UNDERSTANDING STRUCTURE AND CHARACTER IN RURALWATER GOVERNANCE NETWORKS

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Abstract

Governance has emerged as one of the key concerns amongst water experts focused on sustainability. Achieving sustainable states of water governance requires alignment of governance structures with water management objectives that are context specific. Two rural watershed planning processes in the province of British Columbia- the Similkameen Valley (Similkameen) Watershed planning network and the Kettle River (Kettle) Watershed planning network - were investigated using social network analysis (SNA) and social discourse network analysis (s-DNA) to map the socio-ecological relationships and analyze the discourse upon which water governance networks are being built. The resulting network structures and key actor characteristics revealed limited evidence for a transition towards collaborative and adaptive water governance models, which have been argued to be better suited in addressing key goals such as adapting to climate change impacts. Recommendations are made for improving water governance processes in rural regions to achieve effective implementation within the context of the new *British Columbia Water Sustainability Act*, 2014. SNA and s-DNA provide a means, through interdisciplinary research, to examine social network drivers and potential barriers to sustainable water governance development. Identifying network structures and measuring network characteristics gives resource managers the insight to intervene into evolving governance processes, to ensure proper alignment with contextually determined water sustainability goals. Results from this research will enable those involved in water governance design and implementation to make informed water resource decisions leading to effective, adaptive, and sustainable water governance.

Preface

The dissertation research evolved from a tri-university forum, Water Science Symposium (2010), hosted by the University of British Columbia Okanagan, the University of Northern British Columbia, and the University of Victoria in collaboration with the BC Ministry of Environment. The intent of the forum was to encourage dialogue between academics and policy practitioners to reduce what is commonly referred to as the science-policy gap within the field of water management. What emerged from the forum, however, was the identification of a range of issues (e.g., responsibilities, resources) preventing the effective and sustainable management of water. An extensive literature review (see Chapter 2) revealed that the issues raised at the forum appear to fall under a broader category referred to as “institutional inertia.” At the start of this research, institutional inertia was identified as the key barrier to water governance models failing to transition to more collaborative and distributed models of water governance theorized to be more adaptive in a non-stationary context associated attributed to climate change. It is argued through this research that the transition in water governance, from existing centralized perceived as failing water governance models to more collaborative models may be both reactive and ill-advised as a general panacea approach.

The research was partially funded by the Water Economics, Governance, and Policy Network (SSHRC and Brock University), and it forms a part of, and informs, a larger water governance research project led by Dr. John Janmaat, Associate Professor and Leading Edge Endowment Fund Chair in Water Governance (UBC Okanagan), who is investigating factors that determine water use in the Okanagan and other regions. All social network survey design, implementation, and interviews were conducted by the author. Co-authors of chapters

4 and 5, which were published as stand-alone papers, were primarily responsible for reviewing and editing draft versions of papers.

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Dedication

I would like to dedicate this dissertation to my wife, Sandra, and my children, Carilia and Damian. I am deeply grateful for their continued patience, support, and sacrifices throughout the completion of this doctoral research.

Chapter 1 - Introduction

1.1 Background

Extreme climate change-related impacts coupled with pervasive development (e.g., land use changes) around the globe have highlighted the inadequacy of current water governance systems in dealing with complex challenges, leaving current and future water resources extremely vulnerable (Pahl-Wostl, 2007, 2009; Milly et al., 2008; Palmer et al., 2008; Cohen & Waddell, 2009; Vorosmarty et al., 2010; Bates et al., 2012; Pahl-Wostl et al., 2012). Water sustainability (e.g., long term quality and quantity) has proven difficult to attain, as evidenced by the many water regimes globally that are in, or are rapidly approaching, a state of crisis (Vorosmarty et al., 2010; Keskin & Varis, 2012). While water related challenges exist for developed and developing nations alike, the majority of compromised watersheds are located in the advanced and fastest developing nations, including the United States, China, India, and many European countries (Vorosmarty, 2010). It is estimated that approximately 30 percent of the world's population is living in water-stressed conditions (Bates et al., 2008; Wada et al., 2010; Gleeson et al., 2012). The increasing risk to the well-being of both humans and nature highlights the pervasive challenge of decoupling growth and development from water degradation throughout most of the critical regions across the globe (Keskin & Varis, 2012; Vorosmarty et al., 2010). For example, the number of rivers in China has reduced from 50,000 in the 1990s to 28,000 currently. This loss of rivers according to government sources has been attributed to statistical errors, climate change and loss of soil and water (Ministry of Water Resource, National Bureau of Statistics. (2012)), but non-governmental sources, point to poor water management, governance, lack of ground water extraction controls and rapid development

(Hsu & Miao, 2013). The loss of hydro-climatological stationarity has rendered traditional water management approaches inadequate. Sandford (2013) notes, “Threats to our way of life demand a fuller understanding of human interaction and impacts on the hydrological cycle. To meet this level of threat will require engagement by everyone including help from nature”.

Canada is not immune to this crisis, contrary to the widely-held belief of an abundance of fresh water (Bakker & Cook, 2011). The Canadian water governance regime has been described as highly fragmented due in large part to its decentralized, multi-jurisdictional nature (Bakker & Cook, 2011). Contributing to this highly dispersed structure are the segmented and often isolated, yet constitutionally entrenched, responsibilities that span fisheries, navigable waters, environment, federal lands and international waters at the federal level; water resources management pertaining to supply (licensing) and water quality at the provincial / territorial level; and water delivery and infrastructure at the municipal level. Adding to this complex mix is the diverse and overlapping context in which water issues interface with human health, ecological integrity, economic benefit, and First Nations health, access and security (Paul-Wostl et al., 2012; Huitema et al. 2009).

Water governance is multifaceted and multi-scale due, in part, to the interconnected complexity of the hydrological cycle and the multifarious actors and sectors that are engaged in water management. Often, responses to water problems fail to account fully for this interconnectedness of both hydrological and social systems (Molle et al., 2009). Unintended consequences frequently occur when the interventions intended to solve a problem for one actor or sector, at one scale, exacerbate or create new challenges for other actors or sectors in different locations that may operate at different scales with different constraints (Stein et al., 2011).

The crisis of water is essentially a crisis in governance (Global Water Partnership, 2003; Briswas & Tortajada, 2010; Wei & Li, 2013; Margerum & Robinson, 2015) resulting from ineffective water institutions faced with unprecedented challenges. Climate change "cannot be simply addressed through technocratic and depoliticised management and engineering processes – it is essentially a deeply political challenge" (Gupta et al., 2013, p. 573). Current water (mis-) management practices have been identified as being a far greater threat than future climate-change impacts themselves (Grafton et al., 2012; Wei and Li, 2013).

Increased public awareness and an enhanced sense of ownership in decision-making processes regarding water resources have resulted in growing pressure on resource managers to accommodate non-state actors in all aspects of water governance. The call for a new, inclusive model of water governance follows on the assumption that centralized, hierarchical models based on command-control strategies have generally failed to produce robust outcomes in water resources management. The growing recognition of the need for a governance transition is tempered by the limited agreement on which governance system is best suited for which purpose (Collins & Ison, 2010; Godden et al., 2011).

Over the past decade, a significant body of literature devoted to public participation in environmental governance has evolved (i.e., Mostert, 2003; Ridder et al., 2005; Mostert et al., 2007; Huitema et al., 2007, 2009; Reed, 2008; Newig & Fritsch, 2009; Wesselink et al., 2011). A rise in popularity of what Irwin (1995) and Reed (2008) identified as "citizen science" has also raised non-state actor expectations for inclusion and participation in the decision-making process, or may possibly be the result of citizens' growing interest in influencing decision-making. This in turn has applied upward pressure for governments to consider increased collaboration with non-state actors in the decision-making processes surrounding water.

Public participation in decision-making has become part of the environmental governance rhetoric in many industrialized countries (Sabatier et al., 2005; Messner et al., 2006; Cronin and Ostergren, 2007; Ferreya et al., 2007; Mostert et al., 2007; Medd and Marvin, 2008; Reed, 2008; Huitema et al., 2009; Neef, 2009). Despite strong support within the literature for collaboration within water governance, there remain significant challenges associated with implementation (Ansell & Gash, 2008; Kallis et al., 2009; Bakker and Cook, 2011; Pahl-Wostl et al., 2012; Tan et al., 2012; Ananda & Proctor, 2013; Cosens et al., 2014). Key challenges associated with the current water-governance crisis include institutional and territorial fragmentation, limited local capacity, unclear roles and responsibilities, and unsustainable (e.g., quality and quantity) resource allocation (OECD, 2011; Grafton et al., 2012). Political dimensions of these water-governance challenges range from the way water is conceptualized and valued to the way water links to other issues, sectors and levels. In addition, the way water-related challenges are framed and organized, as well as the way comprehensive water governance and management systems are designed (e.g., centralized, integrated, adaptive, collaborative or distributed), will have a fundamental bearing on how successful a water-governance structure will be at maintaining or re-establishing sustainable watershed functionality (Gupta et al., 2013).

Conventional natural-resource governance approaches have focused on asserting control over natural-resource systems and maximizing the yield while minimizing the risk to society (Crona & Hubacek, 2010). This approach, often associated with centralized "command and control" modes of governance, relies on predictability and adopts a linear cause-effect management approach. Historically, centralized models have also been criticized for being too mechanistic and technocratic, largely neglecting inherent complexities associated with human-nature interactions. Critics have argued that this omission has rendered these models ill-suited for addressing escalating water-related challenges (European Commission, 2001; Bates et. al., 2008; Cohen & Davidson, 2011; Pahl-Wostl & Knieper, 2014; Gupta & Pahl-Wostl C. 2013; Margerum & Robinson, 2015). Because of the social, economic and environmental costs associated with ineffective water governance, there is strong incentive to better understand how existing models of governance are being used, how new models might provide for better outcomes (Menard & Saleth, 2011), and how the context (i.e., issues, challenges, capacity) in which the models are being implemented influences their effectiveness regarding water sustainability.

While there is limited recognition of mixed model approaches within the water governance literature, the wide variation in applied governance reforms (Ostrom, 2010a, 2010b) supports the contention that no single model of governance can adequately address contemporary water challenges (Saleth and Dinar, 2004, 2005; Manard and Saleth, 2011). While the prevailing water-governance dialogue argues in favour of a transition towards a paradigm focused on collaborative style solutions, the findings of many studies, including the OECD (2011) and Grafton et al. (2012), suggest that abandoning centralized models as a viable option for specific situations may be ill-advised. For example, Lubell et al. (2014) found that policy coordination was facilitated by a combination of senior levels of government (centralized) and geographic boundary-spanning institutions (bridging organizations).

With continued contestation associated with identifying the ideal water governance model best suited for addressing today's water challenges, and a broadening recognition that any decisions involving the governance and management of water takes place within a socioecological context, understanding the social foundations to decision-making becomes paramount in any water governance design. What is becoming less contested is the notion that the challenges associated with governing water are becoming increasingly complex or wicked (Moser et al., 2013). It is also becoming broadly accepted that to address the increasing level of complexity will require a collective (collaborative) approach with multiple knowledges applied in innovative ways (Pahl-Wostl et al., 2007; Neef, 2009; Taylor, 2013)

The social underpinnings of governance are operationalized through the interactions or relationships that form or exist (or do not exist) between actors during a water governance process like a watershed planning process. These social relationships, referred to as links or edges in network science, have unique characteristics and, when viewed from a whole system perspective, form a network with unique characteristics that impact things like knowledge transfer and the ability of a social network to learn and ultimately adapt (Pahl-Wostl et al. 2004).

Social networks are comprised of individual actors (stakeholders) representing their own views or those of a group or institutions (e.g., environment, industry, community, etc.) or a level of government, such as municipal or First Nations. These connections may be formal (e.g., identified members of a watershed committee) or informal (e.g., specific knowledge-holders or trusted informants). What bounds these particular actors is a common goal or purpose such as the development of a watershed management plan.

Governance research has shown that the existence of social networks is an important aspect of effective, multi-stakeholder, natural resource decision-making processes (Bodin & Crona, 2009). Crona and Bodin (2005) have pointed out, "Not all networks are created equal." To be effective, water-governance models must be suited to the identified water-sustainability goals (Crowe, 2007). Recognizing the complexity associated with the inter- and intra-relationships and interdependencies that exist within a socio-ecological system mandates that water governance be re-conceptualized as a multi-directional, multi-scale, relational-based network system. Re-conceptualizing water governance will enable effective design and implementation without preconceptions or bound limitations (i.e., hierarchical limits) rather than focusing on the dichotomous argument of centralized versus collaborative. In other words, rather than pre-selecting a style or system, the eventual governance model must evolve out of the contextualized goals. An emphasis on the processes and interrelationships associated with power and social networks is needed, with a specific focus on institutional dynamics and scalar construction (Norman et al., 2012).

1.2 Research goals

This study examines watershed governance by investigating the watershed planning processes of two rural water-scarce regions in British Columbia. One of the central goals of the research is to utilize social network analysis (SNA) to examine the degree to which existing network structure is aligned or misaligned with goals identified within the terms set out for the development of the watershed plans, specifically addressing the long-term sustainability of water within the watersheds in the face of future climate change impacts. The results of the SNA are used to inform further analysis using a novel approach referred to as *social discourse network analysis* (s-DNA). S-DNA is a methodology incorporated to reveal deeper levels of meaning associate with the various relation patterns, patterns that may ultimately be responsible for the existence of potential framing of water issues, resource allocation and eventual long term watershed planning goals.

Network structure and actor characteristics are quantified through the use of theory-based quantitative metrics (i.e., component identification, closeness centrality, betweenness centrality (bridging) and clustering co-efficient measures (community detection)) identified in the Bodin et al. (2006) Adaptive Management (AM) network typology framework. The research will advance knowledge of applied water governance by empirically quantifying the water governance network structure and the impacts various relational patterns may have (e.g., coalitions, affiliations). Mapping and analyzing the social relationships (e.g., level of collation or isolation) that define the governance networks will provide insight into the associated challenges that enable or hinder the development of effective water governance policy within a rural context. By focusing on the social relationships that practically activate and enable information exchange, the fundamental elements of learning and adaptation within these governance processes are made explicit.

This research hypothesizes that there is a mismatch in the watershed goals and recommended governance network structure, resulting in the marginalization of key actors and their knowledge bases from the decision-making processes.

The primary questions being investigated are:

- Which network typologies best characterize the two case-study rural watershed planning processes?
- Considering the contextual challenges and goals of these watershed-planning processes in rural British Columbia, are the network structures aligned well with the identified water governance goals according to water governance theory?

In addition, the research investigates the role that bridging actors and organizations play in facilitating multi-scale and cross-scale interactions, and analyzes the watershed planning discourse to identify possible affiliation, coalition, and framing aspects that may be associated with the identified network structures influencing rural water governance. Recommendations are made for improving rural water governance and governance processes to achieve effective water-governance implementation within the context of the new British Columbia - *Water Sustainability Act*, 2014.

Chapter 2 - Literature Review: Water Governance in a Rapidly Changing World

2.1 Water Governance Defined

Although water governance has emerged as one of the most prominent issues within the international water community (Rogers & Hall, 2003; UNESCO, 2006), a universally agreed-upon definition has proven elusive. From the broad range of governance definitions in Table 2-1, three key themes emerge: (1) governance is consistently viewed as the process of decision-making; (2) the process of decision-making takes place through the agency of institutions; and (3) both the process and the institutions are comprised of multiple actors (Lautze et al., 2011). These three aspects are highlighted in Table 2-2, which presents some of the more prominent definitions of water governance. As Table 2-2 illustrates, definitional ambiguities remain, which include: whether management is or is not considered a part of or separate from governance (Norman & Bakker, 2009); whether water governance is or is not an instrument to achieve an identified goal and as a process that defines the goals (Lautze et al., 2011); and, whether water governance is, or is not just systems and mechanisms which should be in place to use water (Global Water Partnership, 2003).

The significance of this divergence is that organizational mandates, evolving out of base definitions and interpretations of water governance, may remain focused on the process that decides how water is used, while others are more concerned with institutions that exist for the purpose of water use.

While there continues to be some debate about the definitive definition, there does appear to be some consensus on the broader components of what constitutes water governance. These include: (1) a broad range of systems that control water resource decisions, (2) these systems include a broad range of political, organizational, economic, and administrative processes, and (3) these water systems are not isolated, rather they are affected by the broader social, political, and economic decisions being made. For the purpose of this research, Moench et al.'s (2003) definition appears to encapsulate not only the aspects identified by others attempting to define water governance, but also speaks to the process of decision making or lack of decision making. This is a central concept, highlighting the issue of institutional inertia, identified as one of the main barriers to transitioning current water governance models to models designed for greater adaptive capacity (Brown & Farrelly, 2009; von Tunzelmann, 2010; Bollig & Schwieger, 2014).

Table 2-1: Governance definition

Definition	Source
. . . Governance is a *process* whereby societies or organizations make their important decisions, determine whom they involve in the process and how they render account. Since a process is hard to observe, students of governance tend to focus our attention on the governance system or framework upon which the process rests - that is, the agreements, procedures, conventions or policies that define who gets power, how decisions are taken and how accountability is rendered.	Graham et al.,2003.
The *process* whereby elements in society wield power, authority and influence, and enact policies and decisions concerning public life, and economic and social development.	Haque, 1996.
The traditions and institutions by which authority in a country is exercised. This includes the *process* by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them.	Kaufmann et al., 2005.
The *process* of decision-making and the process by which decisions are implemented (or not implemented).	UNESCAP, 2009.
The exercise of political, economic and administrative authority to manage a nation's affairs. It is the complex *mechanisms, processes and institutions* through which citizens and groups articulate their interests, exercise their legal rights and obligations, and mediate their differences.	UNDP, 1997.
The manner in which power is exercised through a country's economic, political, and social institutions.	Miller & Ziegler, 2006.
Governance: the process through which decision-makers are chosen, stakeholders (including citizens and interest groups) articulate their interests, decisions are made, and decision-makers are held accountable. Governance is distinct from management.	Nowlan & Bakker, 2007, pg.5.

(adapted from Lautze et al. 2011, p.1-8)

Table 2-2: Water governance definitions

Water Governance Definition	Source
Water governance is defined by the political, social, economic and administrative systems that are in place, and which directly or indirectly affect the use, development and management of water resources and the delivery of water service delivery at different levels of society. Importantly, the water sector is a part of broader social, political and economic developments and is thus also affected by decisions outside of the water sector.	UNDP Water Governance Facility (http://www.watergovernance.org/ Whatiswatergovernance).
Water governance refers to the range of political, social, economic and administrative systems that are in place to regulate development and management of water resources and provisions of water services at different levels of society.	Global Water Partnership in Rogers & Hall, 2003, p. 6.
Water governance is the set of systems that control decision-making with regard to water resource development and management. Hence, water governance is much more about the way in which decisions are made (i.e. how, by whom, and under what conditions decisions are made) than the decisions themselves	Moench et al., 2003.
The range of political, organizational and administrative processes through which interests are articulated, input is absorbed, decisions are made and implemented, and decision makers are held accountable in the development and management of water resources and delivery of water services.	Nowlan & Bakker, 2010, p. 5.

2.2 Water Governance Development

To analyze the current state of water governance, it is important to first examine the historic events that have led to current water-governance regimes, policies, and processes. The importance of viewing historical developments to identify remnants or left-over policy structures that continue to influence current and future policy development and governance design is described within the “path dependency” literature (Shapiro & Summers, 2015). Shapiro and Summers (2015, p.735) explain the importance of contemporary water governance history, saying, “…[I]t must be understood that such a complex governance arrangement is inseparable from its history and evolution," and, "The future trajectory is not simply a function of idealized goals but also a product of past decisions entrenched within the management framework." In common terminology, path dependency is best described as the concept that "where we go next depends not only on where we are now, but also on where we have been" (Liebowitz & Margolis, 1999, p. 981).

In Canada, significant variation in water governance exists across provinces and federally (Hill et al., 2013). In addition to a high level of variation, significant levels of fragmentation are present within Canadian water governance (Bakker & Cook 2011; Cook, 2011; Moore, 2013). Jurisdiction for water constitutionally resides primarily with the provinces, with fisheries, navigable waters, and additional areas of water deemed to be within national jurisdiction. Jurisdictionally, fragmentation exists both vertically between federal and provincial bodies and between provincial and local governments, and laterally across provinces and territories, both cross and inter-departmentally (Hill et al., 2013). In these instances, fragmentation can be defined as "the allocation of responsibility for water governance amongst multiple actors and/or agencies, with relatively little or no coordination" (Hill et al., 2013, p.316). One of the over-arching factors contributing to this high level of fragmentation is the fact that Canada is one of the most decentralized countries in the world (Hill et al., 2013) and, correspondingly, one of the most fragmented (Bakker & Cook 2011).

Changes in Canadian water governance in recent decades have been very rapid. Hill et al., (2013, p. 316) in their review of Canadian water governance and policy, noted three prominent trends: (1) The willingness of some provinces and territories to engage in delegating authority and water-related decision-making to the local (or watershed) level. As an example, British Columbia's new *Water Sustainability Act* contains provisions that identify the opportunity for local regions to engage in sustainable watershed planning and the potential for alternative governance arrangements that promote place-based solutions; (2) Increased levels of water-policy reporting and increased legislation to address water quality issues post-Walkerton. As an example, there has been a greater policy emphasis on source protection, higher water quality standards and / or transparency in reporting protocols: and, (3) Governments, predominantly centralized, implementing power sharing initiatives with non-state actors (e.g., citizens and NGO's) by way of collaboration in water decision-making historically under the purview of senior levels of government. British Columbia's new *Water Sustainability Act* and Alberta's *Water for Life Strategy* (Hill et al., 2008) are provincial examples of the trend towards greater collaboration.

Realization by senior levels of government of their failing ability to meet the escalating and often competing demands of their citizens (e.g., increased access to good quality water with greater transparency in decision-making) and of environmental requirements (e.g., ecosystem service requirements), have led to senior levels of government pulling back and delegating traditional water management roles and responsibilities to lower levels of executive authority (e.g., local government) (Nowlan and Bakker, 2007; Tortajada, 2010; Bakker & Cook 2011; Hill et al., 2013). These actions coupled with increasing public awareness and interest in water governance, and increasing non-state actors' expectation regarding inclusion in traditionally centralized governance decision-making processes has added further complexity to the water governance arena while also pressuring governments towards various forms of collaborative water governance (Rogers and Hall, 2003; Pahl-Wostl, 2009; Margerum and Robinson, 2015).

2.3 Complexity conundrum

There is a deep-seated link between biophysical environments and human health, security, economy, culture, and social justice (Bodin et al., 2011). These connections make it difficult to fully understand the uncertainties associated with complex socio-ecological networks and the sustainable management of water resources (Bodin et al., 2011; Levin, 1998). While the governance of water is recognized as becoming increasingly more complex, there is limited discussion on what constitutes this complexity, as highlighted in the following table (Moore, 2013):

Table 2-3: Complexity factors in water governance

Global Scale	Local Scale
-Historical neglect of "political" aspects within water research and governance practices -Opaque governing context increasing system complexity	-Political aspects obvious, and not all challenges considered complex -Complexity resulting from severe ecological challenges which serve as disturbances within watershed that are difficult to understand, resolve, or prevent -Highlights critical link between "human" and "ecology" -Sense-making required to draw on experience to understand factors contributing to challenges
-Diverse set of actors and institutions involved without clarity of authority or leadership for water governance, yet maintain influence over governance policy agendas, contributing to complexity	-"Fuzziness" of roles and responsibilities may not be an impediment for decision-making and management on day-to-day basis -Severe ecological challenges occurring without clear cause-effect relationships, which challenged existing governance authority -Lack of clarity in turn potentially creates conflict among those responsible for governing at local scale
-Development and advocacy for competing definitions and uncoordinated governance frameworks leading to fragmentation	-Similar fragmentation at local scale from diversity of frameworks, ideas, interests and values -True challenge is moral and ethical dilemmas posed by confronting this diversity and making decision -Human degradation harms the environment and human health and livelihoods, which makes determining concrete solutions in light of the potential risks very difficult, increasing perceived sense of complexity

(adapted from Moore 2013, p. 501)

Moore’s findings reflect three key aspects associated with multi-scale water governance: (1) there are local implications of global approaches to water governance; (2) understanding the linkages between humans and their environment is critical in identifying water governance solutions (Bodin et al., 2011); and (3) employing a sense-making (social relational approach coupled with a formal analytical framework - see Appendix IV) can begin to address the lack of clarity surrounding roles, responsibilities, and authorities at the local level (Bodin & Prell, 2011).

2.4 Preferred Water Governance Models

The following section provides a description of the idealized water governance models identified as categories of water governance capable of addressing contemporary water challenges. The water governance models supported in the academic literature as preferred models include: collaborative, polycentric (distributed), delegated (devolved), adaptive, adaptive co-management, and watershed (river). While much of the literature focuses on categorization of various water governance approaches the following section will argue that in fact that each idealized model is not in fact succinct rather there is significant crossover between categories rendering the process of categorization depending upon how each category is defined.

2.4.1 Collaborative

The concept of collaborative governance emerged from the convergence of the ideas expressed in the literature on public participation in natural-resource management with deliberative democratic theory (Neef, 2009). Huitema et al. (2009) define "collaboration" as different government organizations working together with non-governmental stakeholders (e.g., citizen and interest groups) to manage cross-jurisdictional and policy issues. Ansell and

Gash (2007, p. 543) describe collaborative governance as “[a] governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets.”

Ansel and Gash (2008, p. 545) provide one example of the implementation stages for collaborative governance:

(1) A forum is initiated by public agencies.

(2) Non-state actors participate in the forum.

(3) Participants engage directly in decision-making.

(4) The forum is formally organized and meets collectively.

(5) The aim is to make decisions by consensus.

(6) The focus of the collaboration is on public policy or public management.

In British Columbia, factors associated with the shifting view of the role and mandate of centralized governance towards a de-centralization for water, based upon subsidiarity, include: new legal requirements (e.g., duty to consult with First Nations); new approaches to citizen participation; a re-emphasis on watershed-scale management; and concern over the implications of climate change (Nowlan & Bakker, 2007; Bakker & Cohen, 2011).

The calls for pursuing a collaborative approach are typically founded upon claims that inclusion of non-state actors and organizations within water governance leads to improved quality of decisions through improved transparency, better use of information, and a broader and diverse set of information (Huitema et al., 2009). Another claimed benefit is improved quality and durability of decisions (Fischer, 2000; Beierle, 2002; Reed, 2008). Some advocates for collaborative governance claim that increased collaboration, particularly at the local level, enables greater access to knowledge, increases capacity levels, and strengthens trust between non-state and state actors. In turn, heightened levels of trust may lead to a greater chance of policy implementation and ultimately, greater political legitimacy concerning better water outcomes (Huitema et al., 2009; Bakker & Cohen, 2011). However, Armitage et al. (2008) assert that, in a time when there is growing demand and capacity by non-governmental organizations and individuals, centralized top-down resource management models currently in use are ill suited to accommodating external participation.

Applying the UN Good Governance principles (e.g., transparency, trust, and equitable participation) framework, should provide non-state actors a better understanding of the decision-making processes leading to increased levels of ownership or "buy-in" and improved implementation (Graham, et al., 2003). Norman and Bakker (2010) extend the definition of collaboration to include intergovernmental agencies (intergovernmental coordination). Fostering increased collaboration may also lead to improved agency-to-agency cooperation, and in turn to the reduction in the degree of governance fragmentation existing in Canada. Norman and Bakker’s recommendation for increased collaboration for intergovernmental agencies may also have a negative impact, as Snowden and Boone (2007), Snowden and Kurtz (2007) and Callahan (2008) point out, if interagency collaboration assumes co-operation or co-ordination as a substitute for true collaboration, via government agencies coordinating with other government agencies (e.g., Ministry of Environment) rather than seeking input from local environmental groups and involving two-way exchanges of information, for example.

Ansell and Gash (2008) also make a distinction between collaborative governance and the often-misused term "consultation". State agencies utilize both legislated and nonlegislated public engagement processes to present options (scenarios or choices) and collect feedback to be considered in the final policy draft. Ansell and Gash (2008) argue that collaborative governance implies a collective process involving formal participation of both state and non-state actors in a deliberative and multilateral process. In contrast, surveys and focus groups and other forms of public consultation, although helpful for attaining information for policy development and testing, do not allow for two-way flows of communication (learning) or multilateral deliberation (Ansell & Gash, 2008). Birkhoff (2003) also concluded, through her analysis of public participation in water recycling programs in the U.S., that substantively better decisions were being made through truly collaborative processes that were inclusive of diverse interests, knowledge, and expertise. However, as highlighted earlier, there remains definitional ambiguities and overlap with respect to collaborative governance further highlighted below.

Bakker and Cohen's (2011, p. 7) definition of collaborative water governance (Canada) includes four primary options:

(1) Traditional government-led governance involves control of decision-making with limited involvement of non-state actors, usually in the form of technical experts. This form of collaboration is typically conducted within a traditional governance framework.

(2) Multi-level government-to-government collaboration through participation in shared governance processes with the goal of improving water outcomes. Formal government agencies retain decision-making-making-powers (e.g., Fraser Basin Council).

(3) Consultative governance where governments consult extensively with stakeholders but retain all decision-making-powers. Typically, this would entail a watershed partnership or collaborative expert panel (e.g., Lake Windermere Ambassador Society and the Fraser Basin Council).

(4) Delegated governance involving a range of state and non-state actors in long-term governance processes with delegated decision-making powers (e.g., Okanagan Basin Water Board).

The differences in collaborative governance model definitions, as defined by Bakker and Cohen (2011) and Ansell and Gash (2008), lie predominantly in collective decision-making and retention of decision-making powers by state actors, indicating a continued contestation or ambiguity in fundamental water-governance definitions.

Bakker and Cohen (2011) identify two prominent trends (Figure 2.1) that describe the changing nature of Canadian water governance: (1) delegation of decision-making (devolution) responsibility involving the shared participation in the decision-making process from senior government to other, often lower, levels of governance or non-government actors; and (2) increased participation, including shared decision-making powers, of non-state actors. Bakker and Cohen (2011) provide a framework (Figure 2.1) for analyzing these trends in water governance. The directionality of the horizontal arrow represents the trend towards greater sharing of decision-making powers (distributive), and the vertical arrow represents a transition towards inclusive models of governance (collaborative).

As the trend, has shown over the past decades, when non-state actors are excluded from early aspects of decision-making process (i.e., framing, analyzing, solution generation, and implementation), key aspects of the UN Good Governance Framework are seldom achieved (Birkhoff, 2003). The diminishing levels of trust for decision-makers and the increasing levels of frustration felt by non-state actors often lead to alternative processes being pursued, which frequently hinder the overall process of finding good water outcomes (Birkhoff, 2003). In the Similkameen Valley of central British Columbia, for example,

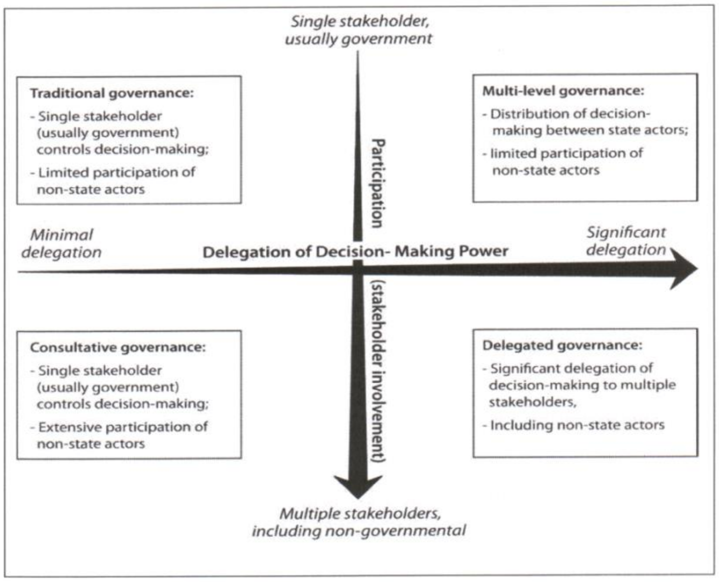


Figure 2-1: Delegation vs. participation Source: Bakker and Cohen, 2011

First Nations bands have initiated a separate watershed-planning process as a result of dissatisfaction with the formal watershed planning process.

Despite strong support for, and popularity of, collaborative governance, significant challenges associated with its implementation remain (Ansell & Gash, 2008; Kallis et al., 2009; Bakker & Cohen, 2011; Pahl-Wostl et al., 2012; Tan et al., 2012; Ananda & Proctor, 2013). For example, Kallis et al. (2009, p. 631) investigated the CALFED Bay-Delta program, “one of the most ambitious experiments in collaborative environmental policy and adaptive management in the world.” The study concluded that although there were some benefits such as mutual understanding and innovation, overall the collaborative approach was “ill-suited to resolve, alone, the distributive dilemmas at the core of many water – and other environmental – conflicts” (Kallis et al., 2009, p. 631).

As the push for collaborative models of governance migrates from the academic literature to real-world applications, the issue of unsubstantiated or rarely tested findings pertaining to the benefits of collaborative governance is often overlooked (Reed, 2008). Beneficial claims, such as greater quality and durability of decisions, have been increasingly used by "proliferating environmental interests," claiming inclusion as their democratic right to increase participation in environmental decision-making (Reed, 2008, p. 2418). Yet supporting evidence of improved implementation and effectiveness is lacking, which may be attributed to the current understanding of collaborative institutions as imperfect and still evolving (Poirier & de Loë, 2010; Barreteau et al., 2012; Ananda & Proctor, 2013). Unsubstantiated but widely claimed benefits of collaboration have led to a growing level of disillusionment amongst environmental managers and conservationists who have failed to see these beneficial claims realized (Reed, 2008). Lee (1999) argues that adaptive governance (AG) can be considered more influential in theory than as a proven paradigm, and this would seem to apply to collaborative governance as well.

Further challenges associated with collaborative governance arise with implementation. The feasibility of collaboration depends on the willingness and ability of authorities to organize participation and of potential participants to become involved (Huitema et al., 2009). This also speaks to the relevancy and resonance of the issues upon which the collaboration is to be based. Morris and Brandes (2013) echoed the concerns that, without cooperation of more than one party, collaboration remains strictly consultative.

Bakker and Cohen (2011, p. 11) offer the following three questions as a guide to encourage research in areas where significant gaps in collaborative governance knowledge exist:

(1) What are the barriers to effective collaborative water governance and how might these be overcome?

(2) Do the potential advantages of collaborative water governance to lower scales outweigh the disadvantages?

(3) Which issues/aspects of decision about water should be collaborative, and which (if any) should not?

Bakker and Cohen recognized that a collaborative approach may not be the best-fit model for implementation in all situations or scales, contrary to the wide call for collaboration in the water-policy and governance literature. The determination of any form or combination of governance should be determined by the contextual aspects for which the governance is being designed.

2.4.2 Polycentric

Polycentric water governance, also referred to in the literature as “distributed,” “devolved,” “decentralized,” “shared,” “co-managed,” and “multi-nodal,” shifts the emphasis from a prescriptive approach to one that emphasizes policy making and planning processes based on collaboration, negotiation, and deliberation among multiple stakeholders, including policy-makers, scientists, state and non-state actors alike (Warner, 2006; Ansell & Gash, 2008; Neef, 2009). The varying terminology adds further ambiguity to the process of water governance categorization confounding any subsequent argument based on such categorization.

Vincent Ostrom and Charles M. Tiebout first formulated the concept of polycentric systems in their work on metropolitan centres (Ostrom 2010c). Building on their work, Elinor Ostrom was one of the original pioneers to apply polycentricism in the field of resource governance, first identifying and studying polycentric water systems in California.

Elinor Ostrom later furthered her study of polycentric systems through work with public and private water producers facing water scarcity due to over-subscription and salt-water intrusion (Ostrom 2010c). Both Collective Action Theory and Game Theory guided Ostrom's work and the development of the Institutional Analysis and Development (IAD), a framework enabling empirical studies (e.g., meta-analysis) of a large number of existing case studies on common-pool resource systems (Ostrom, 2010c).

One of the central themes within the literature has been the lack of agreement on basic features of "polycentric" governance (Galaz et al., 2012; Ostrom 2010c). Table 2.4 contains a typology of water-governance models and the varying definitions of these typologies. Galaz et al. (2012) have, through a literature review, attempted to identify generic processes within polycentric systems. These four processes include information sharing, coordination of activities, problem solving, and internal conflict resolution. They then rank these processes from the weakest, information sharing and mutual adjustment, to the strongest version of polycentric order requiring strong formal ties, joint projects, and evolution of rules (Galaz et al. 2012).

Skelcher (2005, p. 89) describes polycentric governance as a system where "political authority is dispersed to separately constituted bodies with overlapping jurisdictions that do not stand in hierarchical relationship to each other." This approach to governance differs from the historical ideals of governance in which jurisdictions existed at a limited number of hierarchical levels such as national, regional, and local, with clearly defined boundaries in responsibility and authority (Huitema et al., 2009). Historically, senior levels of government perceived local communities as lacking the resources and capacity for self-governance (Huitema et al., 2009). Although this centralist view was rooted in democratic thought, more recent scholarship has recognized that local communities have unique issues and contextualized localized knowledge and skills with which to address these issues (McGinnis, 1999; Dietz et al., 2003; Ostrom, 2005; Huitema et al., 2009).

One of Elinor Ostrom's key observations is that trust plays a central role in individual choice and coping with social dilemmas and that (Ostrom, 2010c, p.642), "the application of empirical studies to the policy world leads one to stress the importance of fitting institutional rules to a specific social-ecological setting. "One size fits all" policies are not effective." The current challenges conceptualized as "global" problems are a cumulative result of small actions by many individuals, local, regional, and national organizations, and private firms (Ostrom 2010b). Ostrom (2010b) recommends a productive and effective approach through multi-scale polycentric efforts, including experimentation and learning from experience with an emphasis on "cheap talk," or communication in an adaptive manner (Ostrom 2010b, 2010c), rather than focussing solely on enforceable global treaties.

2.4.3 Adaptive

Adaptation has always existed within ecological, physical, and human systems; however, in more recent times, adaptation has been identified globally as the key governance response needed to address changing climate impacts. Depending upon how Adaptive Water Governance is defined, adaptive management (AM) may or may not be a discrete approach to water management or a component of an over-arching adaptive water governance program. AM was developed by the International Institute for Applied Systems Analysis to support the management of natural resources under uncertainty (Holling, 1978; Walters and Holling, 1990; Irwin and Wigley, 1993; Prato, 2003; Medema et al., 2008). Medema et al.

(2008) describe uncertainty as a deficiency of information with regard to the problem under study. Uncertainty, in current terms, applies far more broadly to the dynamic and unpredictable changes that occur in the physical and socio-ecological systems we hope to manage, in addition to a deficit of information. Holling et al., (1998) described AM as "…an integrated, multidisciplinary and systematic approach to improving management and accommodating change by learning from the outcomes of management policies and practices."

AM acknowledges the realities of environmental variability and complexity in socio-ecological systems explicitly, and has led to a renewed interest in the theory of learning through experimentation (Gunderson & Holling, 2002). AM involves the design and implementation of programs that allow for experimentation with an identified range of policies and practices (Medema et al., 2008). Allen and Gunderson (2011, p. 1378) note that "… there will always be inherent uncertainty and unpredictability in the dynamics and behaviour of complex ecological systems as a result of non-linear interactions among components and emergence, yet management decisions must still be made."

AM emphasizes learning through doing (managing), based upon the philosophy that our knowledge base is incomplete and much of what we know may not be correct (Allen et al., 2011). To avoid paralysis in absence of complete knowledge, AM provides a framework which fosters resilience through flexible "safe to fail" management approaches which account for the inevitable change during times of non-stationarity (Allen & Gunderson, 2011). The distinct phases of an adaptive management framework include (Holling, 1978; Walters, 1997; Lee, 1999; Medema et al., 2008):

(1) Elucidation of goals and assumptions

(2) Establishment of alternative theories about the system

(3) Translation of theories and goals into plans, actions and processes

(4) Monitor and evaluate to test effectiveness

(5) Adapt theories, goals and assumptions

(6) Repeat process for continued improvement

Common elements associated with AM include: the desire to improve the effectiveness of resource management; to integrate disciplinary knowledge; to enhance information flows among policy makers; and to create a shared understanding among scientists, policy makers, and managers (McLain & Lee, 1996; Wondolleck & Yaffee, 2000; McDaniels & Gregory, 2004; Medema et al., 2008). Lee (1993) recommended several institutional prescriptions as part of adaptive management including: collaboration, experimentation, and bioregional (distributed or watershed) approaches (Huitema et al., 2009). Many authors (e.g., Mostert et al., 2007; Ostrom, 2010b; Pahl-Wostl, 2007; Gustavsson et al., 2009; Neef, 2009) have supported the inclusion and encouragement of public participation, noting that it results in better decision-making, increased levels of trust, and deeply meaningful collaborative processes (see Sproule-Jones and Johns, 2002; Birkhoff, 2003; Huitema et al., 2007; Mostert et al., 2007).

While the broad call for a transition in water governance is focused upon transitioning to more adaptive models of governance better able to respond to the non-linear threats including climate change, Huitema et al. (2009) identify a recent trend of convergence between AM and co-management. Figure 2.2 shows how these two alternatives actually co-exist within the broader category of adaptive governance (AG). This unifying perspective explicitly highlights the complementary aspects of learning (experiential and experimental) and collaboration (vertical and horizontal) functions that are necessary to improve our understanding of, and ability to respond to, complex social–ecological systems (Armitage et al., 2008). Although collaborative water governance is often described as a stand-alone model of governance and an essential element for integrative planning (see Bates, 2012; Tan et al., 2012; Green et al., 2013), various scholars (Lee 1993, 1999; Lautze et al., 2011) view collaboration as part-and-parcel of adaptive management.

Figure 2.2 illustrates the evolution of resource governance from an early focus on ecosystem management through to the contemporary focus on adaptive, multi-level models of governance capable of addressing landscape scale challenges and uncertainties in a manner flexible enough to account for the highly contextualized socio-ecological systems (SESs) and inherent complexities associated with unpredictable environmental and social feedbacks (Dietz et al. 2003, Folk et al. 2005; Chaffin et al., 2014). Chaffin et al. (2014) refer to AG as an emerging model; however, AG (management) has been in development for over 20 years, yet shows limited levels of implementation (Holling & Meffe, 1996; Lee, 1993; Walters, 1997; Rogers and Hall, 2003; Medema et al., 2008; Reed, 2008). Cosens and Williams' (2012) work, as an outgrowth of the Universities Consortium on Columbia River Governance, provides a clear example of this in the early attempts to implement adaptive governance in the U.S. portion of the Columbia Basin.

A recent review of the adaptive literature by Chaffin et al. (2014) has revealed that even a consistent use of the term "adaptive governance" continues to elude researchers, even though there has been a significant increase in the use of the term. However, "Much of the foundational AG literature approaches governance of SESs [socio-ecological systems] in terms of resilience: the capacity of a SESs to absorb both a natural and human disturbance while still maintaining structure and function" (Chaffin et al., 2014, p. 56) and socio-ecological sustainability (Folke et al., 2005; Lebel, et al., 2005; Chaffin & Gunderson, 2016).

Transitioning to AG models will require re-conceptualization of water as a network of specific bi-directional socio-ecological relationships to be fostered according to contextually derived goals rather than as a set of entrenched processes standardized across socio-political circumstances.

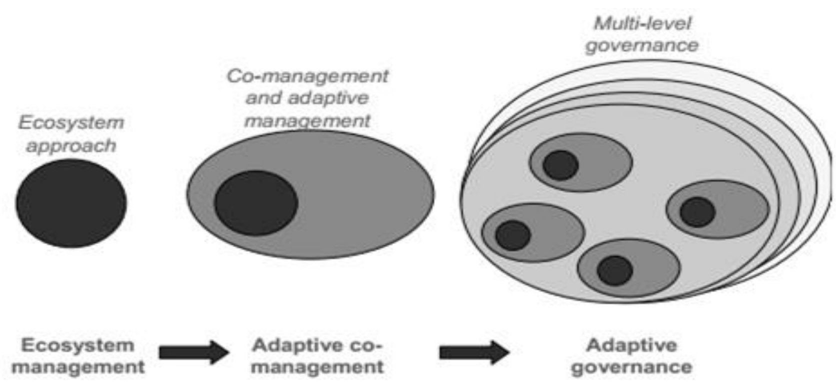


Figure 2-2: Environmental governance evolution
(adapted from Dietz et al., 2003; Folke et al., 2005)

For example, if the goal is to develop a climate-resilient water-governance regime then developing a comprehensive understanding of the context (social, political, economic, and environmental) along with decision-making network structure (network), provides a strong foundation for achieve this goal.

Framing of the water-governance context, including aspirations and eventual outcomes, becomes paramount in achieving this comprehensive understanding and may be part of the contemporary push for collaborative models absent of discussion of the highly-contextualized SESs. Pahl-Wostl et al. (2012, p.25) point out, “Idealized design principles based on institutional and technological panacea have been applied to water issues without long-term monitoring of their performance and effectiveness and without revision and critical reflection on practice that would have responded to failure earlier." In response, experts have called for a radical paradigm shift in water governance to address the continued failure to recognize complex interdependencies inherent in a socio-ecological system (Pahl-Wostl et al., 2012, 2007a, b). Baird et al. (2016, p.748) furthers this criticism, saying, "[T]he notion of characterizing an 'ideal' governance network structure is unrealistic."

2.4.4 Adaptive (co-)management (ACM)

Adaptive co-management (ACM) is generally defined as "a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organized process of trial and error" (Folke et al., 2002, p.8). "Co-management" suggests that the traditional hierarchical and often opaque management systems should yield to non-state actor involvement in the governance and management of water resources (Wallace et al., 2003). ACM consists of a variety of actors across multiple scales and through various networks who undertake trial-and-error to build knowledge and to inform future processes (Olsson et al., 2004; Folke et al., 2005; Armitage et al., 2009). Chaffin and Gunderson (2016, p. 82) define socio-ecological sustainability in relation to adaptive governance (AG) as, "The equitable allocation and conservation of life-sustaining resources and ecosystems services (both now and for future generations). In addition, governance with sufficient adaptive capacity to forward sustainability goals (e.g., AG).".

Huitema et al. (2009) describe ACM as a convergence of adaptive management (AM) and co-management (CM), where AM focuses on learning through flexible structural experimentation and CM emphasizes sharing of rights, responsibilities, and power amongst various levels of government and non-government actors. While acknowledging the novelty of this convergent model, Huitema et al. (2009) also recognize that ACM closely resembles Lee's (1993, 1999) much earlier conceptualization of (non-technocratic) adaptive management. Lee's notion of AM implied several institutional prescriptions, including collaborative, watershed (bioregional), experimentation, and learning.

Lee's conceptualization of AM was a departure from Armitage et al.'s (2007) technocratic approach, which was strictly focused on the experimentation and learning aspects (Huitema et al., 2009). Approaches that emphasize collaboration, learning and building adaptive capacity continue to increase in practise within the natural resource field (Plummer et al., 2013), and specifically within the water sector. Plummer et al. (2013, p.21) highlight three such examples including: bridging of knowledge systems in the Arctic (Armitage et al., 2011); water-market creation and expansion of planning in the Murray-Darling Basin (de Loë & Bjornlund, 2010); and collaboration in addressing socio-ecological challenges in South Africa (Fabricius & Cundill, 2010). These examples lend support to Lee's (1993) significant contribution in recognizing that a "whole systems" approach, in the sense of an understanding of the whole of the watershed, was necessary to adequately manage it (Huitema et al, 2009).

2.4.5 Watershed (rivershed)

Watershed scale governance is an approach that involves the human demarcation of a "natural" regional water system that encompasses the area of a landscape draining into a specific lake, river or stream shed (Nelson & Weschler, 2001). Watershed governance has alternatively been described as “bioregional governance,” “river-basin approach,” “water-systems approach,” or “integrated water-resources management” (e.g., Mostert, 2000; Huitema et al., 2009). The concept of watershed governance as a unit for place-based governance originates from conventional water-resource management literature (Nelson & Weschler, 2001). Water-resource managers view a watershed as a natural physical feature which is the most effective scale at which to align human governance systems. Environmentally oriented groups also see the watershed as a fundamental scale at which ecological systems operate, and therefore the right scale to sustainably manage water (Nelson & Weschler, 2001).

One of the most significant challenges for watershed governance is the misalignment between natural watershed boundaries and existing human-fabricated governance boundaries and their associated geopolitical, cultural, and economic implications. Schlager and Blomquist (2000) observe that the water-policy literature over the past couple of decades has centred on two main approaches to ecologically oriented governance. The first approach is to use the watershed as the appropriate scale for establishing water resource governance, as advocated by Nelson and Weschler (2001). The second approach is to create a watershed-scale decision-making structure to overcome the mismatch between the existing regional political jurisdictions created through amalgamation or transfers of responsibilities (Huitema et al., 2009). These differing approaches have been referred to as "weak" and "strong" approaches respectively (Schlager and Blomquist, 2000, p. 4). Many questions remain as to the viability of either approach while other models, such as trans-regional cooperation, have been suggested as preferred water governance models (Huitema et al., 2009). The following points highlight some of the challenges associated with a bioregional approach to water governance:

- River-basin (watershed) boundaries are not necessarily clearly delineated; rather, boundaries of bioregional watersheds areas are multi-scale, overlapping, multi-connected and nested with other watersheds (Schlager and Blomquist, 2000, p. 15-16). The challenge arises in the process of defining the boundary, which then involves all the geopolitical, cultural and economic implications associated with boundaries and boundary development. Huitema et al. (2009) summarize the challenge as a question of "ultimately who decides and to what effect?"
- The Organisation for Economic Co-operation and Development study (OECD, 2011) identified the 1998 South African Water Act as "widely viewed as one of the most progressive in the world with its provisions for ecological reserves," but noted it was ultimately hindered in the implementation stage by a lack of resources and capacity at the catchment (watershed) scale.
- The decision-making process for any newly established water governance body will involve either the consensus model or elite decision-making (Schlager and Blomquist, 2000). Consensus may result in a lengthy decision-making process, which may not align with the temporal nature of the problem to be managed, or worse, result in complete stagnation. Elite decision-making may suffer from uninformed and ineffective choices, alienation of non-decision makers, and oppression of minorities or marginalized groups (Schlager and Blomquist, 2000; Huitema et al., 2009).
- Decision-making and responsibility of newly created water-governance organizations may suffer the same challenges as other bureaucratic organizations, particularly when

the scale of the bureaucracy is substantive (Schlager and Blomquist, 2000; Huitema et al., 2009).

The literature on watershed governance remains divided between those who continue to advocate for the benefits of a watershed-governance approach (e.g., Schlager and Blomquist, 2000; Imperial and Kauneckis, 2003; Baril et al., 2006; Koehler and Koontz, 2008) and those who highlight the challenges (e.g., Fischhendler and Feitelson, 2005; Draper, 2007; Ferreyra and Kreutzwisser, 2007; Huitema et al., 2009; Norman and Bakker, 2010; Cohen and Davidson, 2011).

Watershed governance is being suggested as the preferred model in British Columbia as well as across other regions of Canada. A study looking at Canadian water policy conducted in 2009 (see Norman et al., 2012) surveyed water policy-makers, managers and practitioners from across Canada, with 80 percent of the respondents indicating that the watershed scale was the most appropriate scale in which water governance should be applied. There was overwhelming support for a watershed approach despite the challenges in implementation of watershed governance, including incongruities between the varying scales at which data are collected and the application of data at the watershed scale (Norman et al., 2009). Cohen and Davidson (2011, p. 1) reviewed the watershed-governance model and identified the following challenges: boundary choice, accountability, public participation, and water asymmetries with "problem sheds" versus "policy sheds." They concluded that these challenges are the result of a fundamental dilemma involving the concept of watershed, which was originally based upon "hydrology" and "scientism," and developed as a technical tool, and later characterized as a governance unit with little or no examination of the broader components of water governance (Cohen and Davidson, 2011). The result has been a fusing of a watershed-governance approach with other governance tools at the expense of a clear understanding of watershed governance. Ferreyra et al. (2008, p. 304) argue that watershed imperatives must be linked to “existing socially and politically meaningful (agriculture) scales,” particularly when considering the existing processes of agriculture and rural change rather than trying to create new entities (i.e., new watershed-based authorities). Schlager and Blomquist (2000) contend that institution building, more often than not, is a reactive "patchwork" process not following a pre-established design, which could be viewed a positive approach, particularly from a resilience perspective.

2.4.6 Water Governance Typology

There appears to be significant crossover between all categories of governance (Table 2-4), blurring the lines between identified categories of governance models to the point of questioning the purpose of the categorization. Multiple terms, including resilience management, interactive governance, transition management, collaborative governance, adaptive governance, and adaptive co-management (Plummer et al., 2013), collaborative experimentation, bioregional approach (Lee, 1993; 1999), and community-based resource management (Chaffin et al., 2014) have been used to characterize ACM. These multiple characterizations are not limited to ACM, but are also prevalent for all the governance typologies within the literature (Table 2-4).

This draws into question the preoccupation amongst the water-governance literature with categorization of water-governance models. Recent focus, however, has started to shift towards the social relationships associated with collaboration within a water-governance system (Ansell and Gash, 2008; Bodin and Prell, 2011; Baird et al., 2016).

Table 2-4: Water governance typology

Water Governance Model	Author	Title - Definitions	Application
Collaborative (delegated, devolved, inclusive, polycentric, multi-scale)	Pahl-Wostl, et al. (2008)	-Getting citizens involved more closely by prescribing public participation in the development and implementation of the Water Framework Directive - "communities of practice" - "building the capacity of policy makers at all levels (multi-level) to create contexts conducive to stakeholders' managing and regenerating watersheds in a locally interactive process." (Pahl-Wostle et al., 2008, p54).	collaborative, multi-scale
	Nowlan & Bakker (2010).	-Broadly defined as the involvement of non-state actors in decision-making for water management. Shared governance is defined as a structure where both government and other stakeholders share responsibility for the development and delivery of policy, planning, and programs or services, but where government (Alberta Water Council) retains legislative accountability (AWC, 2008a).	shared, devolved, delegated, collaborative
	Dewulf et al. (2011).	-Collaborative governance arrangements have been suggested to deal with complex and interdependent problem domains, in which multiple public and private actors have a stake (Ansell and Gash, 2008; Huxham, 2000; Kickert et al., 1997; Mandell, 2001).	collaborative
		-Collaborative governance arrangements bring a number of these actors together in a process of multi-actor decision-making Gray, 1989; Huxham and Vangen, 2005).	collaborative, distributed
		-Governing arrangement where one or more public agencies directly engage non-state actors in a collective decision-making process that is formal, consensus-oriented, and deliberative, and that aims to make or implement public policy or manage public programs or assets' (Ansell and Gash, 2008, p. 545).	collaborative
	Brisbois and de Loë (2016,).	-Collaborative approaches are grounded to varying degrees in the assumption that all actors will be able to contribute to ultimate outcomes in non-trivial ways (Brisbois & de Loë (2016, p.202).	collaborative, inclusive
Polycentric (distributed, devolved,	Pahl-Wostl and Knieper (2014, p.140).	-Polycentric governance systems are characterized by multiple centers of authority and distribution of power along with effective coordination structures. Decentralization does not imply that adequate coordination structures will automatically come into being.	polycentric, distributed, devolved, collaborative
collaborative, inclusive)	Skelcher, (2005).	A system where "political authority is dispersed to separately constituted bodies with overlapping jurisdictions that do not stand in hierarchical relationship to each other." Skelcher, (2005, p. 89).	polycentric, distributed

Table 2-4: Water governance typology

Water Governance Model	Author	Title - Definitions	Application
	Ostrom, (2010b).	- "Polycentric" connotes many centers of decision-making that are formally independent of each other. Whether they actually function independently, or instead constitute an interdependent system of relations, is an empirical question in particular cases. To the extent that they take each other into account in competitive relationships, enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts, the various political jurisdictions in a metropolitan area may function in a coherent manner with consistent and predictable patterns of interacting behavior. To the extent that this is so, they may be said to function as a "system." (V. Ostrom, Tiebout, & Warren 1961: p. 831–32). Ostrom, (2010b, p. 643).	polycentric, cooperation, collaborative, multi-scale
		- Elinor Ostrom, one of the leading scholars working on polycentric governance of social-ecological systems, highlighted as well the importance of self-organized network governance, the involvement of numerous and diverse actors, and multiple paths toward polycentricism, rejecting the reliance on simplistic panaceas (Pahl-Wostl & Knieper 2014, p.140)	polycentric, network, collaborative
	Galaz et al., (2012).	-Which are the basic features of polycentricism? While the question might sound simple, there is little agreement in the literature (Aligica & Tarko, 2011; McGinnis, 1999, 2000; Ostrom, 1999, 2000, 2010b). - Based on existing literature, we suggest that there exist four generic processes in polycentric systems at the international level, namely information-sharing, coordination of activities, problem-solving, and internal conflict resolution (Galaz et al., (2012, p.21-22).	collaborative, sharing, learning, network, coordination
Adaptive (co-management)	Chaffin, et al., (2014).	-Based on this synthesis, we define adaptive governance as a range of interactions between actors, networks, organizations, and institutions emerging in pursuit of a desired state for social-ecological systems Chaffin, et al., (2014, p.56). .	adaptive, network, collaborative
	Huitema, et al., (2009).	-Adaptive management emphasizes learning and uses structured experimentation in combination with flexibility as ways to achieve this (Huitema, D. et al., 2009, p. 26).	Adaptive management,
		-Co-management emphasizes the sharing of rights, responsibilities, and power between different levels and sectors of government and civil society. Adaptive co-management, then, is a novel combination of the learning dimension of adaptive management and the linkage dimension of co-management (Olsson et al., 2004; Armitage et al., 2007).	learning, experimentation polycentric
	Lee, (1993).	-Implied several institutional prescriptions: collaboration, experimentation and a bioregional approach to resource management. Collaboration refers, first, to the fact that different government bodies have to work together in	adaptive, collaborative, experimental, bioregional,

Table 2-4: Water governance typology

Water Governance Model	Author	Title - Definitions	Application
		order to manage issues that cross jurisdictional boundaries and fall into different policy sectors. Secondly, collaboration refers to the need for collaboration between these bodies and non-governmental stakeholders, such as individual citizens and interest groups. Experimentation implies the probing of the system to be managed, monitoring its response, and adjusting interventions on the basis of the findings. Unexpected outcomes are not seen as failures but as an opportunity for learning. As a final institutional prescription of adaptive management, Lee (1993, p.57) suggests that "seeing the ecosystems as a whole must precede efforts to manage it." According to him, this implies a focus on the bioregion, also when such a region crosses multiple administrative borders. (Hutema et al., 2009).	interagency cooperation, experimentation
	Baird et al., (2016).	-Adaptive co-management (ACM) is generally understood as ''a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organized process of trial-and-error'' (Folke et al.,2002, p. 8). It involves heterogeneous actors interacting across scales and through networks (horizontally and vertically) to undertake actions and learn through feedback (Olsson et al., 2004; Folke et al., 2005; Armitage et al., (2009) in Baird et al., 2016, p.747).	collaborative, co-management, network, multi-scale, learning, resilience
		-An adaptive governance is operationalized by way of adaptive co-management (Olsson et al. 2004; Folke et al. 2005).	
Watershed (river, landscape, bioregional)	Morris and Brandes, (2013).	-Use a broad definition of "watershed" that refers to the sophisticated interplay between social, ecological and hydrological systems. Terms such as 'catchment" or "river basin" are also commonly used. Spatially, watershed concerns a defined area of land that drains surface water, along the natural ecosystems and human activities that take place with in it. The land-water dynamic is central to the concept of watersheds and it is important to recognize that the vast majority of a watershed is land.	integrated, multi-scale, socio-ecologically based
		-Regarding the notion of a "socio-ecological" system, our definition of watershed includes a range of scales. A watershed might, for example, form part of a larger basin (as seen with sub-watersheds in the Fraser or Columbia River systems)., or be defined by a clustering of smaller sub-watersheds that aligns with a given population that forms an identifiable freshwater community or culture (as might be the case along the B.C. coast where communities span multiple smaller stream systems).	

Table 2-4: Water governance typology

Water Governance Model	Author	Title - Definitions	Application
	Parkes et al., (2010).	-Explicit focus on the reintegration of water resources management with the determinants of health (Parkes et al., 2008). -Utility of the framework increased when watersheds were considered the place-based setting. -Integrated governance for water, health and social–ecological systems. -Governance for sustainable development (watersheds, ecosystems, social systems). -Focuses on the "triple-bottom" line of economy, society and environment within a watershed, catchment or river basin (Parkes et al., 2010, p.694-5).	integrated watershed governance, (socio-economic, environmental & health), catchment, riverbasin, adaptive, regional watershed scale, local, place-based
	Rathwell and Peterson (2012).	-Cross-scale linkages, horizontally across landscapes and vertically between actors from local to watershed scale, are especially important for shared resources, such as water, whose users operate at multiple spatial scales (Cash et al., 2003, Olsson et al., 2007)	coordination, collaboration, cross-scale, collaborative networks, social networks, multi-scale, inclusive
	Simms et al., (2016).	-Debates over Indigenous rights to water intersect with broader trends in water governance, including growing support for shifting water governance in BC towards an approach that is watershed-based, collaboratives, and involves Indigenous peoples more centrally and meaningfully in decision-making (Fraser Basin Council, 2012; Brandes & O'Riordan, 2014).	Indigenous water gov., collaborative,
		- Contributing to momentum for water governance reform is an emphasis within water-governance scholarship on the idea that in order for water governance to be equitable and effective, it should be collaborative, and should include affected populations—specifically Indigenous peoples—in shared decision-making processes. These trends are further bolstered by a suite of ecological and social arguments that have also led to rescaling of many water governance institutions and practices to the local watershed level (Bark et al., 2012; Cronin & Ostergren, 2007; Barnhill, 2009; Jackson et al., 2012; Phare, 2009; Tipa and Welch, 2006; Brandes and O'Riordan, 2014; Memon and Kirk, 2012).	collaborative, inclusive (equity & effective), shared-decision-making, local
Local (place-based)	Reed and Bruyneel, (2010).	-That is, as the state has been reconfigured and 'hollowed out', with the redistribution of state functions upwards (to international and transnational institutions), downwards (to state/provincial/regional and local authorities), and outwards (to non-state actors), new 'geographies of governance' have emerged.	multi-scale

Table 2-4: Water governance typology

Water Governance Model	Author	Title - Definitions	Application
	Lemoine and Patrick, (2014).	-Water governance may be re-scaled from the federal and provincial level to a more regional level. Here we define water governance as the process which guides decisions, and who makes decisions, regarding water management, planning and policy.	regional, delegated

This research argues that this shift is constructive, considering that environmental governance is both dynamic and in constant reconfiguration (de Loë et al, 2009; Plummer et al., 2013). Regardless of the definitions of the various water governance models, all involve some aspect of collaboration, including command and control (intergovernmental collaboration). Moving beyond the focus on idealized model categorization and the optimum model, more effort is required to better understand the social relationships (networks) that facilitate or impede collaboration within water governance system, which will enable more effective water governance interventions targeted towards better water outcomes.

2.5 Implementation challenges

Despite the recent focus on models necessary for transition within the literature, significant challenges remain associated with implementation (Ansell and Gash, 2008; Kallis et al., 2009; Bakker and Cook, 2011; Pahl-Wostl et al., 2012; Tan et al., 2012; Ananda and Proctor, 2013; Cosens et al., 2014). Manard and Saleth (2011) looked at numerous experiences of water governance in many different countries and contexts, finding no optimal solution. Similarly, Ostrom et al. (2007, p. 15176) state:

> In the context of governance of human–environment interactions, a panacea refers to a blueprint for a single type of governance system (e.g., government ownership,

> privatization, community property) that is applied to all environmental problems … Large studies of land-use and land-cover changes have not found evidence for any single, ever-present driver of change. Experimental and field research has consistently found that individuals overtly facing the same situation vary substantially in their behaviour … The track record of the use of panaceas is one of repeated failures.

Reed’s (2008) "grounded theory" analysis of stakeholder participation in environmental management, reveals key insights into the challenges associated with collaboration in the form of democratic representation, issue-framing, and provision of adequate resources for implementation. Reed (2008, p. 2418) views grounded theory through a stakeholder-centric lens, defining participation as “a process where individuals, groups, and organizations choose to take an active role in making decisions that affect them.”

Review of contemporary water governance discourse reveals an ongoing, often opposing, dialogue delineating the prescriptive nature of alternative water-governance models. The wide variation in applied governance reforms within the literature (Ostrom, 2010a, 2010b) supports the contention that no single model of governance can effectively address contemporary water challenges (Saleth and Dinar, 2004, 2005; Manard and Saleth, 2011).

2.5.1 Rural water governance and the subsidiarity challenge

Subsidiarity theory states that decision-making with concern for water resources should be made at the lowest appropriate level where the resource is being used (Nowlan and Bakker, 2007). While "local" is very context-specific, localization and localism draw upon subsidiarity principles that are defined in broad terms, such as “decentralizing each task (governance) to the lowest level with capacity [and political authority] to conduct it satisfactorily (Marshall 2007, p. 93), subject to the corollary that complementary high–level institutions are established to address tasks that span multiple levels" (Garrick et al., 2012, p. 917). The underlying philosophy posits that, in order for local communities to achieve social and economic self-determination, governance must be developed on principles of effectiveness, responsiveness, representation, and legitimacy, thereby enabling communities to take advantage of environmental opportunities while protecting the community against threats and challenges (Hunt and Smith, 2005).

Subsidiarity reveals two separate and possibly competing frames of reference: (1) an economic frame in which subsidiarity is viewed as decentralization for the purposes of efficiency that requires divesture of powers to lower levels in order to create competitive pressure, to maximize preference satisfaction, and to minimize circulation problems (see Charles Tiebout, 1956); or, (2) a religious (teleological) frame, based upon ancient Greek philosophy, that "recognize[s] the singularity and uniqueness of every social sphere and its place in the total social structure … and the powers given to every sphere would match its essence and purpose" (Blank, 2010). In the case of the economic framing of subsidiarity, there is potentially an unlimited number of social and political entities that could take on responsibilities and perform various governance functions. This can lead to the creation of new entities or special-purpose governments at scales that provide the most efficient management of resources (Blank, 2010). The religious framing decentralizes power, responsibility, and authority to a limited and pre-existing number of entities (e.g., provinces, regions, cities, or towns).The free-forming economic version of subsidiarity is driven primarily by efficient management of resources for the maximization of wealth, whereas in the religious framing, “the fit between a sphere and an activity (or function) is a result of the essence of the sphere and the nature of the activity at hand” (Blank, 2010, p. 542).

Other issues with the allocation of decision making to local levels, including poor and inconsistent financial management, poor economic regulations, poorly drafted legislation, and the lack of long term strategic planning, were also identified as significant challenges to the development of sustainable water practices (OECD, 2009). Often the capacity to address water-related issues is lacking at the local level, and whatever capacity does exist is often fragmented due to varied viewpoints, values, and norms (Dewulf et al., 2011). Dispersed and sparse rural populations with limited communication abilities are particularly susceptible to high levels of fragmentation (Bakker and Cook, 2011). One critical form of fragmentation is the absence of intra- and inter-agency communication linkages that are essential for effective water governance (OECD, 2009, 2011; Dewulf et al., 2011).

Although there is a significant and growing body of literature regarding the theory and application of various forms of water governance, including collaborative, adaptive, distributed, and watershed, the empirical evidence regarding the effectiveness of any single model over another is inconclusive (Huitema et al., 2009). This gap in evidence highlights the ongoing challenge associated with policy implementation in the water-governance field. Compounding these challenges are the wide and divergent views on the definition, theory, and application of water governance, emphasizing the need to reassess the advocated approaches to governing water resources in the 21st century.

Increasing public awareness, socio-ecological knowledge, levels of ownership in the water decision-making process, and pressure on water resources have all provided upward political pressure to accommodate non-state actors in the decision-making process. The transition towards inclusive models of governance, while potentially capitalizing on a broader pool of knowledge, raises issues such as legitimacy, capacity, and necessary resources to carry out aspects of policy implementation, timing, and democratic representation. Bakker and Cohen (2011) present a schematic (Figure 2.1) that advocates for greater collaboration through delegation and increased multiple stakeholder involvement. While much of the water governance dialogue has been focussed on collaborative and inclusive models, recent attention has been directed towards challenges associated with transitioning towards "rich" governance approaches (e.g., multi-model, and scale) conceived in a dynamic socio-ecological systems context (Gunningham, 2008; Werbeloff and Brown, 2016).

Many of the existing water problems persist, not because of a lack of technical or managerial knowledge, but because of a continued focus on simplistic linear solutions. Manard and Saleth (2011) looked at numerous experiences of water governance in many different countries and found no optimal solution to the problem of urban water and irrigation governance. This lack of proof is not an indication that the current models of governance are not, or will not, be part of the solution; rather, the success of a specific arrangement, its implementation and monitoring depend on its relationship with the suite of institutional arrangements and the context within which they function (Manard and Saleth, 2011). The OECD’s (2011) recent study investigating water governance in 17 different countries concluded that the water crisis is primarily a crisis in governance resulting from: (1) a mismatch in hydro-geographic and geopolitical boundaries; (2) inadequate funding, (3) conflicting goals; and (4) poor accountability.

In Grafton et al.’s (2012) study of four major mid-latitude watersheds—Colorado (United States), Yellow (China), Murray-Darling Downs (Australia), and Orange-Sengu (Botswana, Lesotho, Namibia, South Africa)— increasingly collaborative, less centralized models, including the Colorado and the Orange-Sengu, appeared to be less effective at sustainable water governance (e.g., water conservation, allocation to ecological needs) than the Yellow (centralized) and the Murray-Darling Downs (centralized-market oriented), which are centrally oriented models. While there is limited recognition of mixed approaches in the water governance literature, the wide variation in applied governance reforms (Ostrom, 2001, 2010a, 2010b) supports the contention that no single model of governance can adequately and efficiently address contemporary water challenges (Manard and Saleth, 2011; Saleth and Dinar, 2004, 2005, and 2006).

Further investigation is required to progress current water dialogue beyond the polarizing debate over model preference, and address the specific knowledge gap in how nested governance can be expected to handle processes and change characterized by “nonlinear dynamics, threshold effects, cascades, and limited predictability” (Duit and Galaz, 2008, p. 311). Grafton et al. (2012), however, show that achieving sustainable water management may in fact be more linear and predictable, and less complex, than what has been portrayed in contemporary water-governance literature. Grafton et al.’s (2012, p. 315) findings show that “hydrological effects of past and current water extractions far exceed projected impacts of climate change. This is an important realization but paradoxically offers the promise that improved water governance could both reduce existing water stresses and prevent further deterioration as a result of projected declines in inflows due to climate change.”

2.6 Socio-ecological framing and institutions

The rising socio-ecological awareness, but continued shortfall in current water-governance responses, has led to a call for new and innovative socio-ecological framing and approaches to water governance. Determining which particular governance type provides a "best-fit" model for addressing a particular need is challenging (Collins and Ison, 2010; Godden et al., 2011). Central to this critical task is the role that water institutions play.

2.6.1 Water institutions

Water institutions are fundamental in addressing growing environmental and social challenges of water governance (Acheson, 2006; Poirier and de Loë, 2010). Sense-making research provides a relational-based tool that can assist in understanding water institutions and the needed change from intra-perspective, stationarity-based mechanisms to open and collaborative knowledge-seeking entities that incorporate a grounded recognition of the rapidly changing environment associated with water resources. A precise definition for our purposes is difficult due to the complex nature of socio-ecological systems and the multiple scales in which water institutions operate (Poirier and de Loë, 2010; Scott, 2008). However, in a very broad sense, institutions can be understood as the "rules and actions of the game, intended to reduce uncertainty by providing structure to everyday life" (Genus, 2014).

As we transition to collaborative and inclusive forms of governance, the need to better understand the changing roles and impacts of water institutions and their intra- and inter-relationships continues to grow (Hall and Taylor, 1996; Hotimsky et al., 2003; Hodgson, 2006; Poirier and de Loë, 2010). In the late 1980s and early 1990s, the term "new institutionalism" emerged, describing the re-framing of governance from a linear process, conducted by rational actors (classic economics), to systems or organizations that were influenced by social, economic, and political factors, and informed by context and actor relationships (Powell and DiMaggio, 1991; Hall and Taylor, 1996). Recent institutional theory has focused on resilient aspects of social structure, through examination of the processes by which structures, including schemas, rules, norms and routines, become established as authoritative guidelines for social behaviour (Scott, 2008).

Scott (2008) developed a brief history of institutional analysis, starting from the mid-20th century. From this review, several major trends emerged, including a shift from organization-centric to field-level approaches, and a transition from institutional stability to institutional change. This transition highlights both external (exogenous) and internal (endogenous) changes that influence and modify institutions. The exogenous factors may be political (delegation and subsidiarity), environmental (changing hydrological cycles) or social (social capacity and capital). Endogenous sources of change may consist of gaps or mismatches between scales of systems or formal regulatory structures and informal activities and processes at the local level (Sewell, 1992; Scott, 2008; Dacin et al., 2012; Norman and Bakker, 2009).

Historically, inter-institutional research has focused predominantly on the "why" and "when" social relationships form (Scott, 2005); however, recent research has begun to consider institutions in a holistic manner, looking at the contextual and social aspects relating to institutions within a network of relationships. The re-framing of institutional development as a bi-directional (affecting and being affected by) network of relationships has provided useful insights into the mechanisms (e.g., role of social capital and environmental and structural interaction) within a given context. It is important to recognize that within this relational re-framing, water institutions consist of multiple political actors, or groups of actors, with varying levels of influence, pursuing agendas aligned with individual self-interest, and this pursuit occurs within a context of unique social and cultural embeddedness, which shapes both the institutional responses and their ability and willingness to respond to particular issues (Saleth and Dinar, 2005).

Understanding institutional operating capacity is important given the central role that institutions play in identifying the issues, framing the subsequent discussions, driving the agendas and ultimately determining the final policies enacted. Although these institutions (i.e., technical committees, planning committees, etc.) may be regarded as goal-directed inter-organizational networks, little is known about the network structure and characterization of these organizations, which gives rise to questions regarding coordination, representation, accountability, knowledge creation, innovation, institutional performance, and overall governance structure.

2.6.2 Continued challenges

The absence of a universally accepted definition for water institution may be attributed to the variety of disciplines and schools of thought that employ the term "institution" with limited agreement (Poirier and de Loë, 2010). The increasingly complex nature of coupling the needs of social systems with those of ecological systems also presents some challenges for identifying a clear definition of what constitutes a water institution, which has led to a multitude of solutions being advocated (Poirier and de Loë, 2010; Pahl-Wostl et al., 2010; Acheson, 2006; Berkes, 2003). Adding further complexity to this socio-ecological context are the multiple scales in which institutional elements operate, ranging from the micro (inter-actor) level, to the meso (inter-cluster or organization) level, to the macro (transnational system) level (Scott, 2008).

As water environments continue to change and become less predictable, the need for adaptive, rather than technical, solutions increase. Adaptation requires new and different ways of managing and operating from those currently being utilized (O'Brien, 2012). Current water management has focused on supply-side-management in the forms of infrastructure-related approaches, including increasing water availability through improved storage capacity and water transfers (Moore, 2013). As a result, water-related decisions, such as allocation, have become highly embedded and normalized within institutions, making water regimes rigid and resistant to change and innovation (Moore, 2013). This rigidity or resistance to change, recognized as "institutional inertia", is identified as one of the leading barriers to transformation of centralized water governance systems (Pahl-Wostl et al., 2007; Engle et al., 2011; Brown and Farrelly, 2009) to new models better suited to the dynamic and non-linear nature of climate change.

The persistence of the supply-side approach to water governance can also be attributed to the normalized convention of using generalized industry-wide "best practice" recommendations, research and de-politicized policy frameworks, which continue to ignore the social, political, and institutional dimensions associated with water decision-making (Cleaver and Franks, 2007; Molle et al., 2009). Moore (2013) uses Integrated Water Resource Management, currently being used in many high-profile organizations such as the Global Water Partnership, as an example of a "best practices" approach, which purports to achieve efficiency, equity, and environmental sustainability through expert knowledge and sound science. Moore (2013) argues that more than good information is required for multiple stakeholders to come together, cooperate, and reconcile differences. Lautze et al. (2011) further argue that there may even be a fundamental conflict or incompatibility associated with the goals of efficiency, equity, and sustainability. Lautze et al. (2011) conclude that popular usage of the term ‘water governance’ has assumed a subordinated interpretation (e.g., use of efficiency, equity, and sustainability as a panacea approach) utilizing predetermined and generic goals, rather than adopting an approach that includes, as a primary role of water governance, a process to define water-management goals according to local preferences.

2.7 Reconceptualization of Water Governance

Increasing interest in water governance within the resource literature reflects both a changing conceptualization--from government to governance (Perramond, 2012; de Loë et al., 2009)--and the changing role played by states in economic, political, and social life (Budds and Hinojosa, 2012). Re-conceptualization of water governance as a collaborative and inclusive process has led to a debate about the optimal scale of governance, highlighting the importance of the political nature of existing and new governance models (Bridge and Perreault, 2009; Budds and Hinojosa, 2012). Associated with this re-conceptualization are fundamental questions relating to the impacts of governance architectures, the overall effectiveness of "earth-system"-oriented governance, the ways in which multiple agents at all levels can influence the processes, and how environments (both human and natural) affect these agents and their involvement in governance (Budds and Hinojosa, 2012).

Bridges and Perreault (2009) propose a critical and dialectical approach for investigating how social (human) relationships of a governance system can influence and shape the water-governance model, and how different water-governance structures can influence human-nature inter-relationships. By locating water governance within a political framework, inquiry is focused on production, mobilization, and contestation of control and distribution of the resource. Socio-political processes can play an important role, for example in determining the choice of scale and inclusion of locally developed knowledge. Because socio-political processes can be influenced by the power and control of a cluster of actors influenced by potential homophilia associations socio-political processes may also limit robust communication, innovation, and knowledge-transfer processes (Rathwell and Peterson, 2012). Homophily, one of the most extensively studied and documented aspects of social networks structures, refers to the network phenomena in which, “nodes tend to be more frequently linked to other nodes that are similar to themselves in terms of their characteristics than to nodes that are less similar to themselves in characteristics” (Jackson, 2010, p. 20). These approaches may be viewed in what Sproule-Jones et al. (2008) and Menard and Saleth (2011) refer to as the intra (structure) and inter (system) "institutional interplay" of governance. Sproule-Jones et al. (2008, p. 8) define institutional interplay as, “The connections, interactions and effects that result from the presence of multiple institutions involved in a water governance system. Institutional interplay is recognized by the common pool of resource researchers as the increasing institutional and political complexity within the policy process inherent within water policy issues.”

As resource regimes shift from government to governance, there is an inherent recognition that water is, in itself, not a single-purpose material resource to be harvested and allocated; rather, its physical appliance and its social relational network inhabit and express each other (Bakker and Cook, 2011; Bakker, 2003a; Linton, 2010; Loftus, 2009;

Swynegedouw, 1999; Budds and Hinojosa, 2012). Budds and Hinojosa (2012, p. 120) argue that the starting point for characterizing water (flows, forms, practices and discourse) must reflect both "the material and social processes through which instances of water become formed." Understanding the material and social processes of water requires attention to a broad spectrum of issues such as flow rates, access and allocation, equity, technology, emerging science, institution adaptation, current legislation and governance frameworks, all of which are defined and guided by the interrelationships among the participating actors and social constructs (Budds and Hinojosa, 2012). This dual conceptualization is known collectively as the "waterscape" of a given context (Baviskar, 2007; Budds, 2008; Loftus, 2009; Loftus and Lumsden, 2008; Swynegedouw, 1999). The waterscape approach focuses on a multi-directional, multi-scale, relational perspective of water. In other words, social processes shape water, and water shapes social processes (Bakker, 2003b; Linton, 2010). This conceptualization enables effective water governance analysis to proceed without preconceptions or bounding limits (i.e., hierarchical limits).

Vogel (2012, p. 161) asserts that improved water governance outcomes will only come about through "more interactive and longer-term models attentive to dynamic political-social geographies." There is a need for closer attention to the processes and interrelationships between power and social networks in water governance, with particular emphasis on both institutional dynamics and scalar construction (Norman et al., 2012). Consequently, by taking a relational approach to water and focusing on governance as a set of risk-trust relationships involving people and places, as opposed to merely a physical apparatus (Loftus, 2009), a clear conceptualization of the governance environment (system and content) and structure (institutions) is possible (Saleth and Dinar, 2004, 2005). However, Saleth and Dinar fail to account for a key aspect of any water governance system, which is the content of the network which determines the development, and eventual structural makeup of the network itself. If the goal, as suggested in the water governance literature, is to improve the adaptive performance of our water systems, then developing a comprehensive understanding of water governance environment, structure and network content is a first step towards achieving this goal.

2.8 Bridging services

Effective water management models have shifted the focus towards substantive engagement of the growing diversity of actors and institutions involved in policy and plan development (Davidson and de Loë, 2014). Bridging actors and organizations are key to facilitating collaboration amongst the diverse actors and institutions, and knowledge co-production and continuous learning that are integral to adaptive governance (AG) (Armitage et al., 2015).

Bridging services have been identified as key attributes, within a governance system, for establishing and / or enhancing connectivity as counters to these barriers such as fragmentation and isolated clusters of groups or institution. Establishing or encouraging bridging services must be intentionally contemplated (Sandström et al., 2015; Alexander and Armitage, 2014; Luthe et al., 2012; Newig et al., 2010), as they go beyond general stakeholder engagement, which has garnered considerable attention amongst water governance researchers (Crona and Hubacek, 2004; Crona, 2006; Stringer et al., 2006; Olsson et al., 2007; Bakker, 2008; Berghofer et al., 2008; Lienert et al., 2013).

Bridging services, provided by strategically located actors within the network structure, facilitate the establishing of important links that connect various actors, potentially increasing the network's knowledge base, a requirement for increasing a network’s adaptive capacity. By definition, a bridging actor must occupy a critical structural location in the network, connecting two or more isolated actors or groups, which helps to build trust amongst a diverse set of actors (Crona and Bodin, 2005; Hahn et al., 2006; Olsson et al., 2007). Bridging actors (BAs) are uniquely positioned to facilitate sense-making, learning, multi-scale collaboration, and conflict resolution, in large part due to their role as information-brokers and trust-builders amongst disparate actors (Olsson et al., 2007; Hahn et al., 2006). BAs are able to monitor, provide, direct, suppress and alter information, and as a result are able to influence the way knowledge is exchanged, and in turn empower the network to learn and adapt to new circumstances (Bodin and Crona, 2009). BAs also serve as information repositories, to resolve conflict and, where supported by legislation, build the legitimacy and credibility needed to encourage behavioural change (Armitage et al., 2015; Cash et al., 2003; Huitema and Turnhout, 2009; Crona and Parker, 2012; Baggio et al., 2015).

Interest in the important role of bridging services provided by key actors and organizations that connect distant nodes in social networks is relatively recent. The academic literature shows fewer than 10 journal articles on the topic in 2004 whereas in 2014 there were almost 400 articles (based on a Google Scholar search). Nevertheless, BAs have proven to be of interest in a broad range of applications. For example, within the emerging field of adaptive co-management (Indigenous), BAs draw together Indigenous members with other levels of government actors in a collaborative domain of knowledge exchange, trust, and collaboration. Examples include: Beverly-Qamanirjuag Caribou Co-Management Board (North West Territories, Saskatchewan, Canada), which provided the forum for knowledge exchange and trust building (Berkes, 2005); the Arctic Borderlands Ecological Knowledge Co-op provided bridging functionality within a forum organized during the annual meeting (Crona and Parker 2012); and, in the Tohono O'odham case, bridging services were facilitated by scientists (Arnold and Fernandez-Gimenez 2007). As these examples illustrate, bridging organizations can consist of   wide range of actors, and processes (Crona and Parker 2012) unique to the context in which they were employed. It is also worth noting that not all BAs are successful, nor is one type of bridging organization necessarily successful in every context.

In a study of the Mkindo Catchment, Tanzania (Stein et al. 2011), academic institutions were found to provide valuable bridging services by mediating conflicts between science and policy across varying scales. This was, however, not the case for the Decision Centre for a Desert City (DCDC), located at the Arizona State University (ASU). The DCDC was specifically designed as a bridging organization with a mandate to build a new model for science policy engagement based upon collaboration (Crona and Parker, 2012). The DCDC was intended to function as a bridging actor sitting at the intersection of highly diverse social groups that included academics, policy makers, resource users, and funding agencies, all seeking potentially conflicting goals resulting in initial failure but eventual success.

Bridging actors play a key role in communicating new ideas and information across varied culture and value systems, thereby promoting a mutual framing of common goals via shared meanings across different epistemic communities (Vignola et al., 2013). One significant potential barrier to establishing bridging actors involves connecting scientific knowledge to other forms of understanding (e.g., traditional ecological knowledge) to bring together government and non-government actors (Crona and Parker, 2012; Armitage et al., 2008; Olsson et al., 2007; Hahn et al., 2006; Berkes, 2005; Olsson et al., 2004). Additional barriers include: situational factors (e.g., power, trust, public opposition); social context (e.g., cultural norms, stereotypes, politics and polarization); institutional context (e.g., conflicting agency mandates, organizational norms and cultures, resource constraints, government policies and processes and inadequate opportunities to interact), and potential remediation strategies for addressing these barriers (Olsson et al., 2007). The eventual success of the DCDC as a bridging organization depended upon the inclusion of key bridging actors within the DCDC, actors who had established legitimacy in both the academic and practitioners' worlds (Crona and Parker, 2012). In recognition of the importance of bridging with a network, there has been significant effort and resources invested in designing and implementing bridging organizations, particularly in addressing water related challenges (Imperial et al., 2003; Lubell and Fulton, 2007; Pahl-Wostl et al., 2010b; Rathwell and Peterson, 2012).

It should be noted that, although bridging connections provide the potential for the services listed above, they do not guarantee that the services occur, nor do bridging-type connections guarantee that these connections evolve into bonding connections with higher levels of trust, for example (Baylis, 2013). Notably, some particularly strong links among just a few actors (known as "bonding" links) may foster prescriptive and socially constraining collective action, leading to higher levels of network homophily, ultimately reducing the adaptive capacity of the network (Newman and Dale, 2005; Cash et al., 2003).

Thus, not all bridges are of similar effectiveness, and depending upon the mandate of the bridging requirements may even be restrictive in nature or play a ‘gate keeper’ role.

Due to the ongoing frustration in addressing sustainable water governance and a growing awareness of the importance of strategic relationships within the network, interest in bridging actors and organizations, and the services they provide within a social network, has seen substantial growth in recent times. There remains, however, a significant gap in knowledge pertaining to bridging actors and organizations, bridging services and influences that bridging actor-organizations may have within a governance network (Crona and Parker, 2012; Rathwell and Peterson, 2012).

Chapter 3 - Experimental Design and Methodology

3.1 Background

Identifying network structure and measuring network characteristics affords governance practitioners the knowledge to adjust or modify governance processes to achieve the "best fit" between water governance structure and the associated water related goals (e.g., adequate quantity and quality). With one of the primary goals being resiliency in response to climate change for each watershed studied (Glorioso and Moss, 2010; Hamilton, 2011), the water-governance literature advocates for a collaborative governance structure. It is theorized that only a broad knowledge base will produce the innovation and multitude of solutions required to address the wicked challenges associated with climate change (Rittel and Webber, 1973; Ansell and Gash 2008; Pahl-Wostl et al., 2008; Brisbois and de Loë, 2016).

The water governance research community has primarily focused upon a small grouping of governance models (collaborative, adaptive, distributed) as a panacea for all water challenges. However, as the typology (Table 2-3) of these models highlights, there is significant overlap and duplication between categories, revealing a somewhat contested and fuzzy picture with respect to idealized water governance models. This study argues that increased efforts should be directed towards understanding the social underpinnings of water governance, operationalized through social networks, as a way to better understand how water governance decisions are made. This new grounded knowledge will enable water governance design to be tailored to the unique context and challenges facing individual water governance initiatives and will provide an informed platform for effective interventions for improved water outcomes.

An innovative case-study research design, utilizing sense-making analysis tools (social network analysis (SNA) and Discourse Analysis (s-DNA) informed by SNA), was employed for this research. Case-study research has been described as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used” (Yin, 1999, p. 23). Case-study research enables us to understand complex issues or objects, and adds strength and further validation to what is already known through previous research (Yin, 2013). This dissertation is predicated on the assumption that mixed method, sense-making research methodology, involving both adaptive network-structure typology metrics coupled with a formal social network analysis, can provide insight into existing deficiencies and limitations in contemporary water-governance debates and management approaches.

Case studies emphasize detailed contextual analysis of a limited number of events or conditions and their relationships (Soy, 1997). Social scientists have long utilized the qualitative aspects of this research approach to examine contemporary real-life situations and to provide the basis for the application of ideas and extension of methods (Soy, 1997). Incorporating social network analysis as the case-study tool enables the collection and interrogation of the data from both quantitative and qualitative perspectives. Multiple data-collection methods and analysis techniques provide researchers with opportunities to triangulate data in order to strengthen the research findings and conclusions.

The case-study research design (Yin, 2013) used in this study utilized social network analysis (SNA) to map, identify, and analyze the existing watershed planning network structure within two rural, water-scarce regions in British Columbia, the Similkameen Valley and the Kettle River. The Adaptive Management Network Typology Assessment Framework (Bodin et al. 2006) was utilized to guide the structural analysis. The study included a macro-level investigation followed by a meso-level investigation, which focused on measuring and identifying bridging actors and their unique characteristics within the watershed planning networks (Rathwell and Peterson, 2012). The final stage of the research involved the use of a novel social-discourse network analysis (s-DNA) (Leifeld, 2013), guided by results from the social network analysis, to identify possible affiliation and/or coalitions that may bias the watershed plan development through framing of issues and strategies.

3.2 Legislative Context

The research was initiated during the BC Water Act Modernization (WAM) process, designed to solicit public input into the development of a new water act to replace the existing 1909 Water Act. The Act, while going through many adaptations over the years, lacked any legislation protection for ground water and continued to use an historic system that allows those with applications for surface water licenses (senior) submitted earlier to take precedence over those whose applications that came later (junior), known as First-in-Time First-in-Right (FITFIR) (Province of British Columbia, 2015). Additionally, limited consideration was given for instream flow needs for fish and the environment more broadly (Watershed Watch Salmon Society, n.d.).

The Ministry of Environment is lead agency for the management of water for the Province of British Columbia (BC). There are, however a multitude of agencies responsible for various aspects of water through numerous Acts including the following federal acts: Canada Water Act; Fisheries Act; Navigable Water Act; Canadian Environmental Protection

Act; and, International Boundary Waters Treaty Act for example. At the Provincial level water, related acts include: Water Sustainability Act (WSA); Drinking Water Protection Act; Water Utilities Act; Forest and Range Practices Act; and the Local Government Act, for example.

Contained within the recently adopted Water Sustainability Act (Province of British Columbia, 2015) are the provisions for Sustainable Watershed Planning, identified as Water Sustainability Plans (WSP) (Section 4 in Province of British Columbia, 2015). WSP's are established through the powers of the minister, by order, and may designate an area for the purpose of a water sustainability plan, and may establish the process by which a proposed water sustainability plan for a plan area is to be developed. The minister may also designate a person other than the government as the person responsible for preparing the proposed plan and may also require the government to pay remuneration and costs, if non-government person (Province of British Columbia, 2015). The government may also limit the process.

When a proposed watershed sustainability plan is being proposed, consideration maybe give to the results of other Provincial government, local authority and first nations government strategic, operation and land or water use planning processes in relation to land or water within or adjacent to the plan area (Province of British Columbia, 2015). Other plans that may be developed in conjunction with a watershed sustainability plan include drinking water protection plan or land use or water use plan. The research investigated two non-legislative watershed planning processes aimed at providing guidance and recommendations to the Provincial government who, as outlined above, retain the ultimate decisions making powers unless designated otherwise in the watershed planning process.

3.3 Case Study Context

The initial research design for the dissertation included three watershed planning processes (Nicola Valley, Similkameen Valley and the Kettle River Valley), all in different stages of evolution. While the research does not include the Nicola, the impacts of the Nicola watershed planning process had significant influence on the remaining two case study watersheds. The Nicola Valley watershed planning process had ended two years prior to the start of data collection for this dissertation. and therefore, the response to the survey questionnaire was marginal with only five returns from a network size of 38 formal watershed actors. A follow-up discussion with the Nicola Watershed Community Round Table coordinator, revealed a high level of frustration with the process because the Nicola Valley Watershed Plan was ultimately rejected under Part 4 of the former Water Act. This sentiment is captured in a letter from the then Water Stewardship Manager, Ministry of Forests, Lands and Natural Resource Operations, "…the plan is not legally binding and therefore the success of implementing its recommendations is contingent on the voluntary participation of the member agencies", and the subsequent response by the NWUMP (Nicola Watershed Use Management Plan) Steering Committee, "…the Plan is not a legally binding document and hence we (both the Steering Committee and the Plan itself) have no authority or jurisdiction. Given this reality, the Steering Committee is uncertain what our role will be or indeed, if there will be a role at all. Furthermore, we have no resources and therefore will not be able to meet the Province's expectations for us as outlined in your letter", (Salomon-de-Friedberg, 2011, p.21).

Approval of the plan would have enabled broad powers for assisting the region in resolving conflicts between users, risks to water quality and conflicts between water users and in-stream flow requirements. As mentioned earlier, the rejection of the Part 4 water management plan application had a profound influence on the watershed planning processes within the Similkameen and the Kettle.   Both regions elected to pursue a guiding document rather than a legislated path for the watershed management plan. Following advice from the Nicola Watershed planning group, both the Similkameen and Kettle watershed networks elected to pursue a non-regulatory watershed plan (Hamilton 2011, 2012). The intent of the Similkameen Water Plan was to be, "…a guidance document for decision making authorities, resource managers, water users and residents to help make more informed and integrated decision regarding the watershed", (SVPS, 2012). The completed watershed plan (Similkameen) was intended to be integrated into the Regional District local planning documents, bylaws, policies and best management practices. However, any decision making regarding recommendations and suggested practices remains with existing authorities including municipal, regional, provincial, federal and First Nations jurisdictions (Hamilton, 2014).

In 2010 a group consisting of predominantly local government politicians along with a few representatives from irrigation districts, industry and environmental groups and led by the Regional District of Kootenay Boundary (RDKB) came together to form the Terms of Reference (TOR) for the development of the Kettle River Watershed Management Plan (KRWMP)While recognizing that the Kettle Watershed spanned the U.S.-Canada border, the TOR did not accommodate provisions for representation from Washington State, even though the Planning (Phase 3) and Implementation (Phase 4) of the Washington State planning process (1990s) were never completed (Regional District Kootenay-Boundary, 2010).

The key concern expressed by the watershed residents concerned the, "…water supply for communities and flow for fish, which are exacerbated by uncertainty about the implications of climate change. Other local water concerns include water quality (both surface and groundwater) and the health of riparian ecosystems", (Hamilton 2012, p.i). The initial goals for the development of the KRWMP included a co-operative development process, recognizing the need for all levels of government and affected stakeholders, including residents. Missing from the list of potential collaborative partners was any mention of First Nations aside from possibly being viewed as another 'affected stakeholder' in the process. Further objectives of the KRWMP development process included: iterative, integrated and comprehensive, collaborative and proactive (Regional District Kootenay-Boundary, 2010). The goal of the KRWMP was to, "provide a guidance document to all watershed stakeholders, including local, provincial and federal agencies", (Regional District Kootenay-Boundary, 2010, p.6). The TOR recognized the ongoing Water Act Modernization and stated the goal of compliance with any anticipated legislative or regulatory changes adopted through the WAM (Regional District Kootenay-Boundary, 2010).

3.4 Case-study regions

Two case studies were undertaken to provide some sense of whether, given that the actors differ, there is variance among different watersheds regarding the network typology that evolves over the process. Limited resources and timing precluded the inclusion of additional case studies, although these are essential to the development of more robust conclusions and broader generalizations about the likely range of variance that characterizes rural watershed planning processes in British Columbia and other water scarce regions.

The two case study watersheds, Similkameen Valley Watershed (Similkameen) and the Kettle River Watershed (Kettle), were selected based upon similar regulatory, environmental, and socio-economic contexts, and strong parallels in the underlying water-related drivers for initiating watershed planning (i.e., increasing demand, changing supply, and conflicting views on legislative and regulating roles in common pool resource management in BC).

Following Yin’s (2009) significance criterion for case study selection, the Similkameen and Kettle were selected as case studies based upon the facts that: (1) both case studies are currently actively involved in a water governance process (watershed planning) at the local level; (2) both watersheds have water scarcity and are susceptible to environmental changes (e.g., climate change), leading to significant potential to inform the implementation of a senior level, province-wide Water Sustainability Act; and (3) both case-study watershed planning processes have identified climate change as one of the top priorities to be addressed through the watershed-planning process. The two case-study watersheds also contain similar environmental challenges in similar socio-economic contexts within the same regulatory regime.

3.4.1 Similkameen Valley Watershed (SVW)

The Similkameen River is a tributary of the Okanagan River, forming part of the larger Columbia River system. The majority of the Similkameen Watershed is located in Canada, with a portion of the headwaters and lower part located in the United States (Figure 1.1). The Canadian portion of the watershed is 7,600 km^2 in size (Water Survey of Canada, 2010). The SVW is the largest watershed within the Okanagan drainage system, contributing

75 percent of the flow of the Okanogan River. The SVW is governed via multiple jurisdictional authorities, including international (Canada / USA), federal, provincial, regional (Regional District of Okanagan-Similkameen), local municipalities (Town of Princeton, Village of Keremeos), First Nations (Upper Similkameen and Lower Similkameen Indian Bands) and six irrigation and improvement districts.

The Similkameen Valley Watershed Plan started not as a watershed management plan but rather a large project designed to develop a *Similkameen Valley Sustainability Strategy* (Sustainability Strategy). To further the interests of communities in Similkameen Valley, a society was formed, the Similkameen Valley Planning Society (SVPS). The SVPS members were recruited through a valley wide advertisement and requests, from which a cross-section of panel members was selected. The panel member experienced covered a broad ranged including: agriculture, arts/culture, business, education environment/archeology, tourism and science. The SVPS initiated and over-saw the Sustainable Similkameen Project. The Project consisted of three phases:

- Phase I – develop essential information on in-migration into the Valley with a specific focus on amenity migration
- Phase II – formulate a strategy for sustainability of the Similkameen Valley
- Phase II – implementation of the Sustainability Strategy (2011-2020)

Several goals and objectives (referred to as aims and means) relating to water sustainability emerged out of the Sustainability Strategy. To address these aims and means the SVPS struck two committees, the Technical Advisory Committee (TAC) and the Stakeholder Advisory Committee (SAC) to guide the development of a non-regulatory Watershed Management Plan. The main drivers for creating a SVW Plan included widespread concerns for water availability, water quality, ecosystem requirements, population growth (amenity migration), economic development activities, transnational concerns (hydro production and water use), and climate-change impacts (Glorioso and Moss, 2010; Hamilton, 2011). Virtually all cropland in the SVW depends on irrigation, and all surface water was considered fully licensed by the mid-1980s. With limited flow in the critical late summer months, increasing populations (5.9% between 2001 and 2006), expanding recreation facilities (e.g., Apex Ski Resort), and increasing mining activity, residents have demonstrated heightened awareness of future uncertainties with regard to water resources management.

3.4.2 Kettle River Watershed (KRW)

The Kettle River, one of British Columbia's Heritage Rivers, lies between the Okanagan and Columbia River valleys in the central part of southern British Columbia. Approximately 75 percent (8,230 km^2) of the total KRW (11,000 km^2) is located within Canada, with the remaining drainage area (2,650 km^2) located within northern Washington State (Regional District Kootenay Boundary, 2010). The Kettle River is located within some of the driest biogeoclimatic zones in British Columbia, with the headwaters being located in the Monashee Mountains. As with most other interior rivers in British Columbia, flow discharge is high during the spring freshet as a result of snowmelt, but is significantly reduced by mid- to late summer when demand from water users is substantial (Hamilton, 2011).

The Kettle River is critical to the region providing water, surface and groundwater extraction for economic and land use activities. The residents within the KRW have expressed concern regarding diminishing flows, adequate water supplies for communities, sufficient flow for fish survival, water quality, and health of riparian ecosystems, particularly during mid- and late summer months (Glorioso and Moss, 2010; Hamilton, 2011). These concerns are exacerbated by uncertainty surrounding the implications of climate change. The Kettle River is ranked as the most endangered river in B.C. (Angelo, 2011), primarily due to the seasonal low flows and current development demands associated with water extraction (Regional District Kootenay Boundary, 2010). Prominent among the proposed developments is a water-use application from a major ski resort requiring 400 million gallons of clean water annually to accommodate planned resort expansion. If approved, water extraction licenses would add further pressure to the oversubscribed river with 994 current licenses (at 826 points-of-diversion) for surface water in the Canadian portion of the watershed (with 1,100+ more in the U.S.). Crop irrigation remains the largest licensed volume for extraction, followed by domestic use.

In the research case studies, the predominant issue was the sustainable management of the watersheds in light of mounting pressures that include increasing development (e.g., domestic, industrial and agricultural) and declining availability resulting from changing climate (e.g., drought and changing hydrological cycles). KRW watershed residents concern for water supply (e.g., quantity and quality), adequate quantity for ecosystems (e.g., flow for fish), and the uncertainties that surrounding the impact of a warming climate (Hamilton, 2011) let to the regional government (Regional District of Kootenay Boundary (RDKB)) applying, successfully, for a federal government grant to develop a Watershed Management Plan (WMP). The WMP consisted of two phases, (1) the Technical Assessment intended to summarize the, “State of the Kettle River Watershed” including any gaps in information, and

(2) the Watershed Management Plan identifying planning goals, actions and policy needed to maintain the health of the watershed over the long term (Hamilton, 2011). A private consultant was hired to develop the “State of the Watershed” report in Phase I. An initial Kettle River Watershed Committee, a committee made up of government representatives and appointed stakeholders acted as the Steering Committee for the plan. The Steering Committee then appointed the Technical Advisory Committee (TAC) and the Stakeholder Advisory Committee (SAC). The SAC was to include a balanced representation from the various sectors in the watershed (government, industry, tourism-recreation) with a primary purpose of advising the Steering Committee. The TAC consisted of various government representatives, with some representation from First Nations, and industry. A Project Coordinator was hired to provide integration and coordination services and be responsible for the Steering Committee.

3.5 Sense-making research

There are gaps between scholarship, policy practice, and practical knowledge as they relate to sustainable water management. This is due, in part, to the fundamental lack of understanding of the roles and the types of influence, power, authority, and legitimacy actors have within water decision-making arenas (Moore, 2013).

Figure 3-1: Case study watersheds (Canada)

Source: Department of Fisheries and Oceans Canada (DFO), Okanagan Nation Alliance, and BC Ministry of Water, Land and Air Protection. 2005. "The State of Fish and Fish Habitat in the Okanagan and Similkameen Basin"

While there is a broad call for change in contemporary water governance, there is limited information on certain aspects of water governance, such as institutional interplay, that may be driving or impeding effective water governance (Saleth and Dinar, 2004). Institutional interplay is defined as, “the connections, interactions, and effects that result from the presence of multiple institutions involved in a water governance system (Sproule-Jones et al., 2008, p.7). Institutional interplay is the recognition, by common pool resource researchers, of the "increasing institutional and political complexity within the policy process inherent within water policy issues” (Sproule-Jones et al. 2008, p.8).

Sense-making research is the field of research involving multiple research methods, including social network analysis and discourse analysis, that is employed to develop a deeper understanding of the drivers and barriers associated with effective water governance. Sense-making research methods have become popular in making explicit what has, up until recently, been implicit information regarding water governance and specifically institutional interplay (Saleth and Dinar, 2004; Sproule-Jones et al., 2008).

Sense-making research consists of a set of research methodologies used to organize and make sense of unknowns. Sense-making involves first determining a plausible understanding or map, then testing this understanding through data collection, and finally refining or abandoning the map, depending on how credible it is (Ancona, 2012; Weber and Glynn, 2006; Weick, 1995).

Because sense-making research methods are designed to make complex and obscured environments and information understandable (Heifetz et al., 2009), they are very well suited to this study, which aims to establish a better understanding of the central drivers in, and the barriers to, the development of water-governance models that are adaptive and sustainable.

Sense-making research draws upon the premise that water governance occurs within a non-linear, dynamic environment, while incorporating complex adaptive system-thinking and complexity theory. The use of a sense-making research analysis facilitates the capture of contextual data typically omitted during survey and questionnaire research methodologies (Kurtz and Snowden, 2003; Kurtz, 2009). Sense-making research is also well suited for multi-perspective analysis of fragmented narratives (text, dialogue etc.), which are associated with areas such as institutional network communication (knowledge exchange), decision-making, strategy development, and policy-making.

One of the key goals of this study is to undertake both qualitative and quantitative analyses of the micro-narratives (e.g., conversation segments) in order to reveal the issues and trends (new knowledge) associated with the water governance networks that either exist or are emergent. The underlying premise of sense-making research is that effective formulation and implementation of policy in water governance will only be achieved through the development of a deeper and more meaningful understanding of the increasing complexities associated with the governance context (environment), the structure (network), and the content (dialogue or narrative) of water decision-making processes.

3.5.1 Social Network Analyis (SNA)

One of the emerging and most effective methods for studying the social relationships that underpin resource governance is social network analysis (SNA). SNA is a research methodology well suited for increasing our understanding of the complex and multi-level, interconnected, socio-ecological processes associated with water governance.

Governance research has shown that the existence of social networks is an important aspect of effective multi-stakeholder natural-resource decision-making processes (Bodin and Crona, 2009). Specifically, "… the structural patterns, or typology, of the network can have significant impacts on how actors behave” (Bodin and Crona 2009, p. 66) and how actors ultimately make decisions with respect to resource management.

SNA involves the mapping (sociograph) and empirical assessment of communication pathways and interconnections (i.e., how knowledge is created and exchanged) that exist and emerge between actors within a bounded social system. Within this study, a social network refers to the communication and relationships that exist or develop between actors participating in decision-making processes that are related to the sustainable management of common-pool resources.

A social network is comprised of a set of actors, whether individuals or aggregated groups, linked through one or more relationships (Scott, 2000; Marin and Wellman, 2011; Stein et al., 2011). Actors are referred to as "vertices" or "nodes" in the network, and the relationships between actors are referred to as "edges" or "links". The latter are associated with communication mechanisms or information exchange pathways. Communication between the actors defines both the network and the social network data.

In SNA, the unit of analysis is the relationship between the actors who provide information for the individual components of the system. Studies have shown that "[a]nalyzing the relational data enables the study of how localized interaction between individuals, organizations, or other social entities gives rise to larger-scale patterns–or structures–that both facilitate and constrain individual actors, while revealing properties of the social system as a whole" (Borgatti et al., 2009; Diani and McAdam, 2003; Stein et al., 2011; Wasserman and Faust, 1994). In this study, a social-relational approach, with both a conceptual and analytical framework, is used to uncover and understand how social networks effect watershed governance decisions (Boden and Prell, 2011).

Social networks play an important role in connecting actors and organizations as they strive to develop collaborative strategies towards attainment of natural resource goals (Imperial, 2005; Olsson et al., 2007; Kininmonth et al., 2015). This is particularly true during times of unpredictability, uncertainty, and rapid change (Bodin and Norberg, 2006; Olsson et al., 2007; Albrecht et al., 2014). It is the connections within the social networks that allow for learning and knowledge exchange within the network, which, in turn, impact how and what water resource-related decisions are made (Pahl-Wostl, 2009).

Through SNA, mapping of the social relations can be conducted at multiple scales, including at the actor level, the aggregated cluster level, and at the whole-network scale. SNA has been used to identify patterns (network structures) that assist and restrain individual actors' ability to influence water-related decisions. Ultimately, properties of the social system that support decision-making are exposed (Wasserman and Faust, 1994; Diani and McAdam, 2003; Borgatti, et al., 2009; Stein et al., 2011). Mapping of the social relationships can reveal hidden characteristics, for example, "communities of practice" that are associated with pockets of localized and / or specialized knowledge, which may have developed over time and place, but may not necessarily be widely known beyond the immediate users or community (i.e., localized conservation efforts).

SNA helps to identify the relevant actors that are likely to interact and learn from each other through their tight connections. Conversely, there may be communication deficiencies that result in knowledge gaps. Isolationism and fragmentation, for example, can be measured to identify potential nodes of innovation that exist on the periphery of the network, which, if more strongly connected, could advance the agenda of the whole-network as a whole.

Structurally speaking, network learning is enhanced through strong links within a group (Granovetter, 1973) through high modularity. High modularity enables the transfer of tacit knowledge (Reagans and McEvily, 2003) and complex knowledge, which is relevant considering the increasing unpredictability of water-resource management (Bodin et al., 2006). However, it should be noted that some degree of separation of the respective groups is required in order to maintain heterogeneity within the network. Having greater access to many actors privileges the network with expanded knowledge repositories, enhancing the potential for innovative solutions. The risk, however, is when there are strong ties amongst few actors, which can then lead to a continued dependence upon a few centralized actors. This can negatively impact network learning because it can result in restricted access to the broadest possible grouping of actors and their varied knowledge repositories (Crona and Boden, 2006).

For each of the two case-study watersheds, a survey was conducted to identify the actors and their relationships, followed by a formal network analysis (Smith et al., 2009; Hansen et. al., 2011). An adjacency matrix was constructed for each of the watersheds using binary data to represent an existing link or relationship between any two actors each pair of potentially linked actors is called a dyad). The relationships were then analyzed through the use of structural algorithms embedded in the NodeXL (Hansen et al., 2011) SNA software. Review of previously conducted SNA surveys (Tindall, 1992; Harshaw and Tindall, 2005) informed the final research survey design by providing social network-specific question formatting.

3.5.2 SNA Approaches in Watershed Governance

Bodin et al. (2011) have identified three broad categorical approaches in social network research on the governance of natural resources (Table 3-1). While Bodin et al. (2011) refer to these as three different categorical approaches, these stages may be viewed as an evolutionary progression of SNA, representing progressive stages from a simplistic understanding towards a precise level of investigation.

One of the key characteristics of the Structurally Explicit Approach, outlined in Table 3-1, involves the analysis of data collected systematically using formally defined models and methods to allow the identification of inferred relationships between quantified structural aspects of social networks and outcomes. Bodin et al. (2006) provide an example of this in the Adaptive Management (AM) – Network Structure Typology Framework (Appendix I). This assessment framework links key features for adaptive management, natural resources, their social network structures, and empirical metrics, thus enabling a systematic collection and analysis of data, supported by AM theory and the comparison of water-governance networks. For example, the *Learning* network structure typology is quantified through the social network metrics of betweenness (bridging), modularity (cluster or community), and reachability (knowledge transfer) as they relate to adaptive governance (management).

SNA serves to characterize the relative arrangement of these network components and the strength of their interaction via a series of quantifiable metrics. These metrics (e.g., betweenness, modularity, reachability, and closeness centrality), which are linked to network structure typology, were found to affect the AM structure development either positively or negatively.

Table 3-1: Range of SNA Approaches in Watershed Governance

SNA Approach	Category Descriptions
Binary metaphorical approach	-Social networks are treated as a metaphor for saying that there is an exchange of knowledge, information or other resources between actors. -Social networks treated as unspecified binary variables; either there is a network or there is not. -Network structure is not explicitly addressed. -Actors are either socially tied or not. -Characterized by studies where social networks in natural-resource governance are identified as instrumental, but where little is said about the actual structure or pattern of the social networks.
Descriptive approach	-This category starts to address some of the key characteristics of the studied social networks. -Descriptors (e.g. vertical, bonding, bridging) are used and often tied to social concepts such social capital or capacity. -Further separation enables a more precise analysis. -Builds on the notion that not all social networks are created equally. -Studies generally lack methodological studies on how to empirically investigate and analytically distinguish between different descriptions of social network structure, lowering studies' ability to explain or increase understanding of how social network structure matters.
Structurally explicit approach	-Studies where social network has been measured using systematic data collection methods. -Relational data have been analyzed using formally defined models and methods. -Objective is to infer relationships between formally defined and quantified structural characteristics of social network and various outcomes in natural-resource governance. -Structural characteristics may include: whole-network characteristics such as clustering, cliqueism, multi-model, central, fragmented or isolates (e.g., Smythe et al., 2014); various types of ties including strength, directionality (e.g., Stein et al., 2011); and even specific actor characteristics such as bridging actors (organizations) (e.g., Vignola et al., 2013).

(adapted from Bodin et al. 2011, 17-18, in Alexander and Armitage, 2014)

For example, high degrees of closeness centrality can negatively impact the learning component of a network, while betweenness, reachability, and modularity can all have positive impacts on a network's capacity to learn (Janssen et al., 2006; Newig et al., 2010).

This study, through use of the AM framework, examined the often-implicit relationship between structure and functionality of the social networks in the two case study watersheds. The framework was employed to guide the collection of social network data through the specific metrics of reachability and closeness centrality and considered key quantitative metrics for measuring adaptive capacity within an AM network (Bodin et al., 2006). The betweenness metric was also incorporated to enable the identification of actors holding a key position within the network, which is considered the optimum for connecting desperate actors and communities (clusters) within the network.

Utilizing sense-making research techniques, and specifically SNA methods guided by Bodin et. al.'s AM Network Framework, is particularly important when considering the ongoing challenges that face water governance regimes, particularly in rural environments where challenges are likely to include the following (Norman and Bakker, 2005):

- mismatch in governance structures and integration between levels and jurisdictions, particularly when watersheds span national borders;
- distinct and sometimes incompatible governance cultures and mandates (political)
- limited institutional capacity, financial resources, participation capacity, and data availability, which is particularly common the more rural the watershed
- distance (both spatial and social)
- psychological-sociological factors, such as mistrust and lack of leadership.

Many of these challenges are associated with the existing formal governance structures and actors (e.g., local political representatives) (Norman and Bakker, 2005). This study adopts the structurally explicit approach to analyzing the watershed planning networks with the intention to make explicit the structural characteristics that may, or may not, be hindering watershed governance in rural regions.

3.5.3 Watershed network bounding survey

Each of the case study watersheds' planning processes followed similar stages, beginning with a technical assessment of the watershed, followed by the watershed plan development, which involved stakeholder committees and steering committee members. Participants in the steering committee consisted of volunteers and local government appointees, whereas members of the technical committee were local government appointees. A local consulting firm was selected through a ‘request-for-proposal’ process, conducted through the regional governments, to complete and compile the initial technical reports for each of the respective watersheds.

The watershed planning committee members consisted of local, provincial, and federal government representatives, First Nation Band representatives, and non-government stakeholders, including environmental groups, and local representatives from tourism, agriculture, and energy producers. The Similkameen Valley Planning Society (SVPS), which had been involved in sustainability planning, a process that led to the initiation of the watershed planning process, provided an existing group of local government representatives and other non-government representatives to populate the watershed planning committees. In the Kettle, the planning process also consisted of a technical committee and a stakeholders’ committee, as well as a steering committee.

As part of the sense-making SNA process, network actors were broadly defined as actors participating in the watershed planning process (e.g., expert advisors, interested watershed residents, technical committee members, advisory committees, water users (licensees) and identified government personnel, general stakeholders, researchers etc.).

Formal actors for each watershed planning process are listed in Appendix II. The SNA survey tool was employed to capture social network data from both the formal and informal actors (i.e., not identified in the formal list, but identified by formal actors as contributing helpful water governance related information) who were involved in the watershed planning processes in both the Similkameen and Kettle watersheds. The total number of actors, including both formal actors identified by regional-district governments and informal actors identified through the survey, included 59 actors (n=59) for the Similkameen Valley Watershed (SVW) planning process and 54 (n=54) actors for the Kettle River Watershed (KRW).

To analyze the communication patterns associated with the watershed planning processes for the SVW and the KRW, a semi-structured bounding survey was designed and implemented, followed by semi-structured interviews. The survey contained both closed questions (e.g., question 5) requiring a given choice, combination questions requiring a choice with opportunity to provide some comment (e.g., question 6) and open questions that allowed significant latitude for response.

The survey questions focused primarily on social network style of questions that focus on communication patterns (see Appendix III). Previously conducted SNA surveys were reviewed to inform the original design of the survey. The survey was implemented online initially followed by phone and in-person interviews guided by the original survey tool. A link to the online survey was sent to all network actors identified in the formal list of participants (Tables 1 and 2 in Appendix II). Interviews lasted from 10 to 45 minutes depending on responses. The relational data collected through the survey and interview process was analyzed to characterize the networks. The survey remained open for six weeks, with two reminders being sent to the participants, and a third notification indicating the date when the survey would close. Consent was obtained prior to conducting interviews

The semi-structured interviews were conducted to ensure that response rates were as close to full network response as possible and to incorporate the collection of deeper and richer responses to questions not easily obtained with an online survey. Each interview was recorded (with approval) and later transcribed. There was a total of 19 interviews in the Similkameen and 10 interviews in the Kettle. Member-checking (allowing respondents to review transcripts) was not incorporated into the study to retain original response integrity, considering the potential political nature of the survey and interview questions. One of the challenges associated with SNA emanates from the requirement that respondents divulge personal information that may have (or be perceived as having) associated risks, such as implications for current employment or negative implications for existing working relationships.

In order to capture the entirety of each network, a relation-based approach, referred to as expanded selection, was utilized to define the final network limits (network bounding) by drawing on the identified network actors' knowledge of their own network or egocentric network limits (Doreian et al., 1994; Marsden, 2005). The expanded selection is an abbreviated form of referral sampling, which allows informal actors to be identified and included. This provides a more accurate bounding of the watershed planning network.

All individuals identified by the regional governments as formally participating in the watershed planning process were included in the initial bounding list for the process. Formal network actors, those identified by the Regional District as members involved in the watershed planning process through committee involvement, were asked to identify up to 10 other members (formal) with whom they interacted the most and whose interaction was the most important as far as assisting in their watershed governance decision-making. The formal network actors were also requested to identify up to five additional people who were not a part of the formal network (informal network), but who influenced their water governance decision-making through knowledge provision. Through this process, both the formal and informal (egocentric) networks for each of the participants was captured.

These limits, ten formal and five informal, were determined through a review of existing SNA surveys, which determined these quotas as a good balance between strong to weak ties versus ease of completion of survey for respondents. Watershed actors remained anonymous and were identified by the organizations, or level of government, they represented, with the exception of actors who self-identified as First Nations or representing a First Nations Band.

The total number of responses (n), including both online survey responses and interview responses reached 27 out of a total 33 (82%) for the Similkameen and 25 respondents out of a total network (formal and informal) size of 36 (70%) for the Kettle.

Early research design included a third watershed, Nicola Valley Watershed, which had concluded its watershed planning process two years prior to the start of the research. Of the total number of formal network actors, obtained through the Nicola Watershed Community Round Table web site (www.nwcrt.org), only five responded. Preliminary information (interview) indicated that the watershed planning process was conducted under Part 4 of the recently rescinded Water Act, which “permitted broad powers to assist communities in resolving conflicts between users, risks to water quality, and conflicts between water users and in-stream requirements and are legally enforceable" (OBWB, n.d.). Even with support from the provincial and federal governments throughout the watershed planning process, the plan was ultimately rejected, leaving network actors disappointed and frustrated with the eventual outcome. The Nicola Watershed planning process outcome significantly influenced the two watershed planning processes of this study in that a non-legislative-approved watershed-management plan was determined to be the preferred format to pursue.

3.6 Network structure typology

Figure 3.2 shows four idealized networks (based on Bodin and Crona, 2009), each with inherent advantages and disadvantages regarding watershed governance. For example, it has been argued that the mesh network typology (A) is preferable for adaptive governance (AG) due to more effective communication along multiple edges, and increased levels of trust, thereby facilitating greater access to a wide variety of knowledge within the network (Currall and Judge, 1995; McLain and Hackman, 1996; Rathwell and Peterson, 2012). Collaborative and distributed network typologies, such as (A), appear better suited to address complex tasks (e.g., climate change adaptation) due to the increased level of innovation resulting from a diversity of inter-connected actors (Bodin and Crona, 2009; Ernstson et al., 2009; Crona and Hubacek, 2010; Bodin and Prell, 2011; Stein et al., 2011; Weiss et al., 2012; Lienert et al., 2013). In contrast, the core-periphery network typology (C) is characterized by centralized decision-making and restricted communication pathways, leading to limited knowledge diversity and homogeneous values (Boden and Crona, 2009).

Typology (B) illustrates a network that is divided into two isolated subgroups, often referred to as having high modularity. Typology (D) is similar to typology (B) with the exception of being connected through key network actors referred to as bridging actors.

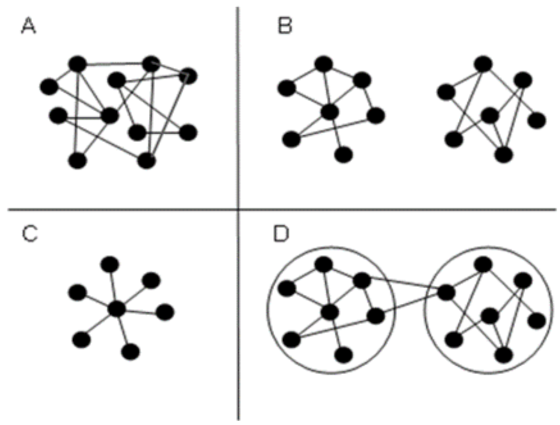


Figure 3-2: Social archetypical network typologies, (A) Mesh, (B) Isolated Clusters, (C) Star, and (D) Connected Clusters (adapted from Bodin and Crona, 2009)

3.7 Network metrics

The structural characteristics of the two case study planning networks were examined and contrasted in order to better understand the existing adaptive capacity embedded within rural watershed planning networks and to investigate how the network structures may or may not be aligned with objectives and vision of the stakeholder groups.

Both case-study watersheds planning processes placed importance upon the need to adapt to climate-change impacts (Glorioso and Moss, 2010; Newig et al., 2010; Hamilton, 2011; Hamilton, 2012). As described in Bodin et al. (2006, n.p.), "New knowledge and / or changing conditions require adaptive capacity and innovation to meet new needs."

As such, certain social network structural characteristics, or network metrics, that are associated with adaptive capacity were deemed important to quantify within this study (refer to Appendix IV). These metrics included reachability and closeness centrality and clustering coefficient (Bodin et al., 2006; Newman and Dale 2005).

High reachability (i.e., short hops to many actors) privileges the network with expanded knowledge repositories and enhances the potential for innovative solutions. On the other hand, high centrality amongst few actors may lead to a continued dependence upon centralized governance models (Bodin et al., 2006). This may, in turn, negatively impact network learning due to restricted access to the broadest possible grouping of actors and their varied knowledge repositories (Crona and Boden 2006).

The clustering coefficient metric is used to quantify the learning capacity, which has been identified as a fundamental component of the adaptive capacity of a social network (Pahl-Wostl et al., 2011).

3.7.1 Reachability

Reachability is defined as the number of independent "components" (e.g., sub-networks) within a broader network for which all vertices in the sub-network are directly or indirectly in contact with each other, but not with other sub-network vertices (Bodin et al., 2006, p. 37; Janssen et al., 2006). Scott (2000, p. 101) defines a component as “a subgraph where all points can reach one another through one or more paths but no paths run to points outside the component.” If a network consists of more than one component (e.g., Typology B in Figure 3.2), it is considered fragmented. The degree of fragmentation can be quantified by measuring the number of components, with large reachability values, indicating greater degrees of fragmentation (Bodin et al., 2006, p. 37). Network fragmentation creates barriers to knowledge transfer, learning, adaptive capacity, and overall network collaboration essential to adaptive and resilient governance models (Dietz et al., 2003; Lee, 2004; Folke et al., 2005; Lautze et al., 2011; Tan et al., 2012; Green et al., 2013). Identification and understanding of the number, size, and pattern of the components in a network provides insight into the opportunities for, and obstacles to, effective communication and, ultimately, collective action (Scott, 2000).

3.7.2 Closeness centrality

In social network analysis, "centrality" and "community" are quite often the focus. However, few studies have looked at both structural properties together (Obradovi et al., 2011). In this study, a cluster analysis has been added to reveal the community structures embedded in the networks. The "closeness centrality" metric provides insight into network inter-connectivity because it measures the shortest (geodesic) distance between a vertex of interest and all other vertices within the network (Sabidussi, 1966; Knoke and Yang, 2008). The closeness centrality score of a vertex indicates the structural positioning of that vertex, as well as the relative importance of that vertex within the network or sub-network. Hansen et al. (2011) describe the closeness centrality score as a distance because it is proportional to the number of steps between any two vertices of interest.

The closeness centrality of a vertex affects the distribution of knowledge, the transfer rates of information, and the mediated nature of knowledge because it accounts for the number of actors and knowledge repositories between distal and proximal vertices in the network. Typically, small closeness centrality scores denote greater inter-connectivity of a particular actor and subsequently greater structural importance to network communication (Hansen et al., 2011). The SNA program employed for this study (Smith et al., 2009; Hansen et al., 2011) utilizes a scoring system in which larger values of closeness centrality indicate greater connection to other vertices. The index of an actor's closeness centrality is calculated as the inverse of the sum of the geodesic distance (i.e., the shortest distance between pairs of vertices) between an actor and all other actors (Knoke and Yang, 2008, p. 65).

Values are normalized to remove network size influence and to allow for comparison across various network sizes. A fully connected node will have a value of 1, whereas isolates are identified with 0. Calculating the closeness centrality of a given actor involves the following:

$$C_C\,(n_i) = \left[\sum_{j=1} d(n_i,n_j)\right]^{-1} \text{where;}$$

$d(n_i, n_j)$ = the number of lines in the geodesic linking of actors $_i$ and $_j$.

The total distance that i is from all other actors is $\sum_{j=i} d\,(n_i, n_j)$ where sum is taken over all $j \neq i$ (Sabidussi, 1966).

To standardize this equation multiply by (g - 1) where g = number of actors in network (Knoke and Yang, 2008; Beauchamp, 1965). Standardization limits the range of measurements from 0 to 1, where an actor is maximally close to all other actors (Wasserman and Faust 1994).

3.7.3 Community Detection

Cluster analysis involves the process of identifying communities of densely connected vertices that are only weakly connected to other communities (Hansen et al., 2011), as shown in Typology D in Figure 3.2. These communities may be undetectable otherwise, or only known intuitively to certain actors. Hansen et al. (2011) and Girvan and Newman (2002) describe cluster (community) analysis as the process for identifying pockets of densely connected nodes that form a coherent community of actors but are only sparsely (weakly) connected to others in the network.

The communities that are revealed within a network through cluster analysis are often quite different from the formalized structures imposed on the network, including organizational hierarchies such as local, regional, provincial, federal governments. Indeed, the clusters may be based solely upon informal communication patterns motivated by other elements, including trust, mutual gain, and accessibility (Loftus, 2009; McEvily and Tortoriello, 2011).

3.8 Bridging

Of particular interest and importance within a social network are the structurally unique nodes that are positioned in such a way as to provide bridging services to build adaptive capacity through knowledge-brokerage and agency (Bodin et al., 2006). Understanding the structural attributes of a water network may enable intentional network interventions that could break down barriers and advance whole-network effectiveness.

3.8.1 Betweenness centrality

Building on the literature on adaptive management of natural resources and the links to social network structure (Bodin et al., 2006), the "betweenness centrality" metric (Borgatti and Foster, 2003) was used to quantify how often a node lies on the shortest path (geodesic distance) between two other nodes (Hansen et al., 2011). The betweenness centrality (or simply "betweenness") enables the identification and characterization of uniquely positioned nodes that provide bridging services to nodes within a network that would otherwise be isolated from one another or from the entire network.

Wasserman and Faust (1994) argue that the concept of betweenness (Freeman, 1978) is particularly important for identifying actors through which diffusion of information and essential social processes, such as collective action, occur (Vignola et al,2013). Borgatti (2005) describes betweenness as, “the share of times that a node i needs a node k (whose centrality is being measured) in order to reach a node j via the shortest path." Specifically, if g_{ij} is the number of geodesic paths from i to j, and $g_i k_j$ is the number of these geodesic paths that pass through node k, which is the node of interest, then the betweenness centrality of node k is given by,

$$\sum i(\sum j(g_{ikj}/g_{ij}))$$

(Wasserman and Faust 1994)

The betweenness centrality (Borgatti and Foster, 2003; Borgatti, 2005) metric is utilized to measure how often a node (k) lies on the shortest path (geodesic distance) between two other nodes (Hansen et al., 2011). This approach builds on previous adaptive co-management work (Olsson et al., 2007) and on socio-ecological systems work that considers bridging functions for enhanced fit between governance systems (see Bodin et al., 2006 Adaptive Network Framework – Appendix V).

High betweenness centrality (betweenness) metric scores identify actors within the network that are uniquely positioned to connect to a high number of other nodes. This connectivity between many pairs of nodes is referred to as ‘bridging’. Bridging actors provide linking services to nodes within a network that would otherwise not be connected to each other or possibly even the network as a whole.

In terms of a governance network, betweenness is viewed as the measure of the volume of communication (knowledge transfer) within the network that would pass through a certain node (k), and in turn, the amount of control that this node might exert over information distribution within the network (Borgatti, 2005). In effect, betweenness is the measure of the interpersonal influence bridging nodes (k) have on others, through their unique positioning "between" other actors (Brandes, 2001). Freeman (1979) describes this measure as the measure that can be applied to each actor in the network to determine which actors contribute most to linking the network, i.e. bridging (see Appendix IV). “The betweenness concept of centrality focuses on how actors control or mediate the relations between dyads that are not directly connected” (Knokes and Yang, 2008, p. 67) which distinguishes the betweenness centrality from closeness centrality. The dyads may also form a larger cluster or community. The assumption contained within the betweenness measure, particularly when associated with the flow of information, is that there would be no external influences or alternative path choices except the geodesic path (Borgatti, 2005).

Simply identifying the nodes with high betweenness scores, may not provide insight into characteristics of the actors or communities that are being connected, nor the nature of the bridging service provided by the bridging actors within a governance network. The detection of these diverse knowledge repositories or communities is an important consideration when determining effectiveness of bridging actors within a governance network tasked with addressing climate-change challenges. In this study, cluster analysis was also performed to provide a meaningful assessment of the functionality and effectiveness of the bridging actor and organizations within the overall network.

3.8.2 Cluster analysis

Identifying groups, or clusters, within a social network and mapping their relationship to one another enables insight into communication patterns and knowledge flows within a network. Cluster analysis involves the process of identifying communities of densely connected vertices that are only weakly connected to other communities (Hansen et al., 2011).

Being well connected within a network is important, but who you are connected to is equally important. The eigenvector metric is often used to measure the importance of a node within a network, because it is a quantitative measure of which actor is connected to other well-connected actors (Newman, 2005).

Hansen et al. (2011) and Girvan and Newman (2002) describe cluster analysis as the process for identifying pockets of densely connected nodes (referred to as "clusters") that form a coherent community of actors, but are only weakly connected to others in the network.

In this study, a clustering algorithm (Girvan and Newman, 2002) was employed to identify the connectivity context of the bridging actors in each case study network. The Girvan and Newman (2002) clustering algorithm works by progressively removing edges between low-centrality nodes until only the major clusters remain. The paths that connect these clusters will have high-edge betweenness values, and their removal results in the stranding of clusters in isolation, which speaks to the importance of the linkage (Girvan and Newman, 2002).

By coupling cluster analysis with betweenness analysis, a richer picture emerges with respect to the communication links that exist within a network. Ultimately, this approach can lead to strategic interventions that may improve learning and adaptive capacity within a network. This, in turn, may lead to more effective water-governance implementation.

3.9 Discourse Network Analysis

As awareness and understanding of the socio-ecological relationships existing between people and nature, and their influences on each other, continues to grow, so, too, does the demand for new socio-ecological research approaches and tools. Social network analysis (SNA) has rapidly become recognized as an effective tool for mapping and analyzing the structure (typology) aspects of these social networks. There has been significant growth in the use of social network analysis (SNA) research over the past decade, due in part to scientific innovation, advancements in technology, statistical modelling, and an increasing interest in relational aspects of governance (Armitage et al., 2015; Alexander and Armitage, 2014; Plummer et al., 2013; Pahl-Wostl et al., 2008; Armitage et al., 2008; Stein et al., 2008). Advancements in technology have included the development and proliferation of easily accessible relational-analysis software (e.g., Gephi, NodeXL, Pachet, Ucinet, etc.), which provides scientists, social and otherwise, the tools necessary to investigate relational aspects of social networks through SNA. The increased use of SNA has, however, come at a cost.

As the research focus shifts towards relational investigations, researchers tend to disregard the contextual information that facilitates deeper understanding of the very determinants of these networks (Moser et al., 2013; Malone and Kinnear, 2014). As effective as SNA may be, much of the richness associated with the social network is lost through the exchange of rich data for assigned integer values. Specifically, information pertaining to the "meaning" (value, content) of these relationships between actors is determined through the process of redefining relationships as a set of binary values (Malone and Kinnear, 2014). The result has been the emergence of a very relational-information repository that provides detailed information on network structure and actor characteristics but still lacks the any deeper or richer insight into the culture and values embedded within these networks (Moser et al., 2013). This is particularly true in the case of network typologies such as core-periphery, where there is a dominant (power) cluster of nodes (i.e., coalition) potentially holding sway over the performance and direction of the remainder of the network. Network structure, while providing theoretical performance insight, does not provide a robust picture of the content of information exchange occurring within the network.

This lack of richness, however, can be partially addressed through the incorporation of discourse network analysis. Discourse network analysis can be used to extend SNA (becoming s-DNA) through a novel approach that provides further insight into how actors relate and the content of their relationships or links (Leifeld, 2013; Lienert et al., 2013; Wasserman and Faust, 1994). The result is a mixed-methods research methodology designed to capture and analyze both the rich qualitative contextual information and the quantitative structural network information. By combining research methods, deficiencies of either approach may be overcome (Leifeld and Haunss, 2012), while simultaneously meeting the increasing call within academia to incorporate more mixed methods and integrated research.

For example, the implementation of purely statistical research analysis has been perceived as insufficient and lacking the ability to scrutinize rich qualitative data in an inductive manner (Graziano et al., 1993). Additionally, qualitative research has been criticized for being too diverse and not structured enough to allow for generalizations at a macro level (Mustafa et al., 2008; Moser et al., 2013). By combining the interpretive approach of discourse analysis (DA) with the quantitative social network analysis methods, a richer and holistic network data set can be developed, one based upon relational information within an adaptive management framework. The result is a research tool, referred to as s-DNA, that uses SNA to inform discourse network analysis (DNA).

Discourse analysis originates from linguistic studies, literary criticism, social sciences and semiotics. It focuses on how individuals achieve personal, social, and political goals through the use of language (Starks and Trinidad, 2007). Discourse not only constructs meaning, but also defines an actor’s role, identity, and subsequent actions (Starks and Trinidad, 2007; Titscher and Jenner, 2000). Through the use of discourse analysis, the creation and maintenance of social norms, the construction of personal and group identities, and the negotiation of social and political interaction can be revealed (Crowe, 2007; Gee, 2005). While the various discourse analysis methods (e.g., critical discourse analysis, category-based content analysis, argumentative discourse analysis, and semantic networks) allow for the collection and analysis of data sets that are richer in content, Leifeld (2013) argues that a gap remains between relational network information and the rich content which ultimately determines the networks under investigation, or what Moses (2013, p. 548) refers to as the "content of ties."

Often SNA research approaches network investigations through two distinct pathways. One approach focuses on the structure of the network, assuming that actors within the network are influenced by this structure according to theorized network behaviour. The second approach is to investigate the position of a specific node, or type of node, and its associated network characteristics, such as number of ties, direction of ties (in-out degree), and weighting of ties (Moser et al., 2013). s-DNA, on the other hand, focuses on the specific motives and actions of the actors within the network, enabling both the network structure and the individual actor-motivational data to be investigated.

s-DNA focuses on the language actors use to assign meaning and ultimately make sense (Jorgensen and Phillips, 2002). The use of s-DNA reveals network characteristics at the actor level (e.g., centrality of specific actors or clusters, or who the bridging actors-groups may be) and, at the whole-network level, reveals information, such as network fragmentation and appropriate network structure (e.g., core-periphery versus distributed). SNA can be extended through the use of s-DNA to provide a deeper analysis into network content so as to determine discussion framing, goal setting, and ultimately the end policy, and whether there is existing alignment between network discourse and network structure. For example, through s-DNA, the framing of water issues is revealed by making explicit the specific bias of human agency occurring with the process.

Category-based s-DNA was initiated for this study using the transcribed interviews, conducted on a random group of actors within the watershed planning processes. The network actor characteristics and network positions were made explicit through the preliminary social network analysis focused on network typology

One of the primary purposes of s-DNA is to analyze the use of specific types of language and terminology by actors in a network as a way to gain insight into the important aspects of a process through discussion (Leifeld, 2013). s-DNA involves an inductive process of coding words into categories, from which network attributes can be extracted. The process of grouping coherent linguistic units, or "frames," into categories is repeated until there are a sufficient number of categories identified in order to reveal the key concepts within the network. Actors within the network are then connected (affiliation network) to these key concepts, either in agreement or in opposition, revealing possible coalition surrounding key concepts. These key concepts are then mapped. Using information developed through the SNA (i.e., core-periphery / isolate locations), actors are mapped (affiliation network) to key concepts. This reveals the concepts around which core actors have developed a potential coalition (Girvan and Newman 2002). This, in essence, reveals potential framing concepts within the watershed planning process by core actors influencing the process.

The following diagram (Figure 3.3) depicts the relationship between: (1) Actor Network, (2) Affiliation Network, and (3) Concept Network, demonstrating a simplified version of the Discourse Network Analysis software:

Analysis occurs at the statement level, where relationships (links) between network actors and concepts are established when a statement is "tagged'" or identified. Actors and concepts are modelled as vertices within a multimodal graph (Figure 3.3). In general, the more statements that the actors have in common, the more aligned each actor discourse will be, and the more explicit the frame within the discourse. Groupings of actors with aligned statements or cohesive subgroups are interpreted as coalitions, while sparser connections between clusters reflect belief- or frame-divergence. The more aligned these sub-groupings are, the more likely they are to belong to advocacy coalitions (Leifeld, 2011).

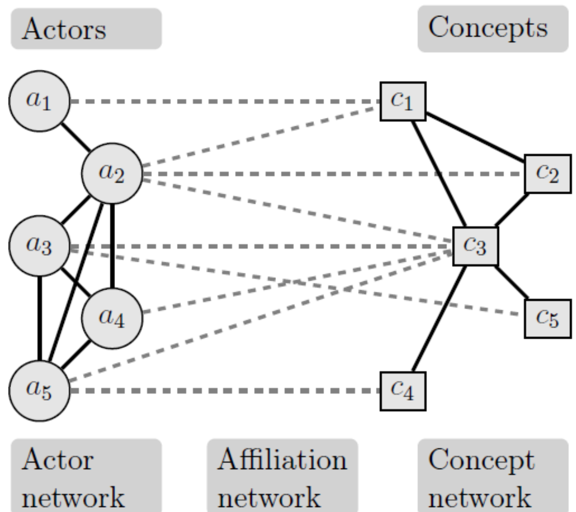


Figure 3-3: DNA – Congruence network model – simplified

Source: Leifeld, 2011, p. 82

Actor Network:	The actor network is created by identifying actors who share common statements. Edge (link or connections) weights are utilized to represent the number of shared concepts by any given dyad; the greater the edge weight, the more shared statements.
Affiliation Network:	The affiliation network links any given network actor with tagged statements or concepts that they are associated with in a two-mode manner.
Concept Network:	The concept network links are created when a single actor is linked to multiple concepts; for example, a link is created

between concepts c_3 and c_4 as a result of each being associated with actor a_3 (Leifeld, 2011, p. 82).

Mapping of the concept congruence provides an empirically based network-mapping of the governance discourse and identified statements. Clustering and distance are an indication of the similarity of concepts. Concepts clustered closely together indicate greater similarity of statements and the likelihood that the statements are a part of the same frame, or argument. It is through the identification of empirically similar arguments (metaphors or solution concepts) that network ideologies can be uncovered (Alvesson and Karreman, 2000; Leifeld, 2011).

The challenge associated with coding for discourse analysis is the time and effort it takes to conduct this labour-intensive reiterative process. DNA software uses a semi-automatic approach to coding, thereby reducing the labour-intensive costs and time required for manual coding, while still maintaining some ability for manual input to ensure reliability of the automated processes (Erkens and Janssen, 2008). The increased reliability also allows for increased transparency.

3.9.1 Coding

In this study, the analysis of the transcript content followed an "inductive" approach. Inductive content analysis (ICA) involves "rendering down" content to words, phrases, or statements to reveal a set of categories for the purpose of addressing a specific research question or hypothesis. Functionally, key words are traced within the discourse to discern the structure of meaning of the dominant discourse (Moser et al., 2013). It is the structure of discourse (verbal and written) that provides meaning to the social network. Thus, the coding phase for a discourse analysis involves identifying themes and roles as signified (e.g., interviewee’s views, belief, interpretation, approach, or solutions) referred through language (Starks and Trinidad, 2007; Leifeld, 2011). One example is the identification, through coding and analysis, of the use of "local historical connection" to signify unique water-management knowledge. Another is the use of technical language and professional jargon, which can potentially lead to implicit claims of authority or expertise (Starks and Trinidad, 2007).

The process ICA involves multi-pass (reiterative) coding of phrases or statements (content or discourse) to identify coherent groupings of categories. ICA was selected over deductive content analysis (predefined categories) due to the discourse categories being unknown and, as such, undefined. The lack of known categorization, particularly within a political discourse, can be attributed to “political discourse and scientific discourse not being merely mirrors of each other” (Leifeld, 2011, p. 52). Statements, or identified pieces of text, are then flagged (tagged) by the Discourse Network Analysis (DNA) software.

In general, the focus of the analysis is to discern meaning from the conversations and responses that have resulted from both the survey and interview process (discourse analysis) rather than focusing on specific facts, data, or research findings. There was potential for bias to be introduced through wording of questions and conduct of interview questions; however, survey questions were designed with this in mind and formulated in as neutral a format as possible. Care was taken not to lead or bias responses during interviews.

While text can originate from a variety of sources, including interviews, newspaper articles, and opinion pieces, text for this study was obtained from a random selection of the respondents to the semi-structured social network analysis surveys. DNA software assigns four values to the identified statements: (1) person making statement; (2) the person’s organization or affiliation; (3) the category (concept) identified by the person; and, (4) a variable identifying whether the statement is a positive or negative statement (Leifeld, 2011). Few research investigations have used DNA in the water governance field, but there is a growing number of DNA studies in other fields including: political analysis (Fisher et al., 2012; Hurka and Nebel 2013; Kammerer, 2016); policy analysis (Muller, 2014, 2015; Leipold and Winkel, 2016; Leifeld, 2011); and energy (Lockhart, 2014; Brugger, 2016; Stoddart and Smith, 2016).

Chapter 4 - Aligning Network Structure with Stakeholder Vision in Watershed Planning Processes

It is well recognized that complex ecological problems cannot be solved by enhanced scientific information alone (Fischer, 2011; Ludwig, 2014); rather, the existing body of knowledge must be translated into effective actions that are broadly accepted by society. To achieve this, existing and new knowledge must be communicated effectively to society in order to garner broad support for future initiatives (Holling, 1978; Roux et al., 2006; Fischer and O'Conner, 2014), building adaptive capacity that is increasingly required of our systems.

Building adaptive capacity within governance systems requires that there be consideration of a multitude of contextual elements, including goals, social memory, heterogeneity, redundancy (resilience), learning, adaptive capacity, and trust (Holling and Meffe, 1996; Folke et al., 2002; Schneider et al., 2003; Anderies et al., 2004, Newman and Dale, 2005; Ostrom, 2009).

Adaptation requires network change in some fashion. Often this change requires some form of learning. Pahl-Wostl et al. (2011) describe one common form of learning within the network as a re-iterative "triple-loop-learning" process, where incremental improvement of established processes, reframing, and transforming constitute the three loops of learning respectively. The 'network learning' is all predicated upon new knowledge or knowledge new to the network, derived from some form of collaboration. The system changes that result from this learning enable networks to adapt. Adaptive governance (AG) approaches allow management systems to engage in a form of experimental learning through a reiterative process. This leads to increased societal learning and, ultimately, to increased adaptive capacity and improved outcomes (Adger, 2009; Pahl-Wostl, 2009; Booth and Halseth, 2011; Pahl-Wostl et al., 2011).

The remainder of this chapter presents and examines the results from an analysis that compares the two case study watersheds, Similkameen Valley Watershed (SVW) and the Kettle River Watershed (KRW). The relative arrangement of network components and the actor interactions were measured using several metrics, including reachability and closeness centrality metrics. The structure of the "communities" within the SVW and KRW networks were also examined using cluster analysis.

4.1 Empirical results

Sociographs for the two watershed networks were created using data compiled from both online and semi-structured interviews (see Figure 4-1 and Table 4-1). The survey response rates were 82% for the Similkameen Valley Watershed (SVW) and 70% for the Kettle River Watershed (KRW) networks.

The Fast Multi-Scale Layout Algorithm of Harel - Koren (2001) was used to create the sociographs. Graphical portrayals of the network provide a visual assessment of the degree to which these networks align with the idealized typologies of mesh, collaborative, distributed, and core-periphery network typologies. which were graphically represented in Figure 3-2,

Table 4-2 provides a summary of general network metrics calculated for the SVW and KRW Planning networks using NodeXL software (Hansen et al., 2011). The total number of actors, formal and informal combined (network vertices), for the SVW and KRW watersheds was n=59 and n=54, respectively. The total number of unique communication pathways (i.e., edges or links) for the SVW was 143 and for the KRW watershed was 126.

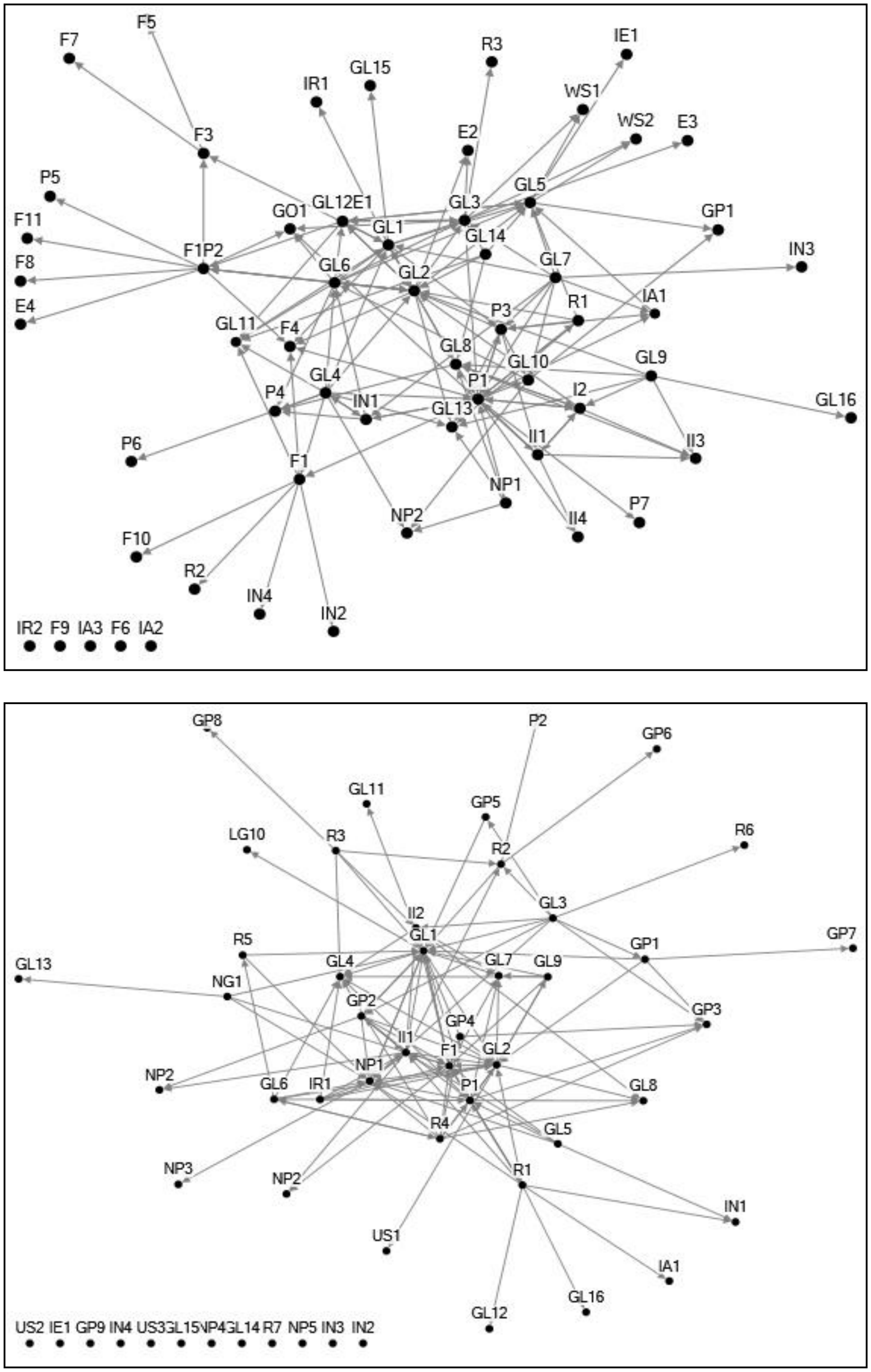


Figure 4-1: Watershed sociographs: Similkameen (Top), Kettle (Bottom)

Table 4-1: Sociograph code table

E	Education:	Education and researcher
F	First Nations:	Self-identifying and representing
G	Government:	**L** – local; **P** – provincial; **F** – federal; **O** – organization assisting gov.
I	Industry:	**A** – agriculture; **E** – energy producer; I – irrigation district **N** – natural resource extraction; **R** – recreation and tourism
NG	Non-government:	Not government related or focused
NP	Non-profit:	Environmental, advocacy groups
P	Private consultant:	
R	Watershed resident no affiliation:	
US	United States actor:	
WS	Watershed representative:	Alt. watershed (Kettle, Similkameen)

Table 4-2: SNA statistics for SVW and KRW networks

Watershed Network Summary Statistics		
Graph Metrics	Similkameen	Kettle
Vertices	59.0	54.0
Unique Edges	143.0	126.0
Reciprocated Vertex Pair Ratio	0.1	0.1
Connected Components (sub-networks)	6.0	13.0
Isolates (single vertex-connected components)	5.0	12.0
Maximum Vertices in a Connected Component	54.0	42.0
Maximum Geodesic Distance (diameter)	5.0	5.0
Average Geodesic Distance	2.6	2.4

Pairs of actors (dyads) that identified each other as important for bi-lateral communication (quantified by the “reciprocated vertex pair ratio,” VPR) were slightly greater in the SVW (VPR = 0.11) than in the KRW (VPR = 0.08). The larger the VPR value, the greater the opportunity for knowledge transfer within the network.

4.1.1 Reachability

The "average geodesic distance" refers to the average number of steps between all dyads in the graph (Wasserman and Faust, 1996). The "maximum" geodesic distance is the maximum number of steps required to connect any two vertices. The larger the geodesic distance between any two vertices, the greater the number of 'jumps' needed to reach from one actor to others within the network. The geodesic distance has implications for knowledge transfer, trust-building and, ultimately, decision-making. While the maximum geodesic distance of both case-study watershed networks was the same (5), the SVW network had an average geodesic distance of 2.6, marginally larger than the KRW (2.4).

Despite a slightly larger average geodesic distance between vertices in the SVW, the overall level of fragmentation was relatively small, with more than 91% of the vertices being connected (54 of 59). The KRW network was more fragmented than the SVW, with only 78% of the vertices being connected (42 of 54).

Isolates are nodes that are not linked to any other nodes within the network. The number of isolates gives additional insight into the level of fragmentation within a network. The KRW had twice the number (12) of "isolates" than the SVW (5). Table 4-2 shows that the KRW network had more than twice the number of sub-networks or "connected components" (13) than the SVW network (6).

The number of isolates (single-vertex-connected components) in the SVW (5) and the KRW (12) accounted for all but one of the connected components in each of the watersheds. This indicates that both networks are comprised of a single, dominant "super" component with several marginalized actors (isolates) along the periphery (more so in the case of the

KRW). Evidently, there were no cliques (small groups of actors sitting in isolation) within either network.

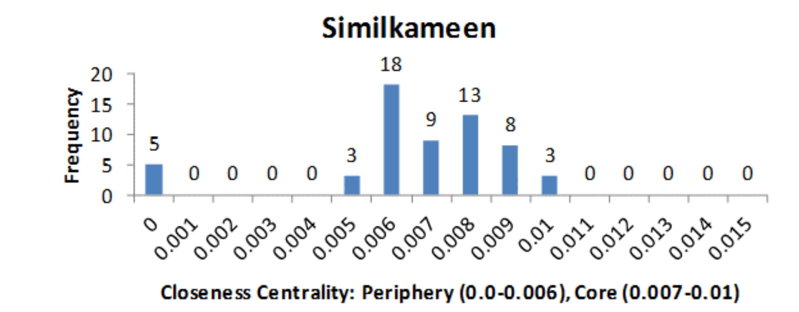
4.1.2 Closeness centrality

Connectivity was measured in each of the networks via the “closeness centrality" metric (Table 4-3). A low closeness centrality score means that the actor is connected to most other actors in the network (although not necessarily through a direct link) and is indicative of a more distributed network structure. Borgatti and Everett (1999, p. 377) describe core-periphery typologies as “cohesive subgraphs in which actors are connected to each other in some maximal sense and a second class of actors that are loosely connected to the cohesive subgraph but lack any maximal cohesion with the core.” In contrast, a mesh-like, randomized network of n=59 would produce a median centrality of 0.014, which is much higher than that calculated for the case study networks (see below). The higher score of the random network can be attributed to the much higher number of edges (1731).

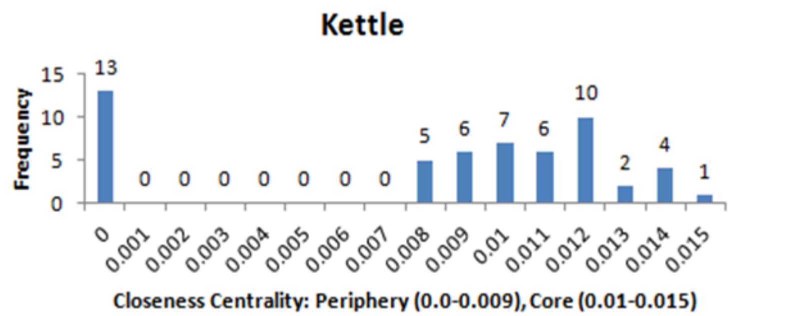
Several "isolates" (completely disconnected vertices with closeness centrality values of 0) can be identified in the case study watersheds. The majority of the vertices in each network are, however, connected to each other to varying degrees. Those actors not connected to any other actors (identified but not participating in network) are shown in bottom with no links). The closeness centrality scores for the SVW are generally smaller (0.005 – 0.01) than for the KRW (0.008-0.015) with median centrality scores of 0.007 and 0.009, respectively, again indicative of a more distributed network.

The differences between the median scores for the SVW and KRW networks are small, in part due to the relative differences in size and complexity of the networks. However, the results suggest that the KRW network has, on average, stronger connectivity between linked paring of actors, despite the larger proportion of isolates (12 of 54) that are included in the calculation of the overall network statistics in Table 4-2. The "super" component (i.e., the only sub-network with multiple vertices) in the KRW serves very much

Table 4-3: Closeness centrality metrics



Minimum Closeness Centrality	0.000
Maximum Closeness Centrality	0.010
Average Closeness Centrality	0.007
Median Closeness Centrality	0.007



Minimum Closeness Centrality	0.000
Maximum Closeness Centrality	0.015
Average Closeness Centrality	0.008
Median Closeness Centrality	0.009

(*Note: NodeXL calculates small scores for low centrality and large scores for high centrality)*

as a centralized core, with several actors isolated on the periphery without any connections to the core. This core-periphery distinction is less evident in the SVW, suggesting that the network is more distributed and less core-reliant in terms of information exchange.

4.1.3 Cluster analysis

The structure of "communities" within the SVW and KRW networks is derived through a cluster analysis, as shown in Figures 4-2 and 4-3, respectively. Statistics for the clustering coefficient accompanying the analysis are presented in Tables 4-3 and 4-4. The standard cluster graphs (Figures 4-2 and 4-3 top) use a color scheme to distinguish between different clusters (communities). Communities consist of densely connected nodes that are only weakly linked to other clusters (Hansen et. al., 2011). To provide better clarity regarding the community structure, the clusters were aggregated (collapsed) with relative node size corresponding to the number of nodes in the cluster (Figures 4-2 and 4-3 bottom).

The total number of clusters for the SVW network was larger (c=26) than for the KRW network (c=20). However, the most striking difference between the two is the relative community complexity of the SVW network (Figure 4-2) in comparison to the KRW (Figure 4-3). The SVW has one cluster that is slightly larger than the others (core), and several clusters that are of similar size. In contrast, the KRW has one dominant cluster containing the majority of connected vertices, and two multi-node clusters that are much smaller. The remaining clusters consist of single dyads (with one connection) or isolates (disconnected vertices).

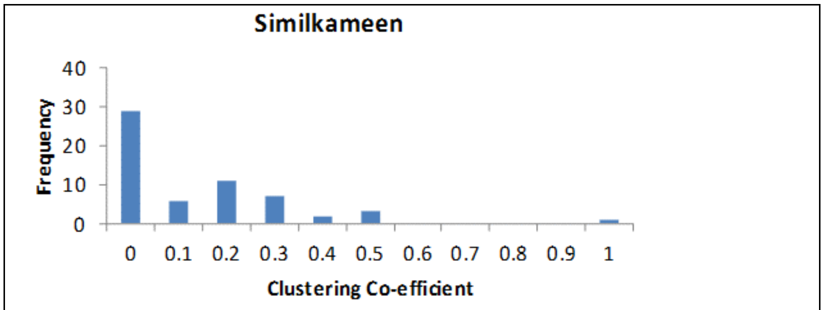
The core for KRW consists of 17 actors, representing 32% of the network. Representation within the core is quite broad and includes government, industry, First Nations, non-profit, and citizens with no affiliation. Representation, however, is not balanced, as it includes only one representative for all categories except government, and government makes up over half (10) of the core. Two additional small clusters, consisting of five nodes and three nodes, developed with more equal representation. These included, in the larger sub-cluster, actors representing government, industry, and no affiliation. The smaller sub-cluster included actors representing private, government, and no affiliation. The remaining links in the KRW were to periphery nodes with connection only to the main core cluster and several isolates.

The SVW, while displaying many similar structural traits as the KRW, including a government dominated core and periphery structure, differed somewhat in the number of sub-cluster formations and in representation within the sub-cluster. In the SVW, the core structure consisted of eight actors, all representing various government institutions. While the core cluster consisted of 100% government actors, the size of the core constituted a small portion (14%) of the overall network, with several additional sub-clusters of similar size within the network. Within these sub-clusters, there was broad representation, including First Nations, residents with no affiliation, industry, and government.

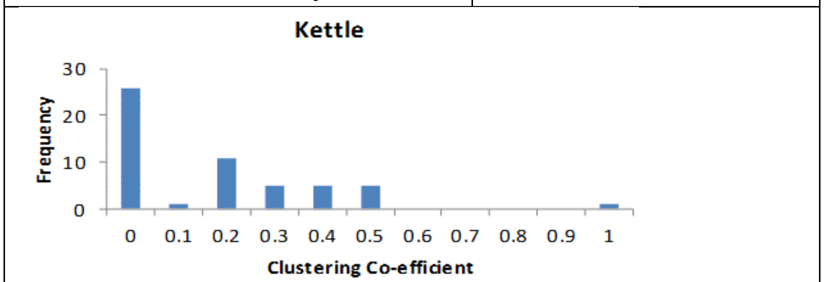
It is evident from the cluster analysis that actors on the periphery of the KRW network who are not isolated remain strongly connected to the core cluster (reinforced by greater median closeness centrality scores and by smaller average geodesic distance scores) than in the SVW. In the SVW, there are multiple communities of influence, each with a relatively tightly connected group of actors that are only weakly connected to other clusters. There was also a smaller number of isolates, suggesting that the SVW enjoys a more inclusive distributed network structure compared to the KRW.

The cluster coefficients for all the network vertices in the SVP and KRW (Table 4-4), range from 1.0 (fully integrated) to 0 (totally isolated). In both networks, there are multiple isolates, however, the percentage of isolated nodes in the KRW is double the number of isolates in the SVW.

Table 4-4: Clustering co-efficient histogram and measures



Minimum Closeness Centrality	0.000
Maximum Closeness Centrality	1.000
Average Closeness Centrality	0.121
Median Closeness Centrality	0.078



Minimum Closeness Centrality	0.000
Maximum Closeness Centrality	1.000
Average Closeness Centrality	0.155
Median Closeness Centrality	0.131

Of note are the larger average (0.155) and median (0.13) cluster coefficient values for the KRW network (Table 4-4) compared to the SVW, which had average and median cluster coefficient values of 0.121 and 0.078 respectively.

These values reaffirm that the KRW can be characterized as displaying stronger centralized integration within a core and a whole network structure that closely resembles the idealized core-periphery typology (Figure 3-2 A). The SVW network also displays core-periphery characteristics, but with weaker clustering (stronger bonding) and a more distributed network structure.

4.2 Discussion

As discussed earlier, the call for a transition in water governance has largely emerged in reaction to the continued decline in health of water systems around the globe (Vorosmarty et al. 2010) and the increasing need to address the complexity of socio-ecological systems in a rapidly changing environment. Despite increasingly strong calls to transition to more inclusive models (e.g., collaborative, distributed, local) of water governance (Brandes et al., 2014), the watershed planning network structures of both the SVW and the KRW developed in a way that closely aligned with a core-periphery (hub and spoke) typology (Figure 3-2 C) rather than the idealized mesh (collaborative, distributive) typology of a more inclusive and adaptive process. A core-periphery structure persisted in both watersheds, despite them each having a specific coordinator intended to ensure a broad dissemination of information and to build a collaborative process and ultimately network.

The SVW network, while maintaining an overall core-periphery structure, also contained structural characteristics that were distributed (mesh-like) in nature. This indicates, compared to the KRW, a more balanced whole network with multiple communities of engagement and interconnections amongst periphery actors. One possible reason for this difference may be the significant amount of pre-watershed planning interaction and trust-building that occurred in the SVW during the development of the Strategy for a Sustainable Similkameen Valley (2011-2020). This process was initially coordinated by the Similkameen

Valley Planning Society (SVPS), a not-for-profit organization composed of local government bodies that included local municipalities, regional districts, electoral areas, and Indian Bands.

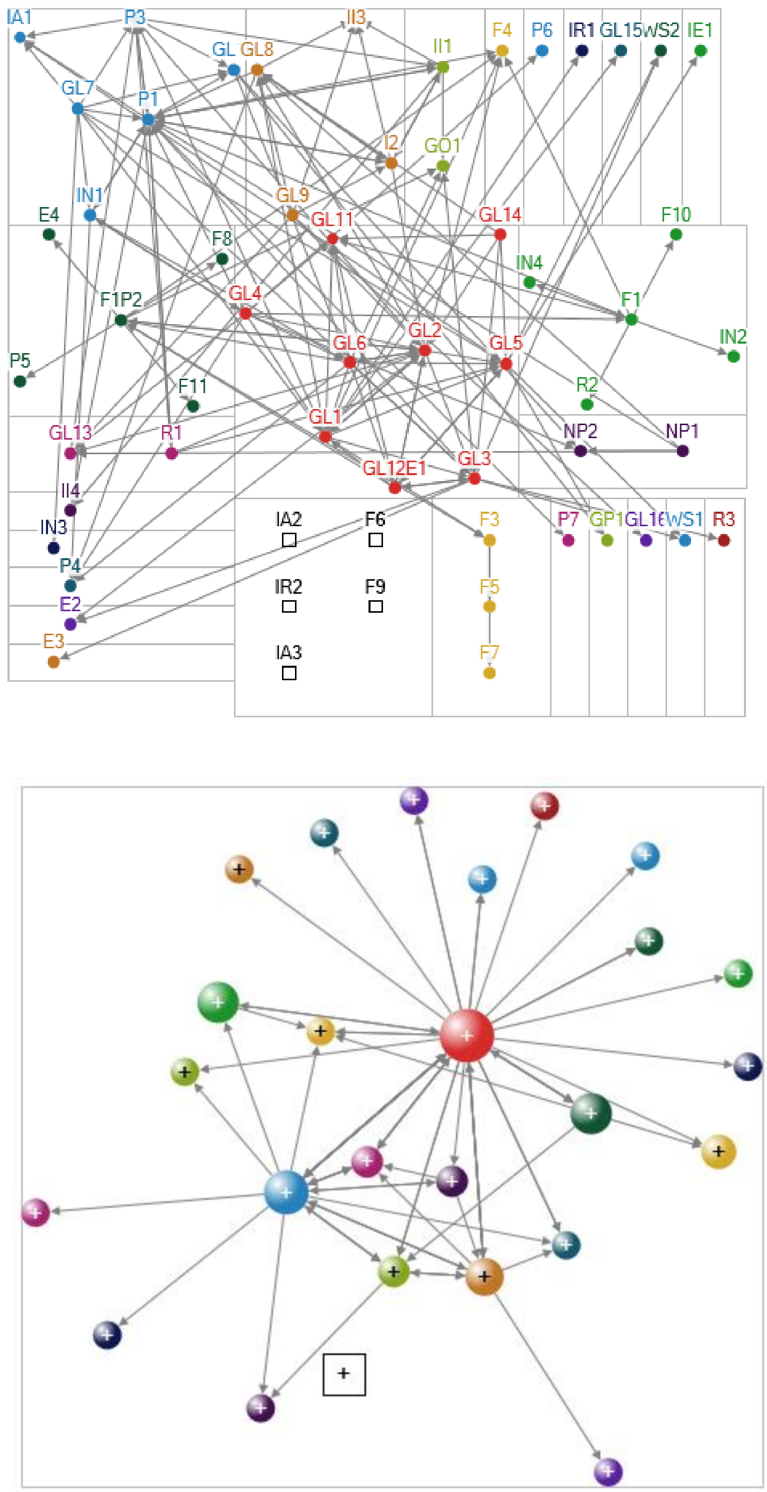


Figure 4-2: SVW watershed cluster network (top), collapsed cluster (bottom)

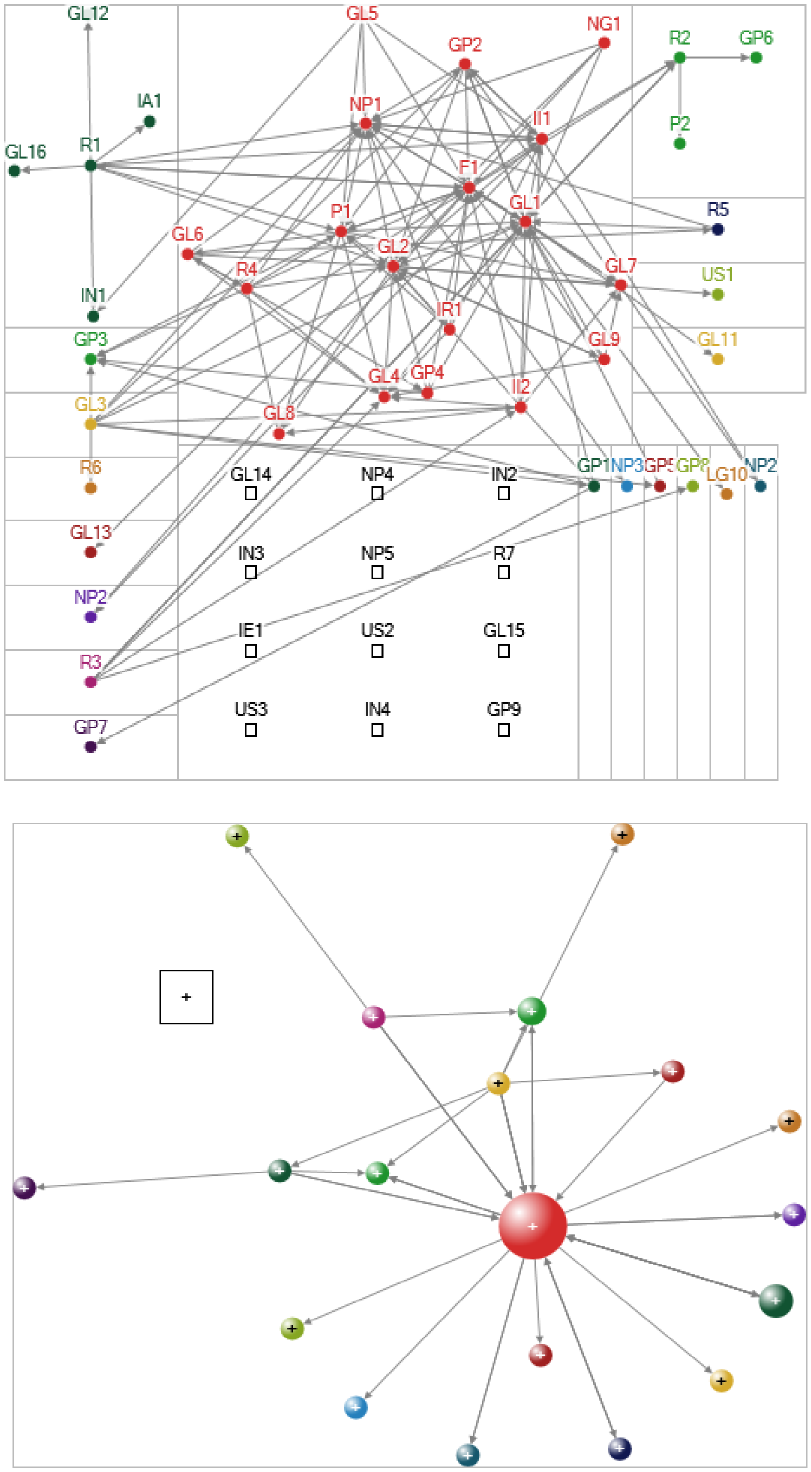


Figure 4-3: KRW cluster network (top), collapsed cluster (bottom)

In contrast, the core cluster within the KRW was comprised of 56% local government staff and politicians. While there was some representation within the core from other fields (watershed residents, irrigation districts, etc.), the core cluster had a far greater influence over the network, with the cluster comprising 44% of the total number of vertices. The actors on the peripheries were either weakly linked directly to the core or were completely isolated. These included industry representatives, environmental groups, First Nations members, and senior government appointees from the watershed planning process. The larger number of isolates found in the KRW network would suggest that it may, compared to the SVW network, face a greater potential challenge in its ability to access useful network knowledge.

Given that the KRW is part of the greater Columbia River Basin Watershed, it is important to note the lack of any significant trans-boundary communication linkage. There was one trans-boundary communication link in the SVW (with the "US" actor in Figure 4). Arguably, this is a significant omission, considering that one of the largest transnational water treaties (the Columbia River Treaty), involves the US and Canada.

In order to establish adaptive capacity, especially with regard to the pressures imposed by climate change on water sustainability, Bodin et al. (2006) recommend that networks should be characterized by a high level of reachability (i.e., minimal number of steps between actors), a dispersed mesh typology (Figure 3-1A), and a high degree of connectivity. Bodin et al.'s network characteristics are difficult objectives to achieve in tandem, and often the network evolves in a manner that favours one metric to the detriment of another. For example, the more dispersed and mesh-like the network, the larger the number of small communities (clusters) and the longer the average geodetic distance (i.e., decreased reachability). This creates potential tensions between the often-touted benefits of collaborative-distributive mesh-type typologies and the desired efficiency of communication pathways needed for adaptive capacity. Complex mesh-like networks may indeed be inclusive of multiple voices, but the increasing complexity of communication pathways also leads to challenges in information accuracy and knowledge exchange. Regardless of end-member typology, then, it becomes critical to build effective information pathways into the network and to enable access to knowledge that may reside at the periphery.

The core-periphery typology of the two case-study watershed networks indicates a degree of structural misalignment between the evolved network and the planning goals, which are focused on adapting to the impacts of climate change. The centralized nature of decision-making imposes a structural barrier to communication and knowledge exchange that involves peripheral actors (e.g., climate change adaptation), and thereby reduces the likelihood of innovation with regard to novel water-policy instruments intended to stimulate collective action. Thus, the very nature of the planning process, which will lead to watershed planning recommendations, may face limited buy-in and legitimacy challenges that stem from the exclusion (whether forced or voluntary) of key network actors such as First Nations and industry representatives. Increased normalization tendencies associated with high levels of centrality will likely reinforce existing institutional inertia and the status quo (Bollig and Schwieger, 2014; von Tunzelmann, 2010).

There has been a long debate surrounding the ongoing exclusion of, and limited engagement with, First Nations Bands in British Columbia with respect to resource use and planning (Booth and Halseth, 2011). The case-study watersheds suggest mixed results with respect to First Nations inclusion. Within the SVK, actors identifying or representing First Nations interests, while not a part of the central core, were well connected to the core and provided direct links to further sub-networks of actors, including industry (e.g., IN2, IN4) and other First Nations actors and subgroups (e.g., F3, F5, F7). Of the10 actors in the SVW network who self-identified (or were identified by other actors) as First Nations, six were still structurally located within the periphery (closeness centrality score less than 0.006) or were not at all connected to other actors in the network. This indicates that there is significant room for greater First Nations meaningful participation. In the KRW, First Nations participation was limited, with only one actor (F1) within the network self-identifying as First Nations.

One of the key situational factors (Olson et al., 2007) evident within the case-study watershed networks was a power imbalance resulting from an over-representation of local and regional government actors and an under-representation of senior levels of government, First Nations, and industrial stakeholders. Such under-representation of key stakeholder groups limits the diversity of knowledge available to the watershed planning network as well as other important aspects such as power distribution, resource allocation and issue identification.

As an example, the results of this study suggest that the framing of the water issues in the Similkameen and Kettle failed to recognize, or were unwilling to recognize, First Nations' inherent right to self-determination and their sui generis rights (Mercer et al., 2010; Dyck et al., 2015; von der Porten et al., 2015), which potentially contributed to the very low representation by First Nations within the watershed planning process. In the absence of a common frame recognizing their inalienable rights, local First Nations within the Similkameen were approached as general stakeholders within a process designed to determine resource outcomes on traditional First Nations lands (Fraser et al., 2006; Crona and Ostregen, 2007; Bark et al., 2012). The result was early disengagement by First Nations actors within the Similkameen watershed planning process, as indicated by actors within the network. This led to further fragmentation of an already fragmented network.

There exists extensive literature on how to engage Indigenous peoples more effectively, including that which encourages approaches that recognize the diversity of First Nations interests (Jackson et al. 2012) and governance arrangements (Fortier et al., 2013). Alfred (2009, p.70) provides a useful framing, stating that "Indigenous nationhood is about reconstructing a power base for the assertion of control over Native land and life," which relates to power, rights and authority, jurisdiction and governance of lands, water and natural resources (von der Porten et al., 2015). Viewing watershed planning through the lens of the varied Indigenous governance arrangements and traditional ecological knowledge provides a useful foundation upon which to develop a broader collaborative watershed planning process (von der Porten et al., 2015).

SNA and cluster analysis results in this study indicated that the KRW was dominated by a core community of local government actors. This suggests that government-to-government communication at the local level dominated the exchange of information and that actors on the periphery had limited access and opportunity to infuse new knowledge and innovative ideas into the dialogue. In contrast, the SVW network, while also having a core community dominated by local government representatives, had its core account for a much smaller portion of the overall network. In essence, the SVW planning process was being shaped by a greater diversity of actors, who could collectively contribute a greater diversity of knowledge from which to develop water-management solutions.

The distributed nature of the SVW network was tempered by the general absence of provincial and federal representation within the planning process. While the KRW network did include several provincial representatives, these key actors remain marginalized at the periphery. As a result, in both networks, access to critical resources and jurisdictional authority that reside at the senior government levels is pre-empted by the structural nature of these networks.

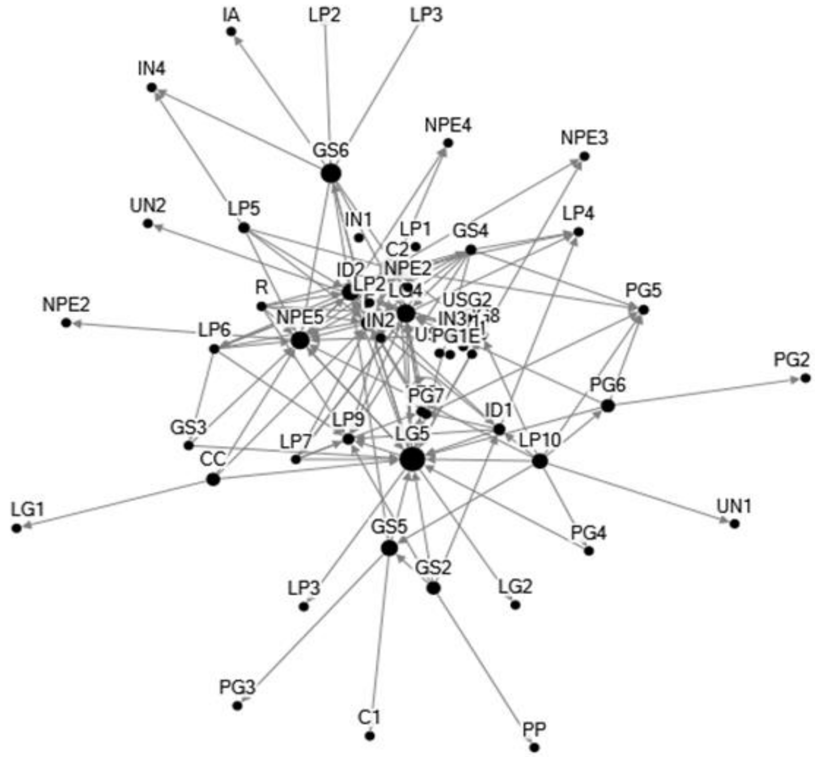
The following chapter furthers network analysis by using the betweenness metric to identify and examine a specific and important type of network actor referred to as a bridging actor. Bridging actors have been identified as key actors within a network. They are uniquely positioned within the network to connect disperate actors and knowledges and their connections serve to enhance overall connectivity and adaptability of a network.

Chapter 5 - Missing Bridges: Social Network (Dis)Connectivity in Rural Water Governance

The primary goal of network connectivity is to foster effective communication among actors and institutions with varying backgrounds, interests, frames, perspectives, goals, and knowledge across legislative, geographic, and social boundaries. The harmonization of these elements, which are often in conflict, remains a central challenge to the implementation of effective water governance (Edelenbos and van Meerkerk, 2015; Medema et al., 2008; Van Schie et al., 2011), This is particularly germane when analyzing the structural elements of social networks identified as enabling robust water outcomes.

Bridging is the act of connecting two disparate actors or communities within a social network. The bridging actors and organizations (BAOs) within the case-study networks were identified and the betweenness metric was used to measure the bridging role played by actors within each network. Because betweenness values alone may not provide a complete picture of bridging services, the research also incorporated cluster analysis. This enabled the mapping and identification of connected communities of actors and the bridging entities that connect these core communities. The mapping provided insight into the levels of heterogeneity versus levels of homophilia within the identified water-governance communities. Jackson (2010) and Golub and Jackson (2010) define homophilia as the tendency for people to maintain relationships with people who are similar to themselves, (e.g., age, race, gender religion, profession or political views).

(A)



(B)

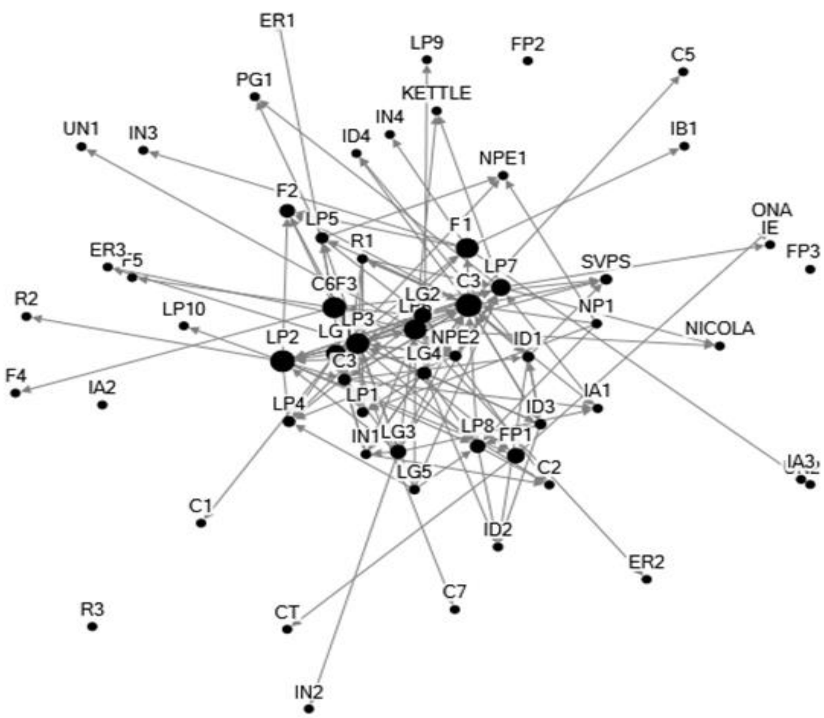


Figure 5-1: Betweenness sociographs, (A) Similkameen, (B) Kettle (betweenness)

5.1 Results

The sociographs showing betweenness scores for both the Similkameen and Kettle River watersheds are provided in Figure 5-1. The size of each node corresponds directly to the strength of the bridging role as quantified by a betweenness score (Table 5-1).

Codes representing each network actor's affiliation-role (e.g., organizational representation) within the watershed planning process are listed in Table 5-1.
The Girvan – Newman (2002) algorithm was used to produce the sociographs in Figure 5-1. A betweenness weighting of each node was used to determine centrality in the sociograph and the size of node. In this case, the higher the betweenness (bridging) score, the greater the size of node.

5.1.1 Similkameen Valley Watershed (SVW) Betweenness Scores and Cluster Analysis

The SVW planning process consisted of both formal and informal actors identified through the survey questionnaire. Response rate for the SVW network was 82%. The total number of actors (n), consisting of both formal and informal actors, identified as participating in the SVW planning network was 59, with 143 unique edges or relationships connecting the 59 nodes. Of the 59 nodes, six nodes contained high betweenness scores, ranging from approximately 405 to 570, which was the most significant bridging node (Table 5-1). The top five bridging nodes (C3, LP2, C6F3, LP3 and FN1) included political representatives and consultants. These nodes (formal and informal) appeared to be structurally located within the core of the network.

The next nearest bridging node, LG1, with a score = 280 (Table 5-1), has a significantly lower level of bridging capacity and presumably of knowledge-brokerage effectiveness within the network. All nodes located within the periphery have small betweenness scores, indicating minimal bridging capacity.

Approximately half of the network nodes (26 / 59) register a betweenness score of 0 (Table 5-1). This indicates either a dyad communication (only two nodes communicating with each other), or a node that sits in isolation with no connectivity to the rest of the network (i.e., not rated by others as one of the top 15 important persons to communicate with in the watershed planning process survey). A zero score indicates limited or no contribution of knowledge to the network, which, in turn, hinders network learning and the ability to adapt.

A cluster analysis of the SVW (Figure 5.2) revealed several clusters of significance and provided a clearer depiction of the connectivity among key bridging nodes within the network. As per theoretical characterization of a core-periphery network, the largest cluster contained the majority of the important bridging nodes (LP2, LP3, LG1, LP7, LG2). All of these nodes represented governmental organizations. Cluster analysis also revealed important information about bridging services potential, beyond what the betweenness score showed. For example, the most important bridging nodes, according to the betweenness score (C3, C6F3, FN1, LP6), figure centrally within the four prominent clusters surrounding the largest central cluster. Of these four bridging nodes, two identified as, or represented, First Nations organizations (C6F3, FN1). These two nodes provided key liaison links with other First Nations actors (C6F3 linked to F5 and F4; FN1 linked with F2). They also provided links with nodes associated with industry (IB1, IN3, IN4), education (ER1), and environmental groups (NPE), as well as local government actors in the central core (Figure 5.2). In the Similkameen context, these bridging nodes play a critically important role because most of the high betweenness scores of the local government actors in the central core were derived from strong connections to each other, which do not necessarily enhance knowledge-transfer throughout the broader network.

Table 5-1: Betweenness (bridging) scores (Score-B) for Similkameen and Kettle networks

Similkameen (normalized)				Kettle (normalized)			
Node	Score-B	Node	Score-B	Node	Score-B	Node	Score-B
C3	1.00	PG1	0.01	LG5	1.00	UN2	0.00
LP2	0.88	KETTLE	0.00	GS6	0.57	NPE3	0.00
C6F3	0.81	NICOLA	0.00	LG4	0.48	NPE2	0.00
LP3	0.78	ID4	0.00	NPE5	0.46	UN1	0.00
FN1	0.72	ER3	0.00	ID2	0.38	LP2	0.00
LP6	0.71	LP10	0.00	GS5	0.35	IA	0.00
LG1	0.49	IN3	0.00	F	0.31	LP3	0.00
LP7	0.49	CT	0.00	LP10	0.28	C1	0.00
LG2	0.38	IA2	0.00	C2	0.23	PG3	0.00
FP1	0.37	UN2	0.00	GS2	0.18	PG2	0.00
LG3	0.27	ER2	0.00	PG6	0.18	LG1	0.00
LP8	0.25	C7	0.00	CC	0.17	PP	0.00
F2	0.25	C1	0.00	ID1	0.09	LP1	0.00
LG4	0.20	IN2	0.00	LP9	0.08	NPE1	0.00
C3	0.13	R2	0.00	PG8	0.08	IN1	0.00
LP5	0.12	FP2	0.00	LP5	0.06	IN2	0.00
LP4	0.10	ONA	0.00	GS4	0.04	NPE2	0.00
ID1	0.09	UN1	0.00	PG5	0.02	GS1	0.00
NPE2	0.09	R3	0.00	PG7	0.02	IE	0.00
SVPS	0.08	IN4	0.00	LP6	0.01	LP2	0.00
ID3	0.07	F5	0.00	R	0.01	USG2	0.00
LP1	0.06	FP3	0.00	GS3	0.00	IN3	0.00
LG5	0.04	IE	0.00	LP8	0.00	PG1	0.00
NP1	0.03	ER1	0.00	LP4	0.00		
R1	0.03	LP9	0.00	IN4	0.00		
IN1	0.02	C5	0.00	LP7	0.00		
IA1	0.01	IB1	0.00	PG4	0.00		
NPE1	0.01	F4	0.00	LG2	0.00		
ID2	0.01	IA3	0.00	NPE4	0.00		
C2	0.01			LP3	0.00		

One exceptional node was LP6. This local political representative not only registered high bridging scores, but also provided structurally important trans-boundary and trans-cultural bridging services by connecting an isolated, but critical, cluster of First Nations organizations. This important cluster included the following: a local First Nations political representative (FP1); the Okanagan Nation Alliance (ONA), a First Nations organization representing six of the First Nation Bands in the greater Okanagan Region; and the Colville Tribe (CT), located within the United States but historically connected to the Similkameen Valley.

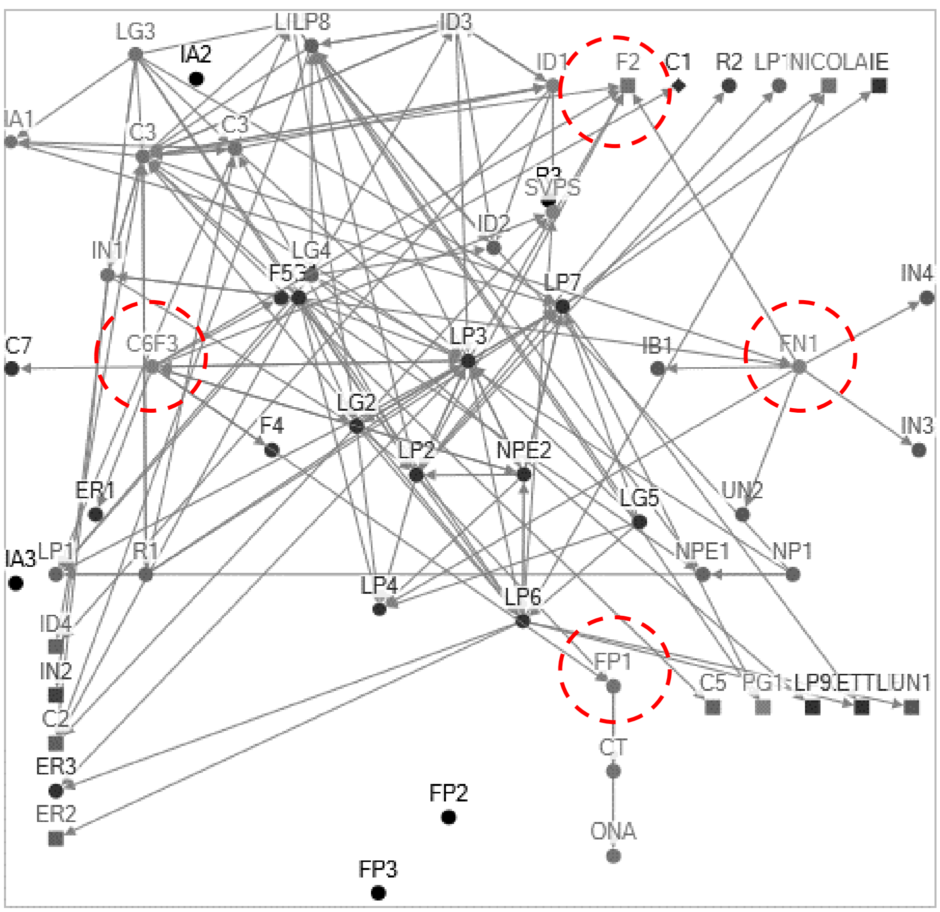


Figure 5-2: Similkameen watershed cluster network with First Nations bridging actors

While not a part of the central core cluster, First Nation actors (C6F3, F1, FP1) registered high betweenness (bridging) metric scores. These actors provided connectivity to not only core actors, but also to key periphery actors, which included industry (IB1, IN3, IN4), other First Nations (F2, F5, ONA), and actors representing education and research (ER1). Amongst these key linkages was the only trans-boundary linkage to organizations from the U.S.-side of the greater Columbia Basin--the Colville Tribe, connected through a local government representative (LP6).

Cluster analysis also revealed several missed opportunities to strengthen bridging services within the Similkameen network. For example, there were relatively weak (or non-existent) linkages to periphery actors, including First Nations (C6F3), education (ER2) and research (ER3). Education and research actors, while providing key background reports, remained only weakly linked to the planning process and provided no substantive bridging service potential. While some First Nations actors held key bridging positions, others remained isolated and disconnected, as was true of industry representatives.

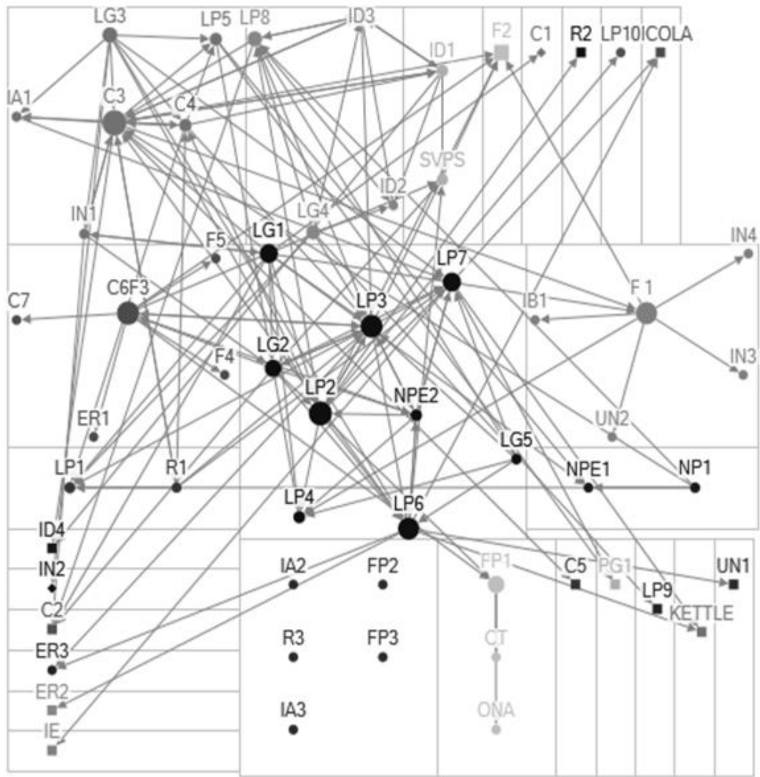
Furthermore, the SVW planning process had only limited engagement with other similar watershed planning processes within B.C. Specifically, there were no bridges to the Nicola watershed planning process or to the Kettle River Watershed (KRW) planning process. However, while the Okanagan Basin Water Board (NPE2) was able to provide some level of bridging service (48.867) to the SVW through its many linkages to core local government actors (LP7, LP3, LP2, LG2, LP6, LG1), the responsibility of OBWB is centred in the Okanagan and not in the Similkameen. The high betweenness score of OBWB does however indicate that while there may be a legislated and mandated ‘boundary’ to the role of the OBWB, it appears that these boundaries may not be in effect when it comes to providing a bridging service for knowledge transfer.

5.1.2 Kettle River Watershed (KRW) Betweenness Scores and Cluster Analysis

The KRW planning network consisted of n=54 nodes with 126 unique links (edges). Response rate for the KRW network was 70%. The Kettle network structure, much like that in the Similkameen, consisted of a core-periphery typology with the dominant bridging actors located within a core grouping of nodes. The highest bridging value was node LG5, a local government representative with a betweenness score of 485. This score is nearly double that of the next closest node (GS6 at 277), which was a general stakeholder (GS6) with no organizational affiliation. The sociograph (Figure 5-3) shows that LG5 was centrally located within the core and was strongly linked to adjacent core nodes. However, GS6 holds a structurally significant position within the network, residing between both the core grouping of nodes and a periphery set of actors. As with the Similkameen, approximately half of the network was composed of nodes with low bridging value (betweenness scores of 0).

Cluster analysis provided a richer picture of the bridging-services potential of specific actors within the KRW planning process. Figure 5-3 reveals that there was a single dominant (core) cluster consisting of the majority of higher scoring bridging nodes (LG5, LG4, NPE5, ID2, F, and C2), with bridging values ranging from 110 up to 485. Interestingly, the general stakeholder, GS6, was located outside the core cluster, providing bridging-services potential between the central core and various non-core local political actors and industry representatives.

(A)



(B)

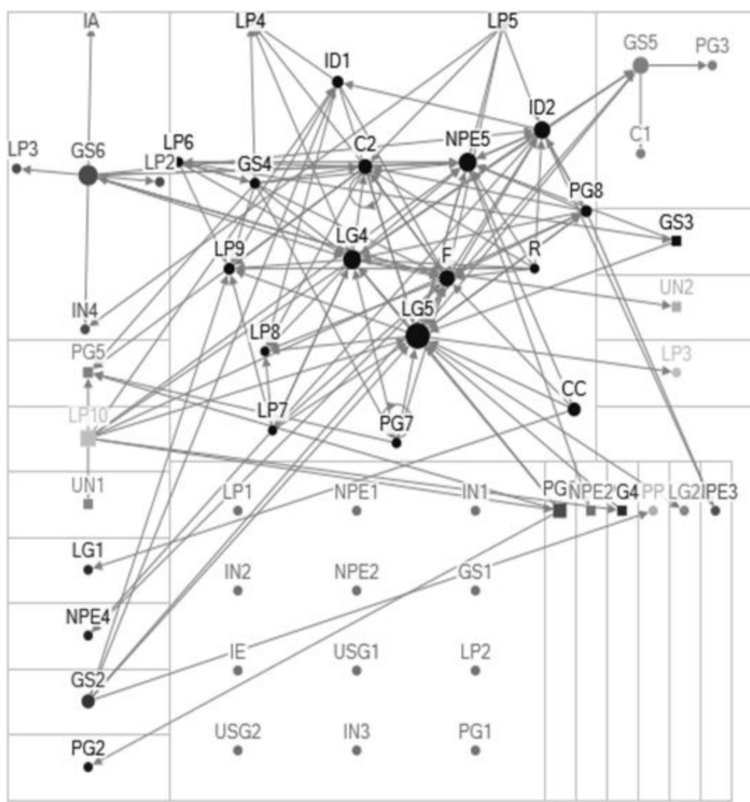


Figure 5-3: Watershed cluster analysis for (A) Similkameen Valley (B) Kettle River with bridge-weighted nodes

Isolated nodes included U.S. government representatives, environmental groups, and local and provincial government representatives. As with the Similkameen network, opportunities to provide bridging services to these disconnected nodes was not taken advantage of, even though these would likely have improved network communication and information flow. Aside from nodes GS5 and GS6, the majority of periphery nodes that were poorly connected appeared to be linked directly to the core cluster via prominent bridging nodes within the core, while being poorly connected to each other. This is characteristic of the core-periphery (hub-and-spoke) typology.

While the KRW is located within the traditional territory of the Okanagan and Ktunaxa First Nations, there were few First Nations represented in the watershed planning process. Much like in the Similkameen, there was little evidence of any cross-cultural exchange of knowledge or sharing of information with neighbouring regions. There was also very limited cross-boundary communication with watershed stakeholders within the greater Columbia or with the U.S. side of the Kettle watershed.

5.2 Discussion

Within both case studies, high-value bridging actors and organizations (BAOs) were located within the core, but the BAOs within the Similkameen network achieved higher bridging values. This may possibly be due to the multitude of clusters they were able to connect. By connecting to the various clusters, the BAOs within the Similkameen were able to broaden access to a multitude of knowledge bases. This, in effect, creates a more distributed, and therefore a potentially more adaptive, network.

A more distributed network was not as evident within the Kettle, where the watershed planning network assumed a structure more like the idealized core-periphery model in which high-value BAOs were located within the dominant core and connected to each other. These structural characteristics work in opposition to the preferred mesh network for participatory and adaptive governance, potentially reinforcing already strongly held beliefs and practices (see Chapter 6 for discussion on lack of dialogue concerning climate change).

Within the case study watersheds, the dominant bridging service potential resided within a select group of core actors who were strongly linked to each other, but who were either weakly linked or not linked at all to other important actors within the networks, including key industry representatives, environmental groups, education and research scholars, and other levels of governments (e.g., senior government representatives and First Nations). Trans-boundary partners in the U.S. were also either missing or very weakly linked in both watersheds. The result was a core-periphery network structure leading to a highly homogeneous network, which often results in high levels of normalization and limited new knowledge flow across the network (Bollig and Schwieger, 2014; von Tunzelmann, 2010).

The hiring of a watershed coordinator in the Kettle and of a process facilitator in the Similkameen implies an awareness, in both watersheds, of the value of obtaining full network participation and the use of bridging actors and organizations (BAOs). Results of this study, however, indicate that, despite this awareness, opportunities to design and implement bridging functions (and the applied component of adaptive governance) were under-utilized (Crona and Parker, 2012; Keskitalo et al., 2014; Baird et al., 2015).

In both the Similkameen Valley and Kettle River watershed case studies, the planning networks adopted a core-periphery network structure typology, which led to the dominance of centralized power brokers (local government) within the network and lost opportunities for meaningful linkages and communication. An example of a where a similar network structure failed to achieve a desired outcome can be found in the study of Rathwell and Peterson (2012). In that case, an intentionally designed bridging organization was created with the goal of engaging a variety of municipalities and actors, across a number of industries within the region, in order to address water-quality issues in the Monteregie region of Quebec. Despite its intentions, the purpose-built BAO eventually failed. The failure is likely due in part to an inability to connect with the more isolated agriculture-oriented municipalities, with whom there was limited interaction, and where trust levels were low (Rathwell and Peterson, 2012).

The above example demonstrates that an intentional BAO design is not always a guarantee for success. Conventional groupings of actors, with limited connectivity to stakeholder groups on the periphery, may continue to define and dictate (even if inadvertently) the framing of water sustainability issues, as well as the potential solutions, unless there are improvements to the process (Stein et al., 2011; Rathwell and Petersen, 2012). These could include, for example, the monitoring of the implementation of the BAO to ensure that the required connectivity has been achieved or the development of a deeper understanding of the context and issues. The OBWB provides and example of the possibility of extends bridging services by providing a repository for local knowledge (e.g., local reports, studies and relevant news items) and best practices.

The outcome in Quebec, and the results of this study, demonstrate the importance of, when formulating intentional water-governance network interventions, tools that can identify and monitor the development of appropriate linkages within a water-governance process, as these links are as likely to result in detrimental effects as beneficial ones. Understanding the structural attributes of a water network allows for intentional network interventions that can eliminate ongoing barriers to water-governance improvement. Making early and ongoing intentional changes within the governance process has significant potential to improve both the legitimacy of the process as well as the alignment of the preferred (theorized) network structures and contextually informed watershed goals (e.g., the identification and development of effective BAOs, purposefully designed and developed to ensure broader and multi-scale connectivity amongst an ever-increasing diversity of watershed stakeholders) (Fritsch and Kauffeld-Monz, 2008; Hahn et al., 2006).

Changes in the governance process, however, will not occur without completion of an initial stage involving identification of the existing network structure and its alignment with the local watershed goals primarily focused on adapting to climate change impacts (Hamilton 2011, 2012). Based on collected data, this study found within the Similkameen network one local example of a BAO, the Okanagan Basin Water Board (OBWB), which contributed a way forward to ensuring the harmonization and advancements of various knowledge bases within the process. The OBWB presented water-management strategies and examples to the Similkameen watershed stakeholders early in their watershed planning process, strategies specific to climate change adaptation that were incorporated within their own water strategy. The OBWB registered a betweenness metric score of 48.867, indicating some level of bridging service was provided, although it was limited predominantly to government organizations or core cluster (Figure 5-1A). While acting outside of their mandated region within the Similkameen, the OBWB was still able to occupy a structurally significant position within the dominant core in the Similkameen watershed. This may have been achieved as a result of their high level of legitimacy, developed through the provision of innovative and applied information in an adjacent watershed.

As a semi-government organization with taxation abilities, the OBWB provided significant levels of scientific data and educational outreach within the Okanagan region and beyond. OBWB actor's high bridging score is a direct result of the 'water legitimacy' that the organization (actors) have developed throughout the region and provincially. This is confirmed both through interview responses as well as the high betweenness score (Table 5-1) partially through programs like *Don't Move a Mussel*, *Okanagan Waterwise*, and *The Okanagan Water Supply and Demand Study*. The OBWB's high level of legitimacy both within the academic (data collection) and policy fields (local government connections) provides an ideal bridging model, which merits consideration as a guide to develop more locally based BAOs.

While British Columbia begins to move into the implementation phases of its newly adopted Water Sustainable Act, institutions such as the OBWB represent a promising example of how an organization can provide the bridging services identified as key to developing more inclusive and effective water-governance regimes and processes. This will be particularly important for implementation of the B.C. Water Sustainable Act, where sustainable watershed planning programs may be rolled out and encouraged across the province (Curran, 2014).

While the establishment of a bridging organization may help to address the issue of the missing key links found in both watershed networks studied, it would likely not have provided an adequate solution on its own. In both watershed processes, there were many opportunities for actors to engage in the watershed planning process through multiple openhouse information sessions and various watershed meetings. However, during the survey and watershed planning process, multiple attempts to solicit responses from these actors were unsuccessful. It may be that this unwillingness to respond resulted not from a lack of information, but instead from a reluctance on the part of the actors to participate (a level of “active non-participation").

The missing links prevalent in both the Similkameen and Kettle watersheds were specifically industry (e.g., winery operators and nurseries) and levels of government (e.g., First Nations, senior and local governments). The industry representative (IN2) in the Similkameen provides an overt example of active non-participation. One of the key industry actors requested to be listed as “to receive information only” and this status was confirmed by "in-bound" edge directionality, which indicates participation was for the sole purpose of assessing progress (change) of the watershed planning process, not to contribute information or knowledge to the process.

Non-participation by industry within both regions was evident from the lack of response to the survey questionnaire and from the lack of identification by other network actors as to their importance within the network. During planning, there was also little or no representation from larger industry water users, including local wineries. While many of the strategies suggested by Olsson et al. (2007) may address this phenomenon indirectly, it may be incumbent on senior levels of government to either incentivise participation for stakeholders (e.g., provide resources for greater representation within BAOs or greater representation in statutory decision-making processes) or to penalize lack of participation (e.g., license restrictions). This non-participatory role of industry is important given that industry groups represented some of the largest users of water within the watersheds (e.g., wineries within the Similkameen).

As Olsson et al. (2007) and many others have argued, removing the barriers to effective water governance, which are significant, requires the integration of a variety of different knowledge bases, including scientific, local, Indigenous and bureaucratic (Edelenbos et al., 2011; Ison et al., 2011). There continues to be, however, a growing science-policy gap highlighting the ongoing challenges associated with addressing these issues (Crona and Parker, 2012). While scientific information in the form of background and baseline reports (Wei and Li, 2013) was commissioned for the Similkameen watershed planning process, the ongoing impact and interaction between the science community and the key stakeholders remained limited within the Similkameen watershed planning network, and non-existent within the Kettle. Within the Similkameen, ER1, ER2, and ER3 (education and research actors) all registered zero scores for betweenness (bridging) values, remaining only weakly linked to the core and structurally located within periphery of the network. Considering the complexity associated with the Similkameen and Kettle watersheds, such as belonging to the greater trans-national Columbia Basin watershed, the significant hydrological changes projected due to climate change, and water demands (e.g., withdrawals) being expected to significantly increase (Vorosmarty, 2000; Armitage et al., 2015), the need for collaboration and coordination between science and policy experts is significant (Pahl-Wostl et al., 2013).

One surprising and promising element that emerged from the SVW planning process involved the role that First Nations played as key bridging actors within the network. Meaningful engagement of First Nations is one of many challenges associated with effective implementation of bridging organizations. There could be great benefit from further research into this issue. The exploration of additional potential barriers (Olsson et al., 2007), such as situational factors (e.g., power, trust, public opposition), social context (e.g., cultural norms, stereotypes, politics and polarization), and institutional context (e.g., conflicting agency mandates, organizational norms and cultures, resource constraints, government policies and processes and inadequate opportunities to interact), as well as more grounded strategies for addressing these barriers, could greatly enhance meaningful First Nations engagement.

Re-conceptualizing First Nations network actors as possible bridging actors might be a significant and positive development in resource governance, particularly in a British Columbian context, where engagement with First Nations by non-First Nations groups (e.g., industry, government, etc.) has often been acrimonious, leading to a continued environment of ill will, legislated consultation, and fragmented resource governance.

This study identified a deficiency in social network analysis (SNA) methodology as it applies to governance research. When examining the betweenness metric scores of the two case studies, it was found that the majority of the highest betweenness scores belonged to local government actors structurally located within the core cluster. Within a governance-analysis context, this result can be somewhat misleading because a node identified as providing a high level of bridging-services potential to "like" nodes is not necessarily creating or distributing new knowledge within the network. Instead, the node may simply be re-enforcing already existing communication patterns. This would result in further network normalization, increased network homophilia, and increased network fragmentation rather than the increased collaboration amongst more diverse groupings of actors and knowledge bases that is being called for in water-governance literature.

Knowledge of whom the bridging node is connecting is essential to understanding the node's utility as a conduit for knowledge transfer. Thus, by coupling betweenness metric measures with cluster analysis, identification of actor or clusters (communities) can be identified. This, in turn, reveals the utility of the betweenness metric in identifying bridging nodes that are providing network-enhancing bridging-service potential.

In response to the need for more in-depth understanding of the linkages between nodes in the network, the following chapter explores an extension of the social network analysis (SNA) described in Chapters 4 and 5 to include social - discourse network analysis (s-DNA). This novel approach enables the use of information derived from the SNA to guide research that will lead to a better understanding of the meaning of network links. s-DNA also provides a means to evaluate the alignment between actor discourse and the sustainability goals, defined as adaptation to climate change that were identified at the beginning of each watershed planning process (Hamilton, 2011, 2012; Glorioso and Moss, 2010).

Chapter 6 - Social Discourse Network Analysis – Water-Governance Framing

The ability of our water-governance institutions to respond and adapt to unpredictable and rapidly changing contexts (e.g., climate change) will determine the success or failure of water regimes in transitioning to a new, more effective governance paradigm (Pahl-Wostl et al., 2012; Stein et al., 2011; Acheson, 2010; Poirier & de Loë, 2010; Cohen & Waddell, 2009; Bakker et al., 2008; Pahl-Wostl & Gupta, 2008). Considering the magnitude of the risk to society associated with water futures and escalating climate-change events, and increasing development impacts, the transformation of water governance will require fundamental structural changes (Pahl-Wostl et al., 2010). However, with the long evolution and embeddedness of historic remnants of human-nature systems (norms, rules, cultural rules, etc.), change will not come easily. To address this will require the "unlearning" of deeply ingrained practices and beliefs. Making these practices explicit provides an effective starting point.

During the course of this study, it was recognized that, while SNA can be quite effective in helping us to understand the structural linkages and nodal characteristics of a network, much of the richness of the information pertaining to the social network is lost during analysis. In SNA, information relating to "meaning" (e.g., value and content) of the relationships between actors is converted to a set of binary values. While this provides information on network structure and theoretical performance insights, it also results in a loss of deeper insight into the culture and values embedded in the network and a less than robust view of the content of the information exchanged within a network.

This lack of richness, however, can be addressed through an exploratory analysis that incorporates discourse network analysis informed by social network analysis (s-DNA). Discourse network analysis can be used to extend SNA through a novel approach that provides further insight into how actors relate and the content of their relationships or links (Leifeld, 2013; Leinert et al., 2013; Wasserman & Faust, 1994).

Guided by this information, category-based s-DNA was initiated using the transcribed interviews, conducted on eight and eleven randomly selected actors (square nodes) within both the Kettle and Similkameen watershed planning processes, respectively (Figures 6-1 and 6-2). The intention of the following analysis was to first ascertain which were the central themes of discourse during the process of creating a watershed plan and to then explore the existence of possible framing (core actors) through affiliation and how well the discourse aligned with the desired outcomes of the planning process (i.e., stated goals, identified issues and concerns to be addressed).

The random selection of survey actors resulted in predominantly core positioned actors being surveyed in the Kettle with 60% being from local government and no representation from industry. While in the Similkameen the sample consisted of 50% local government, with the remainder including industry (water purveyors), First Nations, and watershed residents with no affiliation. Most of the core and periphery categories (themes) identified in the combined affiliation maps, Figure 6-3 and Figure 6-5 remained consistent with those mapped in the positive affiliation maps, Figure 6-4 and Figure 6-6, indicating actors within the networkers were positively affiliated to the identified themes. Categories that held a central position in the combined affiliation maps but were positioned on the periphery in the positive affiliation map indicated a strong but equally negative affiliation with category.

6.1 Analysis

6.1.1 Code assignment

Discourse Network Analyzer (Leifeld, 2012) was used to evaluate ten (random) interviews conducted in both the Kettle and Similkameen watershed planning networks during the SNA component of the research. A total of 284 and 275 statements, both positive and negative, were identified from the transcribed interviews for the Kettle and Similkameen, respectively. The statements were then coded and analyzed, resulting in thirteen aggregated categories or themes (Table 6-1). Examples of each category are listed in Table 6-2. Most of the categories were consistent within the discourse for both watersheds. Differences in categories between the two watersheds included climate change only appearing in the Similkameen watershed discourse, and land use regulation and ‘Us vs Them’ only occurring in the Kettle. However, the category of Climate Change is identified as being closely related to the Environmental Protection, Conservation, Governance-Management categories.

While some statements appear as negative commentary with regard to the categories (e.g., collaboration), the underlying communication often conveys support or agreement for the category. For example, many actors identified the non-participation by some of the largest water users within the region (e.g., nursery, farmers, school board) as a key aspect in the development of a successful watershed plan. While presented as a negative towards these groups, these statements were interpreted as the desire of the interviewee for greater participation by isolated or periphery organizations within the watershed planning process.

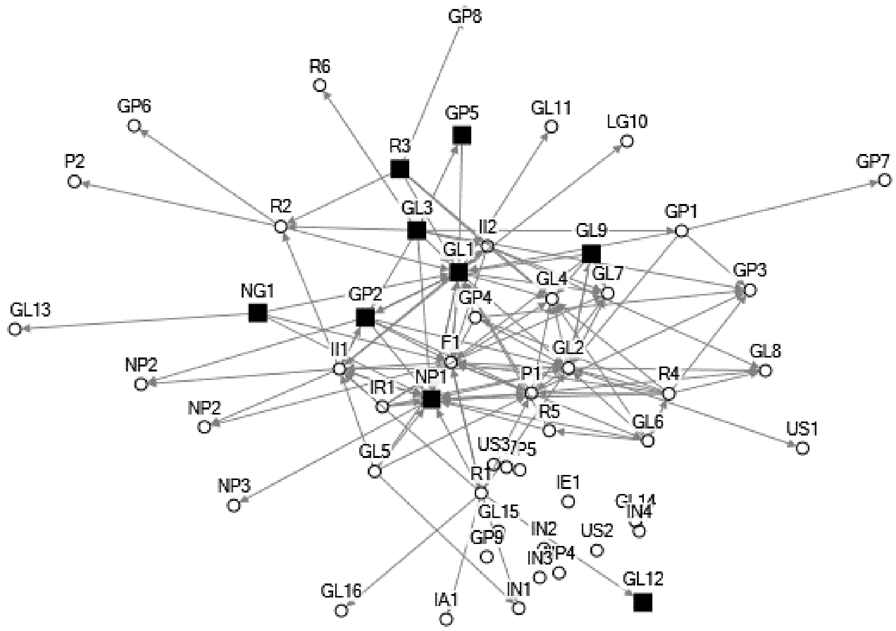


Figure 6-1: Watershed planning network (Kettle) - surveyed (s-DNA) actors

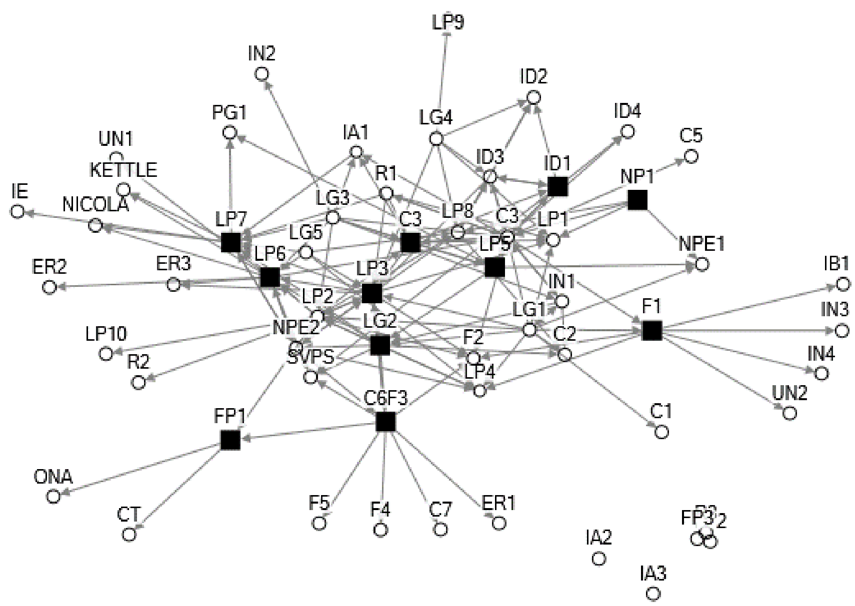


Figure 6-2: Watershed planning network (Similkameen) – surveyed (s-DNA) actors

Table 6-1: Discourse categories defined

Category[*]	Description
Capacity	Network actor or organization's abilities conducive to advancing watershed planning and sustainability *related to: education, collaboration, process buy-in*
Climate Change	Reference to the need to recognize and develop strategies for the impacts of climate change *related to: environmental protection, conservation, governance-management*
Collaboration	Any reference to an existing communication or (more often than not) a desire to establish or increase communication with a desired actor or group currently not participating in planning process *related to: capacity, process buy-in, education, us vs them.*
Conservation	Dialogue emanating out of the "quantity" aspect of water and the recognition of a limitation of the resource with a possible secondary recognition of unsustainable practices resulting in overuse *Related to: environmental protection, education, land use regulations, us vs them*
Education	Any reference to the need to provide more information, training or distribution of existing knowledge. Lack of information was included in the capacity category *Related to: collaboration, capacity, environmental protection*
Environmental Protection	Identification of the "quality" aspect of water resulting from the need to address some aspect of the environment that is deficient, i.e., riparian degradation *Related to: conservation, education, land use regulations*
First Nations[**]	Targeted questions aimed at identifying views on inclusion of First Nations and their beliefs and knowledge within watershed planning process *Related to: collaboration, education environmental protection*
Governance – Management	Reference to the process of governance or management (e.g. decision-making) *Related to: buy-in, collaboration, us vs them*
Industry – Human Needs	Dialogue referencing the needs of industry or specifically people (non-environmental) as a primary concern for water *Related to: us-vs them, governance, -human needs*
International Cooperation	Recognition of importance of transnational communication and knowledge exchange *Related to: collaboration, environmental protection*
Land Use Regulations	Specific reference to land-use impacts on water quality and quantity and integrated decision-making *Related to: environmental protection, governance-management, industry-human needs*
Process Buy-in	Identification of actor (organization) support (through resource allocation or participation) for development of the watershed planning process and ultimately a sustainable watershed plan *Related to: governance-management, collaboration, capacit*y
Us vs Them[***]	Identifying the use of "local historical connection" to signify unique water-management knowledge or the indication of some other aspect to position two parties or groups in opposition to each other (Starks & Trinidad, 2007) *Related to: process buy-in, collaboration, governance-management*

[*] Responses may be either positive or negative responses to any particular issue within a category

[**] Based on the SNA and the structural location of First Nations actors within the periphery, interview process contained specific questions addressing First Nations involvement in watershed planning process

[***] Categories of discourse that act in opposition to collaborative, sustainable watershed plan development

Table 6-2: Statement category examples (both + and -)

Category	Description
Capacity	*- We really don't know how much water there is being used (-)* *- I consider myself really lucky just to be able to sit between those two (+)*
Climate Change	*- I think my interest in both trying to figure out ways how to cope with climate change (+)*
Collaboration	*- It's getting the people to come out and know that we are very interested in what they have to say (+)* *- I say another big gap is on the ranching committee (+)* *- I haven't really engaged at all with the Similkameen (-)*
Conservation	*- Yes, the limited supply to the perception of a lot of people that there is an unlimited supply. That is a big one. And the demand on it from all the different users (+)* *- I think use of water. There has been a lot of talk recently especially going through a water metering debate in our community and this being brought to the forefront of how much water people should be allowed to use, our right to use, that kind of thing (-)*
Education	*- Biggest challenge is convincing people that we have a problem (+)* *- I really don't think the education has been happening (+)*
Environmental Protection	*- I felt like there needed to be a strong voice in there for ecosystems and species (+)* *- Yes, having come from Okanagan and seen riparian [areas] so poorly managed (+)*
First Nations	*- With respect to First Nations we have a challenge; we don't have a reserve in our district, we are surrounded by them. They may claim it as the territory, but they are not residing there really (-)* *- We had one project that we had discussions with first nations and that was only b/c it was a requirement of the grant (-)*
Governance – Management	*- I found reasons I backed out was I found an awful lot of politics was getting into the situation as a system rather than … (-)* *- When there is those drought years and flow is low and making those tough decisions between what's more important (+)*
Industry – Human Needs	*- We had one rancher show up at half of the meeting the other day. You could tell he was completely out of the loop. He didn't know what the group was about and kind of came there asking whether or not on one topic pretty much do you support or not support putting thousands of little dams in all the creeks in all the watersheds? (-)* *- No, sustainability of water for domestic use (+)*
International Cooperation	*- I think there was a little bit of information came from south of the border but not a lot. Not as much as I would expect (+)* *-Yes, in Curlew (US) there were a lot a people at that meeting b/c they're concerned too (+)*
Land Use Regulations	*- More heavy use of the land that's going to impact the aquifer (+)* *- On the upper watershed how do we address roads resourced roads and all that diverting of water. It's such a huge (?) (+)*
Process Buy-in	*- From process to now, the most successful elements in developing the plan so far is having the public responding to survey questionnaires (+)* *-Yes, I would say the elected officials buying into making changes to zoning and reg's to promote water conservation and value of the [water] so they need to buy in (+)* *- It's going to be buy-in from the whole boundary. It's going to be difficult to do. I think that we can't go forward without that (+)*
Us vs Them	*- Interior Health implemented their tool kit and they are really really starting to squeeze (+)* *- The Ministry of Environment came out with the new Water Sustainability Act and we have to take those regulations and download them onto the people and try to make them understand that we are regulated*

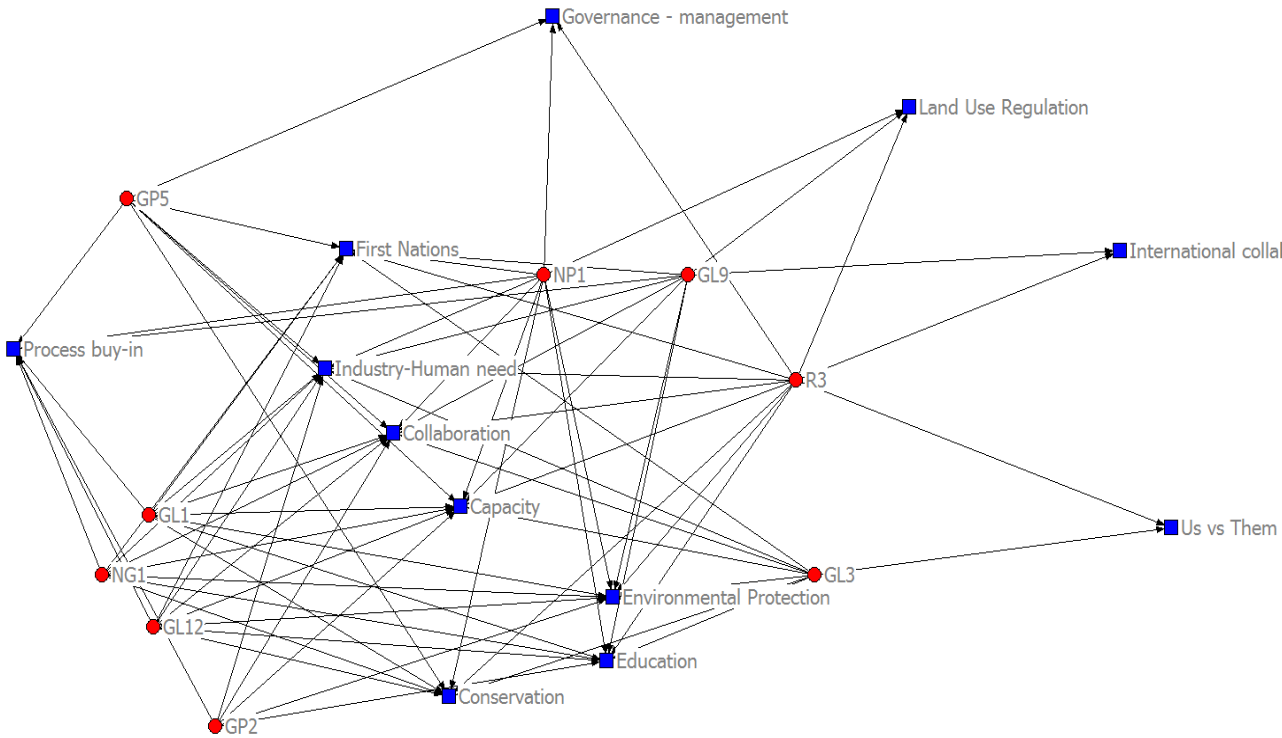


Figure 6-3: Affiliation network (Kettle) – combined (in agreement and against)

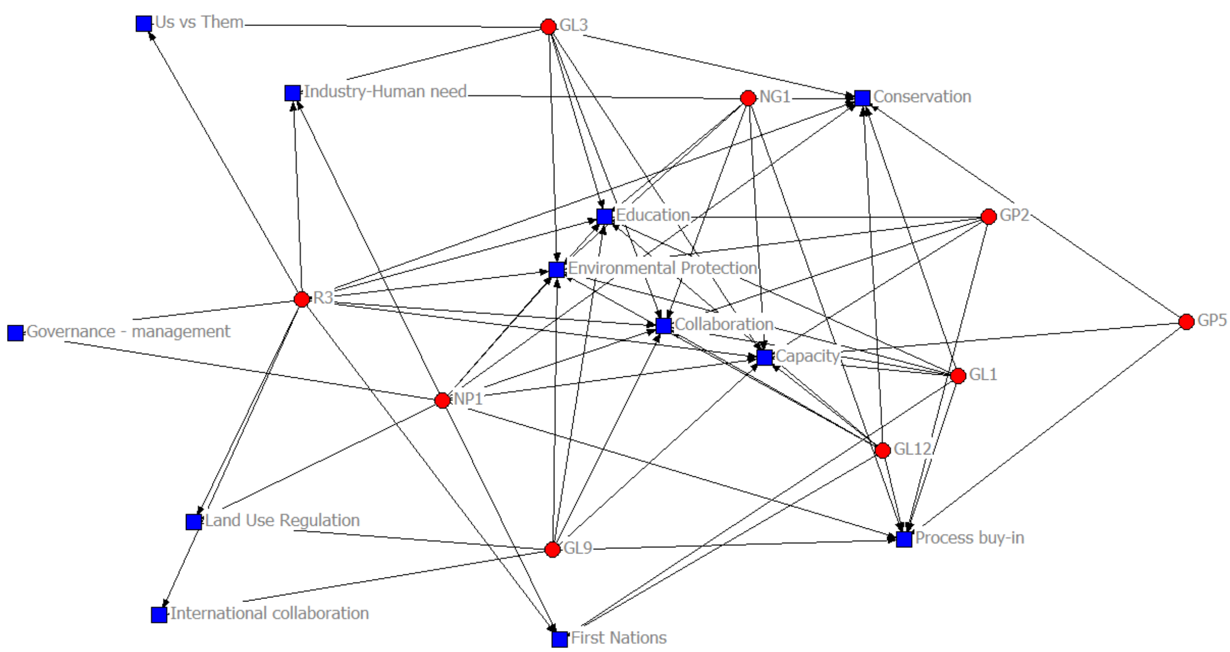


Figure 6-4: Affiliation network (Kettle) – in agreement

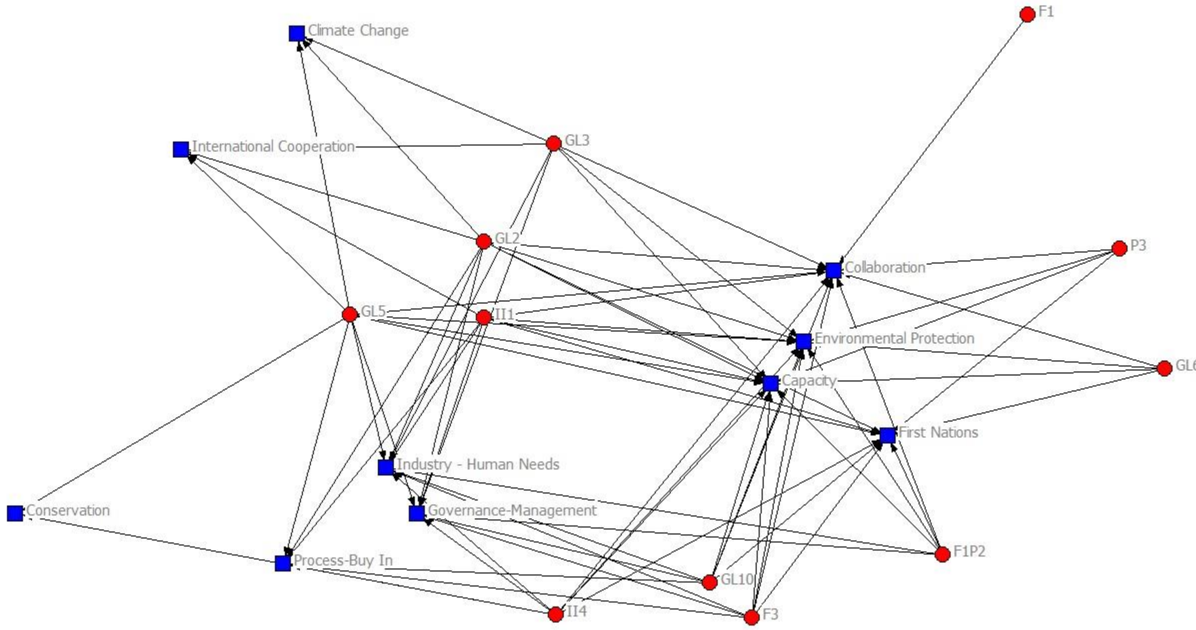


Figure 6-5: Affiliation network (Similkameen) – combined (in agreement and against)

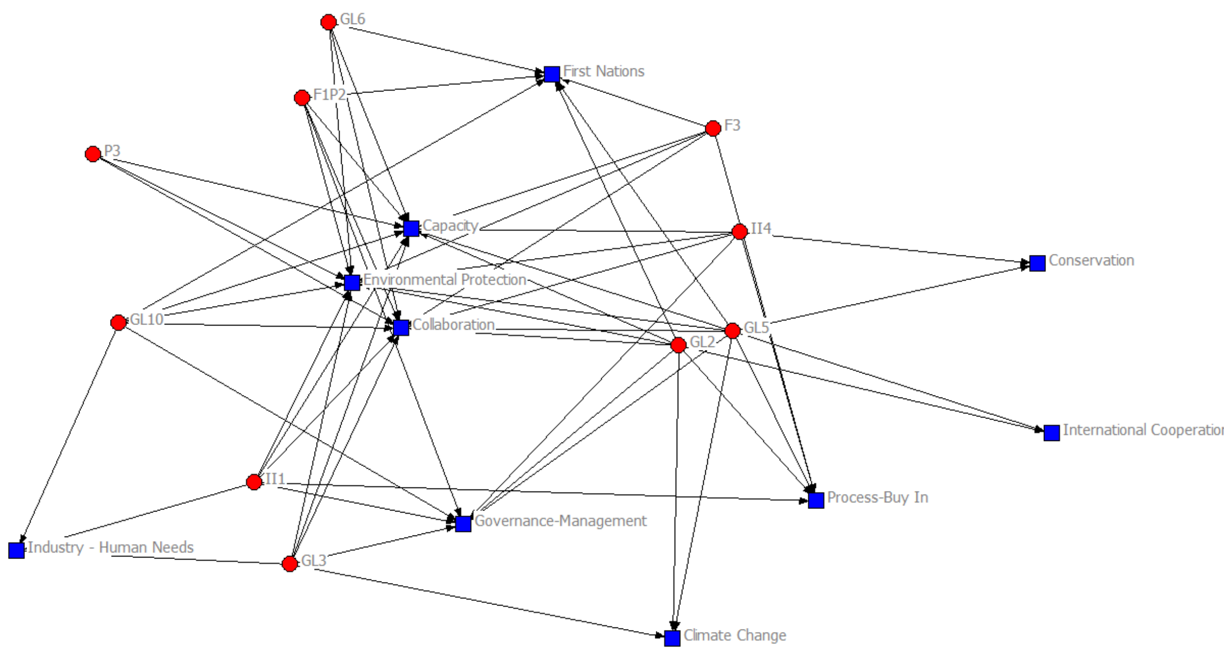


Figure 6-6: Affiliation network (Similkameen) – in agreement

6.1.2 Mapping

Discourse network analysis software was employed to code network actor's statements by identifying discourse passages of significance and the category (meaning or theme) emerging from the statements. This specific type of discourse mapping, referred to as affiliation (bipartite) network mapping, provides an empirical means to identify the culturally determined themes guiding (e.g., framing) each watershed planning process.

Making explicit the themes affiliated with each actor enables the exposure of potential groupings of like-minded individuals or coalitions as well as possible framing or bias around a specific topic area, concern, issue or theme.

The affiliation network maps for the Kettle and the Similkameen (Figure 6-3 to Figure 6-6) model the actors (red circles) statements (links) that are affiliated with the categories or themes (blue squares) identified through the s-DNA coding process. The affiliated relationships can be both a positive relationship, where the actor is in favour of the theme, or a negative one, where the affiliated actor is not in agreement with the theme. For example, in Figure 6-4 (Kettle) and Figure 6-6 (Similkameen), many of the actors were positively affiliated with themes of environmental protection and collaboration.

The color coding used in network maps allows a reader to more easily discern between network actors and discourse themes. The more affiliations that a category has, the more centrally the category is located within the map. For example, within the Kettle (Figure 6-3), governance-management, land use regulations, international collaboration and us vs them themes are located on the periphery of the map indicating a low number (2-3) of affiliations while themes including capacity, industry-human need, and environmental protection had the highest number of affiliations.

The affiliation (combined) network map for the Kettle reveals two groupings of actors predominantly connected to or affiliated with a core grouping of categories:

GL1, NG1, GL12 GP2, GP5, NP1 GL9, R3, GL3	→	First Nations, Industry-Human Need, Collaboration, Capacity, Environmental Protection, Education, Conservation

Further subgroup affiliations (combined) include:

GP5, NP1, R3	→	Governance-Management
NP1, GL9, R3	→	Land Use Regulations
GL9, R3	→	International Collaboration
R3, GL3	→	Us vs Them

The dominant positive (agreement) affiliations within the Kettle included: Industry-human need, education, environmental protection, collaboration, capacity, process buy-in. Strong affiliations (as opposed to broad or many) included:

GL1	→	Capacity
GL12	→	Collaboration
R3	→	Us vs Them

The affiliation (combined) network map for the Similkameen reveals the following groupings of actors predominantly connected to or affiliated (+/-) with a core grouping of categories:

F1P2, F3, GL2, GL3, GL5, GL10, II1, II4, P3	→	Collaboration, Environmental Protection, Capacity, Governance -management, First Nations

Further subgroup affiliations (combined) for the Similkameen include:

GP3, GL2, GL5	→	Climate change
GL5, II4	→	Conservation
GL3, GL2, II1, GL5	→	International Collaboration
F3, II1, II4, GL2, GL5	→	Process-buy in
GL3, GL10, II1	→	Industry-Human Need

The dominant positive (agreement) affiliations within the Similkameen did not vary from the combined affiliations listed above. Themes more emphasized (higher affiliation (+) weight) were as follows:

GL2, GL3, GL5, F1P2, II4	→	Governance-management
GL2, GL5	→	Industry-human needs
GL2, P3	→	Capacity
F1P2, F3, GL5, GL10, II1, II4	→	First Nations
GL5, II1, P3, F1, F3	→	Collaboration
II1	→	International cooperation

6.2 Discussion

Based upon actor interview responses, the s-DNA and affiliation network mapping of the watershed planning processes (Figures 6-3 to Figure 6-6) provided inconclusive evidence that the case study core-periphery network structure, dominated by predominantly government actors, had biased the watershed planning process through concept affiliation or coalition development. Within the limited discourse available for analysis there was indication, however that the lack of awareness towards misalignment between watershed planning network structure and watershed planning goals exists. For example, the continued core-periphery network structure and limited discourse directed towards climate change adaptation did not align with the stated primary goal of climate change adaptation for both watershed planning processes (Hamilton, 2011, 2012).

The random selection of survey actors resulted in predominantly core positioned actors with one to two being located adjacent to the core cluster of actors in both watersheds. Out of the total of 559 statements (Kettle-284 and Similkameen-275), 13 categories emerged. Each of the core categories (e.g., education environmental protection, collaboration, capacity, governance-management) have been identified within the climate-change literature as important elements for climate-change adaptation and resilience (Adger et al., 2012; Engle & Lemons, 2010; Prell et al., 2009; Boden et al., 2006; Adger et al., 2005) and for ensuring long- term sustainability of the water resource. The core categories identified in this analysis are also consistent with those identified in the literature as being important when a watershed planning process intends to address climate-change impacts (Watt and KRWMP Stakeholder Advisory Group, 2014).

Of the 13 categories in this analysis, eight emerged in response to questions concerning the watershed and watershed planning process. Of these eight categories, five were discussed in positive terms, including Education, Conservation, Environmental Protection, Collaboration, and Capacity. Actors felt these categories represented important issues that should have received increased attention, or been expanded upon, during the watershed planning process.

Most of the core and periphery categories (themes) identified in the combined affiliation maps, Figure 6-3 and Figure 6-5 remained consistent with those mapped in the positive affiliation maps, Figure 6-4 and Figure 6-6, indicating actors within the networkers were positively affiliated to the identified themes or in other words the core group of actors surveyed continued to feel positively towards issues such as collaboration, process buy-in and environmental protection. However, the Industry-Human Need and First Nations categories within the Kettle, and Industry-Human Need and Governance-Management in the Similkameen appear to be less central within the positive affiliated map. These exceptions indicate that a higher number of actors viewed these themes negatively compared to the categories which remained central in the positive affiliation mapping.

While there is, limited evidence confirming the existence of a core "coalition" potentially biasing the watershed planning process through framing, issues that continue to challenge transitioning of these water governance systems were identified. For example, there was indication of ongoing dissatisfaction with senior levels of government ranging from lack of participation to outright mistrust characterized as “Us versus Them” in the categorized statements. The lack of participation was interpreted as a positive affiliation with the Collaboration theme, however the mistrust was categorized as ‘Us vs Them’. As Figure 6.3 and Figure 6-4 illustrates, this view was relatively isolated and not part of the core concepts emerging from the interviews within the Kettle and was not identified in the Similkameen. The key concerns associated with this category of statements involved a view that a "wrong-headed decision out of Victoria" to remove a dam on an existing reservoir compromised both safety and amenity for local residents. The “Us versus Them” category was closely linked to the dialogue surrounding the need for better participation by senior levels of government, which was also closely linked to desire for “Process Buy-in” by the same levels of government. As one respondent indicated:

> "I worry about the level of support for long-term stewardship from the provincial government stewardship resource. I say that is a key need for them to endorse in spirit

and principle as well as surely endorse the watershed plan that we come out with. We need a lot more policy support for healthy watersheds."

Much of this local dissatisfaction with senior governments may be born out of a lack of capacity at these senior levels, particularly the province, to fully engage with local interests on water governance-related issues. The new Water Sustainability Act may address this perceived conflict through adopted language, which encourages greater, locally based decision-making opportunities (Curran, 2014). However, adoption of locally based water governance and management solutions without dedicated resources for implementation will not address the ongoing issue of capacity. Rather the new legislation may instead perpetuate the view that senior levels of government continue to “download” responsibility onto local governments without providing associated resources and capacity building to adequately address the new responsibilities. This view was reflected by one respondent, who stated that “The ministry of environment came out with the new water sustainability act and we have to take those regulations and download them onto the people and try to make them understand that we are regulated.”

Discourse analysis identified Capacity as an important issue in watershed planning. Highlighted in the Kettle discourse were two key capacity-related issues: (1) broad acknowledgment of the high capacity of the lead coordinators; and (2) the lack of knowledge within the region pertaining to the understanding (e.g., baseline data) of water and the lack of local capacity to develop this knowledge. However, in the Similkameen, there appeared to be a sense of confidence in the level of capacity resulting from the involvement of a few key local actors who retained a deep level of historical and localized knowledge pertaining to local and regional water related aspects.

The watershed planning sociographs developed earlier in this study (Figure 4-1) highlight the central location and high level of connectivity of both watershed coordinators (Kettle-GL1 and Similkameen-P1) within the overall network. This structural location is consistent with the discourse that acknowledged the benefits of having a high-capacity actor within the role of watershed coordinator. For example, one participant said, ". . . is someone that can grasp technical, policy and people…presentations that are so well directed to the audience."

High-capacity actors within the network extend beyond the coordinator to what can be considered "bridging" actors or organizations (BAOs). These included not-for-profit organizations such as the Christina Lake Watershed Society, Association of Kootenay-Boundary Local Governments, Okanagan Basin Water Board and the Columbia Basin Watershed Network. While in-region bridging organizations participated in the watershed planning process, through their respective member actors, one significant in-region bridging organization, the Columbia Basin Trust, was identified as "not having a lot of direct interaction." This would appear to be a missed opportunity, considering the mandate of the Trust to assist residents within the Columbia Basin, and the high level of capacity the Trust has developed through many water-related initiatives over the past decade. However, within the Similkameen, the OBWB (Figure 4-2) was structurally embedded within the core, being viewed favourably as an organization with deep repository of watershed related knowledge and broad experience with many watersheds within British Columbia.

In the Kettle, there was a strong call amongst network actors for greater participation by the external bridging organizations, particularly the Okanagan Basin Water Board (OBWB). For example, one actor stated the following:

"…what they are doing across their network is very, very important and what they are learning. They are also a model of what a regional district scale of water resources and watershed timing can be and they haven't done everything that I want to do there, but they are doing all the things that you need to do in a very innovative and great way."

While the OBWB was recognized as having something positive to contribute to the planning process, the fact that the organization was located outside of the region made it difficult for Kettle watershed network actors to participate in meetings and workshops hosted by the OBWB. Also, their lack of mandate to engage outside of the Okanagan region hindered both the transfer of knowledge and the opportunity for capacity-building.

Collaboration is considered a key strategy for addressing climate-change impacts (Huntjens et al., 2012) and it emerged from the discourse as a theme with the greatest affiliation amongst the network actors' responses (Figure 6-3 and Figure 6-5). However, much of the discourse pointed towards a need for greater collaboration, directed at key water-users who did not participate in the watershed planning process. The prominent cohort identified amongst the non-participants was the industrial users within the Kettle and the Similkameen. The following quotes highlight the frustrations associated with participation in the water governance planning process:

"Well I still want to see the tree growers at the table. We're all busy and some people think they're busier than other people. So depends on what list of priorities they have…. So you know I'm not sure but I know that the tree people--the nursery people--felt that this was a threat and they pretty much made that statement. The stupidity of that is if you think it's a threat you should be at the table.", “I say another big gap is on the ranching committee, there is a specific kind of industrial agriculture component that we’re not that well connected with--is the nursery operation. They’re probably the biggest water users in the Midway and Grand Forks area. They’re not really interested in coming to the table and they were invited in the beginning.” and,

“One of the big nurseries here were invited but I think they see any water planning at a local level as a potential threat to their existing interests, I’ve seen that happen in so many planning processes where whatever big industry that could lose the most gets engaged in the process then undermines it at the end.”

Absence of the largest water users and industry with the greatest impact potential from the watershed planning process created doubts as to the possibility of successfully achieving network buy-in and the successful implementation of any policies or strategies developed towards the goal of creating a sustainable watershed.

Notably absent from the Kettle planning process was representation from First Nations. Included in the invitations to participate in the Kettle planning process were the Ktunaxa, the Sinixt, and the Okanagan Nation Alliance, who all have historical claims to the West Kootenay region (Burgmann, 2014). In addition, directly south of the watershed is the Confederated Tribes of the Colville Reservation. Discourse statements relating to the representation of First Nations consistently indicated a level of frustration with the lack of participation in the planning process by First Nations. For example, one actor stated the following: “…even though they were invited in the same manner that other stakeholders were (rather than as a level of government), they refused to participate.”

Several respondents indicated that there were few, if any, First Nations within the immediate region and there was no reference to the historical events of First Nations within the region (BC Hydro, 2009). One respondent identified the lack of any formal or semi-formal structures to guide engagement with First Nations as a possible explanation for their non-participation:

> "My feeling is local governments is very uncomfortable with opening up any questions about any territories or treaties and traditional use studies and things like that. And they're completely unwilling … it's hard, there isn't a working model that the Regional District was familiar with for incorporating their perspective and representation from the beginning. I've only recently come to this understanding of how it could work."

The attitudes expressed above were reflected in the sociographs created for this analysis. First Nations were positioned as part of the core in the combined (+ and -) affiliation map (Figure 6-2), however, when only the positive responses were mapped, First Nations were positioned in the periphery (Figure 6-2).

Within the Similkameen, there appeared to be mixed results with respect to First Nations participation. Figure 6-5 indicates that the First Nations category was a key theme in the discourse being centrally located within the map. Figure 6-6 shows the First Nations category as a little less central within the positive affiliation map, indicating that there were both positive and negative views with respect to First Nations participation within the watershed planning process. The negative affiliations, which also relate to other categories including Process-Buy-in, emanated out of the First Nations actor's frustration with planning process and the continued lack of recognition of fundamental rights as land and resource owners. One participant described it as follows, "…. think of it as a protocol agreement from the beginning of time".

Further confusion or division in affiliations may be a result of the division between the two bands, the Lower Similkameen Indian Band and the Upper Similkameen Indian Band with respect to willingness to participate in the watershed planning process. This division was indicated by a letter emphatically stating the Upper Similkameen Indian Band was opposed to participating or being identified as participants in the watershed planning process.

The need for increased education and knowledge-building was not limited to First Nations participation in watershed planning. While collaboration was identified as one of the key themes, it became apparent that the motivation for collaboration was often not aligned with current thought on collaborative governance and its role in climate change adaptations. For example, the expressed desire to have organizations like the School Board within the Kettle participate in the watershed planning process was born out of desire to change practices associated with wasters of water, not out of a desire to engage in the exchange of knowledge within the planning process (to create greater innovation through increased diversity in knowledge as it relates to water management in a climate-changed environment). This demonstrates a deficiency in the understanding of the positive aspects of meaningful collaboration. The following statement from one participant illustrates this point: "It's the school district. We have all the schools and play fields and there is an abuse of watering and to see watering when not needed … they should be here because they are abusing the water."

With the increasing diversity associated with decision-making and overall governance of water, employing s-DNA research methods enables the identification of potential commonalities and affiliations as the starting focus. s-DNA further enables sustainable watershed planning by making explicit any potential coalitions and barriers arising from biased framing early on in the process. Network Structural Theory and the need to augment SNA research with rich discourse analysis enables greater understanding of network culture and dynamics, such as active non-participation, uninformed engagement, institutional inertia and fragmentation, identified in the Kettle watershed planning process.

As the interrelationships and interactions between water-governance environments (context) and structural components (institutions) continue to increase the level of complexity within socio-ecological water governance systems, the need for greater proficiency at analysis and, ultimately, a better understanding of water governance as a network of relationships becomes more imperative. This exploratory investigation demonstrates that through the use of s-DNA valuable insight into the nuances of attitudes and discourse exchanges within the planning process can be achieved.

Chapter 7 - Summary, Limitations, and Recommendations

7.1 Summary

This comparative case-study research has argued that waterscapes consist of complex, multi-scale, socio-ecological inter-relationships with considerable context specificity characterised and constrained by local capacity and urgency of challenges. The research has shown that within these rural watershed planning processes, where climate-change impact has been identified as a key challenge to water sustainability: (1) centralized, command and control (CC)-style topologies persist, contrary to the inclusive, collaborative models that are recommended to address climate-change impacts; (2) the core-periphery network structure that was evident in the two case-study watersheds is associated with classic challenges of communication and information-exchange, due to core actors remaining strongly linked to each other and weakly linked to periphery actors; (3) the role of bridging actors and organizations (BAOs), while critical in adaptive systems, is under-utilized or ineffectual in addressing the identified fragmentation challenge; and (4) due to periphery isolation (particularly amongst actors self-identifying as First Nations), network access to alternative knowledge bases and to innovative ideas and solutions remains limited.

In combination, these challenges suggest that successful implementation of newly developed water policy recommendations may be hampered due to isolated actors (e.g., First Nations, senior government) and "active non-participating" key industry actors (e.g., agricultural representatives) having little to no representation or voice in the process. Overall, the research demonstrates that, while water governance theory has evolved rapidly over the past decade, in practice, institutional inertia continues to favour the status quo in B.C., hindering any transition to inclusive (e.g., collaborative, polycentric, multi-scale, distributed, adaptive) water governance. The research emphasizes the importance of understanding how water governance evolves in order to design water-governance networks in a way that facilitates the enhancement of appropriate (contextualized) and informed bridging services.

7.2 Limitations

The research, while providing valuable insight into governance processes and the continued institutional inertia, was limited both by the basic design and the research methods chosen. Specifically, the use of SNA and the addition of s-DNA at a later stage introduced specific data related challenges. The original research design, using three case studies at different stages of process evolution, recognized that social networks are dynamic and that each survey is a "snap-shot in time" (Liben-Nowell and Kleinberg, 2007), which limits the ability to predict forward trajectories. The original research design was based upon the notion that three similar case studies (Nicola, Similkameen and Kettle) in various stages (early, middle and end, respectively) of their watershed planning processes could be used as a proxy for the evolution of one planning process at different points in time (i.e., a temporal model). However, as was indicated earlier, too much time had transpired, and possibly the outcome of the planning exercise in the Nicola Valley had resulted in a network that, for all intents and purposes, had ceased to exist. This resulted in a survey process with a marginal return. As a consequence, a comparative study of only two watershed planning processes was undertaken.

The point in the evolution of the case study watershed networks is a representation of a long and evolving relational process based upon years of familiarity, trust building and normative behaviour. It has been argued (Stein et al, 2011; Leifeld, 2013) that social networks can be very stable over periods of time as long as a decade, changing only when something impacts the network significantly enough to change beliefs. Considering this, it is likely that the network structures had not changed (structurally) for lengthy periods of time. Measuring knowledge transfer within the network, while beyond the scope of this study, may allow quantification of the stability within the network structure assuming that the change in a network can be reflected in a change in knowledge within that network.

The research was initially designed to incorporate social network analysis metrics to investigate institutional inertia, which is recognized as an ongoing and major hurdle to water governance transition. When the research was initiated the use of SNA within the water governance field was quite novel. As the research progressed and knowledge of the process increased both for the primary researcher as well as within the field at large, it became evident that SNA would enable the identification of network structure and individual actor characteristics but would not allow for any deeper level of analysis directed towards uncovering the meaning of the individual relationships, or the formation of coalitions, coalitions that may bias the watershed planning process. For this reason, an additional investigation was initiated using s-DNA informed by SNA. However, not designing this research method into the research program from the beginning resulted in a very small data set from which to draw observations or conclusions. The initial survey (online and guide for interviews) was designed to elicit social network related data primarily limiting the overall data set for the discourse network analysis. Using the novel approach of SNA to inform s-DNA, demonstrated the potential advantages to increasing knowledge pertaining to the operations of governance system in action, through the use of this (SNA & s-DNA) holistic approach to investigating social networks within the resource governance field. This research has indicated that by making explicit the structure, actor characteristics and nature (culture) of networks through the application of s-DNA a deeper understanding of water governance network, specifically watershed planning can be achieved moving the dialogue ahead on governance transition in response to climate change impacts. However much more research using larger and broader data sets are required to enable broader generalization and proof of hypothesis (e.g., core normalization leading to ineffective framing of water issues) to occur.

As with all case studies, the results are most germane to the contextual realities of those locations. Watershed planning processes in urban oriented contexts or in various bioclimatic zones where water is not as scarce may yield different results. Watershed planning processes that involved a different approach (e.g., no coordinator involved or led by non-government organization) may also yield substantially different results. One possible example was the recently completed Cowichan Watershed Plan, which involved significant levels of trust building initiatives and was structured under a more co-management framework (Hunter et al., 2014).

7.3 Recommendations

As demonstrated within this research, a combined SNA and s-DNA research design provides an effective investigation tool for improving understanding of: key government and stakeholder participation and interaction (e.g., knowledge exchange); network structure typology (e.g., centralized versus more inclusive and distributed models); and, network actor characteristic information (e.g., bridging service provision and clustering). A deeper-level understanding of water governance and the process of water governance (e.g., earnest and extended efforts of all levels of government, including First Nations, to engage in meaningful sustainable watershed management) will enable more strategic interventions into watershed governance processes including watershed planning. This will likely lead to more effective water-governance processes and better water management outcomes.

The results of this study suggest that it is important that the identified issues, current context (social, political, economic and environmental) and the most optimum water-governance structure are well considered and that strategies, such as SNA, are applied to the process to ensure network structure aligns with watershed planning goals such as climate change adaptation. Further research into techniques for monitoring the planning process, as well as the development of more tools for watershed planning, are required to enable the use of limited resources in a strategic manner.

Successful integrated resource-management, in the form of sustainable water-management planning, such as sustainable watershed management plans that are legislated within the new British Columbia Sustainable Water Act, will be greatly enhanced by identifying and addressing institutional inertia through empirical research rather than rhetoric.

While this research has provided valuable insight into advancing the dialogue on effective development and implementation of adaptive governance, further research is required to develop a fuller understanding of the socio-ecological relationships driving network connectivity and fragmentation in Canada's watershed governance. Specific areas for further research could include the following:

- Utilization of SNA/s-DNA to monitor water governance processes while the processes are evolving, which has the potential to enable interventions and corrections that may increase the legitimacy of the process and outcomes. For example, identification of potential bridging actors early in the planning (governance) process (or even pre-planning stage) could significantly enhance connectivity amongst diverse watershed stakeholders. This could help to ensure greater innovation in policy development and increased ownership and buy-in for policy implementation.

- Linking established watershed planning goals (e.g., climate change adaptation) to the recommended governance structures by making the structure explicit, would provide watershed residents with previously inaccessible knowledge to better inform governance design (e.g., mesh versus core-periphery). Implementation of the SNA/s-DNA 'diagnostic' tool would also provide information pertaining to important issues such as biasing that leads to specific framing of watershed goals and resource allocation. Identification of key boundary agents (e.g. OBWB) is also made possible, BAOs who may be leveraged throughout the planning process for improved knowledge development and transfer.
- Considering the dynamic nature of socio-ecological systems, more longitudinal research designed to assess both changes in governance networks and water-resource challenges is important. This dissertation has argued that "one size does not fit all" when it comes to water-governance design. Longitudinal research will provide richer data on the forms of governance models required at different stages of the life cycle of a governance network and allow for a more effective approach to multi-model and nested governance approaches.

- Highly centralized networks are extremely vulnerable, lack robustness, and are extremely susceptible to disruption (e.g., a few key local government representatives retire). Meanwhile, highly dispersed networks are susceptible to failure because of their complexity and lack of any coordination (central). These realities speak to the need for finding the optimum network configuration that is also structured for the nuances of context. Achieving this outcome presents significant challenges without the aid of SNA.
- Further research is needed to directly and empirically observe the development of governance networks and the effectiveness of various institutions and actors within a network (Lubell et al., 2014) so that ways to enable timely interventions, such as bridging service support, can be developed. There is considerable potential for improvement in water-governance decision-making processes through the use of innovative network research approaches that allow for more effective monitoring (potentially even real-time monitoring).
- More effective network approaches to water governance could be achieved by reframing water governance as an ongoing, adaptive process, and basing interventions on a contextually informed and empirically measurable network approach. This approach could reveal and address barriers associated with legitimacy, capacity, and representation.
- Case-study findings revealed "active non-participation" by key industry leaders (e.g., wineries and resource companies). This issue needs to be addressed such that good water outcomes are measured against a process that ensures the right actors are engaged in a meaningful and effective manner, and that the optimum network

structure is implemented so that knowledge transfer is sufficiently diverse to yield informed and innovative solutions.

- The results of this study suggested that broader re-framing of the role of First Nations participation would be a significant and positive development in resource governance, particularly in a British Columbia context where engagement with First Nations by governments and industry have historically often been acrimonious, contributing to an environment of ill will, legislated consultation, and fragmented resource-governance.
- Based upon what is known about bridging actors and by extension the services they provide (e.g. essential for the incorporation of multiple knowledges, including citizen science, traditional ecological knowledge (TEK), and other forms of locally based knowledge repositories) the research demonstrated that there was a lack of bridging actors and bridging services in the watershed planning processes. The 'missed opportunity' of enhanced connectivity within the watershed planning networks contradicts the stated objectives within the planning documents to create a collaborative and inclusive planning process
- The study found that the OBWB, with its high level of legitimacy within both academic and policy fields, provides an excellent bridging model that could be used as a guide for the development of other locally-based bridging organizations throughout the province. This will be particularly important for knowledge exchange and policy implementation of the B.C. Sustainable Water Act, which encourages the creation of sustainable watershed management (SWM) programs across the province.

- There was a strong desire on the part of actors within the Similkameen for direct collaboration with UBCO as a result of very positive interactions with researchers from UBCO, both student and faculty. Considering the ongoing efforts to bridge the gap between science and policy (e.g., Water Science Symposium, UBCO, UVic, UNBC), and the critical nature of water within the region, further support and resources should be directed by the Province, UBC O and local governments towards increased research targeting watershed governance building on the existing research. Potentially a more formal integrated water related institute to focus and coordinate the research would provide an effective vehicle to make the region a world leader in water management.

Key to understanding water-governance institutions is recognizing that they are embedded within specific and unique contexts, including political mandates, environmental influences, and regulatory frameworks, and that there is a significant level of interconnectedness between these institutes. To understand the level of interconnectedness requires the development of an appreciation for the social elements underpinning the governance framework (Menard and Saleth, 2011).

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Appendices

APPENDIX I: Adaptive Network Structure Typology Framework

Feature	Link to social network structure
Social Memory	
Collective memory / experiences to be used in times of challenge and uncertainty (e.g. McIntosh, 2000, Folke et al., 2003)	*Reachability*: access to many individuals *Density:* many links to others in the network
Heterogeneity	
A diversity of many types of actors or actors with differing knowledge will broaden the collective knowledge base and increase the capacity for innovation and maintenance of different knowledge systems and frameworks for interpretation (Folke et. al, 2005)	*Betweenness / Modularity*: A certain degree of separation of groups in the network is needed to maintain heterogeneity. *Density:* High density may have negative effect on heterogeneity because it promotes homogeneity of experience and attitudes among actors and reduces the potential for innovation (e.g., Reagans & McEvily, 2003, Oh et al., 2004)
Redundancy	
Provides buffering capacity in case of loss, i.e. if one or more actors are weakened or lost others can fill the position and continue t perform the management functions (Janssen et al., 2006)	*Density:* Many links makes the loss of single actors less disruptive, with a lesser effect on the average distance in the network.
Learning	
Knowledge about ecosystems can be continuously increased and improved and thereby governance and management can be updated and adapted to changing conditions (Holling, 1978)	*Betweenness / Modularity:* Maintenance of strong links within a group to some extent requires high modularity (Granovetter 1973), and strong links are needed to transfer tacit knowledge (e.g. Reagans and McEvily 2003 and references there in) and complex knowledge, i.e. knowledge that involves interpretation of a number of nonlinear and noncausal variables. *Reachability*: access to many actors from whom knowledge and information can be amassed or to whom it can be distributed (e.g. Oh et al., 2004) *Centrality*: a high degree of centrality may give rise to centralized management and thereby fewer

Feature	Link to social network structure
	experiments and experiential learning (Leavitt, 1951, Shaw, 1981)
Adaptive Capacity	
New knowledge and/or changing conditions require adaptive capacity and innovation to meet new needs (e.g., Gunderson, 1999, Walker et al., 2009 for a discussion on adaptive capacity, resilience, reorganization, and novelty)	*Reachibility:* Collective action requires multiple actors to collaborate, but too much decentralization may have negative effects on the potential for collective action (Steel & Weber, 2001). *Centrality:* Coordination ability, which is important in times of change and rapid response, increases with centrality (Leavitt 1951). *Density:* Too many links to others may lock an actor into a political position because of, e.g., peer-pressure, thereby limiting his/her ability to innovate and act (e.g., Frank & Yasumoto, 1998).
Trust	
Co-management is facilitated by trust among actors (e.g. Olsson et al. 2004)	*Density:* Many links foster feelings of belonging and group identity (Coleman 1990). *Betweenness/ Modularity*: A high degree of separation among groups can undermine the development of trust (Borgotti & Foster, 2003)

Source: Bodin et al., 2006.

APPENDIX II: Actors in the Watershed Planning Process

The following tables list the formal actors for each watershed planning process. The names listed are those that can be accessed publicly. Following REB rules, the subset of actors from this list that were actually interviewed have not been disclosed.

Table 1: Similkameen Valley Watershed management plan network (formal participants)

Name	**Affiliation**
Frank Armitage	Town of Princeton (Mayor)
Manfred Bauer	Keremeos / Chair SVPS
George Bush	Cawston (Area B)
Brad Hope	Dir. - Area H (Princeton)
Angelique Wood	Dir. - Area G (Keremeos/Hedley)
Gwen Bridge	Consultant - Lower Similkameen
Robert Edward	Chief - Lower Similkameen-Keremeos
Brenda Gould	Upper Similkameen
Gary Theilmann	Village of Keremeos
Colleen Christensen	Recording Secretary-SVPS
Tom Siddon	Dir. - Area D (Kaleden / OK Falls)
Janice Johnson	Facilitator
Dan Ashton	MLA - Okanagan Similkameen
Bill Newell	CAO - RDOS
Bob Wilson	CAO (Interim) - Princeton
Laurie Taylor	CAO - Keremeos
Charlotte Mitchel	Upper Similkameen - Hedley
Stewart Phillip	Grand Chief -ONA Chair
Anna Sears Warwick	Executive Director - OBWB
Linda Allison	Rancher - South Interior Reg. Stockmans Assoc.
Rob Dawson	Orchardist
Michelle DesJardins	Copper Mountain
Walter Despot	Former Mayor of Keremeos
Chris Goodfellow	Coalmont Community Assoc.
George Hanson	Former RDOS Director
Ron Harkness	Fly-fisherman
Kevin Huey	Keremeos Irrigation District
Roger Mayer	Former RDOS Director
Lee McFadyen	Mariposa Consulting
Brian Mennell	Fairview Irrigation
Norm Parkin	Keremeos Cawston Sportsman Assoc.
Henry Rykers	Town of Princeton Public Works Manager
Robert Thurston	Thirsty Water Services
Ian Walters	Keremeos Irrigation District
Charles Weber	Rancher
Lynn Wells	Hedley Improvement District
Stephen Juch	RDOS Public Works
Liisa Bloomfield	RDOS Engineer
Rob Marshall	Weyerhaeuser (to receive correspondence)

Angela Hook	Recording Secretary

(Source: http://www.rdos.bc.ca/departments/public-works/similkameen-valley-watershed-study/)

Table 2: Kettle River Watershed plan network (formal participants)

Name	**Sector / Affiliation**
Lorri Harpur	West Boundary Agriculture -Kettle River Stockmen's Ass.
Doug Norin	InterFor
Fred Marshall	Small Business Forestry – West Boundary
Darryl Arsenault	Tourism – Big White Ski Resort Limited Paul
James Wilson	Tourism / Small Business – Regional Chamber of Commerce
Murray Knox	Grand Forks Irrigation District
Steve Babakaiff	Sion Improvement District
Jenny Coleshill	Granby Wilderness Society
Brenda LaCroix	Christina Lake Stewardship Society
Paul Manson / Sonny Banjac (Alt.)	Energy – Powerhouse Developments Inc.
John Jewitt	Mining – Boundary Mining Assoc. (President)
Peter Shilton (observer, not directly participating)	Industry - Roxul
Victor (Sonny) Lockhart	Beaverdell Resident
Dawn Guido	FLNRO (Grand Forks)
Larry Jmaiff	Resident-at-Large
George Dagg	Resident-at-Large
Gary Schierbeck	Resident-at-Large
Kathy O'Malley	Resident-at-Large
Grace McGregor	Electoral Area "C"
Roly Russell	Stakeholder Advisory Group Chair; RDKB Area "D" Director
Bill Baird	Electoral Area "E"
Brian Taylor	City of Grand Forks
Barry Noll	City of Greenwood
Marguerite Rotvold	Village of Midway
Mark Andison	RDKB
Jeff Ginalias	RDKB
Graham Watt	Watershed Coordinator
Conrad Pryce /Michael Epp	MFLNRO (Penticton) / MFLNRO - Vernon
Tara White	MFLNRO (Penticton)
Ted Van der Gulik	Ministry of Agriculture (Abbotsford)
Carl Withler	Ministry of Agriculture (Kelowna)
Cheryl Unger	Interior Health (Grand Forks)
Dean Watts	DFO
Sasha Bird	City of Grand Forks
Jean Parodi	Washington Department of Ecology
Rusty Post	Washington Department of Ecology
Lisa Tedesco	FLRNO Nelson – Habitat biologist

(Source: http://www.rdkb.com/HotTopics/KettleRiverWatershedManagementPlan.aspx)

APPENDIX III: Watershed Governance Social Network Analysis Survey Tool (Online)

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

1. Which watershed are you a part of?
   Nicola
   Similkameen [GO TO Q3]
   Kettle [GO TO Q4]

2. Please identify up to 10 people with <u>whom you have had the most discussion</u> regarding watershed planning and water-related issues during the Watershed Planning process. The Planning Committee members are listed below. If any of your top ten people are not listed, add their names, contact information (email) and organization/vocation to the bottom of the list.
   Other 1: please specify: ________________________
   Other 2: please specify: ________________________
   Other 3: please specify: ________________________
   Other 4: please specify: ________________________
   Other 5: please specify: ________________________

   ======================[Go to Q5]=======================

3. Please identify up to 10 people with <u>whom you have had the most discussion</u> regarding watershed planning and water-related issues during the Watershed Planning process. The Planning Committee members are listed below. If any of your top ten people are not listed, add their names, contact information (email) and organization/vocation to the bottom of the list.
   Other 1: please specify: ________________________
   Other 2: please specify: ________________________
   Other 3: please specify: ________________________
   Other 4: please specify: ________________________
   Other 5: please specify: ________________________

   ======================[Go to Q5]=======================

4. Please identify up to 10 people with <u>whom you have had the most discussion</u> regarding watershed planning and water-related issues during the Watershed Planning process. The Planning Committee members are listed below. If any of your top ten people are not listed, add their names, contact information (email) and organization/vocation to the bottom of the list.
   Other 1: please specify: ________________________
   Other 2: please specify: ________________________
   Other 3: please specify: ________________________

Other 4: please specify: ___________________________
Other 5: please specify: ___________________________

5. For the ten people you identified above:

	a) On average, How often do you communicate with this person?	b) What is your primary method of contact with this person?
Person 1	Daily WeeklyMonthly Yearly	Email Phone In-person
Person 2	Daily WeeklyMonthly Yearly	Email Phone In-person
Person 3	Daily WeeklyMonthlyYearly	Email Phone In-person
Person 4	Daily WeeklyMonthly Yearly	Email Phone In-person
Person 5	Daily WeeklyMonthly Yearly	Email Phone In-person
Person 6	Daily WeeklyMonthly Yearly	Email Phone In-person
Person 7	Daily WeeklyMonthly Yearly	Email Phone In-person
Person 8	Daily WeeklyMonthly Yearly	Email Phone In-person
Person 9	Daily WeeklyMonthly Yearly	Email Phone In-person
Person 10	Daily WeeklyMonthly Yearly	Email Phone In-person

6. To determine how helpful and therefore how important the communication with each of the 10 people listed is please rate each person's communication from "Very helpful" to "Not helpful at all":

	Very helpful	Somewhat helpful	Made no difference	Not helpful	Not at all helpful
Person 1					
Person 2					
Person 3					
Person 4					
Person 5					
Person 6					
Person 7					
Person 8					
Person 9					

Person 10

7. Did the information you received during the watershed planning process change your view with respect to how your watershed should be governed / managed? ☐ Yes ☐ No
   a. If 'YES' then please describe how your views were changed

   ____

8. Please indicate the type(s) of information that was most beneficial from each of your key people:

	Environment Information	Legislative / Policy / Political information	Technical related (i.e. license holders)	Instilled trust to enable meaningful discussion on difficult topics	Other Information about water and watershed planning Describe
Person 1	☐	☐	☐	☐	☐ ____________________
Person 2	☐	☐	☐	☐	☐ ____________________
Person 3	☐	☐	☐	☐	☐ ____________________
Person 4	☐	☐	☐	☐	☐ ____________________
Person 5	☐	☐	☐	☐	☐ ____________________
Person 6	☐	☐	☐	☐	☐ ____________________
Person 7	☐	☐	☐	☐	☐ ____________________

Person 8	☐	☐	☐	☐	☐ ___________________
Person 9	☐	☐	☐	☐	☐ ___________________
Person 10	☐	☐	☐	☐	☐ ___________________

9. Please list up to five individuals with whom you would like to communicate with but have not been able to and why you would like to communicate with them. Also indicate what has prevented you from communicating with them. They may be someone that is already a part of the process or someone outside of the watershed planning process:

	Reason for wanting to communicate	**Reason preventing communication**
1. __________		
2. __________		
3. __________		
4. __________		
5. __________		

b. Is there information that you have not been able to get that you feel would help you in the watershed planning process? ☐ Yes ☐ No

If "*YES*" then please indicate what type of information and describe.

	Type of Information	Description
☐	Environmental information	
☐	Legislative / Policy / Political information	
☐	Technical information (i.e. License holder etc.	
☐	Other new Information about water and watershed planning	

10. Does this watershed planning committee integrate well with other organizations, including other levels of government? ☐ Yes ☐ No

If the response is 'Yes", given the categories below, which best describes these interactions?

☐	We hold friendly relations, but it is not necessary to work together
☐	We share information and experiences
☐	We work together to develop strategic management plans
☐	We collaborate to organize joint activities and on common projects

11. Given the descriptions below, choose the one that best characterises your interactions with other watershed groups in the last five years on the subject of watershed planning /management and/ or water quality management.

	Share information (facts, events, problems)	Exchange advice (find solutions to problems)	Participation in projects (municipal, regional, provincial, other)	Collaborate to organize joint activities & projects	Other interactions	Did not collaborate
Kettle Watershed	☐	☐	☐	☐	☐	☐
Okanagan	☐	☐	☐	☐	☐	☐
Similkameen	☐	☐	☐	☐	☐	☐
Other(s)	☐	☐	☐	☐	☐	☐

Are there any other watershed groups that you have not mentioned, that you interact or collaborate with? ________________________________

12. As part of the watershed planning committee have you communicated with other groups or organizations, (non-profit, local government, First Nations etc.) who were not part of the formal watershed planning process? If yes please describe below

	Share information (facts, events, problems)	Exchange advice (find solutions to problems)	Participation in projects (municipal, regional, provincial, other)	Collaborate to organize joint activities & projects	Other interactions	Did not interact with local groups
Please specify Group/organization: _____________________						
Please specify Group/organization: _____________________						
Please specify Group/organization: _____________________						

Please specify Group/organization: ______________________						

13. In your opinion, which stakeholder groups or institutions have played the most significant role or have been the most important in providing information that was critical in developing the [INSERT Q1 RESPONSE] Watershed Management Plan (select up to but no more than five with #1 being the most important):

Rank	Stakeholder Group or Institution
#1	
#2	
#3	
#4	
#5	

14. What organization do you represent within your Watershed Planning Process: _______________

15. Have the First Nation perspectives and traditional knowledge been adequately represented/incorporated into the Watershed Planning Process? Yes ☐ No ☐

    a. If "No", why not?: ____

16. Do you self identify as a First Nations person? Yes ☐ No ☐

    a. If "YES" then please indicate which First Nations Band or organization you belong to: ____

17. Are you: Male ☐ Female ☐

18. What age group are you in?
    a. Under 18 years ☐
    b. 19 to 40 years ☐
    c. 41 to 65 years ☐
    d. Over 65 years ☐

19. What level of education/qualification do you have?
    a. High School (Grade 12) ☐
    ☐

b. College Diploma / Trades

c. University degree ☐

d. None of the above ☐

20. How long have you worked in your profession (years)?
    a. Less than 5 years ☐
    b. 6 to 20 years ☐
    c. Over 20 years ☐

21. Please indicate whether your job is:
    ☐ a. Full-time
    ☐ b. Part-time
    ☐ c. Temporary
    ☐ d. Other: please specify_____________________________

22. What is your occupation: ____________________

23. Do you: Own land in town ☐ Own land out of town ☐ Don't own land ☐
    If your answer is "Out of town", what size of parcel to you own:
    a. 5 acres or less ☐
    b. 6 – 20 acres ☐
    c. More than 20 Acres ☐

24. Is there any other information or issues that you would like to discuss?
    ____

25. Please confirm your name: ______________________

26. Please confirm your email address: _______________________

This research will help us identify some of the critically important watershed management issues that are or will be important to the future of the Similkameen. Would you be willing to participate in a brief follow up interview to discuss some of the issues in more depth? Please indicate below if you would like to be contacted to arrange a convenient time to discuss this further.

ES O

☐ ☐ Contact information – email and/or phone number | |

Thank you for your participation

APPENDIX IV: Network Characteristics - Quantitative Measures

Characteristics	Quantitative Measure
Density	Number of links divided by the number of nodes in the network
Reachability	Diameter, i.e., the number of steps maximally needed to reach from one node to any other node in the network Number of components. A component is an independent network within the larger network in which all nodes are directly or indirectly in contact with each other. If a network consists of more than one component, it is considered fragmented; the degree of fragmentation is quantified by measuring the number of components .
Betweenness	A measure that quantifies the degree of betweenness (Freeman 1978), i.e. how much each node contributes to minimizing the distance between nodes in the network (compared with reachability above). This measure can be applied to individual nodes and can then be used to identify the actors that contribute most to linking the network. The measure can also be applied to the network as a whole to quantify the degree of modularity, i.e. separation into smaller groups or modules.
Centrality (closeness)	The degree of centrality indicates how many links a node has (Freeman 1978). This measure can be applied to individual nodes or the whole-network. A high degree of centrality for an individual node indicates that it has many links compared to other nodes. Centrality for the whole-network indicates the tendency in the network for a few actors to have many links, e.g. a wheel-star structure.

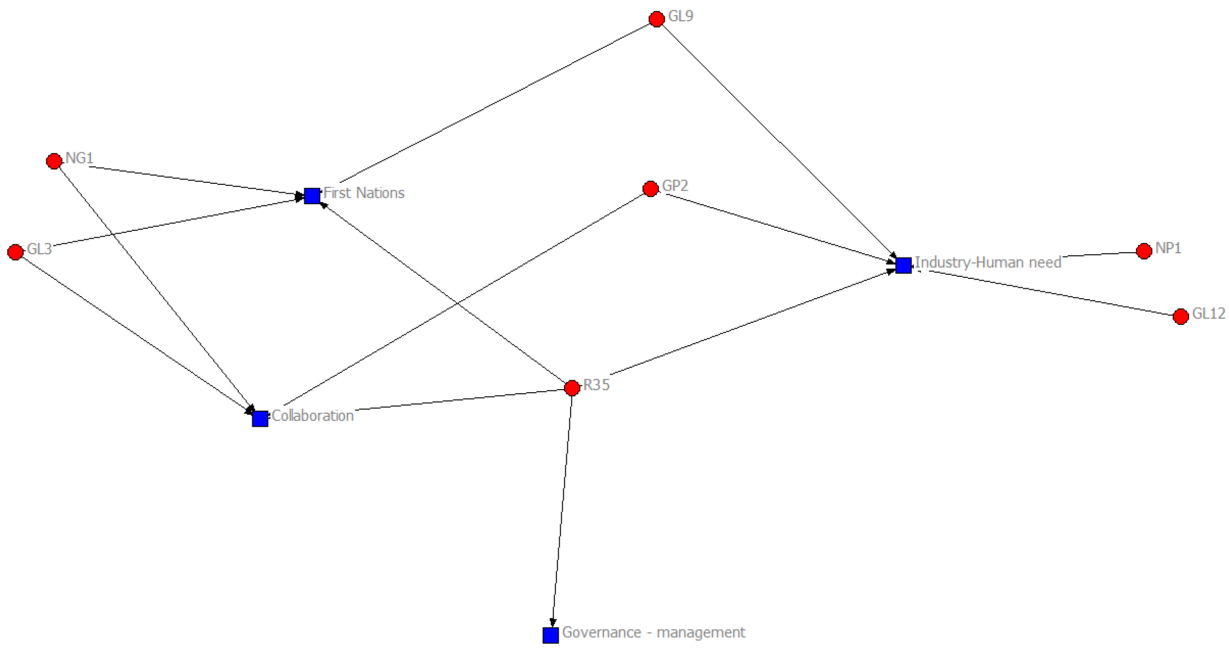
Source: Bodin et al. 2006.

APPENDIX V: Adaptive Management Network Structure Typology Assessment Framework

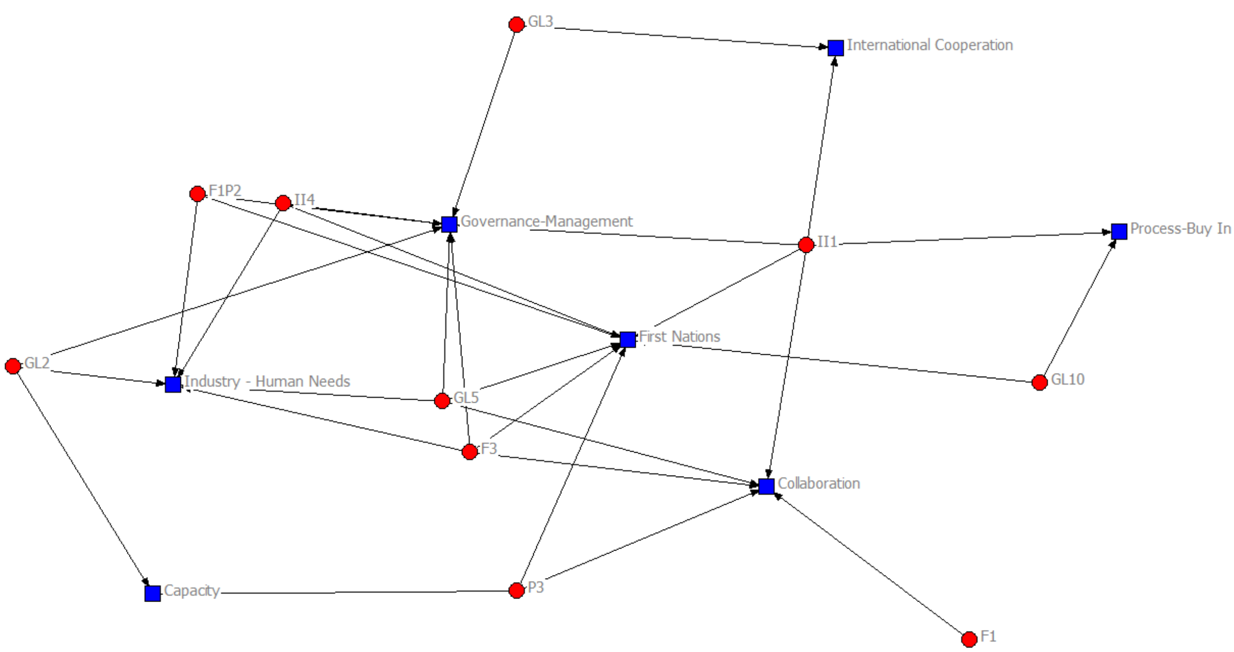
Adaptive Management Network Structure Typology		SNA Quantitative Metrics			
		Reachability	Density	Betweenness / Modularity	Centrality
Network Structure Features	Social Memory	x	x		
	Heterogeneity		x-	x	
	Redundancy		x		
	Learning	x		x	x-
	Adaptive Capacity	x	x-		x
	Trust		x	x-	

(adapted from Bodin et al. 2006)

APPENDIX VI:Affiliation Networks Negative



Affiliation network (Kettle) – negative responses



Affiliation network (Similkameen) – negative responses