



Applying an integrated governance framework to watershed management plans in British Columbia

A comprehensive sustainability perspective

May 2025

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Funding

This work was supported by the Social Sciences and Humanities Research Council (SSHRC) of Canada's Insight Development Grant Program (Grant File Number: 430-2023-00014). The report was produced by the Transdisciplinary Research on Integrated Approaches to Sustainability (TRIAS) lab (www.triaslab.ca), which is funded by the Canada Research Chair in Climate Change, Biodiversity and Sustainability program at Royal Roads University.

Summary

Healthy watersheds are essential for the provision of not just clean water, but also for supporting biodiversity, recreation, food security, economic activities, and the wellbeing of local community members. Watersheds are also highly vulnerable to a complex array of issues, including anthropogenic activity and climate change. To address this complexity, multiple levels of government and community stakeholders must collaborate to develop integrated watershed management plans. In the Canadian province of British Columbia (BC), integrated watershed management plans for urban and rural areas have been developed to guide planning and management strategies in ways that integrate different factors related to ecological health and human wellbeing in the watersheds. This study investigates the nature and degree of integration in these plans by analyzing the plans using a watershed governance prism framework. The framework characterizes a comprehensive approach for integrating social, environmental, health, and wellbeing issues in watershed governance and management efforts. Using the watershed governance prism as an analytical framework, key features and gaps in BC's integrated watershed management plans are revealed. The analysis demonstrates that the majority of watershed management plans in BC do not cover all the framework's components, in particular social systems and human health and wellbeing considerations are missing from many of the plans. The outcomes and insights from this research are valuable for developing and updating integrated watershed management plans in ways that can effectively and comprehensively contribute to sustainability objectives.

Introduction

Watersheds are threatened by development, population increase, and climate change. In the Canadian province of BC, high water demand, pollution, habitat loss due to erosion, drought and flood risk, and periods of insufficient water availability present challenges for recreation, fish, and wildlife. The need to safeguard and regenerate watersheds is becoming more urgent due to climate change and an increased frequency of extreme weather events. Actions that contribute to watershed management in BC include improving standards and regulations for protecting freshwater systems and habitat, supporting efforts that involve collaborative watershed governance, implementing current knowledge and techniques in water and watershed management, enhancing data and knowledge creation and sharing, identifying opportunities for low-carbon economic growth, and managing climate change risks (e.g., droughts, floods, etc.). Such actions can result in co-benefits, such as improved food security, community health and wellbeing, and opportunities for local economic development.

Stakeholders, rightsholders, and community members in watersheds, including representatives of local governments, Indigenous Peoples, farmers, business owners, and members of environmental groups, are essential partners in watershed planning and management efforts (BC Ministry of Water, Land and Resource Stewardship, 2023). To support these efforts and facilitate collaboration, local watershed management plans have been created for several watersheds in BC. The plans are designed to capture a variety of watershed management considerations related to ecological, economic, and social factors.

Despite the fact that BC has multiple watershed management plans in place, watershed challenges are becoming increasingly more severe. For example, the need for water conservation and restrictions on water consumption in the Sunshine Coast region has impacted local economies and quality of life of the residents, and the water management plans and strategies in the region are only partly effective in terms of resolving these issues (Botelho, 2018). Examples such as these demonstrate a need for evaluating current watershed management plans to identify areas of improvement with respect to enhancing integrated planning, management, and governance. This study analyzes integrated watershed management plans in BC, examining the comprehensiveness and gaps in how the plans integrate key components of and considerations around sustainable watershed planning and management.

The watershed management plans developed in BC are referred to as integrated watershed management plans. Integrated watershed management involves addressing issues and considerations related to land use, water resources (e.g., protected areas, source water protection, etc.), human activities, and ecosystem functioning at the watershed scale. Plans developed using an integrated watershed management approach view watershed issues and strategies through a comprehensive sustainability lens, and accordingly, these types of plans involve assessing and managing cumulative effects from various environmental stressors (CCME, 2016). The development process of an integrated watershed management plan is collaborative, with such processes typically involving the knowledge and input of different local governments, organizations, and community members.

The analysis done in this research employs Parkes et al.'s (2010) watershed governance prism, which is a framework that defines key areas of integration in watershed governance, namely social, environmental, and health factors. The research identifies key features and gaps in the integrated watershed management plans from places across BC. The outcomes of this work can be used by policymakers, planners, and community organizations to update and strengthen local watershed management plans and policies.

Methods

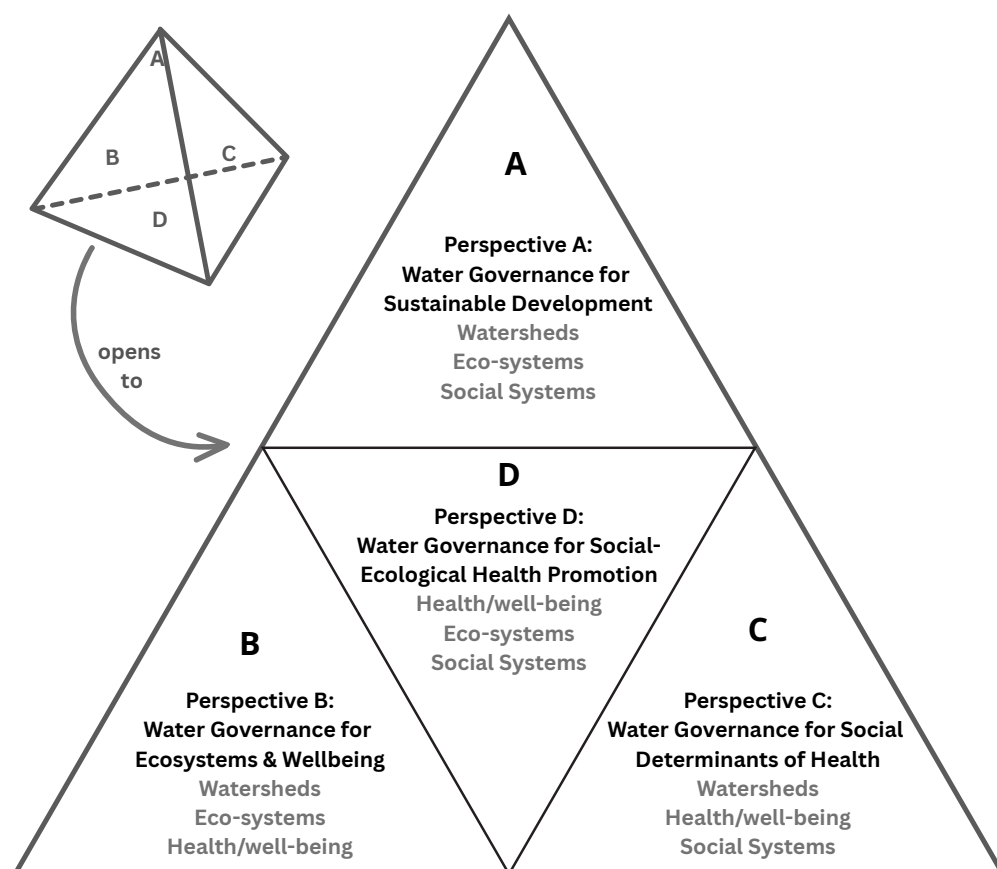
Data Collection

The integrated watershed management plans for BC watersheds are publicly available on the websites of municipal governments and the provincial government. This study collected analyzed plans produced after Parkes et al.'s (2010) framework was published. A total of 12 integrated watershed management plans of the 17 available plans fit this data inclusion criterion.

Analytical Framework

The watershed governance prism was developed by Parkes et al. (2010), and it is a conceptual tool for defining and understanding areas of integration in integrated watershed management and governance. The framework is organized into a “prism shape,” which consist of four vertices labelled as ecosystems, social systems, health and wellbeing, and watersheds (Figure 1). Parkes et al. (2010) explain that the framework serves as an illustration of numerous interrelated policy priorities and that it can be used as a roadmap for integrating policies and strategies related to water, health, and social-ecological systems. Applying the framework can reveal the multiple and highly-varied aspects of managing and governing watersheds, as well as the complex relationships watershed management and governance form with diverse environmental and social factors and issues.

Figure 1. Watershed governance prism framework (adapted from Parkes et al., 2010)



The watershed governance prism provides a useful means for examining the nature and degree of integration in watershed management plans. The framework serves as an appropriate analytical tool for this study for two reasons. First, it was developed in the context of integrated watershed governance in Canada, and this study focuses on watershed management plans created in the Canadian province of BC. Second, the framework provides a social-ecological lens for the analysis.

The watershed governance prism characterizes four “perspectives” on watershed governance, based on the focus and priorities of watershed planning, management, and policy. In the prism, each of these perspectives are represented as the collection of (and connection among) three of the four vertices (i.e., ecosystems, social systems, health and wellbeing, and watersheds). Each of these perspectives have strengths and shortcomings in terms of what they capture with regard to watershed management, issues, needs, and approaches.

Perspective A consists of the ecosystems, social systems, and watersheds vertices. This perspective captures governance for sustainable development, focusing on a “triple-bottom line” of economy, society, and environment. The perspective does not fully recognize how the ecological, social, and economic elements in watersheds are also “upstream” contributors to the determinants of health.

Perspective B consists of the ecosystems, health and wellbeing, and watersheds vertices. This perspective represents governance that focuses on ecosystems and wellbeing, particularly in terms of the benefits and services that freshwater ecosystems provide. For example, these ecosystems can serve as a buffer against threats from environmental toxins and diseases. The perspective somewhat ignores problems of social justice and the connections among ecosystems and social determinants of health.

Perspective C consists of the social systems, health and wellbeing, and watersheds vertices. This perspective centres on the social determinants of health, and it recognizes the significance of water resources to social equity, livelihoods, and socioeconomic factors that influence health. The perspective favours practices that align with equitable and multi-stakeholder watershed management. The perspective does not involve much attention to considerations related to ecosystem services and biophysical processes.

Perspective D consists of the ecosystems, social systems, and health and wellbeing vertices. This perspective focuses on governance for social-ecological health. The perspective involves a recognition of the “double dividend” that comes from building socio-ecological resilience and connecting goals related to both improving social equity and protecting/enhancing freshwater ecosystem services.

Data Analysis

The analysis employed a thematic coding approach, using NVivo qualitative data analysis software. A deductive coding approach was used, which involved applying the watershed governance prism as an analytical framework. The framework is organized into four main components: ecosystems, social systems, health and wellbeing, and watersheds, and these components were used to code the text in the watershed management plans. Then, an inductive coding approach was done to identify emergent themes that elucidate how integration occurs among the watershed governance components.

A coding matrix was created to organize the data via the watershed management plans (i.e., the row headings) and the codes (i.e., the column headings). The matrix was used to identify which (and how many) watershed governance prism components were coded in each of the plans. The purpose of this matrix work was to reveal the different watershed governance perspectives associated with the plans.

Watershed Profiles

This section provides details on the integrated watershed management plans analyzed in this research. The section discusses the watersheds with respect to geographical, environmental, social, and management-related features and issues. Table 1 provides a summary of the watershed management plans used as data in this study.

Table 1. Summary of integrated watershed management plans

Watershed	Region	Year	Plan name
Bowker Creek	Greater Victoria Area	2012	The Bowker Creek Blueprint
Partington Creek	Metro Vancouver	2012	A New Watershed Development Planning Process
Nelson Creek	Metro Vancouver	2012	Nelson Creek Integrated Watershed Management Plan
Scott Creek	Metro Vancouver	2012	Scott Creek Integrated Watershed Management Plan
Coquitlam	Metro Vancouver	2014	Watershed Planning and Rainwater Management: Creating the Future in the City of Coquitlam
Kettle River	Regional District of Kootenay Boundary	2014	Kettle River Watershed Management Plan
St. Mary Lake	Southern Gulf Islands	2015	St. Mary Lake Watershed Management Plan
Chines Watershed	Metro Vancouver	2016	Chines Integrated Watershed Management Plan
Comox Lake	Comox Valley Regional District	2016	Watershed Protection Plan
Elk/Beaver Lake	Greater Victoria Area	2021	Elk/Beaver Lake Watershed Management Plan
laney, North Alouette, and Fraser River	Metro Vancouver	2021	Blaney, North Alouette, and Fraser River Integrated Stormwater Management Plan
Maple Creek	Metro Vancouver	2021	Maple Creek Integrated Watershed Management Plan

Bowker Creek

The Bowker Creek Watershed is located in the Greater Victoria Area, and it experiences issues such as flooding, water pollution, and habitat degradation. The Bowker Creek Blueprint was created by the Bowker Creek Initiative (founded in 2004) to manage and restore the watershed and stream corridor over the long term (e.g., 50 to 100 years). The Blueprint was created through collaboration and extensive participation of local government and community members, and it builds on work done through the Bowker Stream Master Drainage Plan, local greenways mapping, assessments of stream habitat, water quality monitoring, and other efforts. The plan is designed in such a way that it contributes to developing a greenway corridor, which runs through residential areas to Victoria's downtown core. The plan supports the development of dynamic, livable neighborhoods, while also making progress toward climate change mitigation and adaptation objectives.

Partington Creek

The Partington Creek Watershed is located in the Greater Vancouver region. It provides habitat for several fish species, including white sturgeon, Dolly Varden, and coastal cutthroat trout, and it is an important ecosystem for mammals and birds, such as Pacific water shrews, black bears, river otters, mink, and great blue herons. In response to development pressures from a growing population in the City of Coquitlam, the Partington Creek: A New Watershed Development Planning Process document directs the urbanization of the city to be centred on an area that minimizes impacts on headwater watercourses, while still allowing for local housing density, livability, and economic viability. Strategies for achieving such objectives include increasing the stormwater infrastructure and identifying locations for different land use types in ways that reduce impacts on the watercourses. The plan also proposes relocating an existing 1.5km roadway 40m further away from Partington Creek in order to build a 30m riparian buffer for the purposes of improving floodplain management and preserving/enhancing ecosystems and habitat. In addition, the plan discusses the implementation of side channels, instream wood structures, spurs and clusters of boulders, and stable debris jams to improve fish habitat and (broadly) the watershed's health.

Nelson Creek

The Nelson Creek Watershed is located in the Greater Vancouver region, and it is discussed in the Southwest Coquitlam Neighborhood Plan. The watershed encompasses approximately 250ha, with it largely consisting of developed land. Land uses in the watershed range from residential in the upper areas to commercial in the lower areas. Due to local land use and development, the Greater Vancouver Sewerage and Drainage District rated the watershed's health as poor (City of Coquitlam, 2012), as it faces issues related to stream channel erosion and sediment transport, poor water quality (e.g., elevated fecal coliforms, nutrient pollutants, and metals), and degraded fish and riparian habitat.

In response to the watershed health issues, the Nelson Creek Integrated Watershed Management Plan pursues “net environmental benefit” goals, which refer to focusing on actions that achieve gains in ecosystem services that outweigh any environmental harms caused by human activities and development. The plan builds on an assessment of the watershed health, which includes considerations around hydrology, geomorphology, water quality, stream base flows, fish presence, spawning locations, riparian integrity, terrestrial habitat, and water nutrient levels. The plan focuses on watershed management efforts toward enhancing fish habitat and ecological productivity.

Scott Creek

The Scott Creek Watershed is located on the southern slope of Eagle Mountain in Coquitlam, and it encompasses an area of 1,950ha. The drainage system includes Scott Creek, Hoy Creek, and their tributaries, as well as roughly 160km of storm drain pipes, two flow diversion systems, and a detention pond (Lafarge Lake). A mix of land uses exists in the watershed, including residential and commercial in the upper parts of the watershed and agricultural in the lower areas. The Scott Creek Integrated Watershed Management Plan was developed to address the major issues facing the watershed, which include stream erosion, sediment accumulation near culvert openings and fish spawning areas, a lowering of the groundwater table, decreases in stream base flows, alteration of fish and riparian habitat, and flood risks.

Coquitlam Watershed

The City of Coquitlam is in the Greater Vancouver region, and the City established their first municipal integrated stormwater management plan in 2002. Metro Vancouver’s (i.e., the regional government government for Greater Vancouver) Liquid Waste Management Plan mandates that watersheds that do not meet a particular threshold of low urbanization (i.e., 80% or more greenspace cover) are required to develop a watershed management plan, and the Coquitlam River Watershed does not meet the low-urbanization threshold,. Accordingly, the Coquitlam River Watershed Roundtable was founded in 2011 to facilitate the development of a plan for protecting and improving the health and sustainability of the watershed (Partnership for Water Sustainability in BC, 2014). The Roundtable's work includes developing a website and resource database, monitoring the river's water quality from dam to mouth, and developing a watershed management plan. Watershed management strategies done in the City of Coquitlam include the Green Lane Standards, with some of these standards relating to the implementation of vegetation and green infrastructure for managing stormwater. In addition, the City revised its Stream and Drainage System Protection Bylaw (in September 2013) to address drainage system challenges and erosion/sediment issues related to the construction industry.

Kettle River

The Kettle River Watershed is located in the Regional District of Kootenay Boundary. The District developed the Kettle River Watershed Management Plan, which focuses on issues and strategies related to water quantity, water quality, and aquatic ecosystems. The plan aims to improve water quality, availability, and security through sustainable resource management, as well as enhance the health and ecosystem functioning in the watershed. The strategies for watershed management include increasing community awareness of and support for Kettle River Watershed stewardship, as well as maintaining and enhancing the recreational, cultural, and amenity values in the watershed.

St. Mary Lake

St. Mary Lake is one of the largest community water systems in the province of BC, as it supplies more than 1,500 residences with drinking water on Salt Spring Island. Additionally, the lake is a popular place for recreational activities, such as fishing. The St. Mary Lake Watershed Management Plan was developed to protect these freshwater system values and to address the issues within the watershed. Watershed management practices identified in the plan include septic input verification, water quality monitoring, community engagement about watershed stewardship, and the development of an environmental farm plan.

The Chines

Metro Vancouver, in collaboration with the City of Coquitlam and the City of Port Moody, led the development of the integrated stormwater management plan for the Chines Watershed. The management plan focuses on lowland areas in Port Moody, which consist of residential development and steep ravines with a diverse, mature deciduous and coniferous forest. Most of the watercourses in the watershed are piped and redirected to centralized discharges to Burrard Inlet (Metro Vancouver, City of Coquitlam, & City of Port Moody, 2016). Environmental challenges that face the Chines watershed include increase in multi-family housing, medium density, and mixed-use developments. Such an increase in urbanization and development also increases impervious surface coverage, which affects runoff volumes and peak flow rates. To address these issues, the Chines Integrated Watershed Management Plan prioritizes controlling stormwater flows in order to mitigate impacts from flooding and to improve the ecological health of the watershed and its streams.

Comox Lake

The Comox Lake Watershed is located in the Comox Valley Regional District, and Comox Lake is the primary supply of drinking water in the region. A risk assessment was conducted to identify issues and threats in the watershed, both natural and human-related (Comox Valley Regional District, 2016).

The assessment identified multiple high-risk threats, including camping in undesignated areas, streamflow augmentation, wildfires, motorized off-road vehicles, severe flooding, drought, aircraft accidents on Comox Lake, water quality issues related to sewage management facilities, impacts from timber harvesting, and contamination in Comox Lake from wildlife. The Comox Lake Watershed Protection Plan focuses on improving drinking water quality, reducing toxins and pollutants, monitoring freshwater systems, and restricting industrial and residential development in some areas.

Blaney, North Alouette, and Fraser River

The Blaney Creek Watershed is 2,574ha, and it is located in the Greater Vancouver region. The watershed is primarily covered by forests, and it encompasses the Blaney Bog Regional Park Reserve, the University of British Columbia's Malcolm Knapp Research Forest, and part of the Codd Island Wetland Ecological Conservancy Area. The North Alouette River Watershed is approximately 1,610ha, and the majority of the watershed is also forest-covered, with the upper watershed containing parts of Golden Ears Park and the Malcolm Knapp Research Forest. The Lower Fraser River Watershed is smaller than the other two watersheds (342ha), and it primarily consists of developed land, with 57% of the land covered by impermeable surfaces. The Blaney, North Alouette, and Fraser River Integrated Stormwater Management Plan was created for the group of three watersheds, and the plan was developed through stakeholder engagement to identify key watershed issues and environmental concerns. These issues/concerns include river flooding, erosion, inadequate drainage infrastructure, impacts from development, and the need to conserve fisheries and other environmental resources. The plan led to the watershed health tracking system, which involves monitoring and assessing watershed health based on total impervious area, riparian forest integrity, and creek-bed biodiversity.

Maple Creek

The City of Port Coquitlam and the City of Coquitlam led a research effort to inform the development of a comprehensive, integrated watershed management plan to improve the health of the Maple Creek Watershed in terms of reducing flood threats, protecting aquatic and riparian habitats, and implementing practical and cost-effective watercourse improvements (City of Coquitlam, 2021). The main components of the Maple Creek Integrated Watershed Management Plan include ecological enhancement, flood management, reducing impacts of future developments, and stormwater management. Watershed management strategies are implemented in time frames of (depending on the strategy) 5 to 10 years, 10 to 20 years, and 50 years or longer (City of Coquitlam, 2021). Collaboration and cooperation among local governments, regulatory agencies, stakeholders, and community members are critical to a successful implementation of the watershed management plan.

Elk and Beaver Lake

The Elk and Beaver Lake Watershed is located in the Greater Victoria Area. Water quality issues in Elk and Beaver Lakes were first documented in the 1960s. The environmental issues have become more severe over the last six decades, impacting the lakes' ecological, social, and cultural values. The issues include blue-green algae (cyanobacteria), invasive plants (Eurasian milfoil), degraded fish habitat, nutrient pollution and eutrophication, and climate change. The Elk and Beaver Lake Initiative was launched in 2016, with aims of reducing blue-green algae blooms, controlling invasive aquatic plant populations, and enhancing fish habitat. The initiative resulted in the Elk and Beaver Lake Watershed Management Plan, which focuses on maintaining ecological functions and services, improving land management practices, reducing impacts from agricultural land use, and preventing water issues related to septic systems. The plan calls for the regeneration and enhancement of riparian and shallow water habitats, and its successful implementation requires collaboration and coordination among stakeholders and local governments, including the District of Saanich, Central Saanich, and the Capital Regional District. Private landowners are critical in the implementation of land management strategies for reducing watershed impacts and improving the watershed's health.

Results

Table 2 provides a summary of the codes used in the analysis. The data were deductively coded using the four water governance prism components: (a) environment and ecosystems, (b) health and wellbeing, (c) social systems, and (d) water quality and watershed health. Then, the coded data were inductively coded with "subcodes" (i.e., emergent themes that appear in each of the watershed governance prism categories).

The data coded with the environment and ecosystems code were also coded with the subcodes: (1) biodiversity, riparian areas, and invasive species, (2) climate change adaptation and mitigation, and (3) flood, drought, fire, flow, and soil erosion management. The health and wellbeing data were coded with the subcodes: (1) minimize exposure to toxins and pathogens, and (2) tourism and recreation. The social systems data were coded with the subcodes: (1) community involvement, and (2) transportation. The water quality and watershed health data were coded with the subcodes: (1) education awareness, (2) nutrient load and contaminants, and (3) rain, stormwater, and run-off management.

Table 2. Watershed governance prism framework components and inductive codes

Framework components	Codes
A. Environment and Ecosystems	▪ Biodiversity, riparian areas, and invasive species ▪ Climate change adaptation and mitigation ▪ Flood, drought, fire, flow, and soil erosion management
B. Health and Wellbeing	▪ Minimize exposure to toxins and pathogens ▪ Tourism and recreation
C. Social Systems	▪ Community involvement ▪ Transportation
D. Water Quality and Watershed Health	▪ Education awareness ▪ Nutrient load and contaminants ▪ Rain, stormwater, and run-off management

The analysis revealed that different watershed governance perspectives were represented in the watershed management plans (Table 3). These perspectives are defined using the water governance prism framework, with each perspective centring on the intersections of the prism components as follows: (a) ecosystems, social systems, and watersheds, (b) ecosystems, health and wellbeing, and watersheds, (c) health and wellbeing, social systems, and watersheds, and (d) ecosystems, health and wellbeing, and social systems. In the analysis, a watershed management plan was only associated with a prism component if a relevant subcode was applied to the plan.

In cases where a prism component was mentioned in a plan in only a vague manner without specific details or mentions of relevant subcodes, the plan was not considered to have included or substantively referenced the component. For example, the Kettle River Integrated Watershed Management Plan only vaguely referenced water quality and watershed health, and no relevant subcodes were applied to the data. Additionally, as the watershed governance perspectives centre on the intersections of at least three prism components, cases where only two components are referenced were deemed as not representing any particular governance perspective.

The analysis revealed that none of the integrated watershed management plans included the complete collection of subcodes, and some plans only related to two components of the watershed governance prism. For instance, the management plan for the Coquitlam Watershed narrowly focuses on source control implementation and rainwater management, which only relates to the ecosystems and watershed health prism components while excluding considerations around social systems and human health and wellbeing.

The analysis demonstrates how some of the prism components are more commonly seen in the integrated watershed management plans than others. For example, social systems are featured in eight watershed management plans (i.e., Nelson Creek, Bowker Creek, Kettle River, St. Mary Lake, Chines, Comox Valley, Maple Creek, and Elk Beaver). In contrast, health and wellbeing only featured in four plans (Nelson Creek, Kettle River, Comox Valley, and Elk Beaver).

Table 3. Integrated watershed management plans relationships to watershed governance framework components and perspectives

Plan Name	Framework Components	Governance Perspectives
Bowker Creek Blueprint	Ecosystems, Social systems, Watershed	A
Partington Creek	Ecosystems, Watershed	None
Nelson Creek	Watershed, Ecosystems, Social systems, Health/Wellbeing	A, B, C, D
Scott Creek	Ecosystems, Watershed	None
Coquitlam	Ecosystems, Watershed	None
Kettle River	Watershed, Ecosystems, Social systems, Health/Wellbeing	A, B, C, D
St. Mary Lake	Ecosystems, Social systems, Watershed	A
Chines Watershed	Ecosystems, Social systems, Watershed	A
Comox Lake	Watershed, Ecosystems, Social systems, Health/Wellbeing	A, B, C, D
Elk/Beaver Lake	Watershed, Ecosystems, Social systems, Health/Wellbeing	A, B, C, D
Blaney, North Alouette, and Fraser River	Ecosystems, Social systems, Watershed	A
Maple Creek	Ecosystems, Watershed	None

Bowker Creek

The Bowker Creek Integrated Watershed Management Plan covers three of the four components of the watershed governance prism framework: ecosystems, social systems, and watersheds.

Accordingly, the plan reflects Perspective A with respect to watershed governance. The plan was developed with a vision of sustainably managing and supporting diverse human uses and ecological functions in the watershed, restoring the creek and wildlife habitats, and creating a community greenway that connects neighborhoods. The plan proposes the following strategies for achieving the vision: (1) use creek-friendly management approaches, (2) minimize impervious areas of new developments, (3) construct infiltration and retention features in boulevards, (4) incorporate watershed goals into relevant municipal plans, (5) communicate the watershed management plans vision and goals, (6) plant and protect vegetation, (7) protect key land in the watershed, (8) include greenways in land use planning, and (9) integrate climate action into all management activities.

Partington Creek

The Partington Creek Integrated Watershed Management Plan covers two of the four components of the watershed governance prism: ecosystems and watershed. Accordingly, the plan reflects none of the watershed governance perspectives defined by the prism framework. The plan is designed to accommodate community growth and development, while also enhancing fish habitat and preserving ecological health. The plan's main components are: (1) integrating land use planning with stormwater engineering, (2) enhancing the best fish habitat in the watershed, and (3) mitigating the impacts of development using stormwater technologies.

Nelson Creek

The Nelson Creek Integrated Watershed Management Plan covers all of the four components of the water governance prism: ecosystems, health and wellbeing, social systems, and watersheds. Accordingly, the plan captures all the watershed governance perspectives, as per the prism framework. The plan contains short-term, medium-term, and long-term objectives. The short-term objectives focus on improving stream protection at concerning erosion sites. The medium-term objectives include improving stormwater conveyance capacity, monitoring flow and water quality, installing water quality treatment units, and removing fish barriers. The long-term objectives involve improving the watershed's health through strategies such as rainwater management, riparian vegetation enhancement, rehabilitation of the mouth of Nelson Creek, and public education.

Scott Creek

The Scott Creek Integrated Watershed Management Plan covers two of the four components of the watershed governance prism framework: ecosystems and watersheds. Accordingly, the plan captures none of the watershed governance perspectives, as per the prism framework. The plan focuses on watershed management strategies that relate to the ecological and hydrological aspects of the watershed, such as stream geomorphology restoration, base flow restoration, hydraulic capacity enhancement, rainwater management, and aquatic and terrestrial habitat enhancement. The plan also includes strategies related to public education and outreach.

Coquitlam Watershed

Coquitlam's Watershed Planning and Rainwater Management plan covers two of the four components of the watershed governance prism framework: ecosystems and watersheds. Accordingly, the plan captures none of the watershed governance perspectives, as per the prism framework. The Watershed Planning and Rainwater Management plan aligns with Coquitlam's Official Community Plan, which includes considerations about protecting the health of freshwater systems within Coquitlam's municipal boundaries through sustainable land use and development.

Kettle River

The Kettle River Integrated Watershed Management Plan covers all of the four components of the watershed governance prism framework: ecosystems, health and wellbeing, social systems, and watersheds. Accordingly, the plan captures all the watershed governance perspectives, as per the prism framework. The Regional District of Kootenay Boundary prepared the plan with the help of an advisory panel, municipal and provincial governments, and various organizations from across the region. The advisory panel, in collaboration with other stakeholders, developed a series of reports on the management challenges, strategies, and opportunities in the watershed. These reports focused on four goals: (1) increase community support and capacity for watershed stewardship, (2) improve the quality and security of water supply by managing water resources sustainably, (3) enhance the health and ecosystem functioning of the watershed, and (4) maintain and enhance recreational and cultural values in the watershed.

St. Mary Lake

The St. Mary Lake Watershed Management Plan covers three of the four components of the watershed governance prism framework: ecosystems, social systems, and watersheds. Accordingly, the plan reflects Perspective A with respect to watershed governance, as per the prism framework. The main goal of the St. Mary Lake Watershed Management Plan is to improve water quality in St. Mary Lake and reduce the prevalence of algal and cyanobacteria blooms. The plan pursues four objectives: (1) preserve and protect ecological functions of watershed, (2) improve water quality in ways that contribute to health outcomes, (3) maintain and enhance water-based recreation opportunities in St. Mary Lake, and (4) provide cost-effective and equitable solutions to water quality issues for landowners and stakeholders.

The Chines

The Chines Integrated Stormwater Management Plan covers three of the four components of the watershed governance prism framework: ecosystems, social systems, and watersheds. Accordingly, the plan reflects Perspective A with respect to watershed governance. The goal of the Chines Integrated Stormwater Management Plan is to minimize environmental degradation, while also supporting the development goals of the municipalities of Port Moody and Coquitlam. Objectives for plan include: (1) reducing erosion in ravines, (2) improving water quality, (3) enhancing aquatic and terrestrial habitat, (4) implementing green infrastructure for managing rainwater and runoff, (5) enhancing aesthetics and livability within the watershed, (6) reducing flooding risks, and (7) addressing issues related to impervious surfaces associated with new development.

Comox Lake

The Comox Lake Watershed Protection Plan covers all four components of the watershed governance prism framework: ecosystems, health and wellbeing, social systems, and watersheds. Accordingly, the plan captures all the perspectives associated with the watershed governance prism framework. The Comox Lake Watershed is difficult to manage because of its size, the numerous landowners surrounding the lake, and the different regulatory bodies that are associated with the lake and its ecosystem services. The plan calls for behavioural change in the watershed, including the behaviours of local landowners; thus, the plan needs to be supported by public education and outreach efforts. The Comox Valley Watershed is a place of recreation for many locals and visitors, and pro-environmental behaviours are needed to improve and maintain the health of the watershed and its ecosystem services.

Blaney, North Alouette, and Fraser River

The Blaney, North Alouette, and Fraser River Integrated Stormwater Management Plan covers two of the four components of the watershed governance prism framework: ecosystems and watersheds. Accordingly, the plan captures none of the perspectives associated with the watershed governance prism framework. The plan was developed to guide future land development and redevelopment in ways that maintain and enhance the ecological health of freshwater systems and ecosystem services in the watershed. Water quality is good in some areas of the watersheds, such as the North Alouette River; however, water quality is a concern in other areas, such as Cattell Brook and Fraser River tributaries. The Blaney Creek Watershed and the North Alouette Watershed provide a variety of terrestrial and wetland habitats that are unique to the region. For example, Blaney Bog and Codd Island Wetlands provide high-quality habitat for rare and endangered flora and fauna species. In addition, the watersheds provide habitat for coho and chum salmon, coastal cutthroat trout, rainbow trout, and other fish species, and North Alouette River and Blaney Creek watersheds contain valuable spawning and rearing habitat for salmon and trout.

Maple Creek

The Maple Creek Integrated Watershed Management Plan covers three of the four components of the watershed governance prism framework: ecosystems, social systems, and watersheds. Accordingly, the plan captures Perspective A with respect to watershed governance. The Maple Creek Integrated Watershed Management Plan aims to maintain watershed health, while also recognizing local needs for new development and housing. The plan addresses trade-offs by applying a “no net loss” principle, which involves identifying how environmental impacts in one area of a watershed can be offset by environmental protection and enhancement in other areas (City of Coquitlam, 2021).

Elk and Beaver Lake

The Elk and Beaver Lake Integrated Watershed Management Plan covers all of the four components of the watershed governance prism framework: ecosystems, health and wellbeing, social systems, and watersheds. Accordingly, the plan captures all watershed governance perspectives associated with the prism framework. The aim of the Elk and Beaver Lake Integrated Watershed Management Plan is to support a healthy and biodiverse lake ecosystem, which can provide both habitat and recreational opportunities for future generations. The plan contains specific objectives related to improving water quality in Elk and Beaver Lake, with these objectives particularly focusing on nutrient pollution (CRD, 2021). The water quality objectives are: (1) to reduce total phosphorus entering the lake by improving land management practices within the watershed, (2) to improve ecosystem functioning within the watershed by reducing phosphorus pollution, and (3) to reduce overall phosphorus in the lake.

5. Discussion and Conclusions

Among the watershed management plans examined in this study, only the Nelson Creek, Kettle River, Comox Valley, and Elk and Beaver Lake plans captured all four components of the watershed governance prism framework. This being said, these plans still had particular emphases and areas where attention was lacking; for example, the thematic coding analysis identified that education and awareness received relatively little attention in the Nelson Creek plan, which instead prioritized controlling and reducing nutrient pollutants entering the watershed's freshwater systems. The Elk and Beaver Lake plan also focuses heavily on nutrient pollution, while other priorities and values (such as tourism and recreation) were not as frequently identified in the plan.

The thematic coding analysis revealed gaps in BC's integrated watershed management plans. Certain codes and planning priorities appeared in only a minority of the plans; for example, the climate change adaptation and mitigation code only appeared in the three of the plans: Comox Valley, Bowker Creek, and St. Mary Lake. Such a finding indicates that the other integrated watershed management plans have critical gaps because the effects of, and need for taking action on, climate change are key considerations for watershed health. Climate change leads to impacts such as those from extreme flooding events and pollution related to surface runoff, and these impacts present concerns related to all aspects of the watershed governance prism framework. As another example, transportation was absent from many plans, despite it being a key consideration in terms of air pollution and pollutants entering freshwater systems and damaging watershed ecosystems. Local and regional governments can use the findings from this study to identify blind spots in their watershed management plans, such as how traffic pollution impacts watershed health, water quality, and human health.

The analysis demonstrated how the integrated watershed management plans were place-based in how they aimed to address local concerns and issues. For example, the Bowker Creek plan discusses specific strategies to control water contaminants and sediments, such as oil interceptors and sediment traps in parking lots. As another example, the Kettle River plan focused heavily on water quality and watershed health, while (to a lesser degree) also included considerations around flood, drought, fire, water flow, soil erosion, and tourism and recreation.

The Chines, Maple Creek, and St. Mary Lake plans align with Perspective A, as per the watershed governance prism framework, which means that the health and wellbeing component of the prism is absent from the plans. The plans primarily focus on ecological and watershed health with respect to water flow, flood management, riparian areas, fish habitat, and water quality. Thus, the focus of these plans are relatively narrow, which can lead to blind spots, even with respect to the main issues the plans aim to address. For example, the absence of climate change from the plans can be problematic, as climate change can severely impact riparian areas and fish habitat. Other examples of blind spots include public education, which is absent from the Chines, Maple Creek, and St. Mary Lake plans. Public education programs can be designed to focus on issues such as fish habitat degradation and water pollution to support priorities around biodiversity conservation and improving water quality.

The Partington Creek, Scott Creek, Coquitlam, and Blaney, North Alouette and Fraser River plans are focused on only two components of the watershed governance prism: (1) environment and ecology, and (2) water quality and watershed health. Each of the watershed governance perspectives that are defined by the prism framework consist of three prism components; thus, these four plans do not represent any of the perspectives. The Partington Creek plan focuses on improving fish habitat, and the other three focus on flood control, runoff management, and drainage systems. Accordingly, these plans capture only a narrow set of concerns and objectives, and although these are important concerns and objectives, there is room to expand the scope and degree of integration in the plans.

Nutrient load and contaminants appeared frequently in the data, with the St. Mary Lake plan particularly focused on this issue (i.e., about one fifth of the total coded references for this code were associated with the St. Mary Lake plan). In contrast, the transportation code only appeared in the Bowker Creek plan, and reducing exposure to toxins and pathogens was only coded in the Comox Lake plan. Similarly, the health and wellbeing component of the watershed governance prism is the least represented in the data of all the framework components. Such findings demonstrate how integrated watershed management planning in BC tends to focus on particular issues while (perhaps) underrepresenting other issues and concerns.

The research revealed that much of the attention in integrated watershed management planning is focused on water quality and watershed health, whereas considerations and issues related to social systems and human health and wellbeing are not heavily featured in these plans. The findings of this research can be used by planners, managers, and stewardship groups in BC to revise and update local integrated watershed management plans in ways that more comprehensively and holistically capture the wide range of issues and considerations related to the sustainability and wellbeing of humans and ecosystems in watersheds across the province. For example, the comprehensiveness of a number of the plans would be improved by including the potential impacts of climate change on watershed health and opportunities for developing public education programs to raise awareness about these impacts. Achieving healthy watersheds and communities involves numerous considerations, including clean water, biodiversity, recreation, economic development, local housing, and many other priorities.

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