

Resilience in a Watershed Governance Context: A Primer

By: Katrina Krievins, Julia Baird, Ryan Plummer*, Oliver Brandes, Allen Curry, Jack Imhof, Simon Mitchell, Michele-Lee Moore, and Åsa Gerger Swartling

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Introduction

Watersheds are complex systems involving social, economic, and ecological dimensions that are constantly interacting and influencing each other. Often the interactions among the different dimensions in a watershed are unpredictable and uncertainty is inevitable.

Think for a moment about the countless factors that influence water quality in a watershed. The effect of making decisions on any one factor is like a chain reaction. For example, consider how agricultural commodity prices factor into decisions that influence the types of crops grown, animal stocking rates, and general land management practices undertaken by farmers. Those decisions, in turn, will have an impact on the quality of the environment both locally and throughout the watershed. For individuals living downstream, that impact can affect their ability to enjoy the natural environment and to live a healthy life. For fish, poor water quality can be fatal or impair their ability to migrate upstream to spawning habitats. This causes impacts throughout the whole watershed.

Watershed **governance** involves a large and diverse cast of actors — representatives of government, public organizations, researchers, conservationists, communities, etc. Their varied interests and conflicting objectives serve to add to the complexity and difficulty in deciding what is best for the watershed and people.

For some time now, those involved in watershed governance have been aware that watersheds offer a logical and effective framework for tackling land and water management problems. Moreover, many of the concerns and issues being addressed by water resource managers and stewards today are similar to those from the past.

However, growing awareness of the uncertainty confronting watersheds and the dynamic interconnections between watershed dimensions is driving demand for new approaches to watershed governance.

In this time of complexity and change, infusing conventional watershed governance with resilience thinking can help by offering a way to understand and navigate these emerging challenges.

Governance refers to which actors are involved in making decisions, the process by which those decisions are made, and the information and data used to rationalize those decisions¹. In other words, governance is about “the *who* and the *how* of making collective decisions”². This includes decision making at the local level, where many watershed management and stewardship activities are undertaken by watershed groups and local associations. So, governance encompasses collective decision making by all those involved in it, from the federal to local levels. We focus on governance because it is increasingly recognized that many water-related problems are, in large part, attributable to the manner in which access to, and control over, water resources and their associated benefits are governed³.

What is resilience thinking?

As a concept, resilience thinking is described as the ability of a **social-ecological system**, such as a watershed and all the components within it, to persist, learn, change, and/or transform in response to a wide range of **disturbances** without compromising future adaptability. Disturbances can come from outside the system, a heavy rainstorm for instance. Or disturbances can come from within, such as excessive fishing pressure. As well, disturbances may be anticipated, or they may come as a surprise.

Why resilience, why now?

Understanding how to improve the ability of the system – including its ecological, economic, political, and social aspects – to adapt to any disturbance is increasingly acknowledged as important, especially when considering the great deal of uncertainty introduced by a changing climate and shifting social priorities and preferences.

As an emerging approach, resilience thinking can be used to help better understand watersheds as complex, dynamic systems of people and nature, and to assist in navigating different values and interests. Unlike approaches to watershed governance that seek to minimize or control change, **a key difference of an approach based on resilience thinking is that it appreciates the value of thinking about complex systems, not in terms of managing against change, but rather, managing for change.**

In essence, the goal in applying resilience thinking in watershed governance is to facilitate a transition towards a more resilient watershed – a watershed better able to deal with a variety of disturbances so as to maintain the same general functions, and human communities better prepared for learning and adaptation.

Research on resilience of social-ecological systems has come a long way in recent decades. And yet, as the researchers and partners involved in the project, “Applying Resilience Analysis to a Transboundary River System: Developing Surrogates for Institutions and Governance,” concluded, there is a lack of watershed-focused resources for practitioners. Specifically they pointed to the need for resources that will provide practitioners with sufficient guidance on what a transition towards a more resilient watershed might look like in practice and offer techniques to build resilience.

This primer is a first step in establishing resources that practitioners can turn to when applying resilience thinking to watershed governance. The primer introduces key ideas associated with resilience and how they may be applied by those engaging in various facets of governance in Canada. It is the product of collaboration involving Canadian and international researchers as well as Canadian watershed practitioners.

In developing the primer, we surveyed experts from around the world and asked them to tell us what factors they considered important for resilience in systems where water is a central focus⁴. Then our task was to take the information from the survey,

Social-ecological systems, watersheds for example, are systems in which the social and ecological dimensions are truly interconnected, interdependent, and co-evolving over time and space. The concept of social-ecological systems emphasizes the perspective of humans in nature. Ecosystems and the ecosystem services they provide form the foundation for social and economic development. Those same ecosystems have been, and continue to be, shaped by human decisions and actions. Considering only the social dimension or only the ecological dimension of a social-ecological system without the other is like looking at only half of the puzzle⁵.

A **disturbance** in a social-ecological system is defined as “a relatively discrete event that disrupts social or ecological communities, resulting in changes to the physical or social environment”⁶.

Disturbances may:

- arise from changes in social and/or ecological variables
- vary over space and time
- range in severity from minor to major events
- vary in duration from short- to long-term events

reflect on our own experiences, and begin thinking about how to make it applicable and relevant to practitioners.

The result of this process is the identification and discussion of six main attributes of resilience to be applied in a watershed governance context:

- more inclusive participation
- building a shared understanding
- inclusion of ecosystem services and functions in long-term planning
- strong leadership
- institutional and decision making flexibility
- decentralized system

Each attribute is described in the following chapters of this report with details as to how the attribute builds resilience. Where possible, based on our experiences with each attribute, additional content is provided including:

- techniques to begin building resilience in relation to the attribute
- real-world examples of how the attribute has been applied in practice
- reflections on applying the attribute in a real watershed
- questions for reflection

The attributes described in this document focus on watersheds in terms of their governance and are intended to apply to a system as a whole, enhancing its capacity to absorb disturbances of all kinds including unknown and unforeseen ones. They are attributes of a system that can deal with management/policy mistakes, can absorb large

shocks, and allow all parts of the system to keep functioning as they have in the past or to adapt.

It is important to note that this document is a primer for individuals engaged in various aspects of watershed governance (e.g., citizens, non-governmental organizations, natural resource managers, conservation professionals) and aimed at initiating a discussion about how to start applying resilience thinking.

It is not intended to be a step-by-step guide for building a resilient watershed. Rather, this primer represents an initial effort to take the scholarly understanding of attributes of resilience and initiate a dialogue about their application in the context of watershed governance.



Salt Spring Island, British Columbia. Photo by: Katrina Krievins

Governance emerges from the interactions of many actors including government, the private sector, and not-for-profit organizations at levels ranging from international to local. It includes not only laws and regulations but also negotiation, mediation, conflict resolution, elections, public consultations, protests, and other decision-making processes. Governance can be formally institutionalized or, equally important, “expressed through subtle norms of interaction or even more indirectly by influencing the agendas and shaping the contexts in which actors contest decisions and determine access to resources”⁷.

Chapter 1: More inclusive participation

Watersheds do not conform to jurisdictional or political boundaries, rather, they often cross municipal, regional, and national boundaries and may be comprised of a patchwork of landscapes – urban, rural, and natural.

Within a watershed is a diverse range of what we refer to in this primer as actors — individuals (e.g., landowners, farmers, anglers), organizations (e.g., non-governmental organizations, watershed groups, businesses), government (e.g., public officials), and Aboriginal peoples. Their perceptions, interests, values, and knowledge can vary greatly. As such, the governance of watersheds will affect each in a unique way, and in turn, each will bring a unique perspective to watershed governance.

In the past, watershed governance has typically been undertaken with limited actor involvement. The approach to involve only a subset of actors in governance (planning and decisions) runs the potential risk of leading to conflicts if individuals and/or organizations feel that their views are not being considered. For example, constructing a dam along a watercourse can be viewed very positively or very negatively, depending on the actors being considered. Leaving certain groups out of discussions and decision making around the construction of the dam — ignoring their various views — could incite hostility and result in a lack of trust that in itself reduces the resilience of the system.

Building trust in relationships through more inclusive participation is crucial to an ability to mobilize a collective response to disturbances. More inclusive participation will set us on the right path from the start. It doesn't mean that all conflicts are mitigated. There will still likely be conflict related to differences in views. However, by ensuring that as wide as possible a range of views are heard, we will be in a stronger position to address conflicts.

Considering different interests and values

The actors in a watershed have different interests and value the watershed and its components for a variety of reasons. For example, the same forested area may be valued by a forestry company for its economic potential, by hikers and mountain bikers for its extensive recreational trails, by historians for its importance in local history, by Aboriginal peoples for its spiritual significance, and by others simply because of its aesthetic appeal. More inclusive participation in watershed governance means that more interests and values can be considered, not just those of the powerful actors in the watershed.

What does inclusive participation look like?

In the most basic terms, inclusive participation calls for the involvement of representatives — actors — from a broad range of groups and interests. At a minimum this should include:

- conservationists
- Aboriginal peoples
- government at various levels
- industry
- researchers
- the public

This model of inclusive participation benefits all as it provides a wide diversity of sources and types of knowledge, and interests, on the many aspects of watershed governance including the watershed planning process, water resource management, and watershed stewardship activities.

Each source offers a slightly different connection with, and understanding of, the watershed. Through these individual perspectives we acquire a richer and more complete understanding of a watershed than would be possible with limited actor involvement.

Including different sources of knowledge (e.g., scientific knowledge, local knowledge, traditional ecological knowledge) is crucial due to the fact that watersheds are complex social-ecological systems. Each type of knowledge adds to the understanding of watershed resilience, including details related to past disturbances and responses of the system, trends and ongoing changes, and future visions of the watershed.

Furthermore, the inclusion of representatives from a range of actors ensures that different values and interests (e.g., economic, spiritual, recreational, aesthetic, intrinsic) are included in watershed governance, even those of marginal, often most vulnerable actors.

We recognize that different types of knowledge may not be understood by all actors. The integration of diverse types of knowledge in watershed governance can create challenges. To help work through these challenges, tools have been developed to assist in identifying who to involve as key actors and how to engage these key actors in aspects of governance through a variety of activities. Later in this chapter we'll discuss one such tool, the Social-Ecological Inventory (SEI), and offer an example of how it has been applied in a Canadian watershed.



Resilience analysis workshop. Photo by: Katrina Krievins

Integrating different knowledges

The integration of a diversity of sources and types of knowledge in watershed governance is integral to building trust and enhancing legitimacy of decision making. However, integration of this sort is often a challenging task and one that continues to be studied collaboratively by scholars and community actors.

The principle of **Two-Eyed Seeing**, for example, has been described as an approach to the integration of Western knowledges with the strengths of Indigenous knowledges. Two-Eyed Seeing encourages comparing and contrasting these ways of knowing, and questioning them to ultimately develop a better understanding of the complex issues facing communities through co-learning and reveal ways to move forward together. Two-Eyed Seeing is said to transcend disciplinary boundaries and serve as a guiding principle in all aspects of life⁹.

How does inclusive participation build resilience?

The very nature of inclusive participation, as presented in this chapter, is a means to creating trust, improving transparency and enhancing the legitimacy of decision making. These combined outcomes build resilience.

Trust, transparency, and legitimacy are required to mobilize and self-organize in response to a wide range of disturbances in watersheds – those that are known and anticipated, as well as others that come as a surprise. Furthermore, inclusive participation allows watershed managers to draw on a broad range of possible responses – traditional or new and innovative – to disturbances and challenges.

Self-organization is a key property of complex adaptive systems. A self-organizing system can spontaneously adjust and reorganize in response to internal and external changes rather than relying on a central authority to coordinate reorganization⁹. A basic example of self-organization in nature is the schooling behaviour of some fish. Absent of a central authority, the interactions at the small scale (e.g., among individual fish) form the large scale pattern (e.g., schooling) which subsequently influences interactions at the smaller scale.

Is it practical to include all actors in watershed governance? Perhaps not in every instance. However, regardless of differing situations, it is feasible to ensure there is broad representation. As a general rule of thumb, the more involved different groups of actors can be in any given situation, the greater the opportunity for building resilience.

Techniques and real-world examples

An introduction to the Social-Ecological Inventory (SEI)

This discussion of the Social-Ecological Inventory (SEI) is not prescriptive in nature due to the importance of context in watershed governance. Rather, the description and examples are offered as a starting point to get watershed stewards thinking about how such a tool may be used in their own context. Links to supplementary resources are provided for more detailed information.

The SEI was developed to capture connections between humans and the ecosystem. It is a tool that can be used in a variety of settings to identify existing knowledge and activities that are already underway. Moreover, the SEI is a very useful tool for finding the key actors involved in activities and engaging them.

The SEI is characterized as a dynamic and iterative process involving six general phases:

- 1. Preparation.** Sort out the focus and expectations of the SEI by answering the questions, why, what, where, and when.
- 2. Preliminary identification.** Compile a list of potentially important actors by speaking to knowledgeable local resource users, completing internet searches, consulting land-use maps, and other appropriate means.
- 3. Identifying key informants.** Narrow the list of actors down to a manageable set of key informants.
- 4. Interviewing key informants.** Conduct formal interviews with key informants.
- 5. Enriching the picture.** Reflect on all of the information collected throughout the previous phases and look for trends, insights, and unexpected issues.
- 6. Engagement.** Engage key actors through some form of facilitated workshops, meetings, or other events, allowing them to interact with each other.

Initially, the SEI was used in southern Sweden to identify ecological values of an area and the local stewards. Since then, the SEI has been used in other parts of the world for a number of purposes related to research on social-ecological systems. For

example, the SEI was used in the St. John River Basin (a transboundary basin situated in Quebec, New Brunswick, and Maine) to understand who the actors are in the basin, how they perceive and connect to the ecosystem in terms of river health, and how they relate and are connected to each other, and then to engage those actors in the initial phases of a collaborative conservation project in the basin¹⁰.

The SEI is useful as a starting point for encouraging inclusive participation as it helps identify and build trust with the most appropriate set of actors in a given situation. Furthermore, the SEI provides access to diverse types of knowledge without attempting to “fit” all forms of knowledge into one framework. In this way, the SEI helps overcome the challenge of incorporating multiple types of knowledge. For a detailed description of how to apply a Social-Ecological Inventory, download the [free workbook](#) available online through the Stockholm Resilience Centre.

Questions for reflection

1. In your watershed, which groups/interests are currently involved in watershed governance? Which groups are excluded?
2. What are some first steps that could work in your watershed to increase inclusiveness in watershed governance?
3. How might you engage other groups using the techniques identified above?



Moon River, Ontario. Photo by: Amanda Puopolo



Jasper, Alberta. Photo by: Samantha Morris

Researcher reflections

Highlighting the need for inclusive participation in the Kristianstad wetlands

A stakeholder mapping and engagement approach has been developed over the course of multiple research projects related to adaptive river basin management, urban and coastal planning, and flood risk reduction in the Kristianstad wetlands in southern Sweden. This low-lying river basin region is situated by the coast and is one of the most flood-exposed regions of Sweden. Through the use of the stakeholder mapping and engagement approach, a need for greater participation in watershed governance has been identified in the Kristianstad wetlands.

Groups included in watershed governance

Responsibility for current flood risk management in the Kristianstad area lies mainly with three actors:

- the municipality (in accordance with the *Planning and Building Act* and the *Public Water Supply and Wastewater Systems Act*)
- private homeowners
- insurance companies (knowledge dissemination and putting demands on residents)

The municipal actors represented are notably local managers from technical departments including the rescue service.

Although flood risk mitigation in the watershed has emerged bottom-up from the municipal level, some national authorities have come to play an important role in providing technical expertise. These include the Swedish Meteorological and Hydrological Institute (SMHI) (provision of weather and climate data); the Swedish Geotechnical Institute (information/projections of soil erosion, landslides, etc.); the Danish Hydraulic Institute; as well as local consultants.

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The main support and funding has come from the Swedish Civil Contingencies Agency through its national level mandate for flood risk management under the *Civil Protection Act*¹¹.

Thus, the interests represented in watershed governance are predominantly of a technical nature, with a small technical group of experts responsible for defining the problems and solutions. Flood risk mitigation measures have traditionally focused on conventional building and reinforcement of embankments, along with pump stations, and some early preparedness measures. Early preparedness measures include an early warning system with its own website with real time updates ('Flood watch Kristianstad'), with monitoring stations in the municipality and access to SMHI monitoring in the Helge River basin¹².

Groups excluded from watershed governance

Groups working in silos in watershed governance include other non-technical sectors such as strategic and spatial planning, and excluded groups including environmental departments of Kristianstad municipality¹. Moreover, other (upstream) neighbouring municipalities in the river basin are not directly involved in watershed governance. Despite the growing recognition of benefits of upstream flood abatement efforts, there is an absence of such measures. Since there are no major dams regulating the flow of Helge River, measures upstream would either be inadequate or controversial (building a large dam in another municipality). The technical departments in Kristianstad municipality have therefore concluded this was not a priority action. However, a recent

study points to an emerging willingness to intensify the collaboration with other municipalities, with the challenge being that Kristianstad does not have the mandate or funding to work at a river basin scale².

Although local residents are severely affected and at risk, their involvement in the flood risk mitigation measures is limited².

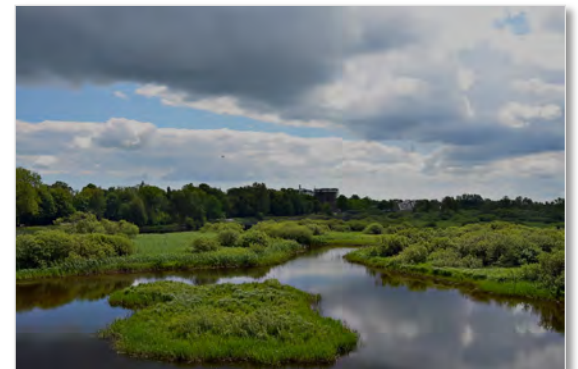
Some first steps to increase inclusiveness in watershed governance

Sweden is a highly decentralized country, and the planning mandate lies with municipalities. Traditionally, flood protection and control strategies have been adopted in planning and management of the Helge River, with little attention given to the river basin scale.

To increase inclusiveness in governance, one early step would be to adopt a more holistic (catchment, landscape) perspective to reduce the flood risks/alter flows rather than to operate solely within traditional, political-administrative boundaries. This requires more proactive consultation and cooperation with municipalities upstream and downstream of the Kristianstad area.

Another step would be to involve new actors, such as farmers and forest owners. The Helge River Basin has forest in its upper reaches and mainly agriculture in the lower reaches before it empties into the Baltic Sea. The land-use sectors are heavily influenced by, and have an impact on, water levels and affect the water quality and nutrient retention in the area.

These groups have been identified, and partly engaged with, through the stakeholder mapping and engagement initiatives.



Kristianstad wetlands, Sweden.
Photos by: Kristianstad Municipality

Chapter 2: Building a shared understanding

Chapter One laid the groundwork for approaching watershed governance, and all of its complexities, through inclusive participation.

This broad representation of different actor groups is important yet, on its own, it does not guarantee that the process of participation will be meaningful through the sharing of ideas and interests.

The key to meaningful inclusive participation is to work with all actors in building a shared understanding.

That does not mean that consensus must be reached on every detail or that actors must fundamentally change their views to align with others. In fact, it would be naive to suggest that all actors will see eye to eye. Some actors simply will not change their views or behaviour. Building a shared understanding implies that actors listen to, understand, and respect the perspectives of others through processes of deliberation.

In a watershed governance context, deliberation refers to a process of open communication, respectful discussion and debate, and reflection among representatives from a broad range of actor groups. Deliberation can help different actors better understand each other's viewpoints and interests. It can lead to a better understanding of the watershed overall, without forcing consensus. Groups that try to work together can too often become "stuck" in their deliberations, with some groups simply trying to convince or persuade others that their view is the correct one. Actors do not have to be in complete agreement, and they likely will not be, it's more important that actors come away from deliberations with a shared understanding of the system.

What does building a shared understanding look like?

The process centres on knowing the life of the watershed — in other words its past, present, and future.

A study into the past can reveal the types of disturbances that have been experienced in the watershed, the strategies used to respond to those disturbances, and the outcomes of those responses.

By observing the current state, actors will acquire information on a variety of levels such as what is valued or considered important at present, what threats, challenges, and potential disturbances exist, what formal and informal institutions are in place to deal with them, and which drivers of change pose the greatest concern.

As for gaining an outlook to the future, this is an exercise often referred to as backcasting. It involves coming to some shared vision of what actors would like the watershed to look like in the future if it were more resilient than today, what actions are required to get there, and how to prepare for and respond to anticipated and unanticipated disturbances.

There is no stronger case for the importance of building a shared understanding than reflecting on how it will

support the key objectives of meaningful inclusive participation outlined in Chapter One as:

- establishing trust to mitigate conflicts and efficiently mobilize resources and people around emerging issues (e.g., looming thresholds, appearance of new invasive species) and after disturbances
- bringing together diverse ideas for the development of innovative approaches in building resilience

Techniques and real-world examples

There are many techniques to help watershed managers engage diverse actors in respectful discussion about, and reflection on, their watershed. We examine two of those techniques — developing a historical profile and values and disturbances mapping. Both techniques are easily modified based on the specific watershed context.

Developing a historical profile

Every watershed has a unique history and a great deal can be learned through creating a historical profile. The exercise needn't be overly complicated or time consuming.

Working as one large group, or in several smaller groups, actors create a timeline to reflect the history of the watershed. This

can be done on a whiteboard or chalkboard, or by laying chart paper across the floor or hanging it up on a wall. Looking back in the watershed's past all the way to pre-development days, actors fill in significant events that have taken place and changes that have occurred — such as major storms, the intentional or unintentional introduction of non-native plants, animals, and diseases that have had a significant impact, changes in legislation, construction of major infrastructure such as a dam, and so on.

Another important element to building a historical profile is to provide a perspective of scale — a three-level view. Think about what has happened in the past in a specific part of the watershed or on a regional or national scale that had an influence on the watershed as a whole.

All three scales can have their own timeline and can be arranged with the watershed timeline in the centre, the larger scale above and the smaller scale below. This way, interactions between the scales can be represented using arrows or other symbols.

While this activity may seem fairly simple, the information and insights generated can be quite powerful. Actors come to a shared understanding of the drivers of change in the system as well as cross-scale causality. Moreover, thinking in terms of

drivers of change and trends can prepare actors to start considering current trends and potential future trajectories of the system. As future trajectories are identified, actions that lead towards desirable trajectories and away from undesirable ones can be developed and undertaken.

A detailed description of developing historical profiles for systems can be found in Walker and Salt's (2012) book titled "[Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function](#)".

Values and disturbances mapping

Inclusive participation and building a shared understanding is particularly important in the initial stages of the watershed planning process. Different actor groups have unique perspectives on what is valued in and about the system, and what the potential threats or disturbances are to those values.

A values and disturbances mapping exercise is one way to elicit these different perspectives and take advantage of multiple sources and types of knowledge.

A mapping exercise was conducted as part of a resilience analysis workshop involving diverse actor groups in the Cowichan Watershed in British Columbia. The participants were asked to write down on a sticky note what they value in or about the

watershed and then place those values on a large map of the watershed and discuss them as a group. Each participant was provided with an opportunity to explain the values they identified. Examples of the types of values listed include unique built and natural features, cultural and medicinal uses and historical value, recreational and educational opportunities, family memories and genealogical connection, and local involvement and collaboration.

The focus then shifted to what threatens the Cowichan Watershed. Using sticky notes of another colour, participants were asked to consider the challenges and disturbances that affect the watershed, including those that occur at a broader scale than the watershed. Participants described and mapped these disturbances, and discussed them with the group. Poor land management, lack of funding, issues related to water level extremes, and governance

concerns are some examples of the types of challenges and disturbances discussed.

Describing the watershed in terms of values and threats highlights the range of experiences and knowledge held by participants. By sharing this personal knowledge and experience with others in the group, shared understanding is built. Mapping these aspects goes one step further by adding a spatial component to the information. Involving as many different actor groups as possible in this activity ensures that a broader range of perspectives — including local knowledge and traditional ecological knowledge — are informing the watershed planning process and watershed governance.

To read more about the values and disturbances mapping exercise in the Cowichan Watershed, refer to: <http://bit.ly/1hquJDg>

Questions for reflection

1. Have you discussed the history of your watershed as a group? If not, whom might you include in that discussion?
2. What values do you hold for your own watershed? How different or similar are they from others'?
3. Disturbances can occur at many scales; what are some of the local, regional, and large scale disturbances that impact your watershed?

Chapter 3: Inclusion of ecosystem services and functions in long-term planning

Watersheds are complex systems of people and nature. The social, economic, and ecological dimensions of the system are strongly interconnected and constantly interacting. Decisions regarding one dimension will have an impact on the other dimensions.

Ecosystem services are the benefits humans derive from the physical, chemical, and biological functions of healthy ecosystems such as watersheds. Ecosystem services contribute to “making human life both possible and worth living”¹³, that is why we value them.

For example, carbon sequestration, the process of removing and storing atmospheric carbon dioxide, is an important ecosystem service provided by healthy vegetation that ensures better quality air for humans. A healthy riparian buffer has the potential to sequester a large amount of carbon dioxide through photosynthesis.

The concept of ecosystem services is admittedly an anthropocentric one. Nonetheless, ecosystem services must be factored into long-term watershed planning strategies because our well-being is dependent on the capacity of natural processes and systems to provide these services.

Ecosystem services are typically divided into four types of services:

1. supporting services (e.g., nutrient cycling, primary production, soil formation)
2. provisioning services (e.g., wood and fiber, food, fuel, water)
3. regulating services (e.g., water purification by aquifers, carbon sequestration by forests, flood control by wetlands)
4. cultural services (e.g., recreation, education, spiritual, aesthetics)

The value of these benefits to humans and wildlife have been studied and described in influential reports such as the Millennium Ecosystem Assessment (see the [synthesis report](#)). Research has shown that the cost of replacing or substituting these services is substantial, if at all possible, when ecosystems are degraded, impaired, or otherwise unable to provide services.

What does the inclusion of ecosystem services look like?

Actors involved in the watershed planning process should come to a shared understanding (as discussed in Chapter Two) of how management decisions affect the type, quality, and magnitude of ecosystem services received in a watershed in order to assess and compare trade-offs associated with various decisions. For example, regulations prohibiting new developments in wetlands help maintain a number of ecosystem services such as flood retention and water purification. However, when decisions are made in watershed planning, these impacts may not be considered.

Some researchers suggest that this is best done through assigning monetary values to ecosystem services using economic valuation methods and including ecosystem services in economic analyses of costs and benefits (see the [Liquid Assets](#) report for an example from the Niagara River watershed). By measuring the economic value of ecosystem services, the argument is that a more accurate account of the economic and environmental costs of different management decisions can be realized leading to more informed and effective environmental policy and management strategies.

Economic valuation is just one way of thinking about ecosystem services. The main message here is that the physical, chemical, and biological functions of ecosystems, and the resulting ecosystem services that they provide, should be taken into consideration in watershed planning as a condition for holistic management of environmental resources.

While the consideration of ecosystem services in watershed planning will not automatically solve issues or address all challenges within a watershed, these services are very important for building and maintaining resilience. Ecosystem services, for example flood mitigation and coastal protection from storm surges provided by wetlands, can assist watersheds in coping with a range of disturbances that would otherwise have potentially detrimental effects on the watershed. By factoring ecosystem services, and the consequences of undermining them, into the watershed planning process, the importance of those services are explicitly recognized and attempts can be made to protect them and/or restore them where they may be degraded. Examples of how ecosystem services have been incorporated in long-term watershed planning are described in the following section.

In Chapter Two, two techniques — developing a historical profile and mapping values and disturbances — focused on

linking actors to their watershed. The next step is for actors to acquire a deeper conceptual understanding of the ecological and hydrological linkages within their watershed. This knowledge will help to inform decisions to ensure identified and important ecosystem services are protected through the watershed planning process.

Some watershed organizations have used the technique of ‘watershed characterization and technical synthesis’ to tell the story of how their system functions by breaking down and simplifying complex interactions and complex physical, chemical, and ecological functions. Additionally, the Mactaquac Aquatic Ecosystem Study is highlighted as a current, real-world example of the inclusion of ecosystem services and functions in long-term planning.



Niagara River, Ontario. Photo by: Samantha Morris

Techniques and real-world examples

Watershed characterization and technical synthesis

Some agency led watershed planning processes are comprised of several components, including:

- amalgamation of existing information
- assessment of outstanding functions and characteristics
- synthesis to characterize how the various components of the watershed interact at a very coarse scale

The Credit Valley Conservation Authority in Ontario has refined this process in order to help local communities better understand the relationships and interactions of water, water flow, and ecological functions driven by water within a watershed. One of the more recent examples of this technique can be found in the Silver Creek Subwatershed Study, Characterization Report.

The characterization process is used to set the foundation of information for the community to review in order to begin the planning process. Historical information is pulled together and gaps in technical information are identified. Then an assessment program is undertaken using various disciplines working together to identify the physical, chemical, and

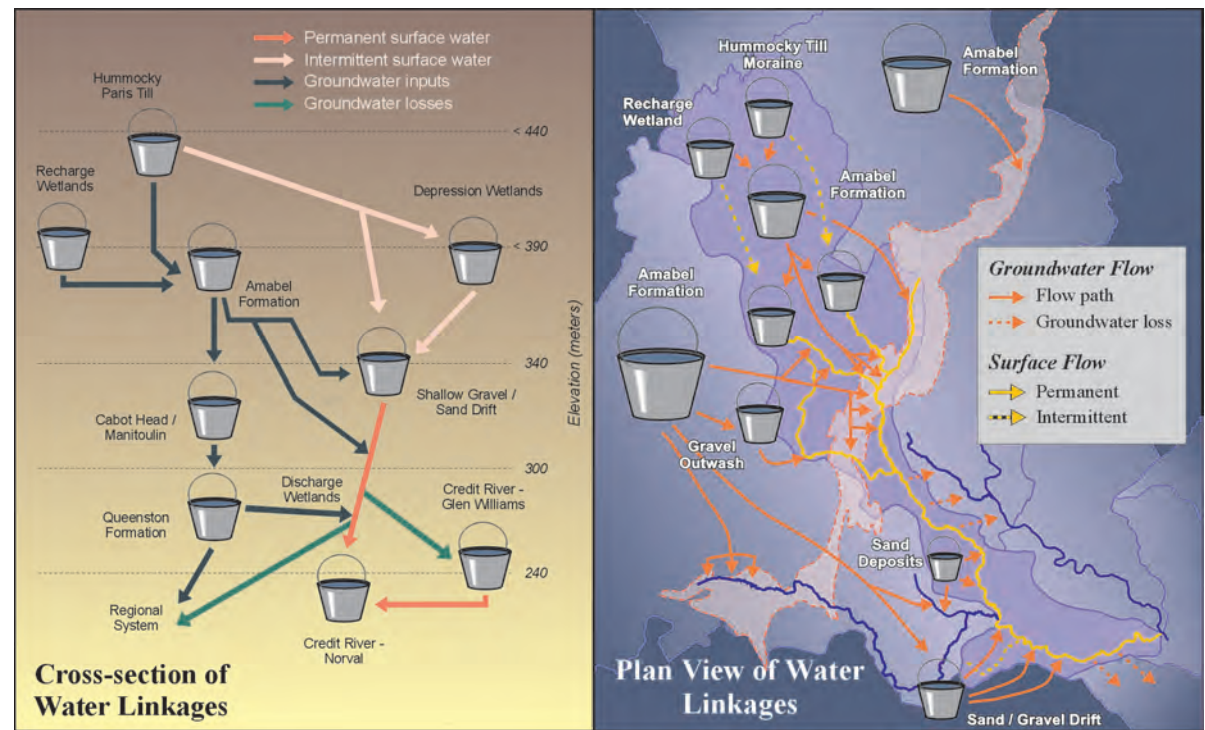


Figure 1: Bucket and pipe models in cross-section and planform of the Silver Creek Subwatershed, Credit River, Ontario, Canada¹⁴

biological characteristics of the watershed. Once this information is collected and summarized, an integration report is prepared to outline how each of the key components (e.g., geology, topography, hydrology, hydrogeology, chemistry, biology, land-use activities) “fit” together.

One of the key approaches to help guide an understanding of the relationship between geology, topography, water resources, and biology is the development

of a conceptual “bucket and pipe” model (see Figure 1).

The conceptual model is built by laying the bedrock and surficial geology over the watershed area. Hydrogeologists and hydrologists then prepare an interpretation of groundwater and surface water movements as part of a model that includes movement of water over and through the landscape. This information is then used to compare where we find

important features such as valley corridors, floodplains, wetlands, and reproductive areas. This model can then be used to understand which portions of the watershed provide which ecosystem services and where they may still exist but may have been altered by past or present land-use activities. This helps to determine what needs to be protected, conserved, or where possible, restored. It's a very powerful visual tool for communities to use to better understand and balance their economic, social, and ecological interests.

For more detail on the integration approach with the use of the bucket and pipe model to help visualize the water flow and ecological characteristics of Silver Creek, refer to: <http://bit.ly/1Kx3r9L>



The Mactaquac Dam. Photo by: Katrina Krievins

The Mactaquac Aquatic Ecosystem Study (MAES)

The Mactaquac Hydroelectric Generating Facility (the Mactaquac Dam) was built in the late 1960s about 20 kilometres upstream of Fredericton, New Brunswick on the St. John River. Because alkali-aggregate reactions are causing expansion and subsequent weakening of the concrete infrastructure, the facility will reach the end of its service life by 2030. The operator, NB Power, will soon make a multi-billion dollar decision to repower the station with a new powerhouse and spillway, rebuild the spillway only, or remove all parts of the dam and facility (www.mactaquac.ca). The Mactaquac project is the world's largest dam renewal project.

NB Power understands the significance of their decision and critical importance of a publicly accepted, successful project. The Canadian Rivers Institute (CRI) at the University of New Brunswick is preparing NB Power for the decision by undertaking the MAES, a multi-year assessment of the structure and function of this large river ecosystem (i.e., what are the environmental challenges and opportunities for either replacing or removing the dam).

In assessing and planning for the future of the dam, CRI is targeting the establishment of appropriate

environmental flow regimes: "...the quantity, quality and timing of water flows required to sustain freshwater ecosystems and the human livelihoods and well-being that depend on these ecosystems"¹⁵. Growing evidence supports the idea that re-establishing the main characteristics of a river's natural flow regime is the most appropriate flow management plan for a river^{16,17} and as such, the concept of environmental flows is being adopted in management plans^{18,19}. Appropriate environmental flow regimes protect the natural ecosystem while addressing needs for water use among all stakeholders. The natural ecosystem is described by its ecological flow requirements (i.e., the flows and water levels required to provide for the ecological function of the plant and animal life present in a water body and at its margins²⁰). Ecological function is sometimes referred to as the goods and services provided by the river (e.g., habitats and adequate water quality). Proper ecological function is sustained by the natural dynamic character of the flow regime within and between years^{16,21}.

The final flow regime for the future with or without the dam will be developed using the Ecological Limits of Hydrologic Alteration (ELOHA) approach^{22,23}. This is a holistic environmental flow framework that has been developed and adopted worldwide over the past two decades¹⁸.

The framework is based on the premise that maintaining some resemblance to the natural hydrological regime is necessary to sustain healthy river ecosystems. The framework integrates the biophysical sciences, typically hydrology, geomorphology, water quality, and various disciplines of ecology, with social, cultural, and economic values to generate ecosystem protection goals specifically, the flow regimes. The method and its final consensus recommendations incorporate both the expert knowledge on river-specific data and observations, as well as input from the river's watershed stakeholders^{22, 23, 24}.

For more information on the ELOHA approach, refer to: <http://bit.ly/1FaEknb>

Canada has the potential to more than double its existing hydropower capacity. The MAES project's focus on environmental flow solutions are both desired and required today by dam managers and planners across Canada. The results of the MAES project, and offered solutions, will advance the protection of ecosystem goods and services in our rivers while sustaining a competitive economy for Canada.

Questions for reflection

1. What is the current suite of resources you use to understand the watershed ecosystem?
2. What resources do you currently have (if any) for your watershed that relate specifically to ecosystem services?
3. Is there someone in your group who has the expertise to lead an assessment of ecosystem services using one of the above techniques or another approach? If not, could techniques from the first two chapters assist in finding a person or group with suitable expertise to do so?



Nashwaak River, New Brunswick



Rivière Saguenay, Quebec



Fisherman's Wharf, British Columbia.
Photos by: Katrina Krievins

Chapter 4: Strong leadership

Strong leadership is an important attribute of any organization, movement, government, or similar group of individuals working together to achieve a common goal.

Global experts have identified key characteristics of strong leadership specific to building resilience in a watershed governance context as being:

- distributed among a networked group
- adaptable
- efficient
- transparent and accountable
- supportive of innovation and experimentation

What does strong leadership look like?

Leadership that is distributed among a networked group: It may be preferable for complex systems such as watersheds to have multiple leadership roles vested in different individuals or groups rather than an individual leadership role. This provides leaders with very diverse, yet complementary skill sets. Broad skill sets are ideal in addressing the range of challenges facing watersheds. New individuals can be called on to provide a fresh leadership perspective as watershed challenges shift over time. In addition, having multiple leadership roles will allow for leaders at different levels — local and regional — and will ensure some continuity when individuals step down from positions for any reason.

Leadership that is adaptable: Adaptability allows for adjustments to be made in response to new information. The inherent uncertainty associated with the complexity of watersheds necessitates that leaders have the authority to act on new information and changing conditions. For example, in the face of unpredictable changes in water supply as a result of a changing climate, and a simultaneous increase in demand for water, it is crucial that those in leadership positions are capable of responding to changes in water availability in order to minimize negative impacts on actors in the watershed.

Leadership that is efficient: It is imperative, in watershed governance, to have leadership that is able to respond to change and disturbances in a timely manner given the potential for negative impacts to be experienced by a number of diverse actors. A major flooding event, for instance, can have devastating impacts for homeowners and farmers, and on public infrastructure. Consequently, the capability to organize efficient responses is another important characteristic of strong leadership.

Leadership that is transparent and accountable: Leaders whose decisions and actions are viewed by actors as being transparent and accountable, are likely to gain enhanced legitimacy and trust. Confidence in leadership leads to more efficient decision processes when responding to disturbances and new information.

Leadership that is supportive of innovation and experimentation: Innovation and learning, through small scale experimentation, is crucial for finding alternative management strategies in the face of new and mounting challenges. Challenges can also bring about new opportunities and a spirit of innovation and experimentation will drive new ideas.

Strong leadership is intuitively appealing. How to promote the characteristics of strong leaders, however, requires some work. As a starting point, review techniques, such as the Social-Ecological Inventory (SEI) and the social network analysis discussed in earlier chapters. Then consider the following techniques and examples to move forward.

Techniques and real-world examples

Analyzing existing strengths of a leadership network

Multiple people may hold leadership positions in a watershed. As a result, it is important to understand the different roles of these individuals and how they are connected to, and share knowledge with, one another. This analysis will help to ensure that leaders in the watershed are holding each other to account, are sharing results of innovative or experimental approaches to managing the watershed, and are providing each other with enough information to adapt to social and ecological changes as they emerge.

One of the first steps may be to conduct a social network analysis to “map” out the network. Using a simple survey tool, individuals in the watershed can be asked about who they turn to for leadership on key issues, and how frequently they are in contact. Their answers provide sufficient information to build a basic picture of the network. For example, a social network analysis was conducted in the St. John River Basin in New Brunswick and involved interviews with 41 individuals and organizations engaged in water management and governance activities in the watershed. The interviews determined that there were five organizations that were the most connected, and most frequently in contact with others in the network. This information has been very useful to a number of actors in the watershed (e.g., New Brunswick Department of Environment and Local Government, NB Power, WWF-Canada,

Although resilience is often thought of as a positive system property, undesirable situations can also be very resilient. Therefore, engaging with resilience involves either building the resilience of a desirable situation or degrading the resilience of an undesirable situation. However, sometimes undesirable situations are very stable and a system can become locked in. At some point it may be necessary or advantageous to create a fundamentally new system, to transform.

Transformation of social-ecological systems is defined as “the creation of a fundamentally new system when ecological, economic or social conditions make the continuation of the existing system untenable”²⁵. Transformations can be deliberate or unplanned, those that are planned have initial costs but these costs are typically minor in comparison to those associated with unplanned transformations that are forced on a system.

Aboriginal communities, watershed groups). The network map (Figure 2) allows those in the watershed to consider the implications of losing one or more leaders, and how to improve knowledge flows to those not in leadership positions.

Once the network of leaders from different levels of government, Aboriginal communities, local associations, and other key actor groups is identified, the next step involves working together to create a

mutual understanding of the impact of activities on individual leaders. For instance, imagine a network in which a member of an environmental non-governmental organization has led the development of environmental education initiatives and a citizen science group to conduct water quality testing. The network representatives will need to jointly evaluate how those education and scientific efforts support the other leaders

present and how did they assist the collective decision-making process. The answers will help to determine the networked connections among leaders, and the sources of information that can help leaders be adaptive and efficient in the face of disturbances or changes in the watershed.

Appreciative Inquiry into existing leadership capacity

Too often, leaders within a watershed face the challenging position of needing to react to an ongoing problem, whether that involves a longstanding conflict between different groups, or trying to improve the effects of restoration efforts for riparian habitat. A typical problem-solving approach involves brainstorming about the causes, and then working to mitigate those issues. However, two challenges exist with this approach. Firstly, it assumes that they can know the problems and the root causes, and pushes those leaders to focus on linear cause-effect solutions. Being able to “see” the complex system dynamics that are present in any watershed is not always likely, and leaders may be better served to take a whole systems approach and accept that they cannot “know” the system. Secondly, a heavy focus on problems can result in a neglect of the strengths and existing capacities in the watershed.

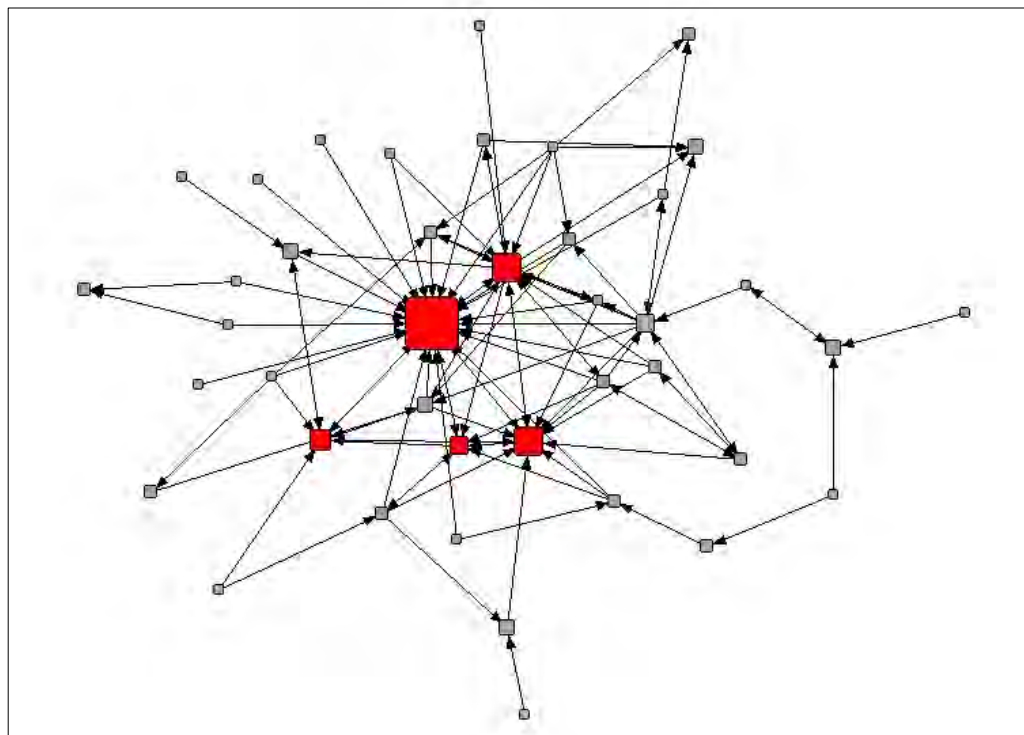


Figure 2. Network of groups engaged in watershed management in the St. John River Basin. The largest nodes (in red) are those most connected to others and arrows indicate direction of information flow

In order to build resilience in a watershed, it is important to first understand the strengths that exist across the distributed network of leaders in the watershed. By identifying strengths, leaders can work to ensure that any goals or visions are grounded in the reality of the skills and capacities that are present rather than setting themselves up to fail.

To identify strengths, the technique of an Appreciative Inquiry can help. In this exercise, a group of leaders may come together and brainstorm responses to the question: “When have we worked well together to make efficient but adaptive, and transparent decisions”? While an informal group discussion could take place, more detailed responses will be uncovered if the group works in pairs with one person serving to “interview” another person to better understand the who, what, when, why, and how of a particular example of the group working well together. Highlights or key findings from each interview can then be shared with the whole group, and the group can identify attributes, skills, and capacities that they share. Then, the next time a problem emerges in the watershed, the group can consider how they can draw upon these strengths and build a new path forward for the watershed.

Facilitation and the Art of Hosting Water Dialogues

The practicalities of strong leadership have changed drastically over the last number of decades — communities and people generally no longer seek, or respond to, top-down management styles, whether it be from business, governments, or other entities in our daily lives. The bottom-up, community-based approach has gained prominence, especially at the community level and within natural resource sectors. This diffuse and often messy approach creates more opportunities for innovation and experimentation and at the same time, can be a barrier to implementation and progress.

Effective leaders within the water movement, watershed organizations, and various agencies have a variety of techniques available to them as they pursue the tools (e.g., policies, regulations, actions, incentives, engagement) that support healthy waters and watersheds. Recently, facilitation has emerged as a specific technique within the sector that assists leaders in bringing the usual and unusual suspects together to address complex water-related issues. The facilitator, convenor, and sometimes catalyst, is a key ingredient of appropriate leadership – this is the person who hosts the dialogue and leads the groups through a process that empowers the participants



Resilience analysis workshop. Photo by: Michele-Lee Moore



Resilience analysis workshop. Photo by: Katrina Krievins



Resilience analysis workshop. Photo by: Kerrie Pickering

towards action. Facilitators are able to see the big picture and to make connections within actor groups and between/across actor groups, jurisdictional boundaries and existing barriers, such that understanding and clarity can be brought to complex issues. It is about understanding the benefits and trade-offs associated with issues and empowering participants to pursue actions that are appropriate, inclusive, and timely, where possible.

The Art of Hosting Water Dialogues is a workshop series with the aim of developing practitioners' facilitation skills. Participants in the workshop series learn how to organize and host meaningful conversations on the water-related challenges and opportunities within their specific context. This is referred to as the 'Art of Hosting'. The workshop series is put on by Waterlution, a Canadian non-governmental organization leading much of the dialogue, training, and expertise in the water sector related to facilitation, creating the next generation of water leaders. Their

materials say it best, "Waterlution is a facilitator of multi-stakeholder dialogue. We use process and content to engage young leaders, organizations, businesses and communities in fostering pattern-breaking and pattern-making change towards inclusive, sustainable ways to manage water" (www.waterlution.org).

For more information on the Art of Hosting Water Dialogues and other programs offered by Waterlution, visit: <http://waterlution.org/program/>

Questions for reflection

1. Who in your group currently leads? Is it a single person or multiple people?
2. If a single person leads, how might that person be supported in their role by others? If multiple people lead, how do they share leadership?
3. How could the above techniques support current leadership and help plan for any changes in leadership – both expected and unexpected?



Moon River, Ontario. Photo by: Amanda Puopolo



Kathleen Lake, Yukon. Photo by: Katrina Krievins



Sucker Lake, Ontario. Photo by: Katrina Krievins

Chapter 5: Institutional and decision making flexibility

In this chapter, we consider formal institutions, that is, the rules and decision-makers in place that create the conditions under which watershed governance occurs.

Formal institutions are a critical part of resilience at the watershed level and can, in fact, be influenced, albeit indirectly, by those working at the watershed level as well as those working in water policy and management through involvement in multi-actor meetings, communication and network connections (both formal and informal) and advocacy efforts, among others.

Watersheds are dynamic systems, constantly changing with uncertain impacts and outcomes. Because of this complexity, it isn't as easy as looking to the past to prepare for the future. For example, in many parts of the world, rainfall events that have been estimated to have a 1% probability of occurring in a given year (i.e. 100-year storm) are predicted to occur more frequently in the future than the expected 100 year return period²⁶. This inherent uncertainty of complex systems requires formal institutions to remain flexible in order to effectively respond and adapt to new information and new challenges.

Institutions that are structured to allow for changes and adjustments will create an atmosphere of flexibility in decision making, planning goals, and procedures for actor engagement.

What does institutional and decision making flexibility look like?

Flexible institutions are part of an adaptive approach to watershed governance and are essential for building resilience. Without flexibility, management and practices become locked in and the ability to adapt to changing conditions is lost, ultimately reducing the resilience of the whole system.

The contaminated drinking water tragedy in Walkerton, Ontario, during which several people died and thousands more got sick, illustrates a strong case for flexibility of institutions. In response to the tragedy, institutions concerning drinking water safety in the province underwent dramatic changes. Source water protection subsequently became a mainstream priority in the province because of the flexibility of Conservation Authorities (CAs) in response to a major crisis. Owing to their local focus and the fact that the scope of their potential programs and services which may be delivered as outlined in the *Conservation Authorities Act* is intentionally broad, CAs have the flexibility to respond to current needs and priorities in their jurisdiction by tailoring their programs and services accordingly or adapting province-wide programs to suit local needs²⁷.

Changes in water availability offer another example of the importance of institutional flexibility. Parts of the country currently experiencing, or expected to experience, changes in terms of water availability will depend on flexibility to make adjustments in water pricing mechanisms in light of new information.

These two examples highlight the value of institutions that are nimble and better able to acquire and incorporate knowledge about ecological processes and ecosystem dynamics in response to disturbances or changing conditions

Questions for reflection

1. Thinking about your own connections or influence on existing formal institutions relevant to watershed governance, how could you increase your influence?
2. In what areas do you feel greater flexibility is needed?

Researcher reflections

Traditionally, top-down governance mechanisms have been utilized by governments and other agencies involved in the regulatory, planning, management, monitoring, and other activities associated with watersheds.

That's changing with increasing support for the concept of flexibility by the myriad of actors engaged in watershed management and governance.

As governance models continue to evolve, the main questions moving forward are how do alternative approaches succeed, within a time of rapid change; and what specific role does resilience play now and into the future?

A number of techniques are being utilized at the watershed level to encourage greater flexibility – the existence of watershed organizations in many jurisdictions across the country and more recently the emergence of co-management models with Aboriginal communities are but two examples. The dispersion of responsibilities evident with these groups contrasts the more traditional management-based organizations and encourages approaches that are respectful of the environment and traditional rights, while working to create resilient institutions and ecosystems. This is a reflection of the nature of these entities and their core values, which contribute to resilience through the creation of new and innovative approaches to resource management.

The effectiveness and ultimately the resilience of these institutions hinges on a number of key aspects of good governance, namely: transparency, accountability, and meaningful and on-going engagement. The on-the-ground experience emerging in Canada contributes to the collective understanding about the suitable structures to support watershed-based governance.

The myriad of formal and informal watershed arrangements is in and of itself contributing to resilience within the sector. This, in addition to the emergence of new models and tools, is leading towards a more resilient water sector. The long-term resilience of these groups and the work they undertake will occur as a result of on-going adaptation to maintain relevance within a period of rapid change.

Chapter 6: Decentralized system

Any authority responsible for making decisions that impact watersheds has to contend with an array of social and ecological conditions that influence watersheds and that occur at multiple levels, from local or site-specific, to global.

How should that authority function — as a centralized unit that involves one single actor operating on one level only in making decisions or as a decentralized unit in which decisions are shared among actors at various levels?

When the authority for making decisions that impact watersheds is centralized the potential exists for influences from other levels and actors to be overlooked in decision making. This may result in actors with authority that are not best suited to address issues at the watershed level and centralized authority may reduce system resilience by limiting the effectiveness of responses to disturbances and change.

On the other hand, decentralized authority allows decision-making to be passed down (or up) to the level in the system, and to the appropriate actor, where a particular issue can be most effectively dealt with. This broader scope has a much greater capacity to enhance resilience.

On their own, community groups lack the power to accomplish decentralization. They can, however, collectively advocate for decentralization and it's important that they be aware of and understand this very challenging but important concept.

What does a decentralized system look like?

A decentralized system is one in which decision making is shared across levels – from national to local – through devolution of responsibility and implementation. Rather than having senior governments as top-down managers, they become enablers of local

solutions through the sharing of authority and empowerment of local communities. In sharing authority and empowering communities, decentralization seeks to address deficiencies of hierarchical relationships and focus on integration of actors across multiple levels. Exactly what this decentralized structure looks like will vary from place to place, and the degree to which power and authority for decision making and implementation are shared is also dependent upon the situation.

While power and authority are distributed among entities at different levels, it is important to note that a decentralized system requires effective coordination between levels to avoid fragmentation. Communication and information must flow across and between levels. In Ontario, for example, watershed governance involves careful coordination between municipalities, Conservation Authorities operating at the watershed level, and provincial and federal agencies. Fragmentation was arguably part of the reason that Southern Ontario experienced such devastating impacts following Hurricane Hazel in 1954. Without a regional approach to flood control or response at the time, efforts to warn and prepare people for Hurricane Hazel were insufficient. The high winds and intense rain brought on by Hurricane Hazel pounded

Southern Ontario over 48 hours and resulted in flooding that killed 81 people, left thousands homeless, and created millions of dollars in damage. These tragic events ultimately spurred greater coordination between actors at different levels.

By creating conditions where capacity to adapt is improved, decentralization plays an important role in building resilience. As a result of a modular structure, distributed authority spreads risks across time and space, thus lowering sensitivity to shocks and resulting in a higher capacity to adapt than would be possible in a centralized system. Failure to adequately respond to a disturbance at one level does not necessarily result in the whole system failing — much like the old adage of “don’t put all your eggs in one basket.” With decision making coordinated across levels, the diversity of response capabilities is greater and can deal more appropriately with uncertainty and change which serves to enhance resilience. Additionally, responding to issues can be done at the level most appropriate to the ecological scale. For instance, the issue of flooding in a city might be best dealt with at the watershed level over the municipal level. Finally, decentralization is closely linked to the attributes described in previous chapters. A decentralized system serves as

an enabling condition for inclusive participation at multiple levels and ultimately provides improved access to local knowledge and expertise. A decentralized system allows for greater responsiveness to public needs and concerns, and builds shared understanding.

Implementing a decentralized system will call for collective action amongst actors in the watershed who recognize its strong potential for building resilience.

Techniques and real-world examples

With continual downsizing of governmental organizations, it is imperative that decentralized systems be built and maintained in order to ensure that good environmental management continues. However, a decentralized system only works well when key factors are included. These factors include a means to connect the various levels of decision making, an engagement process, active communication amongst the different levels, and sharing of information.

One example of this type of decentralized system is the management of aquatic and fisheries resources through watershed and community-based fisheries management plans and their committees.

Grand River Fisheries Management Plan

The Grand River Fisheries Management Plan and the process of creating and implementing the plan demonstrates the value of engaging partners, agencies, and individuals to collectively manage the aquatic and fisheries resources of the 6,700+km² Grand River Watershed in Ontario.

The Fish Plan was created with the help and support of non-governmental organizations that cared about the aquatic resources of the Grand River Watershed. The process of creating the plan was facilitated by agencies at the watershed (Conservation Authority) and provincial level (Ontario Ministry of Natural Resources and Forestry) with input from the federal level (Fisheries and Oceans Canada). It was the local actors however that were charged with confirming the guiding principles of the plan, the code of conduct of interaction with all partners, and the final decision on the various elements of the plan. The role of the agencies was to provide the technical and scientific input and the facilitation process to ensure good discussion, communication, and decision making towards an agreed upon plan. All decisions along the way were reached by discussion and consensus and all parties understood and recognized their contributions.

At the end of the planning process, all participants from various levels of decision making approved the plan and the partners switched to an implementation committee dedicated to implementing the plan at all scales. What has kept this initiative effective has been the constant and ongoing communication between the various levels and the creation of an Implementation Committee including all levels to facilitate implementation of each strategy by the appropriate partner. Where issues arise, the Implementation Committee determines what additional support or help is required and ensures that it is provided. Although the province has responsibility for fisheries

management, the federal government has responsibility for fisheries regulations, and the Conservation Authority has responsibility for water resource management, all work together to ensure the plan is successful and all link together to support local partners working on local strategies found within the plan. However, this system only works because of the effort to maintain engagement through bi-monthly meetings, ongoing communication, and collaborative projects.

For further information on the plan and its approach, refer to: <http://bit.ly/1JFVERU>



Grand River, Ontario. Photos by: Amanda Puopolo

Final thoughts — What to take away from the primer

Without a doubt, watersheds are complex social-ecological systems owing to their dynamic nature, the strong interconnections between the social and ecological dimensions, and the large number of diverse actors with a stake in the watershed. The reality of an uncertain and unpredictable future adds to this complexity and renders conventional approaches to watershed governance alone inadequate.

In this primer we have highlighted how infusing resilience thinking into watershed governance holds great promise. Throughout the document, six main attributes of resilience were introduced and discussed as a means of initiating a conversation about applying resilience thinking in a watershed governance context. The idea behind this primer was not to create a how-to guide for creating a resilient watershed. Rather, the primer is a critical first step to get individuals engaged in various aspects of watershed governance thinking about how these concepts might apply in their own watersheds.

We hope that this primer starts a conversation at a range of levels, from local to international; that it inspires watershed stewards, managers, and policy makers to ask questions about how watersheds are currently governed and how the attributes identified here could contribute to a more desirable, resilient system. We invite readers to use the techniques and resources identified in the primer to explore the attributes more fully within their own context.

It will take time to gain more experience with the attributes highlighted in this primer and with applying resilience thinking more broadly. Important further insights will also emerge. We encourage readers to share lessons learned and develop additional resources to provide further guidance to those actively engaged in enhancing the resilience of their watersheds.

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**Resilience in
a Watershed
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