puget Sound restoration efforts with local priorities for actions on a smaller spatial scale. Such bridging is not always successful, and different goals between the PSP and localities make an imperfect alignment. But cooperation as structured by the PSP does bring in information that is incorporated into plans to help align local actions with system-wide needs.

In the fracking cases, conflict and conflict resolution interactions have occurred at multiple levels within the polycentric systems. In the case of New York, many local jurisdictions banned fracking, although some passed resolutions in support. When the state level actors ultimately banned fracking, there was coherence with those lower level jurisdictions that imposed bans, but not with those in support. In Colorado, the Task Force recommendations led the state regulatory commission to pass new rules that expanded some of the local government authority for

consultation in oil and gas permitting decisions, which arguably mitigates the likelihood that state-level decisions may potentially harm local governments. At the same time, state court decisions clarified how the limits to local decisions (i.e., bans) that state government argued could harm their interests. Despite these examples, some of the actors in the system still express concerns about coherence. Perhaps to some degree in a polycentric system it is unreasonable to expect perfect coherence across a system. Moreover, some incoherence or diversity may be beneficial to the functioning of the system. Yet, if authority of some centres is impinged upon, then such lack of coherence may be detrimental. It can also mean that conflicts fester, especially if authority is constrained.

In competitive interactions, competition can be enabled and regulated at multiple levels nested within cooperative and other coordination structures. This creates cross-level interactions in two ways. First, competition at lower levels depends intrinsically on an overarching set of rules and the availability of conflict resolution mechanisms when dispute arise. For example, water planning, regulations and trading rules have all predated efforts to use market-based water transactions to address competition between agricultural and environmental water needs. Second, competition at lower levels may lead to incoherence at higher levels due to externalities. For example, in both the Ebro river and Columbia river cases, local jurisdictions established robust market mechanisms for reallocation within their boundaries, maximizing water productivity. These local approaches created spill over effects in the form of land abandonment and polarization of socio-economic profiles of farmers within and across districts (Ebro), and across geographic zones (Columbia) when accounting for the ‘third party effects’ of water reallocation. This concern about externalities has led to rigorous monitoring and reporting processes in the case of the Columbia Basin (McCoy and Holmes 2017).

Outcome performance measures across interaction types are summarized in Table 6.

Table 6: Outcome Performance Measures across Interaction Types

Performance measure	Cooperation	Conflict and Conflict Resolution	Competition
Efficacy	Centres achieved some movement towards shared goals.	Decisions were made on some disputed issues (i.e., local authority question in CO and ban in NY) but disagreements persist. Perceived efficacy of decisions depends on actors' goals/interests.	A valued good/service (water) was provided and allocated in qualities/quantity/timing that satisfies demand to some degree. However, perceived efficacy depends on actors' goals/interests, and it is difficult to determine for non-priced goods and services such as environmental quality.
Efficiency	High transaction costs and duplication of functions reduced efficiency.	High transaction costs of dispute resolution across scales and venues reduced efficiency.	Competition for funding spurred delivery of maximum value for the costs.

<p>Coherence across system levels/ decision centres</p>	<p>Cooperation led to local level plans that fit with broader system aims</p>	<p>Variable coherence in NY, as statewide fracking ban matched local bans enacted in some places but not others.</p> <p>Coherence in CO improved through new rule adoption</p>	<p>Competition between implementing organisations in specific geographies limited coherence</p>
--	---	--	---

8.2.2. Process Performance Measures

In addition to outcome performance measures, we can also consider process performance. These measures include accountability, representation, social learning, adaptability, and network building.

8.2.2.1. Accountability

Accountability is the ability of those affected to hold a decision centre to account for its actions (Acar et al. 2012). Whenever a centre makes a decision or takes action on behalf of others (e.g., citizens of a jurisdiction), accountability comes into play.

Although cooperation can be effective in encouraging action, it requires the government to give up control. Unlike in a hierarchical structure where higher level authorities can demand compliance, a polycentric system involves different amounts of action across the landscape. This is a benefit in terms of allowing localities to tailor actions to their local circumstances, and a

drawback in that it can raise questions of accountability for failure to achieve system-wide goals. Cooperative efforts for Puget Sound ecosystem restoration involve fiduciary accountability when resources such as funds are shared from the Puget Sound Partnership to the Local Implementing Organizations, but the attainment of system-wide goals lacks clear accountability mechanisms because authority is so diffuse.

Resolving conflicts can be done with more or less accountability. For example, in New York and Colorado, certain constraints on local authority can make it difficult for local jurisdictions to be accountable to their citizens. However, some conflict resolution efforts in both instances (i.e., through the Governor's Task Force in Colorado or through the public comment period of the Environmental Impact/Review process in New York, and in various local government venues in New York prior to the state-wide ban), demonstrated how accountability to diverse constituencies can be encouraged.

In competitive interactions, accountability requires that competition operate within the boundaries established by rules and norms governing markets and provision of public services based on the public interest. In the context of public service provision, accountability entails mechanisms to foster competition in public service industries to give citizens options. In the context of resource appropriation (common pool resources), accountability involves steps to redress information asymmetries. In the Ebro case, water reallocations across the WUAs rely on an integrated system of water accounting which restrains the immediateness of transfers but also prevents water speculation. In the case of the Ebro and Columbia River basins, accountability involves adherence to the 'no harm' principle for identifying and responding to negative third-party effects of water reallocation.

8.2.2.2. Representation

Representation refers to the degree to which those making decisions can be said to “speak for” affected parties who are not participating in the decision making. As the number of individuals affected by a particular issue increases, at some point it becomes untenable to directly engage all affected interests in decision making. Instead, it is expected that their interests will be represented by others. The assurance of representation, along with accountability, helps ensure a process is viewed as fair and legitimate.

An important consideration for measuring the representation in cooperation is the diversity of interests represented at the collaborative table. Most collaboration scholars have found that including diverse stakeholders in a cooperative effort can bring more complete information for consideration, encourage stakeholders to support agreements, increase social learning, and build social capital that may be used for tackling other societal problems. Ethically, those affected by a process should have the right to be represented in that process. At the same time, inclusion of more diverse interests can reduce process efficiency, lead to “lowest common denominator” recommendations that are agreeable to all but not dramatic enough to be effective, and delay action in the face of urgent problems. In the Puget Sound recovery efforts, the PSP worked with LIOs to create diverse representation. Most LIOs had at least a dozen members representing a wide range of organizations such as county elected officials, Tribes, environmental nonprofit organizations, county public health departments, county natural resource departments, conservation districts, marine resources committees, salmon recovery Lead Entities, university researchers, Water Resource Inventory Areas, and municipal officials. This diverse representation was fostered by the PSP’s power to provide resources to LIOs contingent on the inclusion of diverse representation. Thus, decisions about who is to be included in decision making, a constitutional-level action, are important.

In conflict and conflict resolution, not everyone with a stake is represented in interactions, however diverse opportunities exist for actors to be represented depending on the conflict resolution venue or forum. In New York, there were complaints against the state when actors did not feel represented in the decision-making process that ultimately resulted in the administration banning fracking. Such complaints even came from actors who agreed with the final outcome, because they were dissatisfied with their voice in the process of reaching that decision. Representation has been an issue for some forms of interactions within different venues in Colorado (e.g., more elite actors involved in regulatory interactions), but overall the openness of the system has brought opportunities for many diverse actors to have a represented voice in the process of debating and addressing the issue.

In competitive interactions, mutually beneficial exchanges are agreed upon by parties to a transaction. When these exchanges have spill over effects, affected third parties are not represented in those decisions. In the Ebro basin, spill over effects across WUAs were partly addressed by restraining water reallocations to farmers with land in more than one WUA. Also, decisions of whether allowing water reallocations at a given year or implementing any reforms to the mechanism are collectively taken by all farmers in the project, regardless of whether they will feature any reallocation or not. Decisions of potential reforms to the mechanism are made only during periods of normal water availability to favour consensus. In the Columbia basin, spill over effects were regulated carefully by state water laws and agencies; they were also addressed proactively and conservatively by implementing organisations working closely with affected agricultural communities to identify and offset the impacts of water reallocation.

8.2.2.3. Social learning

Through the process of interacting, participants can gain information and insights that increase their knowledge of the system. Such social learning allows for mutual adjustment and adaptation.

Previous collaborative watershed management studies have highlighted the importance of social learning (Koontz 2014; Muro and Jeffrey 2012; Pahl-Wostl and Hare 2004; Ison et al. 2013). Cooperation by its very nature features interactions among different stakeholders, and when these stakeholders work together to develop plans and take actions they are expected to learn about ecological, social, political, and process realities (Koontz 2014). Cooperative interactions can be structured so as to provide more or less social learning, depending on who participates and how exchanges are structured. In Puget Sound ecosystem recovery cooperative efforts, performance data have not been collected regarding what participants learned.

Social learning is also an important performance measure in conflict and conflict resolution interactions. This is because conflictual interactions can bring divergent perspectives on issues into public venues or into forums for decision-making. Learning is possible where people have adequate levels of trust in information being shared in these forums. In the case of fracking, this has occurred on some issues. In Colorado, on the issue of chemical disclosure of fracking fluids or on reducing air pollution from drilling operations, actors worked through rule-making processes to come to some agreement on the nature of the problems and feasible solutions. In New York, efforts to study the health and environmental impacts arguably led to some learning and agreement among select state-level actors. However, when trust among actors is low or questions arise over basic questions of authority, social learning can be impeded.

Competition may structure social learning as centres seek to address appropriation and provision challenges. In the Ebro case, droughts and the exploration of ways to adapt (including

water reallocations) triggered debates about distributional effects across WUAs. The centralization of said debates in the second order organization allowed the formation of a common understanding about the existence of “modernized” and “traditional” WUAs, and the need to accommodate the stakes of both types. In the Columbia basin, monitoring protocols and reporting requirements ensured information was gathered, and social learning has varied across the Basin. Social learning has required effective linkages between monitoring and decision-making by multi-stakeholder groups and place-based initiatives engaged in the acquisition of water for the environment.

8.2.2.4. Adaptability

Adaptability refers to the ability of a system to adjust to change in a manner that continues to provide desired functions (Engle and Lemos 2010). If interactions fail to adjust over time in a dynamic system, their utility decreases.

Cooperative interactions can boost adaptability to the extent that centres are connected to multiple sources of funding and information. The loss of one centre or connection does not mean a loss of function if a centre can turn to cooperation with other entities. For example, in the Puget Sound ecosystem recovery effort, one centre worked to integrate with an LIO in the face of reduced funding. LIO meeting minutes indicate interactions with a wide range of stakeholders and outside organization to help the LIOs accomplish their goals, adapting strategies and partners to pursue opportunities. This is in line with the Koontz and Sen (2013) finding that collaborative groups can persist beyond the end of program funding by seeking to align with other funding sources. The trade-off between economic efficiency and adaptability in systems has been highlighted by resilience scholars (Walker 1992; Korhonen and Seager 2008),

who point out that having duplicate efforts in a system is not economically efficient but does provide redundancy in the face of a system shock. Cooperation in polycentric governance systems such as the Puget Sound recovery efforts exhibits this trade-off.

Conflict and conflict resolution interactions in the fracking cases are highly adaptive. Efforts to resolve conflicts have led to numerous policy changes, reinterpretation of authorities, and the creation of new venues. This may not be efficient, but it does indicate the ability to be responsive to differences in positions among the actors in the system.

Competitive interactions promote innovation and risk-taking behaviour by the public service industry (provision) and resource users (appropriators). Hence, competitive interactions among centres can allow centres to adjust to changing information but cannot guarantee they will be adaptive. In the Ebro case, the possibility to transfer water from other WUAs constitutes an incentive for farmers to invest in drought adaptations (i.e., irrigation efficient technologies). It is unclear, however, whether competition encourages an unhealthy specialization in certain adaptations by individuals (i.e., irrigation efficiency and intensification), which foreclose other types of adaptations in the system. In the Columbia Basin, adaptation involves efforts by implementing organisations to adjust trading rules and create institutional mechanisms to facilitate water banking and groundwater mitigation. It also involved capacity building processes for drawing on implementation experience, and transferring lessons across tributaries in the basin.

8.2.2.5. Network building

Finally, network building – connections among actors -- may emerge from interactions.

Strengthening existing networks and creating new networks can generate greater resources and channels to achieve collective aims (Margerum 2011). This performance measure is especially

relevant for cooperative interactions, where multiple stakeholders come together to share information and resources. In the Puget Sound ecosystem recovery case, cooperation did not uniformly build networks. Rather, network building was inversely correlated with existing networks (Scott and Thomas 2015). That is, centres with many pre-existing networks exhibited little network building, while centres with few pre-existing networks gained considerable network ties.

Network building is apparent in the conflict and conflict resolution interactions, largely because actors started to build coalitions with other like-minded actors in an attempt to shape governance outcomes in support of their positions. At this same time, this may increase the level of cross-coalition polarization, as we have seen in the fracking cases. Still research on the actors and their network relationships in both fracking cases we explored has shown that the actors do engage in network relationships across competing coalitions (Heikkila and Weible, 2016). This is especially true as actors interact with each other across diverse types of venues. These cross-coalition networks were stronger in Colorado than in New York.

Network building is possible for competitive interactions. In the Ebro case, water reallocations across the same WUAs tend to repeat over time, strengthening interactions among subsets of WUAs. In the Columbia Basin, market transactions are embedded in informal networks and collaborative governance processes, although the success in strengthening networks varied tremendously across the Basin.

Process performance measures across interaction types are summarized in Table 3.

Table 7: Process Performance Measures across Interaction Types

Performance measure	Cooperation	Conflict and Conflict Resolution	Competition
Accountability	Diffuse authority reduced accountability for meeting system-wide goals.	Increased through Task Force (CO) and Environmental Impact process (NY)	In the Ebro case, the nested authority serves as the basis for a sophisticated accountability system In the Columbia basin case, monitoring and evaluation protocols ensure compliance and ‘value for money.’
Representation	PSP gave resources to LIOs who included diverse stakeholders, thus increasing representation	Some constraints in CO and NY, but opportunities emerged in different conflict resolution venues for representation in both cases.	There is a nested and inclusive system of elected representatives that guarantees minimal consensus over the conditions for competition. Involvement of local collective choice arrangements in planning and rulemaking addressed third party effects of reallocation.
Social learning	Interactions may have provided opportunities for social	Evidence of social learning through rule making processes (CO) and studies of health and	In the Ebro case, the authority and centralization of information by the second order organization counteracts the effects that competition may have on social learning.

	learning but data have not been collected to measure this.	environmental impacts (NY). Depends on trust and information availability.	Monitoring protocols and reporting requirements may have provided opportunities for social learning but data have not been collected to measure this.
Adaptability	Multiple sources of funding and information enhanced the adaptability of the system.	Both cases were adaptable, as efforts to resolve conflicts led to numerous policy changes and creation of new venues.	In the Ebro case, water reallocations may be driving specialization in irrigation efficiency and a particular farm business model, which may hurt system adaptability over time. In the Columbia Basin, different transaction tools have been developed to create flexibility for reallocation.
Network building	Interactions built some new networks where existing	Interactions built networks by building coalitions, but sometimes they become more polarized in their	In the Ebro case, water reallocations have given visibility to a network of highly efficient farmers and WUAs within the project. Repeated reallocations

	networks were sparse.	networks . Actors in the CO case built more cross-coalition networks than did actors in the NY case.	strengthen interactions among subsets of WUAs. In the Columbia River case, networks connecting agricultural communities, state and local environmental NGOs, and regulatory agencies are present and essential for market exchanges.
--	-----------------------	--	---

8.2.3. Trade-offs among Performance Measures

As described above, there is no single performance measure for all polycentric interactions. A range of process and outcome measures may be appropriate for different types of interactions, and these measures cannot all be simultaneously optimised. The trade-offs and conflicts among desired criteria in polycentric governance were recognized by Ostrom, Tiebout, and Warren (1961) and many scholars since. Below we compare likely performance trade-offs within cooperation, conflict and conflict resolution, and competition.

Cooperation is a means to navigate the complex array of decision centres to find appropriate information and resources, but it can incur high transaction costs. These transaction costs can be increased in pursuit of diverse interest representation. At the same time, cooperation can provide adaptability in the face of change. Also, cooperation entails government steering rather than controlling, which can raise questions about accountability; without a central controller with agreed-upon authority and responsibility, it is not clear who to hold to account for system performance. Such steering includes the possibility that local efforts can be steered into

alignment with system-wide goals. Cooperation that builds networks in the focal action arena may do so at the expense of pre-existing networks in adjacent action arenas.

In conflictual interactions, at least two opposing stakeholders contest an action or decision. This makes measuring efficacy challenging, as different stakeholders have different desired results. One measure of efficacy in conflictual interactions is whether opposing stakeholders are able to reach an agreement. In addition, efficiency of resource use is of interest as disputants expend resources in seeking to prevail or in finding common ground for an agreement. Of course, what makes sense for parties to a dispute doesn't necessarily promote coherence across system levels or centres, so agreement may come at the expense of system coherence. Besides agreements reached, the process of working through conflicts and conflict resolution can generate social learning and adaptability. In fact, reaching an agreement more efficiently may reduce the social learning and adaptability benefits that come from prolonged searching for common ground, creating an inverse relationship between these process and outcome measures.

Competition is typically measured in terms of whether a valued good or service is provided, and the efficiency with which it is provided. But achieving greater efficiency can come at the expense of coherence. As illustrated in the Ebro case, such trade-offs can be partially addressed via representation of all affected interests in the design of the competition rules. However, such representation, along with the need to provide accountability, makes the system less adaptable to cope with swift changes in water availability. In the Columbia Basin, the cooperative efforts by environmental groups and state governments purchasing or leasing water from irrigators led to a reduction in efficiency and overall efficacy in order to enhance accountability, representation of diverse interests and social learning.

8.3. Conclusion

This chapter set out to synthesize findings across the three previous chapters regarding cooperation, conflict and conflict resolution, and competition interactions. Our cases indicate that authority, information, and resources create different incentives by type of interaction. In the cooperative case of ecosystem restoration in the Puget Sound, resources and information were the most important factors affecting how the interactions performed. In the conflict and conflict resolution cases of fracking in Colorado and New York, distribution of authority and lack of shared understanding about authority spurred conflicts that were resolved in one case (New York) largely from information. In the competition case of water management in Ebro and Columbia basins, information and resource asymmetries affected interactions regardless of the distribution of authority.

We examined the performance of our cases on several outcome and process criteria. On the outcome criteria of efficacy, results were mixed across all three interaction types. Efficiency in the cooperation and conflict and conflict resolution cases was limited by high transaction costs. Coherence was high in the cooperative case, mixed in the conflict cases, and low in the competition case. For process criteria, accountability was low in the cooperation case, increased for the conflict cases, and high for the competition cases. Representation was generally high in the cooperation case, in certain venues within the conflict cases, and in the competition cases. Social learning was evidenced in the conflict cases (depending on trust and information availability), but is unclear for the competition cases, and cooperative cases. Adaptability was high in the cooperation and conflict cases, while it was uneven in the competition cases due to varying success embedding markets within collaborative governance structures. Network building was mixed in the cooperation case, higher in the Colorado than the New York conflict

case, and high in the competition case. Overall, no case performed well across all performance criteria, and no performance criterion scored well in every case.

It is important to note that the many performance measures exhibit trade-offs. Higher levels of performance based on one measure may mean lower levels on another, as was evident across our cases. For example, the many connections present in the cooperation case promote high levels of adaptability, coherence and efficacy but at the expense of accountability and efficiency. In the conflict and conflict resolution cases, working through the conflicts generated social learning and adaptability benefits, but also decreased efficiency. In the competition cases, allowing water right reallocations favored efficiency but may result in lack of coherence at higher levels of the system.

Although we treated the three types of interactions (cooperation, conflict/resolution, competition) as distinct for purposes of analysis, in reality a polycentric governance system includes all three types of interactions. Existence of multiple centres tied together under a common set of overarching rules provides many opportunities for all three kinds of interactions to occur. Centres in generally cooperative relationships likely compete with each other for resources such as grants; centres in conflict attempt to resolve the conflict by creating cooperative interactions; centres in competition that do not act coherently (align local actions with system-wide needs) encourage other centres to create mechanisms for coordination and conflict resolution. These dynamics were all present across our study cases.

Further research is warranted to test our findings in other contexts. This will require attention to different types of polycentric interactions, which may be analyzed distinctly even while recognizing that they occur simultaneously and interact.

Building on the in-depth understandings of polycentric governance, its dimensions, determinants and change in section 1 and its operation and performance in section 2, the next section will address determinants and change of polycentric governance arrangements at a deeper level before it ends on insights on how polycentric governance could be put into practice.