

**TOWARDS URBAN AND REGIONAL RESILIENCE: A CASE STUDY OF METRO
VANCOUVER REGION, CANADA**

by

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Abstract

Climate change necessitates investments in urban and regional resilience to address existing and novel risks. Drawing on disaster resilience, socio-ecological resilience, planning, and institutional adaptation literatures, I investigate the relationship between the institutional capacity to deal with floods (specific resilience, sp-R) and the overall ability to deal with change (general resilience, gen-R). I make a theoretical and empirical contribution by operationalizing the interdisciplinary sp-R–gen-R framework and testing it in Canada’s Metro Vancouver region. I employ a nested comparative case-study design, drawing on 60 interviews (with engineers, planners, emergency managers, policy-makers, and politicians) and a regional expert survey to analyze the institutional responses to existing and future flood risk by answering the following question: What is the relationship between sp-R and gen-R across governance scales?

Overall, sp-R and gen-R are related through feedback loops across spatial, temporal, and jurisdictional scales, enabled by champions and social capital, subject to political and institutional changes within the governance system and bureaucracy.

Municipally, sp-R and gen-R are related through urban planning *processes* and *outcomes*, organizational dimensions, and decision-making processes. Carefully constructed planning processes and nurtured organizational cultures enhance trust, shorten feedback loops between the politicians and bureaucracy, foster sp-R action and enhance gen-R. Municipal sp-R mechanisms (practices, tools, and innovations) reflect gen-R principles such as diversity and modularity but also present a governance/coordination challenge. By emphasizing site/area specific tools, municipal-scale planning mechanisms reduce opportunities for strategic region-wide flood management. While numerous municipal-scale sp-R–gen-R trade-offs (e.g., fiscal, equity, design) exist, regional decision-making mechanisms for addressing the cumulative effects of municipal sp-R responses are lacking.

Provincially, the eroded gen-R limits municipal and regional sp-R options. Regional sp-R is constrained by multi-scalar barriers including regional-level flood risk governance regime gaps, a lack of federal and provincial leadership, and provincial sp-R path-dependencies (e.g., competitive funding arrangements that favour structural approaches). Moving from *government* to *governance*, regional sp-R planning is driven by champions and boundary organizations, which fosters gen-R through learning, collaboration, and exploration of options. *Implementation* of these options will require support and engagement from higher government levels and wider governance actors.

Lay Summary

This research aims to understand how planning for familiar hazards (floods) is related to the ability to deal with change in general. This relationship is explored at the municipal, regional, and provincial levels in the Metro Vancouver region, British Columbia, Canada through interviews and a regional survey.

Municipalities use a wide range of planning, organizational, and decision-making tools/processes that connect ability to manage floods and ability to manage change in general. Municipalities do not have enough resources to address regional flood risk on their own.

This gap in regional flood governance is partially filled by organizations that connect flood science and flood policy, thus contributing to regional learning and collaboration.

The province plays an important role in determining options and [dis]incentives for municipal flood management. A more equitable and participatory flood management approach that considers long-term social, economic, and environmental outcomes could improve ability to deal with change in general.

Preface

This dissertation is original, and independent work by the author, Lilia Yumagulova.

This study was approved by the University of British Columbia Behavioural Research Ethics Board on September 18, 2012 (Certificate # H11-02787).

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Lilia Yumagulova wrote the article. Prof. Vertinsky contributed to the Conclusion and Recommendations section of this article.

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List of Abbreviations

- ACT, SFU – Adaptation to Climate Change team, Simon Fraser University
- APEGBC – The Association of Professional Engineers and Geoscientists of BC
- BARC – The Building Adaptive & Resilient Communities Program
- BCERMS – BC Emergency Response Management System
- BC RAC – British Columbia Regional Adaptation Collaborative
- BCREA – British Columbia Real Estate Association
- BC – British Columbia
- CAS – Climate Action Secretariat, Ministry of the Environment
- CNV – City of North Vancouver
- CoD – Corporation of Delta
- CoPC – City of Port Coquitlam
- CoPM – City of Pitt Meadows
- CoR – City of Richmond
- CoS – City of Surrey
- CoV – City of Vancouver
- DFAA – Disaster Financial Assistance Act
- DNV – District of North Vancouver
- EM – Emergency Management
- EMBC – Emergency Management British Columbia
- EPC – Emergency Planning Coordinator
- EMO – Emergency Management Office
- FBC – Fraser Basin Council
- FMP – Flood Management Professional
- FN – First Nations
- ICLEI-Canada – The International Council for Local Environmental Initiatives – Local Governments for Sustainability
- IFHM – Integrated Flood Hazard Management
- IOD – Inspector of Dikes
- IPREM – Integrated Partnership for Emergency Management
- ISWP – Integrated storm water management
- JPC – Joint Program Committee (within FBC)

LMLGA FCRMC – The Lower Mainland Local Government Association’s Flood Control and River Management Committee

MFLNRO – Ministry of Forests, Lands and Natural Resource Operations

MOE – Ministry of Environment (BC)

MOT – Ministry of Transportation (BC)

MOU – Memorandum of Understanding

NSEMO – North Shore Emergency Management Office

OCP – Official Community Plan

PCIC – Pacific Climate Impacts Consortium

PICS – Pacific Institute for Climate Solutions

PSC – Public Safety Canada

REAC – Metro Vancouver’s Regional Engineers’ Advisory Committee

RAAC – Regional Administrative Advisory Committee

REPC – Regional Emergency Planning Committee

REAC CPS – Regional Engineers Advisory Committee - Climate Protection Subcommittee

RFC – River Forecast Centre

RPAC – Metro Vancouver’s Regional Planners’ Advisory Committee

SLR-C – Sea Level Rise Collaborative

UBCM – Union of British Columbia Municipalities

WCEL – West Coast Environmental Law

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RESPONSIBILITY

In addition to gratitude and privilege, it is a sense of responsibility that I feel the most. How can I leverage my knowledge and skills to make a difference given the acute and immense challenges facing us as citizens of this planet and professionals and academics in the field of climate resilience and disaster risk reduction?

Back in 2010, I talked about this with Buzz Holling, a father of ecological resilience theory: “We are having a hard time with applying ‘resilience’, a beautiful theoretical construct, to practice in the field of disaster risk reduction. What needs to be done?”

An unusually heavy snow was falling behind the window on the Salish Sea; Buzz’s dog was curled up, snoring in an armchair in his home on Vancouver Island. Buzz smiled at me and said: “Try harder”. And so I did.

Dedication

To my parents: my Mom Raikhana who walked 14 kilometres to her school and my Dad Anver, a fearless human and environmental rights activist who fought for the right of his children to better education.

Chapter 1: Introduction

Over half of the global population now lives in cities, with some predicting that two thirds of the projected 9.5 billion in 2050 will inhabit towns and cities. Between 1950 and 2005, the level of urbanization increased from 29% to 49%, while global carbon emissions from fossil-fuels increased by almost 500% (UN Habitat, 2016). Climate change poses fundamentally novel planning challenges for coastal regions (e.g., sea-level rise, loss of agricultural lands due to salt water intrusion); current decision-making processes and institutions are inadequate to deal with this change (National Research Council, 2009). For example, in the field of water management, climate change undermines a basic fundamental assumption of ‘stationarity’ that historically has facilitated management of supply, demand, and risk (Milly et al., 2008). Climate change also exacerbates the challenge of identifying the range of impacts of natural hazards in terms of scale, location, timing, and frequency (Birkmann et al., 2010).

Set against this backdrop of demographic and environmental changes, the increased uncertainty, connectivity, interdependence, and complexity of socio-technical systems enables quick escalation of small disturbances into compound and cascading crises (Boin & Mcconnell, 2007; Pescaroli & Kelman, 2017). “Just in time” supply chains, reliance on electronic systems, planning and development patterns that place development in risk-prone areas, aging infrastructure and increasing congestion are frequently cited as causes for increased potential for cascading failures and escalating losses (Boin & Mcconnell, 2007; Chen, Chen, Vertinsky, Yumagulova, & Park, 2013; Rinaldi, Peerenboom, & Kelly, 2001). These risks are amplified in cities that are highly dependent on critical infrastructure networks that support them, yet lack the necessary infrastructure and institutions to respond to the high rate of change (UN Habitat, 2016). Connectivity and interdependency of megacities and regional and global financial systems enables spreading of the negative consequences of a specific hazard in a specific location across the global economy with significant systemic loss effects, triggering international disruptions.

In this rapidly urbanizing world, subject to an increasing number of conflicts, disasters, food shortages, droughts and extreme weather, we are seeing a shifting focus from a question of “How can urban systems grow sustainably?” to “How to ensure that cities survive in the face of multiple shocks and stressors?” The concept of ‘resilience’ has penetrated and propagated urban theory and practice: from international frameworks to municipal plans, resilience seems to offer

a promising nexus between the qualities of cities that we strive to maintain while using a crisis to transform them into a more desirable state.

Given the acute pressures ranging from extreme weather events and disasters to economic downturns, cities around the world have been adopting resilience as a guiding principle for urban planning and management (e.g., ACCCRN City Resilience Framework, Rockefeller Foundation City Resilience Framework, UNISDR Resilient Cities Framework; also, see Sharifi & Yamagata, 2014). In North America, several cities have developed strategies and plans that connect shocks and stressors to general adaptability. Some of the examples were partially facilitated by the Rockefeller Foundation's 100 Resilient Cities campaign. For example, New Orleans' "Adapt to Thrive" strategy connects the most urgent threats to long term environmental change and seeks ways to redress the legacy of inequity and risk by transforming urban systems through planning. It places a specific emphasis on regional cooperation: "Single jurisdictions cannot effectively build better levee systems, restore the coast, create stronger economies, ensure safe and affordable housing for our workforce, or build transportation systems that will serve us into the future. It is only through cooperation, among cities and towns acting together as a region, that we will be able to effectively engage these challenges" (City of New Orleans, 2015). Similarly, in San Francisco, an initial focus on planning for earthquakes (a familiar and previously experienced hazard) has led to a proactive approach to sea level rise planning. This also resulted in a coordinated effort to connect hazard planning and management with the city's broader strategies on housing inequality. A special emphasis was placed on regional resilience to move beyond 'talking about regionalism' to acting and cooperating through an umbrella organization. In Boston, the Chief Resilience Officer is tasked with connecting emergency management issues to racism, in a city of high racial tensions with over 50% of people of colour.

These examples of connecting specific hazard planning to the general adaptability of an urban system were unprecedented when I started my research on this topic, with one exception: the Greater Vancouver Regional District. It offers a unique case study for studying the policy and practice of regional resilience, as a region with a distinctly collaborative regional planning culture, "*l'exception canadienne métropolitaine*" (Smith & Oberlander, 2006).

Metro Vancouver (formerly Greater Vancouver Regional District (GVRD)) is a single administration for several legal entities and subsidiaries. Administratively and politically, Metro Vancouver it is a federation of 21 municipalities, one treaty First Nation, and one electoral

(unincorporated) area, all of which vary greatly in size and character. It provides local government services, mainly through the member municipalities. It was created in 1967 but core utilities (water and sewer) date back to the early 20th century. For example, the Committee of the Greater Vancouver Joint Sewerage and Drainage System was established in 1911. History shows that the regional district has been able to adapt to the new needs of the region by acquiring new responsibilities over time and expanding its territorial jurisdiction as the urban area grew and changed (Taylor, 2010).

The diversity of Metro Vancouver municipalities is frequently emphasized in the official documentation, especially in relation to size, cultural diversity, history, geography, and economy. Respect and reinforcement of this diversity, character, and the independence of local municipalities lay the foundation for core principles of regional governance. The first climate change related report (“Clouds of Change” for the City of Vancouver) was produced as early as 1990. It is also one of the first regions in the world to develop an internationally acclaimed, award winning plan for regional resilience – ‘citiesPLUS’ (as early as 2002-03).

Given the rapid expansion of resilience frameworks and applications around the world, theory and scholarly endeavors have also burgeoned but are seemingly behind the practice of resilience planning in cities. Some important unexplored dimensions remain: how does planning for resilience in individual cities influence adaptive capacity (latent ability to handle change) of city-regions? How do existing hazard management regimes influence the ability to deal with new hazards and risks? As a test in navigating the new reality, are there ways in which planning for hazard-specific resilience contributes to a general ability to deal with change?

One of the key aspects of the complexity of planning for resilience that has been identified in socio-ecological (Carpenter et al., 2012; Walker, 2005; Walker et al., 2014), socio-technical systems (Haimes, 2009), organizational theory (Wildavsky, 1988), and emergency management (Handmer & Dovers, 2007) literatures, is a tension between planning for specific hazards or threats (referred to here as specific resilience (sp-R)) versus planning for the overall ability to handle change (referred to here as general resilience (gen-R)). Some have suggested that the more the system is ‘optimized’ to respond to specific or regular shocks (sp-R), the less resilient it becomes to unknown shocks (Walker, Abel, Andries, & Ryan, 2009). However, few studies have examined this question empirically. In part, this is due to methodological difficulties. The proliferation of academic literature on measuring and assessing resilience has

been criticized for its reductionist measurement focus: “Measuring and monitoring a narrow set of indicators or reducing resilience to a single unit of measurement may block the deeper understanding of system dynamics needed to apply resilience thinking and inform management actions” (Quinlan, Berbes-Blazquez, Haider, & Peterson, 2016, p. 677).

I address the procedural dimensions of specific and general resilience planning in a multiscale setting – municipal, urban metropolitan and provincial contexts – by critically examining how planning for specific risks (such as flooding) contributes to long term resilience of a nested governance system in the context of climate change. I focus on freshet and coastal flood management planning processes within municipalities in MVR. Within the broader procedural theme, I am particularly interested in two issues: structural versus non-structural approaches to flood management and addressing regional planning interdependencies. These two issues are interwoven throughout my research questions.

Few studies have explored regional resilience planning for multiple risks. To address this gap, I primarily focus on the regional scale, with consideration of the perspective that resilience cannot be understood by focusing on one scale where at least three scales need to be explored (Walker, 2011) – the focal scale (regional), one above (provincial) and one below (municipal). Similarly, it has been long understood that environmental and resilience issues are best addressed at the regional scale (Bizikova, Neale, Burton, 2008). Nonetheless, the development of responses to the issues of regional governance is slow (McGee & De Castro, 2010) and is weakly explored particularly from disaster resilience planning and management perspectives. In the context of climate change, an explicit analysis of resilience planning initiatives and the hazard-risk-resilience continuum is important, given their differing perspectives on whether climate change will primarily amplify existing hazards, requiring enhancement of existing functions, or present categorically distinct threats requiring innovative management strategies (Hess, McDowell, & Luber, 2012) and investments in the general ability to deal with change. For floods, Hegger et al. (2014) suggest that assessing changes in flood risk management regimes requires tracking changes in actors, rules, power, and discourses which means that flood risk governance arrangements should be analyzed longitudinally to acquire insights in the degree of stability and dynamics.

Internationally, examining the relationship between specific and general resilience is especially timely in the light of the new United Nations *Sendai Framework for Disaster Risk*

Reduction 2015 – 2030. The framework expands beyond the narrowly focused objective of better managing disasters and calls for integration and mainstreaming of disaster risk reduction as part of urban planning processes, informed by long term demographic and environmental trends. It calls for higher levels of collaboration and learning, for recognition of stakeholders and their roles and all-of-society and all-of-State institutional engagement. Compared to the *Hyogo Framework*, Sendai calls for a stronger emphasis on disaster *risk* management as opposed to disaster management, the strengthening of disaster risk *governance*, reducing existing risk and strengthening resilience but also for mobilization of risk-sensitive investment to avoid the creation of new risk. The scope of disaster risk reduction has been broadened significantly to focus on both natural and man-made hazards and related environmental, technological, and biological hazards, and preventing new risk. In other words, the much broader framing of ‘risk’ calls for a more general understanding of resilience.

1.1 Focusing on the resilience process

Resilience of cities and regions is determined by many factors, including relationships with ecosystems (Alberti & Marzluff, 2004; Ernstson et al., 2010; Pickett, 2004), social networks (Adger, 2000; Goldstein, 2007, 2009; Matyas & Pelling, 2015), governance structures (Duit, Galaz, Eckerberg, & Ebbesson, 2010; Lebel, Andries, Campbell, & Folke, 2006; Leichenko, 2011) and infrastructure systems (Chang, McDaniels, Fox, Dhariwal, & Longstaff, 2014; McDaniels, Chang, Cole, Mikawoz, & Longstaff, 2008; Ribes & Finholt, 2007; Shinozuka et al., 2003) that can respond to and plan for a variety of demographic, economic, and environmental changes.

A considerable amount of research effort has gone into identifying the metrics for measuring (socio-technical systems (STS), socio-economic systems (SES), engineering, social systems) resilience following a disruption, disturbance, failure, and subsequent recovery. However, an increasingly important and less explored research dimension is understanding the resilience building process prior to disturbance. As Linkov et al. suggest, “advancing the fundamental understanding and practical application of resilience requires greater attention to the development of resilience process metrics, as well as comparison of resilience approaches in multiple …contexts for the purposes of extracting generalizable principles” (2013, p. 10108). This study makes a contribution by explicitly focusing on the pre-disruption *planning process* for building resilience and its key procedural dimensions such as collaboration, learning, and the

ability to maintain options. This study makes a theoretical contribution by combining the sp-R – gen-R framework that was proposed within the SES literature (but acknowledged as a weakly understood one (Carpenter et al., 2012; Walker et al., 2014) with planning, hazards/disasters, and organizational studies bodies of literature. This contribution is based on understanding that planning is a distinct capacity of human systems and thus it can play a foundational role in defining the relationship between sp-R and gen-R, as both a constraining and enabling mechanism. An empirical contribution is made by applying the framework to a specific context and expanding its application from SES theorizing to a practical nested, multi-scalar case study.

How are sp-R and gen-R connected? For the purposes of this study they are connected *procedurally*. The planning process across different scales (e.g., municipal, regional, provincial) can enhance or erode resilience. To better understand synergies and tensions within this process, a multiple-case study design nested within multi-scalar policy context was employed. A comparative analytical approach was employed along two angles of inquiry: 1) comparison of the established freshet flood with the emergent sea-level rise regime, and 2) the inter-municipal variation in risk that allowed for an in-depth exploration of municipal institutional responses nested within the regional and provincial policy content and planning practices. In addition to focusing on exploring the practice and policy of sp-R and gen-R, an emphasis on the politics was also placed, given the gap in our understanding of the politics of urban and regional resilience in the face of climate change (Abel et al., 2011; Shaw & Maythorne, 2013).

Sp-R management (planning processes, organizational characteristics, learning procedures, and decision making for resource allocation) can contribute synergistically to gen-R mechanisms or they can erode it. Sp-R planning can also take a multi-objectives approach where, for example, flood resilience measures are weighted against general measures of adaptability. Testing sp-R through specific events (e.g., a regional scale flood) can also expose limitations in gen-R, e.g., levels of regional cooperation. Theoretically, lessons learned in the acute state that are carried through to the normal state of operation would make the system more resilient. It is important to note that given that resilience is a process and not a state, focal characteristics are to be treated as sp-R and gen-R trends or vectors rather than deterministic indicators. In other words, no measurement is being proposed that would definitively indicate that the region is ‘resilient’. However, I hope that this study will provide critical insights to the following question: how can sp-R processes be designed in order to build gen-R?

1.2 Flood management as a shared responsibility

Floods are the most frequent and costly natural hazard in Canada. Some recent examples of damaging events include the 2013 southern Alberta floods (approximately 4,000 businesses and 2,000 homes were directly impacted, more than \$50 million was spent on emergency response, and overall damages were estimated at \$6 billion) and the 2013 flood event in Toronto (nearly \$1 billion in damages and a disrupted transportation network). Flood management is considered to be a ‘shared responsibility’ in Canada between the federal, provincial, regional and municipal governments and property owners. It has been suggested that Canada does not properly manage its flood risk (Jakob & Church, 2011). Over time, Canada has seen a significant reduction of federal programs and funding in the area of flood risk management with an increasing responsibility at the municipal level. Federally, there have been some recent changes in the flood management arena.

Flood hazard management is framed as a shared responsibility in British Columbia between the various levels of government. However, as will be illustrated in Chapter 4, since the 2003-2004 legislative changes, it is local governments that bear a lot of responsibility for planning and land use with respect to hazards, as well as planning and responding to flood events when they happen. Local governments are also the main owners and responsible entities for engineered flood works (e.g., the diking authority). Under the current legislative context, the provincial government sets guidelines for land use planning in flood hazard areas and regulates flood protection structures such as dikes. Several Ministries are involved in flood protection, mitigation, and response. As Chapter 4 will illustrate, the overall flood management regime in BC can be characterized by the dominance of structural approaches, weak scientific basis (flood mapping), ad-hoc, competitive funding mechanisms and lack of strategic approaches to regional flood management.

1.3 Research objective and goals

The objective of this research project is to investigate how hazard-specific planning influences the general ability to plan for change across levels of governance. Two flood hazards were identified as regional priorities: freshet flooding (existing, known) and sea-level rise (emergent). These hazards, while both addressed under the flood management regime that characterizes sp-R, have distinct profiles which hypothetically result in distinct planning

approaches and practices. This interplay provides an opportunity to explore gen-R through institutional responses to existing and emergent flood hazards.

My overall research question is:

What is the relationship between specific and general resilience?

Practical question:

What planning processes and practices specific to flood management enable or constrain a general ability to deal with change across levels of governance?

More specifically, I answer the following questions:

Chapter 5 (municipal and sub-regional):

- What are the key elements of sp-R at the municipal scale?
- What is the relationship between sp-R and gen-R at the municipal scale?

Chapter 6 (regional; multi-scalar):

- What are the barriers for sp-R at the regional scale?
- What is the relationship between sp-R and gen-R at the regional scale and across multiple scales of governance?

These questions and sub-questions are linked to preliminary propositions that guide data collection and analysis. The main proposition of this research is that sp-R and gen-R are related through *planning*, a dedicated process for connecting knowledge to action (Friedmann, 1987) across temporal and spatial scales and a distinct capacity of human systems.

The propositions are schematically presented in Table 1-1 and are subsequently spelled out.

Table 1-1 Key propositions: barriers and enablers of sp-R and gen-R

	Sp-R to floods	
	Known risk (freshet)	Emergent/novel risk (SLR)
Barriers	Proposition 1A	
Enablers		Proposition 1B

Proposition 1A: A high degree of emphasis on planning for sp-R erodes a system's gen-R, because it:

hinders the development of social capital, self-organizing for political influence and collaboration by prompting more insular planning practices within already established actors and institutions;

- inhibits proactive learning as it focuses on known risks and known approaches for managing them;
- limits future options and creates path-dependency by diverting limited financial and staff resources from alternative solutions and options by investing existing approaches (esp. technocratic approaches to risk reduction such as dikes);
- enables rigidity by emphasizing existing procedures focused on specifics and thereby reducing institutional flexibility and improvisation.

Proposition 1B: Planning for emergent and novel risks increases gen-R as it:

- builds social and human capital by increasing the range of stakeholders involved beyond already established actors and institutions;
- fosters learning, innovation, and knowledge co-production by seeking to include a variety of knowledge systems beyond experts (e.g., local, Traditional Knowledge);
- fosters inter-organizational, inter-sectoral, and cross-scale collaborative arrangements as it motivates organizations to seek new solutions beyond the scope of current planning policies/practices and existing networks. This fosters institutional diversity and reservoirs and contributes to gen-R;
- presents an opportunity for considering alternative regional approaches for maintaining options (e.g., green infrastructure, multiple co-benefits of hazard mitigation options that could contribute to gen-R of the region);
- serves as an opportunity to rethink regional governance process for flood management resulting in new ways of thinking and acting regionally (e.g., builds new forums for interaction on the specific issues that contribute to more efficient communication, lowers transaction costs, etc., in procedural co-benefits in other regional planning domains).

1.4 Making a case for a Canadian case of regional resilience planning

This study focuses on the Metro Vancouver region (MVR) located in British Columbia (BC), the westernmost province of Canada. At 944,735 square kilometres, BC is about the size of France, Germany and the Netherlands combined but only about 5% is arable. Nearly 55% (2.464 million) of the population of the province lives in MVR on 2,882.55 square kilometres (0.31% of the total landmass). The region lies at the foothills of mountains, surrounded by ocean at the mouth of the Fraser River. The area has been inhabited by the Coast Salish First Nations for thousands of years prior to the intensification of European arrivals in the mid-1800s.

The metro region experienced a 9.3% growth rate between 2006 and 2011 (Statistics Canada, 2011), mostly fueled by immigration. Within the 24 regional member municipalities, there is a significant variance in growth from 0.5% (District of North Vancouver) to 19.9% (City of Port Moody). The City of Vancouver is the largest municipality in the region, with 27% of the regional population residing on 4% of regional land share, making it one of the Canada's most densely populated cities with 5,249 people per square kilometre. Some of Canada's fastest growing municipalities (e.g., City of Surrey) are also located in this region. A mild climate, breathtaking scenery combined with the region's internationally acclaimed livability image contribute to one of Canada's most expensive real estate prices fueling a housing affordability crisis. The diversity of member municipalities in terms of demographics (from stable to Canada's fastest growing municipalities), size variance (from villages of 650 people to Vancouver at 650,000), cultural diversity, economies, and geographical and historical contexts, combined with drivers of change/risks make this region a rich case study for furthering the understanding of the dynamics behind regional planning for resilience.

This densely populated region is subject to significant natural hazard risks. Seismic activity puts it at the higher risk of catastrophic earthquake than in other parts of Canada. It is also subject to intense rain storms, potentially catastrophic Lower Fraser River flooding (Figure 1-1) and an increasing rate of sea level rise (SLR). The ocean water levels in the region are influenced by short term processes, acting over a period of a few minutes to a few days (tides, storm surge, wind setup, wave setup), and long-term processes, acting over a year or more (El Nino, the Pacific Decadal Oscillation, SLR, subsidence/uplift) (NHC, 2015). In the past 200 years, intensive development altered the shoreline for industrial, commercial and residential uses, including dikes, sea walls, and other armouring that allowed for placing buildings and structures at sea level and lower. This presents a temporally and spatially distributed planning challenge.

The regional vision of "Cities in a Sea of Green" called for a compact region surrounded by a natural landscape and an agricultural land reserve, a progressive 1973 policy to permanently protect public and private agricultural lands from other uses. Some of the regional gems include Pitt Lake, the largest tidal lake in North America (City of Pitt Meadows, 2011); Burns Bog Ecological Conservancy, the largest raised bog ecosystem on the west coast of the Americas and the largest undeveloped urban landmass in North America (Corporation of Delta, 2014c), and

Stanley Park, an old growth rainforest and the third-biggest urban park in North America at 400 hectares.

Some of the region's critical infrastructure such as Vancouver International Airport and four out of five wastewater treatment plants are located in the floodplains. Approximately 300,000 people are protected by the dikes and an estimated \$50 billion-worth of infrastructure and property is at risk (Richmond Chamber of Commerce, 2014)). A high-level overview of the floodplain of the Lower Fraser River is presented in Figure 1-1 on the next page. A large magnitude flood is likely to affect a significant portion of the region's population, directly or indirectly, and disrupt local, regional, provincial, and national economic activity (Fraser Basin Council, 2015).

Regional adaptation and resilience planning demand the contribution and participation of multiple stakeholders given the dependencies between them in planning, maintaining infrastructure, and delivering services for effective regional functioning. Management of the diversity of interests and interdependence needs to be done in a strategic way that would ensure participation of affected parties and avoid sub-regional balkanization. Yet, accommodating hazard-specific and site-specific solutions has been the dominant historical approach in MVR. The trade-offs and the costs of autonomous (municipal) adaptations have not been systematically considered against regional investments and priorities. Resilience as a policy objective requires a generalizable approach applicable to a diverse array of systems and revealing of their interconnectivity (Linkov et al., 2013). Insufficient knowledge and institutional capacity to address issues of metropolitan interdependence, 'unequal' spatial distribution of risk across the region, historically and spatially based factors for collaboration (e.g., geographic proximity), and systematically absent actors at the regional scale (e.g., First Nations) are some of the issues that became immediately evident during my initial research and proved that this would be a compelling case for studying the outlined research questions.

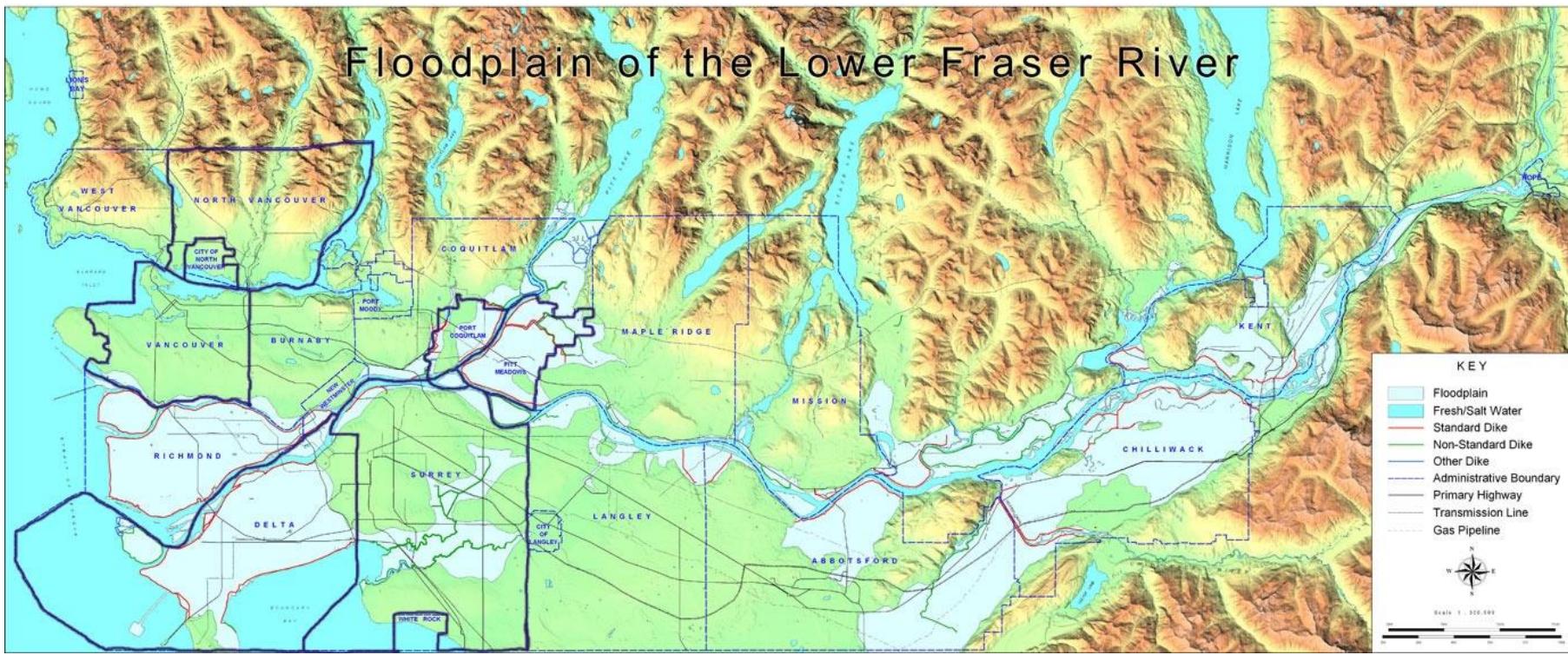


Figure 1-1 Floodplain of the Lower Fraser River with highlighted selected case-studies

Note: Maple Ridge and Langley are the eastern borders of the study district. Source: Fraser Basic Council. Used with permission

1.5 Regional institutional context and governance

This area provides a unique case for investigating the role of metropolitan governance as it is Canada's only non-amalgamated major metro area. Metro Vancouver (MV) is a partnership comprised of 21 municipalities, one Treaty First Nation and one unincorporated area that collaboratively plans for and delivers regional-scale services (such as drinking water, wastewater treatment, solid waste management, air quality regional planning, regional parks, and affordable housing). There is no single flood management authority for the region; instead, each municipality is the principal authority responsible for flood mitigation, preparedness, and response within their boundaries. The degree of risk that municipalities face for the two identified natural hazards varies across the region given their diverse topographic, demographic, and socio-economic conditions.

The regional district is governed by the MV Board which has 37 Directors, comprised of elected officials from each local authority. According to their official website, MV is both a nonpartisan political body and corporate entity operating under provincial legislation as a regional district on behalf of members. Its three primary roles are service delivery, planning, and political leadership. Core services, provided principally to municipalities, include the provision of drinking water, sewage and drainage, and solid waste management. The three main areas of regional planning and regulatory responsibility relate to regional growth (land use through municipalities and transportation), waste management (solid and liquid waste), and air quality management (a delegated Provincial function).

MV serves as the main political forum for discussion of significant community issues at the regional level. The core principles of this non-hierarchical partnership are that issues are resolved through consensus, and results are based on coherent regional action and services which respect and reinforce the diversity, character, and integrity of local municipalities; protect the natural environment; and maintain cost effective service delivery. Municipal independence has always been a cornerstone of any regional organization as a quote about the early years of metropolitan Vancouver history shows: "Intermunicipal governance is based upon ad hoc incrementalism, an approach which creates intermunicipal institutions only where the continued delivery of a service by municipalities alone is unfeasible. This approach – really an upward delegation of municipal authority – is adaptive and flexible, having evolved over a period of decades during which the Province has maintained an arms-length, yet responsive approach to

local self-determination” (Cameron & Karlsen, 1992, p. 2). An overview of this type of governance structure suggests that this system exhibits properties of resilient systems: it encompasses diversity; it has the capacity to self-organize from the bottom-up while being enabled by a consensus-driven body; and as a system based around consensus, it ensures sensitivity to local municipal issues and a balance to parochial interests. However, from disaster and climate resilience perspectives, this diversity also shows a need for a more coordinated regional approach. Reactive and autonomous adjustments (Smithers & Smit, 1997) to changing flood risk undertaken by individual municipalities may accumulate long-term costs for the region. Local adaptation planning is subject to policies designed at the higher levels which can have unforeseen consequences at local scales (Baker, Peterson, Brown, & McAlpine, 2012). Thus, the implications of this governance system for the resilience planning in the region need to be further examined.

1.6 Dissertation Structure

Six chapters follow this introductory chapter. In Chapter 2, I review resilience theory with a focus on urban resilience. I draw on hazards, risk, and disaster studies, socio-ecological systems, and urban and regional planning resilience literature. I specifically explore how the relationship between sp-R and gen-R has been conceptualized across these broad disciplines and provide some examples of the application of resilience in practice to support my theoretical arguments. I conclude with a conceptual framework that connects sp-R and gen-R based on the literature review. In Chapter 3, I explain the research design, strategy, and the mixed methods I employed to collect and analyze my research data. The remaining chapters present my data and findings. In Chapter 4, I provide a detailed description and analysis of the multi-scalar institutional and governance context with a focus on the regional scale: from a brief history of regional planning in MVR to the current day flood management regime. In Chapter 5, I analyze key enabling and constraining legislation, tools, and mechanisms, and trade-offs that define the sp-R–gen-R relationship at the municipal scale. In Chapter 6, I explore the sp-R–gen-R relationship at the regional scale situated within the analysis of barriers and drivers of action across multiple scales of governance. By focusing on historical antecedents of the current flood management regime, I provide an analysis of how sp-R planning contributes to the gen-R of formal and informal institutions that comprise the flood governance regime in BC. I conclude this study with policy recommendations and identify further research areas.

Chapter 2: Literature review and conceptual framework

In the past decade *resilience* has rapidly gained momentum as a metaphor, a subject of academic endeavours and a public policy objective at a community, municipal, regional and national scales. An analysis of the resilience planning process in MVR demands a thorough understanding of the co-evolving rise of ‘resilience’ theory and praxis. I begin with an outline of recent trends through a review of international grey literature that highlights the quest for resilience as a critical policy objective. I then provide an overview of several streams of resilience theory that inform this inquiry. These range from socio-ecological to hazards and disasters to urban and regional studies. I conclude with a conceptual framework.

2.1 Why ‘resilience’?

A rapidly populating and urbanizing world, subject to resource shortages, increasing conflicts, extreme events and disasters resulted in a reduced “safe operating space for humanity” (Rockström, et al., 2009). As the International Geosphere-Biosphere Programme synthesis report suggests, the Earth System has now entered a “no-analogue state” (Steffen et al., 2004) in which past behaviour of the system can no longer serve as a reliable predictor of future behaviour, even when circumstances are similar (Duit et al., 2010). Climate change exacerbates the challenge of identifying the range of impacts of natural hazards in terms of scale, location, timing, and frequency (Birkmann et al., 2008). In the context of escalating losses (Munich Re, 2015; UNISDR, 2009, 2011, 2015) we are seeing a shifting focus from a question of “How to ensure sustainable growth?” to “How to survive in the face of multiple shocks and stressors?” The concept of ‘resilience’ has penetrated and propagated theory and practice: from international frameworks to municipal plans, ‘resilience’ offers a promising nexus between the qualities that communities strive to maintain, while using a crisis as an opportunity to transform into a more desirable state. What can theory contribute to practice of resilience? What could more resilient planning look like? What theoretical frameworks and cross-sector multi-disciplinary principles can inform resilience building at different levels? Drawing on several decades of socio-ecological, public policy, organizational and urban studies, this literature review traces the historical antecedents of planning for resilience principles and grounds them in current examples of applied resilience planning.

Global disaster trends indicate that while the number of deaths has been decreasing over the past century, the number of reported disasters, the number of people reported affected, and

economic damage from disasters has been increasing (CRED, 2011). The most recent data shows that from 2005-2015, disasters caused over 700,000 deaths, 23 million were made homeless and more than 1.5 billion have been affected, with women, children and marginalized and poor suffering the most (UNISDR, 2015). The total economic loss exceeded \$1.3 trillion (*ibid*).

Disaster are outcomes of deep-rooted inequitable policies and planning and development failures. Yet, disasters continue to be addressed as discrete, unfortunate events while disaster risk is considered as an externality to be managed, “the act of a ‘bad star’ (Latin: dis-aster) that must be prepared for, and not as a socially constructed problem driven by underlying processes neglect of which manifests as a predictable and tragic ‘down turn’ (Greek: cata-strophe)” (Lavell & Maskrey, 2014, p. 271)

There is a direct relationship between urbanization and disasters. Disaster risk is amplified in cities that are highly dependent on critical infrastructure networks that support them, yet lack the necessary institutional capacity to respond to change (UN Habitat, 2016).

Connectivity and interdependency of megacities and regional and global financial systems enables spreading of the negative consequences of a specific hazard in a specific location across the global economy with significant systemic loss effects, triggering international disruptions. Some striking examples of the interconnected and cascading events include the 2004 Indian Ocean tsunami that directly affected 14 countries, killing 230,000 people with more than 5,000 people killed in Thailand alone, including tourists, and causing the largest numbers of deaths from a natural hazard in Sweden’s history (G-Science Academies Statement, 2016); the 2006 drought in Syria was one of several contributing conditions that led to the current humanitarian refugee crisis (G-Science Academies Statement, 2016); the 2013 hottest heatwave in 130 years and fires in Russia caused 54,000 additional deaths, an economic damage of 1.4% GDP, and the subsequent export ban resulted in a 16% increase in wheat prices and a 1.6% increase in poverty over this period in Pakistan (Welton, 2011); and, finally, studies have shown that increase in Ebola outbreaks are associated with drastic changes in forest ecosystems (e.g., deforestation) in tropical Africa through bat habitat displacement (Muyembe-Tamfum et al., 2012).

These levels of complexity, interdependency, and hyper connectivity necessitate a fundamental reconfiguration of how crises and disasters are planned for and managed by moving from planning for specific risks to planning for system-wide resilience. Resilience, a built-in capacity to respond to change and multiple risks, is increasingly becoming a popular policy

objective at the organizational, community, regional, national levels (e.g., National Research Council, 2011; Australian Government, 2010, 2011; Public Safety Canada, 2011, 2015; United Kingdom, 2014). Cities around the world have been taking leadership in adopting resilience as a guiding paradigm for urban planning and management (e.g., ACCCRN City Resilience Framework, Rockefeller Foundation City Resilience Framework, UNISDR Resilient Cities Framework). Some suggest that resilience offers practitioners a new dynamic perspective on change that reconciles the short- and long-term perspectives of crisis management and planning for sustainable development (Sellberg, Wilkinson, & Peterson, 2015).

Globally, the concept of resilience has also seen a proliferation within the leading international frameworks and initiatives. For example, in 1994, the “Yokohama Strategy and Plan of Action for a Safer World mentioned ‘resilience’ once in relation to local communities “self-confidence to cope with disasters through recognition and propagation of their Traditional Knowledge, practices and values as part of development activities” (p.8). The subsequent *Hyogo Framework for Action (HFA)* used ‘resilience’ as a key word: it states “Building the resilience of nations and communities to disasters” (UNISDR, 2005) calling for knowledge, innovation and education to build a culture of safety and resilience at all levels. The word ‘resilience’ was mentioned 16 times primarily referring to resilience at different scales of governance (e.g., resilience at all levels including national and community resilience (6), building culture of disaster resilience (4), hazards resilience (1), and health sector resilience (1). HFA defined resilience as a proactive term:

The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures. (UNISDR, 2004)

The most recent Sendai Framework for Disaster Risk Reduction (UNISDR, 2015) mentions ‘resilience’ over 40 times and significantly expands on the application as a cross-sectoral and multidisciplinary concept. Building on HFA, it speaks to cultural resilience and social resilience, community resilience, household resilience, but also expands the notion calling for investing in the resilience of persons, communities and countries and the environment. It mentions economic and business resilience and supply chain resilience; technology and

resilience; resilience of infrastructure and critical facilities, including health resilience and educational resilience, investments for resilience and workplace resilience. It provides a narrower definition of resilience, focusing on more reactive qualities compared to proactive Hyogo definition:

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. (UNISDR, 2009 in UNISDR, 2015)

While the concept has captured imagination of policy makers, politicians and planners, can ‘resilience’ uphold the promise? What theoretical frameworks and cross-sector multi-disciplinary principles can inform resilience practice? In what follows, I review the evolution of conceptual frameworks and the associated management practices: from controlling *hazards* to managing *risk* to planning and organizing for *resilience*. I review some of the core underlying theoretical antecedents of the *hazard* to *risk* to *resilience* continuum. I then discuss limitations of planning and identify core principles of resilient systems drawing on interdisciplinary literature review from socio-ecological, hazards/disasters, planning, public policy and organizational studies. I then discuss key emergent challenges in organizing for resilience: the relationship between sp-R and gen-R. I conclude with a conceptual framework for this study.

2.2 An evolving continuum: from controlling hazards to managing risk to organizing for resilience

Hazard mitigation and adaptation to climate variability are as old as human development. Ancient civilizations (e.g., China, Maya, Egypt, and Mesopotamia) directly intervened to mitigate the effects of disasters with governments playing a major role in developing and financing elaborate systems of flood control (Covello & Mumphord, 1985). *Hazard* is commonly defined as the potential occurrence of natural or human-induced physical events that may adversely affect vulnerable and exposed elements. For the longest time *hazard management* has been framed as a technical problem to be solved for controlling nature, rather than a complex challenge of planning for and building systems that could respond creatively to the unpredictable stresses of changing environmental risk and disasters (Godschalk, 2003). A hazards school of thought lead by geographers and geoscientists (Burton and Kates, 1964; Burton, Kates, & White, 1978) focused on understanding the hazard itself (e.g., floods or earthquakes). A focus on hazard

cycles, physical processes, probability and impacts of natural and technological hazards portray disasters as epiphenomena (Perry & Quarantelli, 2005) which resulted in an emphasis on engineering solutions to control hazards rather than addressing root causes of disasters such as inequity and social construction of risk. In 1942, Gilbert White's seminal work challenged the notion that natural hazards are best addressed by engineering solutions by suggesting that flood losses are largely acts of man. For example, the levee effect (Tobin, 1995) can bring a false sense of safety based on structural protection which encourages further development and eventually results in losses once the levees get overtopped, as was vividly exemplified in Hurricane Katrina. To focus on what lies behind the levee – the river that can flood – is to focus on the *hazard*. To focus on a likelihood of an event occurring and its consequences – is to focus on *risk*. To focus on what and who can be harmed by the flood when a flood occurs – is to focus on *vulnerability*. To focus on how communities and systems that could be harmed respond, adapt, learn from and plan for future floods – is to focus on *resilience*. There is a need to coordinate these theoretical frameworks for better understanding and management of *disaster risk* and resilience planning. Only through a journey that links causes with effects is it possible to identify policies or practices that could manage processes of risk construction and consider the trade-offs inherent in any process of risk management. (Oliver-Smith, Alcántara-ayala, Burton, & Lavell, 2016).

The effectiveness of disaster risk management policies is impeded by the lack of a comprehensive conceptual framework that facilitates a common multidisciplinary risk evaluation. What follows is an analysis of policy implications and trade-offs between some of the key approaches to disaster risk reduction and climate change adaptation (Table 2-1), adapted from Eakin et al. (2009, p. 214) and Moser (2011). Most policy decisions concerning disaster risk and hazard policy can be identified primarily with the core tenets of the following approaches: risk-based, vulnerability and resilience. Each approach is associated with parallel and occasionally overlapping intellectual trajectories as well as gray areas in the theoretical literature on disaster risk management, social vulnerability and resilience of socio-ecological systems.

Table 2-1 Risk-based management, vulnerability and resilience approaches

Approach Criteria	Risk-based Adaptation	Vulnerability	Resilience
Stressors	Single stressor	Multiple stressors	Multiple variables

Main approach	Identifying and reducing risk (physical, social, etc.)	Reducing social vulnerability	Managing ecosystem resilience
Policy context of origin	Natural hazard mitigation	Poverty and social welfare investment; development literature	Natural resource management
Spatial scale of implementation	Sectoral focus	Places, communities, groups	Large-scale coupled socio-ecological systems (e.g., a populated watershed)
Temporal emphasis of implementation	Short-term and medium-term future risks	Past and present vulnerabilities	Long-term future
Actors	Public-private partnerships	Public sector, vulnerable groups	Civil society, public sector
Policy goal	Address known and evolving risks	Protect populations most likely to experience harm	A new ‘normal’; enhance system capacity for recovery and renewal
Desired outcome	Maximum loss reduction at lowest cost	Minimize social inequity and maximize capacities of disadvantaged groups	Minimize probability of rapid, undesirable and irreversible change
Experience/implementation	Well-established	Well-established	Emerging

Eakin et al. (2009) suggest that given the challenges of climate policy making a blended approach might be necessary while the *trade-offs and assumptions* must be made explicit during the policy process (from formulation to implementation) for stakeholders to adequately evaluate policy options. In practice, these trade-offs are rarely considered, which means that the process of adjusting to future change can inadvertently lead to, for example, the privileging of efficiency over equitable distribution of resources (risk-based approach), equity at the expense of cost (social vulnerability approach), or intergeneration equity over political legitimacy (resilience approach) (Eakin et al., 2009).

2.3 From controlling hazards to comprehensive risk management

Risk is commonly defined as “the combination of the probability of an event and its negative consequences” (UNISDR, 2007). Disaster risk is a function of hazard, exposure and vulnerability: disasters occur when hazard interacts with vulnerable and exposed populations, assets and livelihoods. Exposure has been understood as a measure of the spatiotemporal extent of elements in an area in which hazard events may occur but is also a reflection of how social relations of production unfold in this area (Oliver-Smith, Alcántara-ayala, Burton, & Lavell,

2016). Understanding disaster risk management as a social process allows for a shift in focus from responding to the disaster event toward an understanding of disaster risk creation through interactions of social-technical-ecological systems.

Organizations and communities manage both existing and anticipated risks through a combination of risk acceptance, risk avoidance, risk reduction, risk sharing/transfer, and/or risk treatment strategies. Risk management can include approaches based on numerical thresholds (e.g., quantitative safety goals); reduction activities derived from the application of the precautionary principle (e.g., as low as reasonably achievable); and standards derived from discursive and deliberative processes (e.g., citizen panels) (Klinke & Renn, 2002). Risk-based approaches use empirical data, probability distributions, and mathematical models to analyze past and predict future adverse events which enable decision makers to anticipate disturbances to the “normal” state of affairs and to make better-informed management decisions (van der Vegt, Essens, Wahlstrom & George, 2015) and implement risk treatment measures that ideally are efficient, socially acceptable and environmentally responsible. Risk management is ultimately about managing trade-offs: for example, trade-offs between development and risk reduction need to be managed, ensuring that development does not exacerbate risk and vulnerability but also ensuring that reducing disaster risk does not compromise development (Munene, Swartling, & Thomalla, 2018).

At a community level deliberative best practices call for participatory approaches to determining community’s tolerance for living with existing risk (Tappenden, 2014). Participatory approaches to managing risk can present challenges given decisions that are complex, replete with uncertainties and perplexing value trade-offs which can turn public engagement into an unproductive, time consuming and costly process that over-emphasizes the interests of the vocal participants and lacks representation (Dorcey & McDaniels, 2001). However, involvement of the community throughout the entire risk management process ensures transparency, community buy-in and a sense of ownership and empowerment (Collins, Glavovic, Johal, & Johnston, 2011; Wells, Springgate, Lizaola, Jones, & Plough, 2013). Normative (a need to consult and engage meaningfully), substantive (including knowledge beyond expert community, e.g., local knowledge, Indigenous science), and instrumental (successful implementation could be lubricated by public buy-in) arguments have been made for involving the public in risk decision-making and “democratizing risk management” (McDaniels, Gregory, & Fields, 1999).

Collaborative planning process also builds capacity and enhances community resilience through relationship development, increased awareness of existing resources and vulnerabilities and build trust and increases opportunities for informed decision making (Tappenden, 2014). However, community organizations or local governments are often unable to address the underlying risk drivers on their own (Maskrey, 2011) which requires taking into account distribution of risk and trade-offs across multiple scales of governance. Spatial and temporal dimensions of risk creation also need to be considered.

Risk that remains unaddressed after risk reduction measures are put in place, *residual risk*, requires contingency planning, investments in positive redundancies and safety margins, a flexible and adaptive response capacity to allow the community to cope with and recover from hazard events and shared understanding of the circumstances of vulnerability (Handmer & Dovers, 2007). Socio-economic policies such as safety nets and risk transfer mechanisms are also encouraged (UNISDR, 2007). Residual risk can be managed through partnerships, new models and financial approaches, including new forms of public–private partnerships in mitigation, preparedness, response and recovery phases (Chen, Chen, Vertinsky, Yumagulova, & Park, 2013).

Risk is socially constructed. As Ulrich Beck argued in his seminal *Risk Society* (1986) even the most restrained and moderate-objectivist account of risk implications involves a hidden politics, ethics and morality (Beck, 2006). Beck argues that defining risk is a “power game” where inequalities of definition enable powerful actors to maximize risks for others and minimize risks for themselves: “This is especially true for world risk society where Western governments or powerful economic actors define risks for others” (p. 333). Despite progress and sophistication in risk assessment tools, the disaster risk management process rarely identifies or quantifies which stakeholders bear the risk and which contribute to its construction, which discourages overall accountability:

Risk becomes objectivized or else externalized somewhere into the commons, meaning that risk constructors are not answerable to risk bearers... No ombudsman, chief risk officer or a similar figure generally exists and disasters are rarely submitted to a deep ‘forensic’ analysis in order to reveal causal processes and risk generators, as is the case of air traffic or technological accidents (Lavell & Maskrey, 2013, p. 274).

Foundational risk reduction measures such as land use zoning, building codes and environmental regulations are influenced by corruption, activities that privatize short-term gains, increase short-term electoral benefits and transfer the resultant risks to other sectors spatially and temporally (Lavell & Maskrey, 2013; Oliver-Smith et al., 2016) resulting in an accumulation of intensive, extensive and systemic risks. Yet, investments in prevention, preparedness and mitigation continue to be low when compared to response and recovery. For example, in 2014 only 0.4% of official development assistance was spent on disaster prevention and preparedness (UN General Assembly, 2016) and just 0.2% of international humanitarian funding was provided directly to national and local non-governmental organizations, while direct funding to affected Governments reached a mere 3% (Global humanitarian assistance report, 2015).

Risk-based approach is one of the most established and well-used approaches. The following three characteristics summarize the approach:

- Based upon utilitarian theory (maximize some utility, e.g., money)
- Works well when uncertainty is low, costs and benefits can be readily calculated and benefits can be readily calculated and stakeholders have a common perspective on risk
- Outcomes are very dependent upon how risk is defined and what metrics are used to measure it (Etkin, 2010)

This policy approach is driven by known risks and the appearance of economic efficiency, where estimation of the probability of exposure and likelihood of damage leads to the assessment of the most cost-effective and expedient means of reducing the risk to a level perceived as tolerable to the society exposed (Eakin and Luers, 2006).

The discussion above shows that despite progress, traditional risk management approaches are insufficient to anticipate, mitigate, and protect from the consequences of increasingly complex disasters and crises: triggered by improbable events, emerging from a pattern of several hazards coinciding in space and time, based on accumulated vulnerability, their consequences cascade within an interconnected globalized world in un-anticipated ways (van der Vegt, Essens, Wahlstrom, & George 2015). What can *resilience* offer, given these pressing challenges?

2.4 From comprehensive risk management to organizing for resilience

Some have argued that economic growth, technological advances and the expansion of scientific knowledge have made humans more confident in their ability to manage environmental

change. Planning for efficiency, standardizing for easier social control, and reducing variability became a leading paradigm that defines institutional practices (Lebel et al., 2006).

Environmental problems are framed as technical and administrative and this approach has dominated Western approaches to understanding and managing natural hazards. Joint efforts of hard science and engineering in the name of public safety and progress (e.g., economic growth) have ensured the dominant position of the technocratic approach to hazards (Alexander, 2000). Mitigation of hazards primarily came to mean abating them or building structural defences, and only when this has been done can mixed structural and other non-structural approaches be considered (Alexander, 2000).

Over the past few decades this approach has been challenged by practical experience: where attempts to tighten control – for example, by excluding natural disturbances like forest fires and floods through effective short term risk reduction measures – have often led, paradoxically, to the creation of larger, more difficult challenges for society and exacerbated long-term vulnerability (Gunderson & Holling, 2002; Burby et al., 1999; Lebel et al., 2006; Tobin, 1999; Goldstein, 2008). The rigid control mechanisms that attempt to direct change can create unintended consequences, exacerbate vulnerability, erode systems' abilities to deal with change, and can lead to a collapse (Folke et al., 2004). Institutional preparedness, flexibility and the ability to learn from surprise is therefore of vital importance for maintaining critical functions following the disturbance (which can lead to a crisis or disaster) – this is ‘resilience’. A significant amount of multi-disciplinary research has been devoted to defining resilience, by many, including but not limited to (Holling, 1973; Timmerman, 1981; Wildavsky, 1988; Mileti, 1999; Adger, 2000; Kofinas, 2003; Andries, Janssen & Ostrom, 2004; Adger et al. 2005; Gunderson and Folke, 2005; UNISDR, 2005; Birkmann, 2006; Birkmann et al., 2010; Pelling, 2011) as well as measuring and assessing resilience.

Resilience is a property of complex systems. Among historically multi-disciplinary applications of the concept, resilience, as applied to understanding socio-ecological systems, originated in the ecological realm and has been defined as the magnitude of disturbance that can be experienced before a system moves into a different state and different set of controls (Holling, 1973). The concept has been translated and popularized in the socio-ecological (e.g., Gunderson & Holling, 2002, Berkes & Folke, 1998, Adger, 2000) and social realms (e.g., Pelling, 2003). Resilience has also been a focus of engineering, organizations, infrastructure, and economic

studies. The unifying theme across research areas is the system's ability to deal with change. Few studies address the overlap and conflicting values between these domains. For example, systems may be ecologically resilient but socially undesirable, or they may be socially resilient and degrade the environment they depend on (Berkes, 2003).

Resilience policy interventions are designed to enhance system capacities to avoid reaching an abrupt threshold that would change the desired state of the socio-ecological system. Once the system is conceived as untenable, the new policies and management approaches could aim to direct the system through a deliberate transformation into a new state. Experimenting, making mistakes and learning from them are welcome within the resilience policy world. The focus of resilience-based policy is on the aggregated capacity of the system to adjust and respond rather than the concern with the differential (and potentially unequal) capabilities for different elements within the system. The main premise of this approach is conceiving the social—ecological system as integrated and interdependent over space and time; there is no long-run trade-off between ecological integrity and human welfare. Policy informed by resilience implies a high tolerance of variability, volatility, and localized loss for the greater benefit of the system's integrity (Eakin, 2010). In what follows I provide a brief review of the literatures contributing to this inquiry: socio-ecological resilience, social resilience, disaster/hazards resilience and urban/regional resilience.

2.5 Socio-ecological resilience: from Buzz's word to buzzword

Resilience, the capacity to lead a continued existence by incorporating change (Holling, 1986), calls for dynamic understanding of how periods of gradual change interplay with periods of rapid change (systems periodically probing and testing limits) and the interaction of those dynamics across temporal and spatial scales (Folke, 2006; Walker & Salt, 2006; Gunderson & Holling, 2002).

This approach emerged in response to the recognition of the limits of “optimal management” of systems, assumed to be stable and predictable, but that has in many respects reduced options and removed the capacity of life support systems to buffer change (Berkes, 2003). It is believed that more resilient social-ecological systems can absorb shocks and stresses without undergoing qualitative change; yet, when massive transformation is inevitable, resilient systems can draw on the componential diversity within the system for necessary renewal and reorganization (Folke, 2002). Resilient system can cope, adapt, or reorganize without sacrificing

the provision of key services and functions and it can learn from previous experience (Folke, 2002).

Ability cope with, adapt to, and shape change while maintaining options for future adaptability comes at a price and “the insurance for dealing with the unexpected has been driven down by suppressing disturbance and reducing the diversity of the environment and eroding social ability to deal with smaller disturbances that build the resilience to larger ones” (Berkes, 2003, p. 353). This eroded capacity requires further examination.

2.6 Resilience to hazards and disasters

There is a significant amount of hazards literature frequently referring to resilience as the guiding notion behind effective urban planning (Beatley 1998; Berke, 1995; Burby, 1998; Godschalk et al., 1999; Tobin, 1999; Mileti, 1999; Mileti & Gaus, 2005; Cutter, 2007). Most studies focus on land-use planning as a way of increasing resilience at local level though hazard mitigation regulation. There is a growing recognition of a need to systematically incorporate ‘resilience’ into the planning and design processes as well as construction techniques (Bosher et al., 2007; Bosher et al., 2008; Williams, 2011) that help to mitigate the effects of natural hazards. The efforts have been geared towards achieving resilience at multiple scales, for example, individual/household (Adger, 2000; Pelling, 2003; Werner and Smith 1982); community (Adger, 2000; Tobin, 1999), city level (Newman & Jennings, 2007; Godschalk, 2003), regional scale (Lebel et al., 2006) and societies (Adger, 2000; Bikmann, 2006; CapHazNet, 2010). Several authors have focused on post-disaster resilience planning (Vale & Campanella, 2002; Berke & Campanella, 2006; Bosher, 2008).

Disaster resilience has been defined as: "The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to react and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures" (UNISDR, 2005). Some have argued that resilience has become a new paradigm in the way hazards, crises and disasters are approached (Henstra, 2003; McEntrie, 2007; Manyena, 2006) including the fact that resilience offers a framework for focusing not only on return to the normal, but also incremental change and transformative potential for change (Handmer & Dovers, 1996; Yumagulova, 2011; Elmquist, 2014; Matyas & Pelling, 2015). Others have suggested that resilience is just a

complementary concept to the long tradition of research on vulnerability and risk in the hazards and disasters field, sometimes called as a flip side of vulnerability (Adger, 2006; Gallopin, 2006).

Some hold a critical position on resilience suggesting that the concept has gained currency “in the absence of philosophical dimensions and clarity of understanding, definition, substance, and most importantly, its applicability in disaster management and sustainable development theory and practice” (Manyena, 2006, p. 435). Major critique within the hazards and disaster field is directed toward operationalization of the concept (Klein et al., 2003), failure to question the framing values and political context for decision-making that falls short of addressing the transformative potential (Manuel-Navarette et al., 2009).

Disaster resilience policies and approaches are influenced – whether enabled or constrained – by surrounding policy processes and institutional systems (Handmer & Dovers, 2007). These, in turn, reflect the broad policy styles adopted by government and society, and by interaction with other big political trends and ideas. Understanding resilience policies for any specific hazard necessitates knowledge of policy-making process in general and the political context within which it resides. The framework characterizes emergencies and disasters *institutional* problems (Handmer & Dovers, 2007) and describes the specifics of resilience policies as a public policy issue. The formulation, adoption, financing, and implementation of resilience measures can be a major political challenge facing hazard-prone communities (Prater & Lindell, 2000) that requires cooperation, collaboration and learning across multiple scales of governance, across various sectors of government, non-governmental actors and the public. Planning plays a crucial role in this process.

There are several unique and distinctive features of disaster resilience as public policy issue due to the historical development of this field. Emergency and disaster-related institutions and policy processes were not originally developed for the broader challenge of longer-term strategic policy development, but for effective response, and occasionally for prevention, emphasizing events well defined in space and time (Handmer & Dovers, 2007). These boundaries are generally defined in administrative terms as required by jurisdictional boundaries and budgets: progressing from local to regional to national emergency/disasters (once the capacities at one scale are overwhelmed). Given the cross-sectoral nature of climate change impacts and increasing uncertainty, policy integration and coordination across the sectors and

across the scales of governance is becoming increasingly important (Dovers & Hezri, 2010; Juhola & Westerhoff, 2011). Increasingly, short-term goals of response, saving lives and protecting assets must be negotiated with more strategic longer planning horizons located within broader policy and institutional settings. To better understand barriers and enablers of hazard-specific resilience, the general characteristics of emergency and disaster policy sector need to be addressed (adapted from Handmer & Dovers, 2007, p. 39 based on the works of Oliver-Smith, Alcántara-ayala, Burton, & Lavell, 2016; White, Kates, & Burton, 2001) provide some of these:

- Whole-of-society and whole-of-government nature of emergencies and disasters, when considering causes, impacts and responsibilities – hazard mitigation is particularly inter-sectoral and diffuse.
- Local scale/community while dependent on the higher scales for regulation, plays a critical role in proactively managing risk and dealing with impacts of emergencies and disasters. Understanding capacity to deal with disaster and climate change across multiple scales is important (Juhola & Westerhoff, 2011);
- A need to address *disaster risk creation* which speaks to the importance of how emergencies and disasters are framed as policy and institutional problems, not only as ‘events’;
- Necessity of incorporating explicit consideration of residual risk and uncertainty in framing policy and designing institutions;
- Negotiation of short-term and long-term goals: need for strategic policy development, as well as event-specific and response focused policy settings and learning;
- Need for more structured and detailed processes for policy instrument choice and policy implementation;
- Importance of learning across temporal, spatial and governance scale, and the connection of this to adaptive processes;
- Necessity of considering redundancy, non-optimized capacities and general ability to deal with change in the face of unknown risks, uncertainty and large-scale potential impacts;
- Crucial role that broader institutional factors play in all the above.

Disaster resilience, thus, is a cross-sectoral policy domain spanning local, regional, provincial and national scales, where multiple governmental, non-governmental and community actors can be actively involved in various aspects of the policy process. The roles of informal and institutional arrangements at local level are increasingly recognized as being of particular importance, where achievement of stated goals depends on collaboration within the local governance unit (e.g., municipality) and region and beyond. While several key academic texts exist on the various aspects of hazard mitigation sector in the US (May, 1992; Godschalk et al., 1999; Burby, 1998), a systematic study of the intergovernmental system for natural hazard mitigation including major elements and the linkages between them is still needed for Canada

(Henstra & McBean, 2004). The lack of holistic analysis of this complex and dynamic policy implementation system makes it difficult to evaluate the success of cross-scale connection between the local, provincial and national hazard mitigation policy. This study contributes to this gap by providing a better understanding of hazard-specific and general resilience planning across multiple scales of governance.

2.7 Social resilience

Social resilience has been defined as the ability of human communities to withstand the external shocks to their social infrastructure, such as environmental variability or social, economic or political upheaval (Adger, 2000). Resilience in social systems has the *added capacity of humans to anticipate and plan for the future* and is largely determined by institutional structures. Humans pursue common goals and reconcile differences, respond to threats and opportunities, through institutions and the mechanisms of deliberation and decision making – policy processes – that are enabled or constrained by institutions (Dovers & Hezri, 2010; Handmer & Dovers, 1996; Handmer & Dovers, 2007). Institutions are the rules by which the interactions between individuals, groups, and states are made tolerably predictable (Dovers & Hezri, 2010). Lebel et al. (2006) suggest that interventions in socio-ecological systems with the aim of altering resilience immediately confront issues of governance. Planning for resilience within a governance system presents a different set of challenges for both researchers and practitioners. It seeks to explore policy alternatives and develop policy solutions based on the capacity-building strategies for institutions to deal with uncertainty and change. To be able to plan for resilience it is necessary to define the system of interest, identify its determinants – the key variables that it is controlled by (Klein et al., 1998), and understand how it can be measured, maintained, increased/decreased (Klein, Nicholls, & Thomalla, 2003).

Resilience is a property of multi-scalar governance systems. Local decisions are shaped and constrained by horizontal interaction at the local level as well as vertical interactions with structures at higher geographical scales that may mandate, encourage and inform local actions (Naess, 2004; Dovers & Henzri, 2010). The importance of cross-scale linkages and the influence of these interactions on individual scales is gaining an increased recognition in the policy design and practice of environmental and risk management context (Ostrom, 1990; Cash & Moser, 2000; Adger et al., 2005, Basurto, 2008; McDaniels et al., 2006). The multi-scale nature of urban resilience necessitates an examination of linkages across multiple scales of influence and impact,

and multiple levels of institutional and regulatory control (McDaniels, Longstaff, & Dowlatabadi, 2006). However, currently there is little attention to the mechanisms of policy and institutional change, to structures and processes within public policy and administrative systems at the crucial jurisdictional scales of national and sub-national (provincial, local) policy and planning (Dovers & Hezri, 2010). Few studies empirically connect conceptual foundations of principles for planning for general resilience with organizational and institutional adaptation to changing environmental risk, a gap to which this study contributes.

2.8 Urban and regional resilience

Since the early 2000s resilience has been increasingly applied to the urban context with a strong focus on the city's ability to respond to a disaster: uncovering the layers of social vulnerability in urban settings (Pelling, 2003); historical accounts of urban resilience following a disaster (Vale & Campanella, 2002); focusing on resilience of the built environment and infrastructure (Bosher, 2008; Graham, 2010); and extending into protection from terrorism (Godschalk, 2003; Coaffee, 2009).

Resilience of the cities and regions is determined among many other factors by the relationships with the ecosystems (Pickett, 2004; Alberti et al. 2003; Liu et al., 2007; Ernstson et al., 2010), social networks (Pelling, 2003; Adger, 2000; Goldstein, 2012), governance structures (Duit et al., 2010; Lebel et al., 2006; Leichenko, 2011) and infrastructure systems (Chang, McDaniels, Fox, Dhariwal, & Longstaff, 2014; Ribes & Finholt, 2007; TISP, 2011; Boin & Mcconnell, 2007) that can respond to and plan for a variety of demographic, economic and environmental changes. Regional resilience can be enhanced, or constrained, by the nature and structure of decision-making relationships and planning policy (NRCan, 2007; Lebel et al., 2006; TISP, 2011; Leichenko, 2011) from municipal to federal levels.

A significant amount of urban resilience literature centres on cities' capacity to plan for and adapt to climate change. Leichenko (2011) provides a review of four approaches to urban resilience in the context of climate change: 1) urban ecological resilience; 2) urban hazards and disaster risk reduction, 3) urban and regional economies; and 4) governance and institutions. Meerow et al. (2016) emphasize the transformative potential of resilience by defining it as "the ability of an urban system — and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales — to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit

current or future adaptive capacity" (p. 45). Three main cross-cutting themes and emerging challenges for urban resilience research can be put forward:

1. Acknowledge the *range of shocks and stresses*: Climate change is one of many shocks and stresses that cities face (environmental, economic, political stresses) and building urban resilience necessitates planning for a wider range of overlapping shocks and stresses. Planning for a specific risk(s) is not enough.
2. Place emphasis on the *key resilience characteristics*: Despite the heterogeneity and disagreement in terms of measuring resilience, some key characteristics of the resilient cities, populations, neighbourhoods, and systems include: diversity, flexibility, adaptive governance, and capacity for learning and innovation.
3. Efforts to promote *specific resilience* need to be bundled with broader development policies and plans and connected to *general resilience*.

Regarding the third point, there is an increasing recognition that a historically dominant approach to hazard mitigation and disaster planning that focused on incremental changes to known risks is not sufficient (e.g., Linkov et al., 2014). For example, in the realm of pre-disaster recovery planning, Berke and Campanella (2006) suggest that local governments have used two approaches: a recovery-specific plan as a stand-alone document (easier to revise, has more technical sophistication, is less demanding of coordination, and is simpler to implement) and integrated post-disaster recovery plan (that feeds into a broader comprehensive plan for an entire municipality, or region). The advantage of the integrated plan include wider array of resources, broader scope of understanding about interactive effects of recovery issues with other local issues (e.g., transportation, housing, land use, environment), and access to a diverse set of planning and regulatory tools. This links recovery to the broader economic, social, and environmental sustainability concerns of achieving a more general conception of community resilience beyond specific resilience to natural hazards. Integrating hazard-specific plans with more general plans (such as Official Community Plans or regional strategies) can serve as opportunity for mainstreaming and synchronization across professional silos (e.g., connecting emergency management to urban planning) and levels of governance (e.g., municipal, regional, and provincial plans).

Regional resilience planning is ultimately about managing trade-offs. Regional planning can be defined as a process designed to regulate, manage and control competing priorities of city-regions (e.g., land use, growth, environmental protection, and air quality) based on a collective vision for a specific geographic area. Regional planning varies significantly as a

function of regional governance form. Metropolitan government takes two primary forms: amalgamated and non-amalgamated. Amalgamated form calls for the abolishment of prior existing cities and districts and establishment of one general-purpose government for the entire metropolitan area, where this one-community, one-government unitary-in-design metropolitan government provides all services to the citizenry (Stephens & Wikstrom, 2000). The second form of government is a two-tier structure, where a separate new government unity serves as a general purpose metropolitan government, providing the regionally oriented system maintenance services such as water, sewers and public transport. In this model, the existing towns and cities are retained, and they continue to be responsible for delivering local lifestyle services (Stephens & Wikstrom, 2000).

Historically, Canada has had a fair share of amalgamation failures (Boothroyd et al., 2010). Under the Canadian system, municipalities are seen as the ‘creatures of the province’ and the senior governments can annex and merge urban governments as they struggle with the challenges of metropolitan growth and the demands for coordination, common standards and economies of scale. While amalgamation offers some efficiency benefits, it also has some organizational costs: civic governments becomes further removed from the people, and loses the flexibilities and efficiencies that smaller-scale delivery provides (Boothroyd et al., 2010). As an attempt to reduce management costs, increase efficiency of service and increase distributed fiscal fairness, the majority of Canada regions have gone through waves of amalgamation and annexation since the 1950s (e.g., Edmonton and Calgary (Alberta) in the 1950s; Metro Winnipeg in 1972 (Manitoba); Halifax (Nova Scotia) in 1996; and Toronto’s (Ontario) multiple amalgamation eras) (Boothroyd et al., 2010). Metro Vancouver is Canada’s last large non-amalgamated area which supports and celebrates the diversity and independence of its 23 members.

Very few studies acknowledge the combined effects of planning for metropolitan resilience: for example, between communities of practice, municipalities, infrastructure sectors and regional authorities. Wilkinson et al. (2007, p. 28) provide a brief review of the interaction between planning and resilience literature and conclude that: “Interdisciplinary exploration between resilience thinking and planning theory and practice is in its infancy”. The authors hardly acknowledge the urban disaster risk reduction literature or climate change adaptation literature - the most prolific areas for urban resilience research. The authors emphasize the power

of resilience framework to challenge the persistently linear conceptualization of planning, in particular notions of ‘end-state’ or ‘blueprint planning’, where a preferred scenario is chosen to be an end objective, which potentially ignores the deeper learning that can come from solutions resilient to a range of futures and unknown outcomes. Can resilience thinking break “planning out of its obsession with order, certainty and stasis” (Porter & Davoudi, 2012, p. 330)? I explore this through one particularly rapidly developing planning domain that focuses on adaptation.

2.8.1 Adaptation planning as an emerging field within urban and regional studies

Adaptation planning emerged as a policy domain and branch of urban and regional planning in response to the need for reducing the vulnerability of city functions and urban residents to the direct and indirect impacts of climate change. Adaptation is related to resilience in a way that it focuses on the *planning and decision-making processes*, undertaken to adjust a system to future shocks, stresses, or other changing conditions in a way that maintains essential system functioning (Nelson et al., 2007). Redman (2014) suggests that adaptation concerns with modest and incremental adjustments which leads to relatively conservative adaptive strategies: “under the pressure of changing conditions, these strategies serve to maintain or return the system to the previous order or one similar to it. Adaptive strategies are often specific and local; they address a potential threat and associated vulnerability and adjust the system as a response to that threat” (n.p.). Adaptation planning offers a rich opportunity for exploring the interplay between sp-R and gen-R.

There are many reasons for making adaptation planning a particularly challenging policy domain. The following are most pertinent to local level adaptation: 1) scientific uncertainty of local level data that requires investments today for potentially uncertain payoffs in the future; 2) municipal political short-term cycles that can inhibit the necessary long term action; 3) the increasing breadth of impacts that necessitates participation of a wide spectrum of actors frequently challenging the established patterns of operation.

Municipal scale is critical to adaptation: it is the most directly accountable and locally informed scale that controls building, development, land use, and provides basic services such as water and sewer and emergency protection. Roberts (2008), drawing on experience in Durban, South Africa, stresses that without developing a meaningful understanding of the science, climate change and its significance are unlikely to be effectively understood and acted upon at

the local government level. As Wagner and Zechhauser (2012, p. 507) suggest: “Policy makers can and must try to overcome inherent psychological barriers and create pockets of certainty that link benefits of climate policy to local, immediate payoffs”. How can this be done? Especially, given that the climatic uncertainties at the local level are compounded by uncertainties in the political sphere, by institutional and technological change, by evolving societal values and economic fluctuations at the local as well as global scales (Handmer & Dovers, 1996).

Considering these pressing challenges and the limited resources that cities have, the long-term anticipatory nature of planning for climate change often does not get enough attention or political will during short-lived office-terms, especially under condition of fiscal austerity.

Another long-recognized major obstacle to the anticipatory approach is the “shared governance” implementation dilemma where the higher level of government has a strong stake in promoting a policy for avoiding development in hazardous lands, but lower governing bodies are unwilling partners (Mileti, 1999). The senior levels of government are encouraging local implementation to ensure the reduction of financial burden (disaster aid) that they will have to provide in an event of disaster. However, local governments are concerned with more immediate and visible objectives such as housing, homelessness, crime and other objectives that fit the short term political tenures. This results in tendency to discount the lower probability high consequences events such as catastrophic flooding, especially, since, in a case of such event, the senior government will have to distribute disaster aid. This dilemma is even more emphasized in regional context where land use management programs for hazard mitigation cannot be effective without the difficult-to-achieve cooperative intergovernmental coordination. The fragmented governance systems tend to discount cumulative effects of land-use changes (Mileti, 1999). In the context of climate change this means that failure to plan and act regionally can significantly undermine long term adaptation options of regions as a whole.

Building supportive institutions that can deal with changing environmental risk across the jurisdictional boundaries and to be prepared to adopt new basic operating assumptions is one of the key challenges of adaptability that is acknowledged across socio-ecological, urban planning, and disaster studies. The broad scope of climate change impacts that range from affecting the physical infrastructure (for example, drainage system) to health (heat waves and diseases) to overwhelming services (e.g., emergency management) makes it difficult to assign a specific department responsible for adaptation. This means that adaptation is no longer under purview of

environmental sector (Juhola & Westerhoff, 2011), and it calls for participation of a broad range of stakeholders given the procedural, substantive and legitimacy benefits. As a result, local government action on climate change, once a narrowly environmental concern, is increasingly being mainstreamed across the municipal bureaucracy (Aylett, 2014). Yet, the role of bureaucracy for enabling and constraining resilience and adaptation is still weakly understood. The downstream/upstream and cascading effects of urban vulnerabilities such as flooding or power outages also make it clear that municipal jurisdictional boundaries are limiting an effective adaptation action calling for broader regional level cooperation. Adaptation planning necessitates working across the silos and adopting an ethos of shared responsibility. Resilience is a governance issue that requires an understanding of how policy and practice operate across multiple scales.

2.8.2 Resilience-based approach to flood management

Can resilience offer a fundamentally different approach to flood management compared to hazard- and risk-based approaches? In the face of climate change uncertainties the limitation of hazard-based approaches (e.g., flood-controlling infrastructure) stems from anchoring of capacity to resist only up to a certain level (e.g., designing based on historical flood of record) (Zevenbergen, Veerbeek, Gersonius, & Van Herk, 2008). Climate change is overwriting the return period idea, making such deterministic and retrospective planning ill-prepared for extreme flood events, which are expected to increase with more intense storms of unpredictable nature (Alley et al. 2007; Liao, 2012).

Resilience-based flood management approaches go beyond resisting the hazard (though levees, dams, and channelization) by acknowledging the inherent uncertainties arising from socio-ecological systems and by proactively planning for the extreme events outside of previous experience (Liao, 2012). Instead of treating hazards as rare and unlikely events, a resilience-based approach looks for means to live with periodic floods and to treat flood events as learning opportunities to prepare the urban regions for next extreme. Resilience approach seeks to connect post-disaster recovery to an overall transformative potential of an interlinked socio-ecological-technical system. In doing so it moves away from prescriptive planning to developing adaptive and flexible frameworks and supporting institutions. Resilience approach seeks co-benefits that physical and social infrastructure can generate in non-emergency times. Resilience approaches work with the natural floodplain functions to accommodate variability, instead of controlling it.

While this may seem as a bit of creative academic writing, examples around the world suggest that these practices are not only possible but are effective, legitimate, and efficient (e.g., Hegger et al., 2012). Various examples of operationalizing of flood resilience exist. For example, Hegger et al. (2014) suggest that “flood resilience” is defined by three capacities: capacity to resist; capacity to absorb and recover; and capacity to transform and adapt. In a region that has not experienced a regional-scale disaster in recent history, capacity to transform and adapt through proactive planning that acknowledges historical antecedents of the current flood management region becomes one of the main vehicle for increasing regional resilience. To operationalize sp-R for the purposes of this inquiry, I focus on planning and decision making processes focused influencing institutional capacity to manage floods.

2.9 Critical perspectives on resilience: an urban issues panacea or a status quo placebo?

The overview above shows a serious proliferation of academic literature on resilience but not without critique. Measuring and assessing resilience remains a challenge(Quinlan, Berbes-Blazquez, Haider, & Peterson).

Resilience theory is also criticized for its implicit and explicit normative judgements. Managing for resilience requires definition of resilience of ‘what and to what?’ (Lebel et al., 2006), asking who and how will decide which components of the system of interest remain the same and at what expense. Some critics have suggested that ‘resilience’ in its vernacular and policy usage has been hijacked by neoliberal agenda where the state gets to step back watching the citizens, civic groups and other forms of organizing be ‘resilient’ in the face of externally imposed disturbances, rather than acknowledging the social construction of environments in which this disturbance takes place. As Welsh (2014, p.16) puts it, speaking to problematic deployment of ‘resilience’ as “a post-political ideology of constant adaptation attuned to the uncertainties of neoliberal economy where the resilient subject is conceived as resilient to the extent it adapts to, rather than resists, the conditions of its suffering”. White and O’Hare (2014, p. 939) suggest that resilience can be “opportunistically tailored to fill policy windows” yielded in the wake of crises or in response to the emerging perils. The discussion around the “dark side” of resilience suggests that resilience in itself is not inherently good, when viewed as the ability to persist around a “stable attractor” or in a “stability landscape” that maintains systems that are trapped in an unhealthy, unproductive, corrupt, or otherwise undesirable states (Moser, 2008).

Can resilience serve as a key planning imaginary in acknowledging the limitations to planning and reimagining it as a continuous journey that helps cities define the problems and develop processes to mitigate complex and emergent issues (Coaffee & Lee, 2016)? In searching for resilience praxis, what can urban and regional planning learn from disaster management literature about planning for crises?

2.10 From resilience plans to testing the limitations of planning

Crisis and disaster management literature deem *planning* as a high priority for organizational, institutional and policy agendas (Boin et al. 2005; Handmer & Dovers, 2007; Quarantelli, 2007). Put simply, “If you do not believe in planning, you don’t believe in disaster risk reduction” – in the words of Margareta Walstrom, the first special representative of the United Nations Secretary-General for Disaster Risk Reduction (Yumagulova, 2015). Crisis can serve as an opportunity for institutionalizing and strengthening planning, through resource allocation and innovative thinking (Inam, 2005). Planning must be “societal [collaborative], future oriented, non-routinized, deliberate [not trial and error], strategic, and linked to action” (Alexander, 1986: 43). The purpose of the plan is not the document itself but rather a *process* of developing the relationships and ‘mindsets’ (Handmer & Dovers, 2007) needed for the management of major events, reducing transaction costs when addressing the unexpected issues and maximizing resources. Pre-disaster recovery planning is increasingly seen as a foundation for “building back better” to limit recurring disasters (International Recovery Platform, 2015).

However, the reality of contingency planning often deviates from these maxims due to the prevalence of the immediate needs over low-probability events, unpredictability of crisis situations that do not fit planning scenarios and institutional fragmentation (Mcconnell & Drennan, 2015) and more urgent political priorities. The utility of plans for unpredictable crisis events has been questioned (Tierney, Lindell, & Perry, 2001; Coleman & Helsloot, 2007) calling for a need to design resilience strategies that go beyond anticipation (Wildavsky, 1988; Barnett, 2011; McConnel & Drennan, 2006) to strategies that enable adaptive behaviours and takes advantage of improvisation and creativity (Somers, 2009) while accounting for qualitative differences of catastrophic events compared to emergencies (Quarantelli, 2007; Handmer & Dovers, 2007). Accepting the limitations of planning and preparedness tools remains as one of the main challenges for emergency managers (Handmer & Dovers, 2007).

Emergency and crisis management are largely driven to maintain the status quo (a constant stable behaviour of the system under conditions of shocks or stressors) by ensuring that the government functions continue, infrastructure systems operate, businesses return to making profits, and social relationships return to normal as quickly as possible. Return to stability is achieved through anticipatory strategies that address a specific threat or disaster scenarios though contingency planning, preparedness and effective response and recovery. For an effective recovery most important are such attributes as *robustness*, the ability to resist disruption and failure and continue functioning effectively; *redundancy*, the extent to which other alternative systems can continue to provide services when primary systems fail or are disrupted; *resourcefulness*, the ability to mobilize resources in a timely manner to address problems in technical, organizational, social, and economic systems determine the end product – *rapidity* – timely capacity to meet priorities and achieve goals to contain losses and avoid future disruption (Bruneau et al., 2002: 6; Tierney & Bruneau, 2007; Tierney, 2009). These attributes reflect the engineering meaning of resilience with an emphasis on the speed of recovery - capacity to return over a short period of time after disturbance to a prior (relatively stable) state through qualities such as efficiency, control, constancy, stability, and predictability.

In addition to these planned attributes, improvisation — an unplanned capacity that encompasses the emergent and actual "what needs to be done", to the normative "what ought to be done" – plays an important role in crisis management (Kendra & Wachtendorf, 2003; Wachtendorf, 2004; Wachtendorf and Kendra, 2005; Kendra and Wachtendorf, 2006). Improvisation occupies a conflicted space since reliance on it during a disaster response seems to suggest a failure to plan for a particular contingency: 'we plan in detail so that we don't have to improvise, knowing that we will have to improvise' (Kendra and Watchkroft, 2006:2). Comfort (1999) calls for rethinking the reactive, command-and-control driven response systems as inquiring systems, activated by processes of inquiry, validation, and creative self-organization which enables communities to face complex events more effectively by monitoring changing conditions and adapting performance to the evolving circumstances. This emergent, adaptive, and self-organizing understanding of resilient response is aligned with SES framing of response diversity.

In the field of emergency management, the need for a generalized capacity to respond resulted in a proliferation of an all-hazard approach that addresses the entire spectrum of hazards,

whether they are natural or human-induced. It is intended to be inherently adaptable to a wide range of exigencies (Alexander, 2002). For example, in Canada an all-hazards approach is adopted at all levels of government; it recognizes that the actions required to mitigate the effects of emergencies are essentially the same, irrespective of the nature of the incident, thereby permitting an optimization of planning, response and support resources. It employs generic emergency planning methodologies, modified as necessary according to the circumstances and adding hazard specific sub-components to fill gaps only as required (Public Safety Canada, 2011). Resilience planning, however, goes beyond the ability to respond to all hazards by addressing the fundamental principles of design and operation of systems such as redundancy, modularization, and connectivity among others defined in the SES literature.

Building resilience in accordance with these principles requires continuous committed long term investments. Yet, in an era driven by efficiency gains, redundancy has become to be seen as a negative term. Cutting public investment is a priority for budget cuts in many countries (OECD, 2011) and investments in generic capacity is increasingly difficult to achieve under the climate of austerity. A choice in favour of specific measures targeting known hazards is simpler and cheaper, and possibly effective as long as events of unexpected magnitude do not occur (Handmer & Dovers, 2007). Allocating resources to emergency management becomes politically feasible and socially demanded during a crisis stage of response and recovery from intense events, it rarely occurs during planning, prevention and mitigation stages.

For example, in Australia, 97% of disaster funding is spent on response activities, while the Australian Business Roundtable for Disaster Resilient and Safer Communities suggests that investing in disaster preparedness and resilience-building could reduce government disaster response budgets by 50% (Resilient Melbourne, 2016). Globally, investments in prevention, preparedness and mitigation continue to be low when compared to response and recovery. For example, in 2014 only 0.4% of official development assistance was spent on disaster prevention and preparedness (UN General Assembly, 2016) and just 0.2% of international humanitarian funding was provided directly to national and local non-governmental organizations, while direct funding to affected Governments reached a mere 3% (Global humanitarian assistance report, 2015).

2.11 Barriers for disaster resilience in Canada

It has been well-documented that risk regulation varies sharply across policy domains in terms of the risk tolerance built into standards as well as the administrative effort and public spending devoted to dealing with different risks (Baldwin et al., 2000:172). Protection of lives and capital from disasters is one of the many political and social goals, competing for discussion space, resources and priority (Handmer & Dovers, 2007). Ex-ante disaster resilience investments (e.g., in hazard mitigation, defined as any action taken to reduce or avoid risk or damage from hazard events (Godschalk, 2003; Mileti, 1999)) and planning can increase a system's or society's resilience to hazards (Bruneau et al., 2003; Burby et al., 2000).

Among frequently cited obstacles to improving the implementation of mitigation are the perception of disaster assistance as a social entitlement, concern about imposing limitations on the use of private property, the costs of mitigation programs (such as public acquisition of hazard prone-lands), and the organizational fragmentation of mitigation effects (Godschalk et al., 1999). In Canada, Henstra and McBean (2004) identified the following barriers to mitigation: uncertainty regarding hazards and vulnerabilities; uncertain benefits and costs of hazard mitigation measures; lack of public demand; lack of organized advocacy; and fragmented incentives and resources and lack of political will. Developing a better understanding of barriers and enablers of resilience planning at different the scales of governance is particular important due to the changing climate. The local nature of climate-related risk management and planning activities requires coordination at higher levels in order to ensure the ability of local actors to adapt is not constrained by national or regional processes (Juhola & Westerhoff, 2011). As Burton (1997) and IPCC (2001) demonstrate the absence of such coordination may even lead to maladaptation, or the increased vulnerability of a particular unit as a result of the activities of another (Juhola & Westerhoff, 2011)). Changing climate offers an opportunity for creating synergies between more established hazard mitigation sectors and emerging climate change adaptation measures; where focusing events such as disasters can potentially open windows of opportunity for policy learning, renewal or transformation (Pelling & Dill, 2009). These synergies can include proactive learning and measures that minimize multiple hazard impacts, which must be incorporated and synchronized in planning practices across governance scales. However, the mechanisms behind these policy changes are weakly understood, particularly across multiple scales (Naess et al., 2004; Dovers & Hezri, 2010). Local decisions are shaped

and constrained by horizontal interaction at the local level as well as vertical interactions with structures at higher geographical scales that may mandate, encourage and inform local actions (Dovers & Hezri, 2010; Nass, Bang, Eriksen, & Vevatne, 2005; Wilbanks & Kates, 1999). The importance of cross-scale linkages and the influence of these interactions on individual scales is gaining an increased recognition in the policy design and practice of environmental and risk management context (Basurto, Kingsley, McQueen, Smith, & Weible, 2009; Cash et al., 2006; Cash & Moser, 2000; T. McDaniels et al., 2006). The multi-scale nature of urban resilience necessitates an examination of linkages across multiple scales of influence and impact, and multiple levels of institutional and regulatory control across temporal and spatial scales. An important gap in the literature is the limited understanding of the mechanisms (barriers and enablers) of policy and institutional change within structures and processes of public policy and administrative systems (Dovers & Hezri, 2010) that inform resilience planning and decision making across multiple scales.

2.12 Moving from specific to general resilience: from conceptual frameworks to action

Despite the challenges identified in the literature the notion of resilience is gaining increasing prominence at the policy level internationally (Australian Critical Infrastructure Resilience Strategy, 2010; the National Strategy for Disaster Resilience, 2011 (Australia); UK Critical Infrastructure Resilience Programme, 2009) and domestically in Canada as one of the main guiding principles for planning in the face of uncertainty: the Emergency Management Framework for Canada (Public Safety, 2007; 2011 editions) and National Strategy for Critical Infrastructure (2009). Since 2010 resilience has been adopted as one of the Canadian government's key performance indicators, although the measurements are still to be determined (Public Safety Canada, 2011).

When it comes to direct implementation, some promising frameworks and practices are emerging at local and regional scales. In developed nations several cities and regions have developed strategies and plans that connect planning for specific shocks and stressors to general capacity to deal with change – general resilience. Some of the more well-known examples were partially facilitated by the Rockefeller Foundation's 100 Resilient Cities campaign. For example, in New Orleans "Adapt to Thrive" strategy that connects the most urgent threats to long term environmental change and seeks for ways to redress the legacy of inequity and risk through transforming urban systems through planning. It places a specific emphasis on regional

cooperation: “Single jurisdictions cannot effectively build better levee systems, restore the coast, create stronger economies, ensure safe and affordable housing for our workforce, or build a transportation systems that will serve us into the future. It is only through cooperation, among cities and towns acting together as a region, that we will be able to effectively engage these challenges” (City of New Orleans, 2015). This plan was created after the notorious ‘green dot map’ in which planning experts identified low-lying former marshland areas in the city and designated to be returned to open green space. These neighbourhoods were also some of the most impoverished neighbourhoods and the plan, while arguably had some valid points with regards to hazard mitigation, failed to take into account social justice consequences of this expert designation. In San Francisco, an initial focus on planning for earthquakes (a familiar and previously experienced hazard) has led to proactive approach to sea-level rise. This also resulted in a coordinated effort to connect hazard planning and management with city’s broader strategies on housing inequality crisis. A special emphasis for regional resilience was placed in an attempt to move beyond ‘talking about regionalism’ to acting and cooperating through an umbrella organization (the Association Bay Area governments). In Boston, as the city embarks on its resilience planning process, the Chief Resilience Officer, Dr. Atiya Martin, is tasked to connect emergency management issues to racism, in a city of high racial tensions with over 50% of people of colour (Yumagulova, 2015). In Australia, Resilient Melbourne strategy connects economic development, unemployment, globalization and population growth to planning for resilience to shocks and stressors at the organizational, community and government levels. It claims to take a critical look at the long-term planning, infrastructure and urban development patterns and social cohesion. The strategy identifies that only 41% of Melburnians are confident that their neighbourhood would pull together in an emergency, and only 39% trust most of their neighbours, which places an increased pressure on emergency services by reducing community self-reliance. Vulnerability is concentrated in outer suburban communities which have poorer access to employment, services and transport, and are at higher risk of becoming isolated and disconnected as well are vulnerable to fuel price and interest rates fluctuation and health risks such as obesity. To address these challenges it calls for increasing redundancy in soft and hard infrastructure (e.g., multi-modal transportation and increased cycling for increased health benefits and in emergencies) (Resilient Melbourne, 2016).

Some promising examples of built-in general resilience as part of hazard specific policies are from Europe: “...while most American cities are just at the point of taking stock of the magnitude of their exposure to climate change... European cities have acted and offer practical lessons learned” (Hill, 2010).

For example, HafenCity is located in the old harbor of Hamburg, along the river Elbe in Germany. Known as one of the largest rebuilding projects in Europe in the 21st century, it has transformed the formerly inner-city port fringes into an adaptive urban environment. Its urban design will allow flooding, and will stay resilient to high water, with waterproof parking garages, a network of emergency pedestrian walkways 20 feet above the street, and no residential units at ground level. The landscaping in the parks is specifically designed to withstand storm surge, either by floating as the waters rise, or by incorporating lots of hard surfaces that only need to be washed off when the waters recede.

The intensive reciprocal interaction between land and water can be regarded as unique, for HafenCity will not be surrounded by dikes, nor cut off from the water. With the exception of the quays and promenades, the total area, i.e., streets, parks and development sites will be raised to 7.5 to 8 meters above sea level. This creates a new, characteristic topography, also maintaining access to the water and emphasizing its typical port atmosphere (HafenCity Hamburg Projects, 2010, p. 5).

One of the fundamentals of the project is “to see urban development as a learning process,” ensuring an ability to recognize changes in the environment and to be able to respond.

Another example is climate-proofing in the Netherlands. If anybody knows how to adapt and to battle the changing risk, that would be the Dutch, as they firmly believe in their ability to live with the changing dynamics of water. As a Dutch saying goes, “God created the world, but the Dutch created the Netherlands,” with all its vulnerabilities, opportunities and risks.

“Rotterdam Climate Proof will make Rotterdam fully climate proof by 2025,” begins a description of Rotterdam’s 2010 climate-proof adaptation program (p.5). Europe’s biggest cargo port city, which houses an increasingly large portion of the Dutch population, is planning to protect the city from direct impacts of climate change (flooding, increased precipitation, groundwater salinization, heat waves) through innovative applications in the area of water management while making it more attractive. From water plazas to floating buildings and communities, Rotterdam is positioning itself as an example to follow as an international water knowledge and climate city. The main themes of the adaptation plan include: flood management,

accessibility, adaptive building, the urban water system, and the urban climate. A major emphasis of the campaign is on marketing the strategy as an export product—for profit. In fact, they have recently hired a marketing coordinator for their marketing campaign in Vancouver. As these examples show, climate change can be an opportunity for changing the status quo, for creating new learning opportunities, and for profit.

These strategies signal recognition of the advantages of general resilience: co-benefits that serve multiple, social, environmental economic goals, not being limited to serving the goal of reducing or managing a specific hazard. As Handmer and Dovers (2007) suggest: “the more systematic the policy approach (assuming effectiveness), the less of an issue spare capacity and redundancy becomes, which is more critical where there is a reliance on the fewer, more targeted options and resources of a specific hazards approach. Generic human development and capacity building generally provide communities with a greater range of coping strategies and fall-back resources” (p. 105).

Globally, examining the relationship between specific and general resilience is especially timely in the light of the new United Nations Sendai Framework for Disaster Risk Reduction 2015 – 2030. The framework expands beyond the narrowly focused objective to better manage disasters and calls for integration and mainstreaming of disaster risk reduction as part of urban planning processes, informed by long term demographic and environmental trends. It calls for higher levels of collaboration and learning, for recognition of stakeholders and their roles and all-of-society and all-of-State institutional engagement. Compared to the Hyogo framework, Sendai calls for a stronger emphasis on disaster *risk* management as opposed to disaster management, the strengthening of disaster risk governance, reducing existing risk and strengthening resilience but also for mobilization of risk-sensitive investment to avoid the creation of new risk. The scope of disaster risk reduction has been broadened significantly to focus on both natural and man-made hazards and related environmental, technological and biological hazards and preventing new risk. In other words, the much broader framing of ‘risk’ calls for a more general understanding of resilience.

2.13 Specific resilience vs. general resilience

One of the key aspects of the complexity of planning for resilience that has been identified in socio-ecological (Carpenter et al., 2012; Walker, 2005; Walker et al., 2014), socio-technical systems (Haimes, 2009), organizational theory (Wildavsky, 1988) and emergency

management (Handmer & Dovers, 2007) literatures, is a tension between planning for specific hazards or threats (referred to here as specific resilience (sp-R)) versus planning for the overall ability to handle change (referred to here as general resilience (gen-R)). Sp-R is the resilience “of what, to what” (Carpenter et al., 2012) or the resilience of part of the system to a known disturbance (e.g., specific hazard such as flood). Gen-R refers to the overall capacity of the system to withstand unknown disturbances, without specifying any particular shock or stress or a system response variable: gen-R is about coping with uncertainty in all ways (Carl Folke et al., 2010).

Some have suggested that the more the system is ‘optimized’ to respond to specific or regular shocks (sp-R), the less resilient it becomes to unknown shocks (Walker, Abel, Anderies, & Ryan, 2009). However, few studies have examined this question empirically. In part, this is due to methodological difficulties. The proliferation of academic literature on measuring and assessing resilience has been criticized for its reductionist measurement focus (Quinlan, Berbes-Blazquez, Haider, & Peterson).

Incorporating both sp-R and gen-R into policy analysis and management has been identified as one of the central challenges for applying the concept of resilience to socio-ecological systems (Carpenter et al., 2012; Folke et al., 2010; Walker & Pearson, 2007; Walker & Salt, 2006). There is a difficulty in incorporating gen-R in policy making because it is difficult to assign costs and benefits of maintaining or losing it until *after* the event (Walker & Pearson, 2007). Decision making for sp-R resource allocation can be guided by the process of risk assessment: probability and consequences of a certain event evaluated against its impact on certain parts of the system (e.g., human settlement). “If we can identify the consequences and likelihood (i.e., the risk) of a known regime shift then we can determine how much it is worth investing in resilience—or at least we can assess the likely consequences of not investing in it. So it is easier to include the specified resilience, the regime shifts that we know about or suspect and want to avoid” (Walker, 2005, p. 92). Higher risk assessments require a higher degree of planning and risk assessment becomes a highly political process of claiming which percentage is associated with which risk (Walker & Westley, 2011), often privileging sp-R investments over maintaining gen-R (Handmer & Dovers, 2007). Increasing efficiency, profits and political pressures present challenges to justifying maintaining gen-R, including such attributes as

preventing erosion of diversity, maintaining redundancy, increasing tightness of feedbacks, and maintaining or increasing options in the system (Walker, 2005, p. 92).

Yet, optimizing sp-R may undermine the gen-R of a socio-ecological system by reducing diversity, flexibility, and response diverse of cross-scale and cross-sector actions (Walker & Salt, 2006). Some evidence suggests that the more the system is ‘optimized’ to respond to specific or regular shocks (sp-R), the less resilient it can become to unknown shocks. Management for sp-R may be narrowing options for dealing with novel shocks and even increasing the likelihood of new kinds of instability (Carl Folke et al., 2010). In tightly linked, optimized management systems, institutions may become highly tuned to cope with particular types of shocks losing their ability maintaining robustness to disturbances and change that exceeds the range of tolerance determined by the history of shocks (Cifdaloz, Regmi, Andries, & Rodriguez, 2010). Observations of engineering systems (Carlson & Doyle, 2000) and biophysical systems suggest that systems respond to the most frequent kinds of disturbances they experience and become very robust in dealing with them. However, they do not self-organize in ways that make them resilient to very infrequent or novel disturbances, thus becoming fragile in relation to these infrequent kinds (Carl Folke et al., 2010). Regional resource and environmental management studies also show that increasing robustness to disturbances or to specified thresholds at a particular frequency may lower the resilience of some other part of the system to other disturbances (Walker, 2005; Walker & Westley, 2011; Folke et al., 2010). This tension between sp-R and gen-R has not been empirically explored in urban regional systems that have a distinct ability to plan for the future, a gap that this dissertation addresses.

The identified tension has direct implications for planning: if all of the attention and resources are channeled into managing for sp-R and associated thresholds, management may unintentionally erode the resilience of the system to other shocks or stressors (Walker, Abel, Andries, & Ryan, 2009). How can this be avoided? Environmental management literature suggests that a system’s overall resilience can be increased by building general capacity to respond to change. This requires understanding resilience as a *process* rather than an outcome. Linkov et al. (2013) suggest “advancing the fundamental understanding and practical application of resilience requires greater attention to the development of resilience process metrics, as well as comparison of resilience approaches in multiple …contexts for the purposes of extracting generalizable principles” (p. 10108). Focusing on gen-R requires investing in social and human

capital, designing modular but connected systems, enhancing learning, investing in strategies that maintain options and increasing response diversity (Walker et al., 2014; Walker, Abel, Andries, & Ryan, 2009). Glassmeyer and McNamee (2007) recommend that it is the planning process – not the plan – that matters most and that building general capabilities is more effective than trying to anticipate and protect against specific threat. This approach is increasingly supported internationally within the national frameworks for resilience (Australian Critical Infrastructure Resilience Strategy, 2010; NIAC, 2007).

Resilience comes at a cost. Business studies suggest that the increasing frequency of unexpected disruptive events and the leaner and interconnected nature of businesses heighten the importance of investment in resilience and flexibility, which results in constant trade-offs between preparedness and efficiency (College, 2007). Other trade-offs could be a result of conflicting values across various scales (e.g., sector-specific vs. regional level), for example improving efficiency on the one hand and preserving the reliability of supply, universal access or the quality of services on the other (van Gestel, 2008). For infrastructure, increased technical efficiency should be valued, but a focus on economic efficiency can lead to reduced redundancy and diversity, thus reducing resilience (Royal Engineering Academy, 2007).

In the context of climate change, an explicit analysis of resilience investments trade-offs at the planning stage is important, given the differing perspectives on whether climate change will primarily amplify existing hazards, requiring enhancement of existing functions, or present categorically distinct threats requiring innovative management strategies (Hess et al., 2012) which would require a different level of investments and different institutions. Advancing knowledge with regard to potential synergies and tensions of planning for specific risks, focused on optimal near-term return or long-term investments to address uncertain climate change impacts is of strategic importance for designing robust policies under uncertainty (Dessai & Hulme, 2007). For example, instead of heavily investing in technical measures to protect from certain hazards, investing in institutions and governance mechanisms capable of dealing with change is increasingly recommended (Handmer & Dovers, 2007; Australian Critical Infrastructure Resilience Strategy, 2011).

The sp-R-gen-R framing might be new to the hazards and disaster management planning field (Walker & Westley, 2011), but the idea isn't. The limitations of narrow structural approaches to floods, for example, have been recognized widely (e.g., the levee effect). The field

has responded to that by combining structural and non-structural approaches. Recognition of the limits of planning for single hazards has resulted in multi- and all-hazard planning approaches. Furthermore, disaster resilience is increasingly understood as closely linked with broader capacity building strategies as a by-product of more general activities designed to improve the social and economic well-being of community residents, with social inclusion and equity being primary indicators of this type of resilience (Mileti, 1999; National Research Council, 2011). From an institutional capacity to plan for risk, Handmer and Dovers (2007) caution against a reliance on hazard-specific approaches to planning which can be misleading in cases where the risk resists clear definition, such as complex emergencies. These events can have uncertain but extensive impacts, and anticipatory management approaches aimed at precise preparation will likely be overwhelmed by events. To mitigate the risk of these overly pre-planned and prescriptive approaches, Handmer and Dovers (2007) call for placing the emphasis on building “generalized resilience” of communities, institutions and systems underlying response and recovery. This involves clear and strong leadership across multiple scales of governance, capable of facilitating and coordinating the response from all sectors of society.

It can be argued that effective short-term disaster risk reduction measures, including high response capacity is not all advantageous as it might delay or prevent more fundamental changes necessary for long-term adaptation (Handmer, Dovers, & Downing, 1999; Schneider, 2011). As Handmer, Dovers and Downing (1999) suggest, the function of emergency management is protection of the status quo: “its emphasis is on very short-term adaptability to deal with a threat - so that the community, the economic system and individual households (as well as the institutions providing guidance) can continue as before with minimum disruption even to day-to-day activities” (p. 273). Emergency management measures such as disaster response and hazard mitigation efforts are typically focused on a single jurisdiction and a limited time period looking at a maximum of five to ten years into the future (Schneider, 2011), thus failing to address longer term planning horizons and larger geographical scales. Increasing emergency response capacity in the face of climate change can be seen as an economically efficient solution to delay the need to deal with long-term gradual change. This can exacerbate underlying vulnerabilities and may inhibit learning and renewal of co-existing contributing to a high degree of technological and institutional path-dependency governing the system (Klein, 2011).

Planning for and investing in sp-R based on priorities identified through risk assessment is an efficient, politically sound and fiscally responsible way of dealing with hazards. Technical hazard mitigation measures and preparedness for and response to a particular emergency involves relatively clearly defined players and has a defined planning scope and procedures associated with it. It is more politically feasible and sound to build a dike to protect from a flood than consider changes in land-use and behavioural changes (Birkmann, 2003; Kelman, 2006). The benefits of investing in hard infrastructure and equipment can be easily accounted for, while direct and immediate returns of soft measures are often unclear. According to Walker and Westley (2011) *the cost of not maintaining general resilience is much harder to estimate*. This results in a tendency to focus on policies whose outputs can be measured in the short term, as opposed to outcomes that are longer term, involving complex interactions across multiple scales, and more difficult to measure.

The changing climate offers an opportunity for creating synergies between more established hazard mitigation practices and emerging climate change adaptation measures; where planning for and dealing with familiar natural hazards events and risks could contribute synergistically to managing less familiar risks associated with climate change. In order to build on these potential synergies, it is increasingly necessary to develop institutional capacities and strategies that would deliver robust returns under a wide range of conditions instead of depending heavily on the specific nature of hazards (The Risk to Resilience Study Team, 2009). Advancing to planning for climate change will require facilitation of multiple-outcome planning methods (WUCA, 2010), designing for multiple purposes, decision-making processes that can explicitly address trade-offs between sp-R and gen-R resilience and organizational cultures capable of dealing with change. In building these capacities, a better understanding of the relationship between sp-R and gen-R is required.

2.14 Conceptual framework

Planning, defined as an ability to connect knowledge to action (Friedmann, 2007), is a distinct capacity of human systems. This research addresses the procedural dimensions of specific and general resilience planning in a multiscale setting – municipal, urban metropolitan and provincial context—by critically examining how planning for specific risks (such as flooding) contributes to long term resilience of a nested governance system (comprised of formal and informal institutions) in the context of climate change. As suggested by the emergent gen-R

literature, conditions that enable general resilience include such varied principles, properties, processes and variables as human and social capital, leadership and trust, diversity, modularity, openness, reserves. Resources and ability to maintain options, feedbacks, nestedness, learning, monitoring, experimentation (Folke et al., 2010; Walker, 2005; Walker, Abel, Andries, & Ryan, 2009; Walker et al., 2014; Carpenter et al., 2012; Walker et al., 2014). Processes for building general resilience are an emerging and crucially important area of research (Carpenter et al., 2012).

Since its ‘inception’ in SES academic circles, the gen-R framing lacked both theoretical and empirical rigour. Full of ambiguous promises, generalized principles, and workshop summaries that make aspirational statements on what gen-R could be about, it lacks a clearly operationalized theoretical framework and/or empirically-based findings. When it came to understanding the components of general resilience, even the most ardent proponents of the theory suggested that “most are difficult to measure, and many are hypotheses that are yet to be tested - and may be untestable” (Walker et al., 2014). The lack of theoretical and empirical solidity was identified as major gap by the early proponents of the theory within the SES literature (Carl Folke et al., 2010; Walker, 2005; Walker et al., 2014; Walker et al., 2009), and by its critics outside of SES. For example, consider this passage:

SES resilience thinking is confronted by what can be called a ‘governability paradox’.

If it was indeed possible to design, guide, and control processes of social change to the extent that is assumed in many of the policy prescriptions emanating from the resilience literature, then there probably would not be any environmental problems to begin with. Ultimately, all environmental problems arise out of governance failures, and to simply argue that we need ‘better governance’ to solve environmental problems is analogous to a physician suggesting that the cure for a sick patient is to make her healthy again.

As an example of this way of reasoning, consider a recent checklist compiled by leading resilience scholars for how to maximize general resilience in an SES. Carpenter et al. (2012) suggest that no less than nine ‘system properties’ (diversity, modularity, openness, reserves, feedbacks, nestedness, monitoring, leadership, and trust) determine the level of ‘general resilience’ in a system and should therefore be maximized by managers and policy makers. Controlling even just one of these system properties (e.g., ‘trust’ or ‘diversity’) lies beyond the capacity of most real-world managers (even more so in countries with weak institutions), and the true challenge for any public administrator is to address social problems without such capabilities (Duit, 2016, p. 373).

What’s missing in this conversation and critique it the role of *planning* as a dedicated field of thought and practice that connects knowledge to action across temporal and spatial

scales. Can carefully designed hazard-specific planning processes influence institutional capacity to deal with change in general? As Walker et al. (2014) suggest in a synthesis of an expert-based multidisciplinary workshop on regional resilience assessment, “the social components of resilience are least well understood or recognized in planning” (p. 1). To address this gap, they recommend putting a “resilience lens” over any existing plan(s) as a way to initiate a meaningful resilience assessment.

In this section, by combining SES, planning and disaster resilience literatures (Walker et al. 2009; Walker, 2011; Nelson et al. 2007, Chapin et al. 2009, Folke et al., 2010; Redman, 2016; Handmer & Dovers, 2007; Pelling, 2003), I operationalize the sp-R and gen-R framing by developing a conceptual framework for this study (Figure 2-1). I unpack its core dimensions in the subsequent sections.

Governance and institutions (upper part of the diagram) define both sp-R and gen-R. *Governance* rather than *government* emerged in response to the growing complexity of governing regions in a globalizing and multilevel context. In particular, adaptive governance that supports “the evolution of new governance institutions capable of generating long-term, sustainable policy solutions to wicked problems through coordinated efforts involving previously independent systems of users, knowledge, authorities and organized interests” (Scholz and Stiftel, 2005, p. 6). Planning policy thus plays an important role in defining the ability to deal with change. Planning policies, practices, and tools can serve as a barrier and an enabler for institutional ability to deal with change. Lynch (1990) suggests that it is the shifting values and motives which are the principal determinants of change in planning policy, and not the iron laws of economics. According to Inam (2005) bureaucratic agencies such as planning institutions are arenas for contending social forces and values, but they are also collections of routines (standard operating procedures and structures) that define and defend values, norms, interest, identities, and beliefs. Innes and Booher (2010) suggest that this diversity and interdependencies of interests can be addressed by promoting collaborative practice in planning and governance and by fostering authentic dialogue among the interested parties. Through collaboration and co-production of new knowledge, unanticipated policies and practices can emerge, that can result in changes in the values, goals, and shared understanding. Innes and Booher (2007) suggest that collaborative processes are resilient in the sense that they can absorb radical change in the environment (negative media reports, political change) and re-organise to maintain their integrity

and function. Lynch (1990), Healey (1999), Inam (2005), and Innes and Booher (2010) suggests that some political cultures provide more fertile ground for collaborative approaches to planning because of their institutional histories which have allowed maintaining reserves/store of institutional capital which encourages horizontal consensus seeking and fosters awareness of difficult trade-offs across spatial issues.

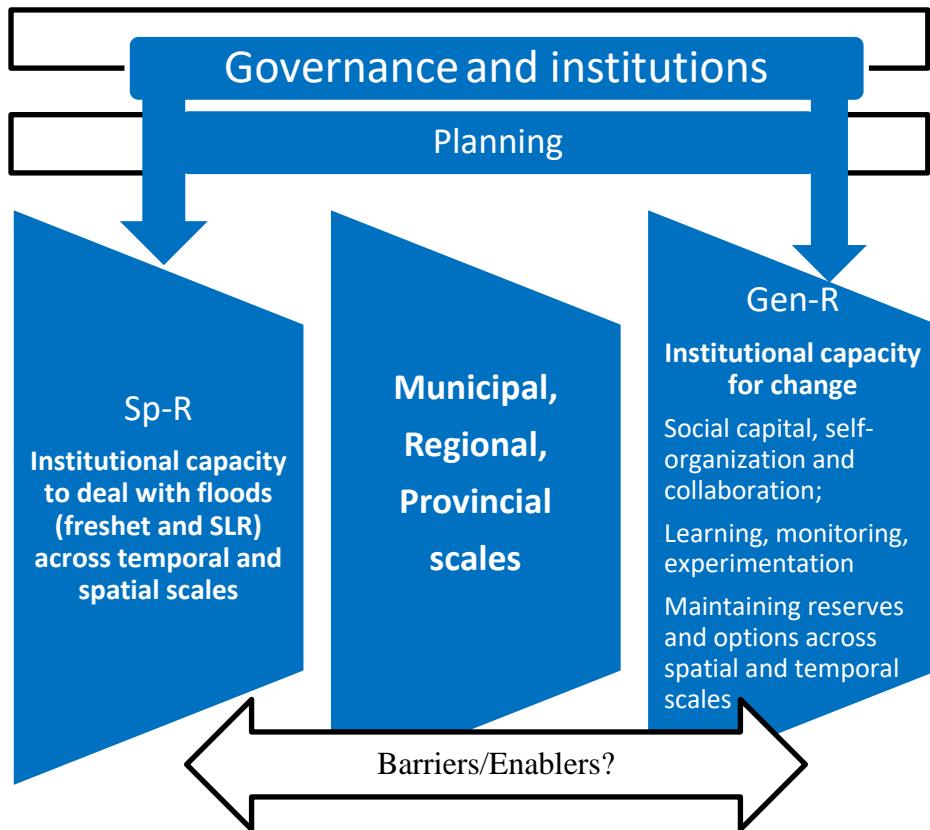


Figure 2-1 Conceptual framework

For sp-R (left side of the diagram), I focus on the institutional ability to deal with floods with a focus on planning processes and tools. For gen-R (right side of the diagram), I focus on key procedural determinants of institutional capacity to deal with change in general (gen-R). As the multi-disciplinary review suggests, these are determined by social capital, and capacity to collaborate, and self-organize; the ability to learn, monitor and experiment; and the ability to maintain reserves and options. I begin with the overall governance and institutional context that frames the relationship between sp-R and gen-R.

2.14.1 Governance and institutions

Research has shown that resilience depends on the capacity of the people to respond collectively to a change or disturbance (Ernstson et al., 2010; Hahn, Schultz, Folke, & Olsson, 2013; Pelling & High, 2005; Pelling, High, Dearing, & Smith, 2008). *Governance*, i.e., creating the conditions for ordered rule and collective action (Stoker 1998), values and the system of informal rules that constitute the social system's institutions strongly influence the ability of a system to respond to disturbances (Walker, 2003). Lebel et al. (2006) suggest that interventions in socio-ecological systems with the aim of altering resilience immediately confront issues of governance. Urban resilience is determined by the governance and the relationships between city and regional actors. Governance involves the crafting of rules in an effort to improve the incentives, behaviour, and outcomes achieved in a situation over time (Norberg & Cumming, 2014), thus, it provides context for institutional capacity to manage sp-R and deal with change in general, gen-R. Since rules operate and are made at multiples levels it is important to distinguish between policy-making (collective choice) and operational level (individual choice) (Ostrom, 1999; Norberg & Cumming, 2008). A complex, dynamic, and diverse urban environment requires substantial governing capacity and the notion urban *governance* encompasses not only traditional forms of government but also actors beyond the public sector, such as private, voluntary and community sectors (Dekker & van Kempen, 2004). To understand the complex process of interaction between city actors and risk creation it is necessary to understand governance and planning dynamics of individual cities and city-regions (Bull-Kamanga et al., 2003). These dynamics are determined by institutional, organizational, and financial limitations and are subject to the legal and institutional framework, and the nature of political processes at national and regional level, as well as local leadership (Pelling, 2003; Devas, 2005), the historic context, and path-dependency. Understanding the pathways of response and resistance of the governance actors to change and mechanisms of institutional change is particularly important for planners as it can enable them to meaningfully engage with 'change' and promote transformative agendas (Healey, 2007).

A significant amount of literature suggests that resilience of a system is largely determined by institutional structures. Berkes et al. (2003) suggest resilience emerges from the institutional inventory of a society's ability to deal with change. The role of institutions in shaping vulnerability and influencing resilience has been discussed in a variety of contexts

(Pelling, 1998; Pelling, 1999; Pelling, 2003; Adger, 1999; Adger, 2000; Sanderson, 1994; Birkmann & Wisner, 2006). Pelling et al. (2007, p.5) differentiate between overtly formulated formal institutions that are visible and subject to rational control and management through public institutional frameworks and informal institutions that include intangibles such as norms, values and accepted ways of doing things. Adger (2000) suggests that there is great heterogeneity in the structure of institutions that manage environmental risk and hazards, but little agreement between social scientists as to the processes by which institutional change reduces or amplifies risk. Folke et al. (2010) suggest that the attributes of transformability and gen-R are closely related and include high levels of all forms of capital, diversity in institutions, actor groups, and networks, learning platforms, collective action, and support from higher scales in the governance structure. A better understanding of institutional barriers and enablers of translating sp-R into gen-R is required.

To further operationalize the sp-R and gen-R framework, I identify key components that contribute to gen-R. Derived from socio-ecological, disaster risk reduction, climate change adaptation, and planning literature review, these include: social capital (including political influence), self-organization and collaboration; learning, monitoring and experimentation; maintaining/increasing options and investing in response diversity (“redundancy”) and reserves of resources across spatial and temporal scale. I review these components in detail below.

2.14.2 Social capital, self-organization, and collaboration

Capacity to self-organize is considered to be one of the core capacities contributing to the adaptability and resilience of socio-ecological systems. Social capital is a complex and particularly important aspect of adaptability (Ostrom & Ahn, 2009; Crona, 2008). Trust, strong networks, and leadership influence the capacity of the system to respond to change and determine social capital “the features of social life – networks, norms and trust – that enable participants to act together more effectively to pursue shared objectives” (Putnam, 1996, p. 56). Strong social ties can both enhance resilience (Hahn et al., 2005; Pelling, 2008) and prevent adaptive change (Diamond, 2005). The role of social networks is being increasingly explored as a factor in building resilience (National Research Council, 2008). Motivation and co-operation depend strongly on the structure of social networks and the flow of information within them. Literature on organizational effectiveness suggests that social capital has direct organizational/management benefits and that people with better social capital can enhance the

performance of their teams, help reach goals more rapidly, help generate more creative options and solutions, and coordinate projects more effectively (Krebs, 2008). Existing networks of social capital can provide a ready template for collaboration but also serve as a ‘barrier’ to interventions if they require ‘reconfiguring’ of existing social ties and networks (Pelling & High, 2005).

Collaboration is routinely recommended for dealing with ‘wicked’ and ‘complex’ problems. Bardach (1998, p. 8) defines collaboration as “any joint activity by two or more agencies that is intended to increase public value by their working together rather than separately.” The objective of increasing public value speaks to the idea that collaborating for one purpose may also contribute positively to other purposes. Collaborative planning approaches foster shared intellectual capital, increased social capital, spin-off partnerships, networks and collaborative projects that results in shared political capital (Frame, Gunton, & Day, 2004). Collaboration is favoured as an approach for developing shared vision, leveraging resources, dealing with scarcities, eliminating duplication, and making collective sense of uncertainty among many others. Collaboration is also recognized as an effective approach to dealing with rapid changes which necessitates recognition of interdependence in terms of problem identification and potential solutions (Taylor-Powell, Rossing & Geran, 1998).

The literature on collaboration is broad and varies from conceptual frameworks of collaborative governance (Ansell & Gash, 2008) to collaborative planning (Innes & Booher, 1999, 2004) and evaluation of collaborative processes (Frame et al., 2004). Increasingly, effective vertical and horizontal multi-scalar collaboration among stakeholders of the community is understood as a factor for system resilience (National Research Council, 2011). Emergency and crisis management literature focus on pre-event collaboration that can improve communication, coordination and interoperability during disaster event (Boin & McConnell, 2007; Comfort, 1994; Kapucu, 2006; Kapucu, Arslan, & Collins, 2010; Kapucu, Arslan, & Demiroz, 2010). This collaboration even if initiated for a specific purpose of disaster risk reduction can "stimulate and develop [the community's] capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems and institutions" (McBean & Rodgers, 2010, p. 876).

Evaluation of collaboration is one of the key methodological challenges (Taylor-Powell, Rossing, & Geran, 1998; Frame, Gunton, & Day 2004; Gunton, Peter, & Day, 2007). As Taylor-Powell, Rossing and Geran (1998) suggest this is especially challenging given the dynamic, flexible and evolving nature of collaboration. Time-frame (short-term collaborative efforts around specific issue or long-term collaborative process around long-term vision) calls for different methodologies of evaluation. For example, Gunton, Peter and Day (2007) used multiple-criteria for evaluating the process around preparation of a strategic regional land use plan in British Columbia. The study revealed that despite a failure to reach a consensus, the process did result in improved relationship and understanding, thus stressing the *procedural benefits* of collaboration. Procedural benefits of collaboration can contribute to general outcomes (such as more inclusive representation, equal opportunity and resources, high quality information, commitment to a plan implementation among others) as well as specific outcomes (a plan, agreement, relationships and social capital) (Frame, Gunton and Day, 2004). Taylor-Powell, Rossing and Geran (1998) suggest that no cookbook evaluation design exists especially for evaluating exploratory collaborative models where goals tend to be broad and imprecise. These authors advocate embedding evaluation as part of the collaborative effort to enhance mutual learning opportunities.

2.14.3 Learning, monitoring and experimentation

Learning is central to resilience and to the adaptive approach in dealing with uncertainty (Walker et al., 2009). As the International Panel for Climate Change (IPCC) suggests: “Learning processes are central in shaping the capacities and outcomes of resilience in disaster risk management, climate change adaptation, and sustainable development (high agreement, robust evidence). An iterative process of monitoring, research, evaluation, learning, and innovation can reduce disaster risks and promote adaptive management in the context of extremes” (IPCC, 2012, p. 439). Adaptive management literature suggests that integrative learning, a structured process that reduces uncertainty, involves phases of assessment: policy as hypotheses, management actions as tests, and evaluation (Allen & Gunderson, 2011).

Learning as a normative goal has been a focus of much focus of both scholarship and practice of planning, hazards/disasters and emergency management as well as resource management and SES studies. These fields acknowledge the importance of social, organizational, institutional and policy learning where collaboration, joint decision-making and

participation of multiple stakeholders contribute to initiation of self-organized learning processes (Friedmann, 1987; Handmer & Dovers, 2007; Armitage et al., 2007, Folke et al., 2005; Birkmann, 2003). Across these disciplines, there is also a shared sense of confusion over definitions, purpose and mechanisms of learning. One of the key barriers to addressing the challenges posed for governance that has been identified within the resource management literature is the lack of a sound conceptual base to understand learning and change in multilevel governance regimes, including network governance and processes of social and societal learning (Pahl-Wostl, 2009).

The multiple definitions, goals and mechanism of learning all share one similar characteristic: they all imply change (Lof, 2010). When learning for resilience, the SES literature highlights the need to better understanding mechanisms (barriers and enablers) behind transformational (forced and deliberate) change across multiple scales. Gen-R is rooted in history and historical analysis (learning from the past) makes an important contribution to understanding the current configuration of a system, the reasons for it, and how it is believed to function (Walker et al., 2009). Transformational change, whether forced or deliberate, often involves shifts in perception and meaning, network configurations, patterns of interactions among actors including leadership and political influence, and associated organizational and institutional arrangements (Folke et al., 2010).

Cross-scalar learning is central to deliberative transformative processes. As Folke et al. (2010, p. 20) suggest “transformational changes at lower scales, in a sequential way, can lead to feedback effects at the catchment scale, which is a learning process, and facilitate eventual catchment- scale transformational change.” Facilitation of different transformative experiments at small scales (that can then spread laterally and upwards through cross-scale learning) is enabled by innovation and experimentation in safe-to-fail arenas. Bridging actors and organizations that can align learning and collaboration across the scales are central to enabling this transformational process. As Folke et al. (2010) note, systems with high transformative capacity may deliberately initiate transformational changes that shape the outcomes of forced transformations occurring at larger scales. In addition to learning and experimentation, monitoring (the degree, the range and the intensity of change) and a reflective capacity (an ongoing evaluation of the conceptual and other models developed within organizations of how

the system responds to disturbances coupled with monitoring the effects of management in response to shocks and stressors to the system) play (Walker et al., 2009).

One of the widely-used frameworks for evaluating learning is the multiple loop framework which has been applied to organizational learning (Argyris & Schön, 1978, 1996), adaptive co-management (Armitage, Marschke, & Plummer, 2008), and learning from disasters (Voss and Wagner, 2010). These bodies of research allowed to assist a more systematic way of understanding the *degrees of change* initiated by learning at different scales and implication of that process for the unit of analysis: from individuals, organizations, institutions to policy. Löf (2010) suggests that complex learning processes occurring across and between scales can be examined by looking at learning aggregation – how learning is embedded into social and organizational practices and routines (group-layer) or becomes formally implemented and institutionalized (institutional/societal-layer). Governance can offer a valuable and cross-cutting perspective as it influences the actors' learning process, their use of available knowledge, and their capacity to deal with change (Winsvold et al., 2009). To identify enablers and barriers for gen-R in an urban context, a combination of theories on governance modes with theories of organizational learning offers a useful framework.

Resilience scholars see transformative institutional learning is a key aspect of a system's ability to deal with change (Folke, Hahn, Olsson, & Norberg, 2005). The concept of multiple-loop learning (Armitage, Marschke, & Plummer, 2008) enables a better understanding of the different levels of learning that provide guidance and stability in a social system at increasing time scales for change (Pahl-Wostl, 2009). Learning modes (e.g., single-loop, double-loop, or triple-loop) that encourage effective institutional changes have been a focus of resource management, socio-ecological, and disaster resilience literatures. By combining literature on governance and organizational and institutional learning, Appendix A presents a review of the learning loops and their implication for the adaptability and transformability of the systems based on the following criteria: the degree of change in the external conditions; the degree of change through the internal response; mechanisms of knowledge generation and the resultant outcome and institutional characteristics required for specific learning loops. First two types range from smaller adjustment in response to errors (single-loop) to actively trying to change protocols and organizational norms in response to detected errors (double loop) (Argyris & Schön, 1978; Armitage, Marschke, & Plummer, 2008; Löf, 2010) but do not question the

fundamental arrangement within the system. Triple-loop learning on the other hand entails fundamental change in the design of governance norms and protocols process and is a required form of learning for transformation (Lof, 2010). Transformation can happen in multiple forms and degrees, but is generally limited by organization's unwillingness to engage in learning that can question the purpose of the organization itself (Armitage, Marschke, & Plummer, 2008). Transformative triple loop institutional learning involves reflexivity, an understanding that "the institution itself is part of the dynamics of the system that it seeks to change, thus it continually re-examines and re-evaluates the foundational assumptions of its work by "opening up" its boundaries to multiple representations and discourses outside the institution" (Miller, Mun, & Redman, 2011, p. 178). From system dynamics perspective and the resilience interplay between continuity and change, learning loops display similarities with Handmer & Dovers (1996) framework for institutional resilience: 1) single loop learning - resisting maintaining status quo, 2) double loop - changing at the margins, and, 3) triple loop – openness and transformation. I use a combination of these frameworks for my analysis in this chapter.

In addition to formal mechanisms of learning and exchanges, shadow spaces (Pelling et al., 2008) hold the potential to create enabling conditions for learning processes to affect institutional change. One such mechanism is connecting communities of practice (Wenger, 2000) through boundary people (with bridging ties) and boundary objects (such as meetings or documents created with the purpose of bringing communities of practice together). Informal collaboration in shadow spaces allows linking people and organizations with *different knowledge systems* (Hahn et al., 2008), enabling *sp-R knowledge co-creation with procedural co-benefits for gen-R*. Within this broad literature on learning, little research has investigated the relationship between individual learning and the underlying communication pathways and institutional constraints through which adaptive capacity and action is negotiated within and between organizations (Pelling et al., 2008) across the scales of governance. In other words, what types of knowledge inform sp-R and how can sp-R learning translate into gen-R across the scales?

Experimentation is another commonly desired measure of learning capacity especially noted within resource and environmental management literature. It has been explored to a much lesser extent with regards to natural hazards and urban planning context with an exception of green infrastructure design approaches and social mobilization themes (Sheppard, 2013). Shadow spaces can be most effective for creating conditions for experiments. Experimentation

relies on existing collaboration levels and trust that provide context that can accept failures and learn from them. Resource management literature identified several barriers for experimentation: the level of risk must be relatively low, where it is “safe” to conduct experiments; agencies and stakeholders often do not want to share control; cost, as experiments can be expensive (direct costs of the data collections, monitoring and opportunity costs). The challenge is to design experiments at the right scale and following the rule of good experimentation in that the consequences of the actions are potentially reversible and that the experimenter learns from the experiment (Walters & Holling, 1990).

2.14.4 Building and maintaining options (including reserves and redundancies)

Ability to maintain options and reserves of resources is central to both sp-R and gen-R (Folke et al., 2010; Walker, 2005; Walker, Abel, Anderies, & Ryan, 2009). Existing institutional arrangements play an important role in defining strategies for building resilience. For instance, formation of a flood protection and dike management agency as a sp-R measure is likely to occur in an area that has accumulated technical expertise to deal with such issues, constructed an institutional framework to support these actions, and entrenched flood protection responses in a system of policies and mandates (Burch, 2009). However, practical experience suggests that single-focus management measures, for example focused primarily on flood mitigation or resource extraction, can negatively impact watershed health (Calder & Aylward, 2006). Not only does this approach necessarily take resources away from gen-R oriented measures at the organizational, community or regional level, but it also leads to a lock-in and limits future options in terms of flood risk management. For maintaining future options, it is important to empirically explore this gap in understanding the financial, temporal and spatial trade-off of resilience strategies and investments. Several principles for maintaining options for resilience have been put forward in the SES, planning and hazards/disaster literatures.

Diversity is considered to be key to resilience. One of the key limitations of sp-R is an overreliance on a specific approach to manage resilience which calls for a diversification of strategies. For sp-R, the hazards and disasters research community call for diverse strategies of hazard mitigation that serve multiple functions: Berke et al. (2006, p. 590) suggest that “the greater the number of techniques that are employed, the more complete and effective the mitigation strategy would be for a proposed project.” Burby et al. (1997, p. 121–2) suggests that

“more-effective hazard mitigation will occur when governments use more, and more varied, techniques and strategies for reducing potential losses from natural hazards.” For example, the Dutch risk-based approach called “multi-layered safety” calls for redundant and overlapping flood resilience functions that connect structural protection, land-use planning and emergency response and recovery capacities. Hegger et al. (2014) call for flood risk management that includes multiples options ranging from flood risk prevention (including land-use planning), flood defense, flood risk mitigation, flood preparation, and flood recovery.

As widely agreed upon in the literature, resilience of coastal communities in practice will require a diverse and interconnected range of adaptive options and actions: hazard identification and risk assessment, comprehensive emergency management, land use planning, shoreline retreat, greenhouse gas mitigation actions, and adaptations to climate change strategic environmental and ecosystem protection, continuously updated and improved climatic design values, and changes to infrastructure codes and standards (Beatley, 2012; Tol et al., 2012). Table 2-2 presents some options for sea level rise and other coastal impacts of climate change (Klein, 2011). These are separated by strategies/policy options (protect, retreat, or accommodate) and solutions.

Table 2-2 Strategies and options for dealing with sea level rise

Strategies	Solutions
Protect: reduce the risk of the event by decreasing its probability of occurrence	Hard structural options (Dikes, levees, floodwalls; Floodgates and tidal barriers; Saltwater intrusion barriers) Soft structural options (Periodic beach nourishment; Dune restoration and creation; Wetland restoration and creation) Indigenous options (Forestation; vegetation-based bank reinforcement; coconut fibre stone units)
(Managed) Retreat: reduce the risk of the event by limiting its potential effects	Increasing or establishing setback zones; Relocating threatened buildings and infrastructure; Phased-out or no development in exposed areas; Rolling easements.
Accommodate: increase society’s ability to cope with the effects of the event	Emergency planning (Early-warning systems; Evacuation plans and systems) Regulatory (Strict regulation of hazard zones; Modification of building styles and codes; Modification of land use and agricultural practice) Fiscal (e.g., insurance; bonds); Technical (Improved drainage).

Diversification is a universal (as in an investment portfolio) strategy aimed at reducing risks; it increases options for coping with change, shocks and stresses, and surprises by making

the systems less vulnerable (Berkes, 2007). Biodiversity, social, physical, economic and institutional diversity are important and effective strategies to support urban resilience (Ahern, 2011). Norberg et al. (2008) by drawing comparisons between species in ecosystems and institutions in governance provide two mutually related methods for sustaining diversity in social-ecological systems: 1) promoting local adaptations; 2) enabling the diversity of local governance or decisions units to minimize the dominance of *single solutions*, stressing the importance of institutional diversity – “a reservoir of alternative strategies” - is an important source of gen-R. The diverse range of operational and collective choice rules that have been tried in a variety of contexts can enhance the systems adaptive capacity to respond to surprise; ‘to alter the relative abundance of its components without significant changes in crucial system function’(p.47). Pelling (2003) emphasizes local participation in decision-making through formal democratic structures and by involvement in local development projects as a way to generate more diverse options and will maximize the benefit gained by citizens from development programs and projects. Diversity thus plays a central role for resilience.

In addition to diversity of options, gen-R requires a certain degree of redundancy and modularization within the system components. Within SES literature redundancy has been characterized as a type of ecological or social memory that provides a source of renewal or continuity when system functions are disturbed (Berkes, Colding, & Folke, 2003; Gunderson & Holling, 2002). Handmer and Dovers (2007) suggest that in the past including some redundancy in systems was a sound practice for enterprises operating in the face of uncertainty. However, redundancy is increasingly seen as inefficient and suboptimal in a commercial world dedicated to being productive (Handmer & Dovers, 2007). From response perspectives, redundancy involves having multiple options in a case of disasters: multiple access levels for evacuation from buildings; having multiple access routes (roads, ferry services, etc.); and multiple emergency centres, in different locations (Wardekker, de Jong, Knoop, & van der Sluijs, 2010).

Ahren (2010) suggests that redundancy and modularization can be achieved when multiple elements or components provide the same, similar, or backup functions. Redundancy and modularization spread risks – across temporal and spatial scales and across multiple systems. Pelling (2003) suggests that risks are greatest when functions are dependent upon a single resource. At the institutional level, diversity of institutions can provide a wider pool of alternatives in a time of crisis. In cities provision of a major urban function or service by a

centralized entity or infrastructure makes it more vulnerable to failure (Ahren, 2011). Providing the same function by a distributed or decentralized system makes the system more resilient to disturbance.

Maintaining redundancy and keeping resource reserves is a widespread strategy for sp-R and dealing with emergencies: hospital store reserves of medications, energy sector plans for power backups, fire fighters maintain excess response capacity and so on. Gen-R, however, also implies investments in trust funds for the future and for unexpected needs, the maintenance of resources with option values despite the pressures of current demands, deliberate overinvestment (in static economic efficiency terms) in social capital and education, investment in multiple energy sources and duplicate infrastructure and other fail-safe strategies and the deliberate fostering of diversity in social, economic, and ecological subsystems (Walker et al., 2009).

2.15 Conclusions

The discussion above has presented the concept of resilience as widely used for understanding socio-ecological systems and increasingly applied to urban systems. Resilience thinking and doing is about understanding and engaging with a changing world. It offers a different way of conceptualizing the complexity of the world around us through metaphors that assume change, not stability, is the norm in complex systems. As such, it presents a constructive alternative to policies aimed primarily at limiting actions. This chapter reviewed an evolution of conceptual frameworks and the associated management practices for hazards, risks, and resilience. It highlighted that qualities and capacities such as diversity, redundancy, multiple pathways, and institutional reservoirs are vital features of resilient systems. These qualities support flexibility, maintain options, and enhance systems ability to deal with long term stressors and acute shocks. Achieving these qualities in practice remains a planning and investment challenge. The literature review identified several interrelated challenges in organizing for resilience, including the relationship between specific and general resilience and a need for resilience investments, especially in an era of austerity. I also provided some promising practical examples that connect general and specific resilience within urban planning and disaster risk management. Critical ongoing evaluation and monitoring of the implementation progress and review of these frameworks will be required to ensure long-term resilience of communities.

The resilience approach emphasizes systems thinking, multiple states, non-linear dynamics, temporal and spatial scales, thresholds, uncertainty and surprise. At its heart lies a

quest for dynamic understanding of change and how periods of gradual change interplay with periods of rapid change across temporal and spatial scales (Folke, 2006; Walker & Salt, 2006; Gunderson & Holling, 2002). More resilient social-ecological systems can absorb shocks and stresses without undergoing qualitative change; yet, when massive transformation is inevitable, resilient systems can draw on the componential diversity within the system for necessary renewal and reorganization (Folke, 2002). Resilience in social systems has the added capacity of humans to *anticipate and plan* for the future and is largely determined by institutional structures. One of the key aspects of the complexity of planning for resilience is a tension between planning for sp-R versus planning for the overall ability to handle change (gen-R). Sp-R is the resilience “of what, to what” (Carpenter et al., 2001) or the resilience of part of the system to a known disturbance (e.g., specific hazard such as flood). Gen-R refers to the overall capacity of the system to withstand unknown disturbances, without specifying any particular shock or stress or a system response variable: gen-R is about coping with uncertainty in all ways (Folke et al., 2010). Incorporating both sp-R and gen-R into policy analysis and management has been identified as one of the central challenges for applying the concept of resilience to socio-ecological systems (Walker, 2005; Folke et al., 2010).

Climate change offers an opportunity for creating synergies between more established hazard mitigation sectors and emerging climate change adaptation measures; while focusing events can potentially open windows of opportunity for policy learning, renewal, or transformation. These synergies can include increased proactive measures that minimize multiple hazard impacts, which must be incorporated and synchronized in planning practices across spatial and temporal scales. However, the mechanisms behind these policy changes are weakly understood, particularly across multiple scales (Naess et al., 2004; Dovers & Hezri, 2010). A systematic inquiry in the importance of scale and cross-scale dynamics in understanding the relationship between sp-R and gen-R at the local, regional, provincial is the central objective of this project. In the next chapter I address the methodology behind this inquiry.

Chapter 3: Methodology

The interplay between ‘specific’ and ‘general’ lies at the heart of research. This interplay is particularly emphasized in the relationship between qualitative and quantitative methodologies; often presented as rivals to objectivity. Qualitative research aims to characterize and describe the unique details of a specific case, a specific phenomenon occurring over a specified geographic area. Qualitative research does not have a generalization in mind, however through research it tends to connect the ‘why’ and the ‘how’ question to broader theories. Quantitative research aims to reduce the specificity, aiming to draw out the generality within a sub-set under inquiry. Mixed methods draw on the strength of both methodologies and emphasize the complementarities of methods, instead of drawing attention to defensive methodological positions of tradeoffs and benefits of one over the other.

This inquiry takes a comparative multiple case study approach to the examination of the relationship between institutional capacity to plan for specific risks (floods) and organizational and institutional abilities to deal with change in general across multiple scale of governance. By focusing on formal and informal institutions that comprise flood management regime in BC, this dissertation uses a mixed methods approach by combining multiple case studies with a regional survey that targets flood management professionals in the MVR. The mixed methods used combined expert interviews, multi-scalar policy analysis, participant observation and structured survey approaches. The comparative approach allowed me to examine patterns of similarities and differences across seven municipal sub-cases embedded within a broader regional case study, to then draw conclusions about the regional scale.

3.1 Mixed methods methodology for studying institutions

The literature on the analysis of institutional and policy changes suggests that both quantitative and qualitative data collection and analysis can be used (Sabatier & Jenkins-Smith, 1998; Markvart, 2009; Nass et al., 2010; Goldstein, 2006; Lebel et al., 2007). Quantitative approaches allow researchers to work with large samples, make generalizations, be representative and test theory. This comes with the cost of limited knowledge about individual cases (Basurto, 2008).

Qualitative research focuses on both the process that is occurring as well as the outcome (Creswell, 2009). Qualitative research can reveal the events in the transitional period of change and bring out the interconnections between the actions of participants in a social setting

(Bryman, 2004). Advantageous for the depth and richness of the data, the ability to unpack complexity, context and history, as well as to understand how different causal conditions combine and interact, it is often criticized for the failure to make generalizations and test theory (Basurto, 2008; Ragin, 1987). This understanding is being increasingly challenged (Flyvbjerg, 2006) based on the assumption that generalities can be created through particularities of the case (Wamsler, 2008). Qualitative approaches are also often criticized for potential bias (Hoggart et al., 2002) and the tendency to confirm the researcher's preconceived notions (Flyvbjerg, 2006), reliance on the researcher's potentially unsystematic views on what is important and personal relationships with the people studied (Neuman, 2003). According to Hoggart et al. (2002) the criticisms stem from epistemology affiliated with notions of detached, objective and value-free research that fail to appreciate the 'aims and claims' of qualitative research discussed above.

This inquiry focused on the process of planning for 'resilience' and its outcomes with regards to human and social capital, inter-organizational and institutional learning, collaboration and the ability to collectively maintain options for future adaptation in the region. Investigating the identified research question by using survey methods only would have produced a 'superficial' encounter, incapable of eliciting the meaning of social actions, and unable to reveal the drivers behind the institutional change or nature of connections between the scales of interest and meaningfully explore the diversity within the municipalities. At the same time, a case study design would not be able to produce results that would speak to the region as a whole. A mixed methods approach was used that combined a comparative case study approach with a regional survey.

3.2 Case-study research design

A case study approach was used for this inquiry. This approach is consistent with methodological approaches previously used for the assessment of the sp-R—gen-R relationship in resource management studies (Walker et al., 2009), for addressing municipal and regional planning dynamics in terms of adaptive capacity for addressing climate change in Canada (Burch, 2009) and for providing insights on how to design and implement urban planning responses to coastal climate hazards in Australia (Macintosh, 2013). Case study research is bounded by time and activity, where data is collected using a variety of strategies over a sustained period of time (Creswell, 1998). Multiple sources of information and strategies of data collection allow for triangulation (Yin, 2009).

Other related academic studies conducted in the region have also used qualitative case study methods which included elements or a combination of document analysis, participant observation, and expert interviews (Lyle, 2001; Crawford, 2010; Shoubridge, 2012; Arros, 2013). I draw on these studies and complement them by adding the mixed methods approach that combined four data collection methods: documentation analysis, participant observation, interviews and survey methodologies. This approach allowed me to conduct analysis across multiple scales, which is a contribution of this inquiry.

I also used a comparative multiple case study approach. The evidence generated by multiple case study design is often considered to be more compelling, which results in a perception of the overall study as being more robust compared to a single case study approach (Yin, 2009). Backer (2011) provides a review of single case study versus multiple case study approaches, suggesting that single case studies provide more detail and in-depth description of the phenomena, while multiple case studies provide a stronger base for theory building and permit replication and extension among individual cases. Fitzgerald and Dopson (in Backer 2011) identify four common types of multiple case study designs, each based on a different logic depending on the study objectives: (1) matching or replication (not sampling (Yin, 2009)) designs intended to explore or verify ideas; (2) comparison of differences, including cases selected for their different characteristics; (3) comparison of extremes to delineate key factors and the shape of a field; and (4) embedded case study designs where multiple units are examined to identify similarities and differences.

With the MVR being the focal scale of this research, the case study design is an 'embedded' case study where attention is given to subunits within the overall case (Yin, 2003) – municipalities within the three identified sub-regions – embedded within the planning process at the municipal, regional and provincial levels. Given the objectives of this research and interest in the regional scale, the cases are understood not as multiple instances of a sample to find generalities or differences but as interdependent and interrelated entities, contributing to the regional resilience planning process. This allows for regional level triangulation that could be particularly advantageous for the analysis of inter-municipal planning interdependencies.

One of the limitations of the multiple case study approach is the difficulty of making systematic comparisons for cases located in different institutional and cultural settings (van Gretsel, 2010). The case studies selected for this project are situated within one regional district,

subject to the same regional regulatory framework, provincial policies, with similar climates which greatly reduces the variability among the cases in terms of socio-cultural and regulatory and institutional characteristics (Burch, 2009). Yet, they provide enough variability in terms of combinations of flood hazards faced, their size, internal organizational and institutional characteristics and approaches to managing risks and uncertainty to provide for unique comparative potential within the planning regimes.

3.3 Research Design

The research strategy and design were guided by several considerations such as methodological gaps and data availability. Within the resilience literature, a focus on theoretical discussion and a lack of proven working methodology for empirical investigation on the interplay between sp-R—gen-R (Walker et al., 2009) and resilience tradeoffs Chelleri et al., 2014) was identified. This required the use of mixed methods approaches to collect multiple sources of evidence to be able to answer the research questions. The uniqueness of the Metro Vancouver region (MVR), a non-amalgamated major metropolitan area, a federation comprising 22 municipalities, one electoral area and one treaty First Nation with no regional authority over flood management, meant that no data were readily available regionally. This included secondary source limitations such as lack of standardized plans (e.g., emergency management plans or climate change adaptation strategies, the quality, content and availability of which varied across the region). It was a challenge to select and maintain focus on one specific hazard (e.g., freshet flood), given the importance of multi-hazard interplay and regional planning interdependences. To overcome this, I decided to focus on the interplay between the existing flood management regime (historically focused on freshet) and the emerging flood management regime (sea level rise). I investigated this interplay through the following main stages of data collection:

- The initial policy analysis to identify the initial functional distribution of flood management responsibilities across the scales of governance;
- Exploratory case study to identify cases and sub-regions for the inquiry and focus the interview questions;
- Expert interviews to identify the historic and current drivers of change and continuity in the flood management regime;

- A regional survey to identify patterns of regional collaboration, learning and the similarities and differences across the region in implementation of flood management policies and tools.

These key stages and the overall research strategy and design are presented in Figure 3-1.

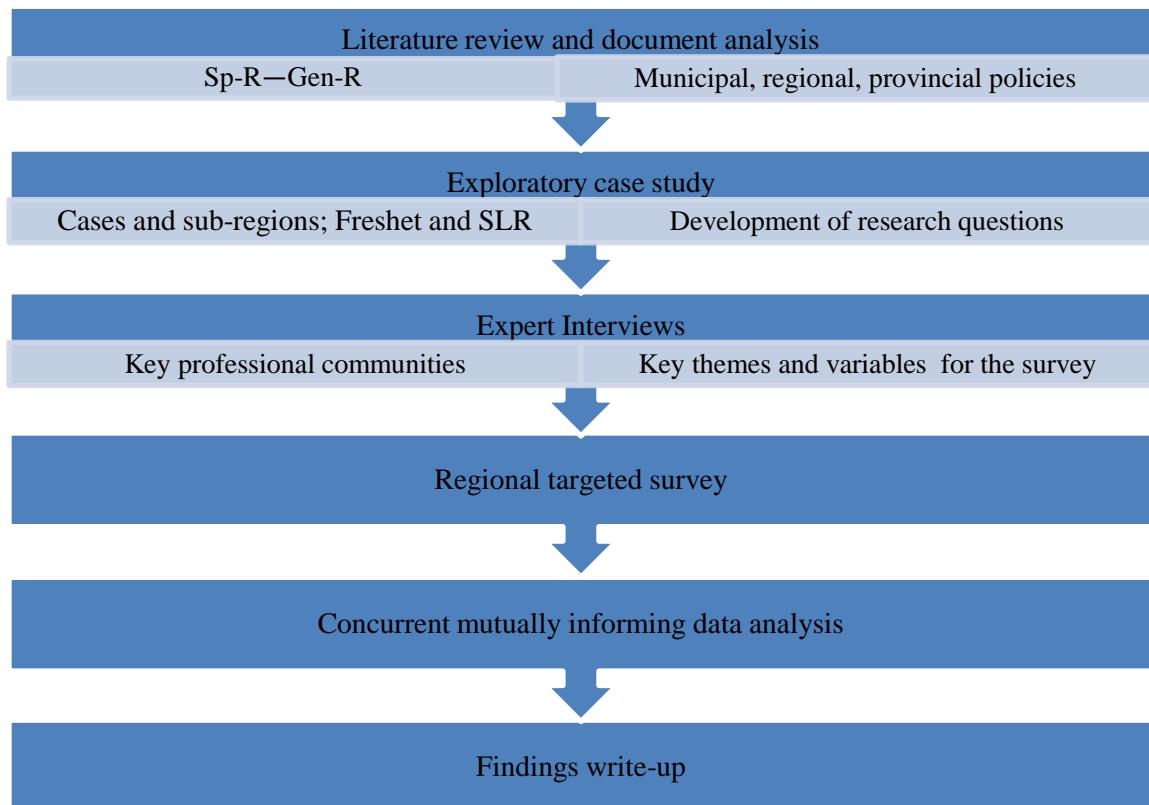


Figure 3-1 Research strategy

These research design solutions and their theoretical underpinnings are discussed in detail below.

3.4 Data Collection

3.4.1 Document review

Preliminary content analysis of the publicly available documents (the Official Community Plans, emergency management plans, hazard-specific maps, hazard-specific management plans, reports, municipal adaptation strategies, provincial documentation, etc.) was carried out for municipalities in the study region to gain a sense of the status and context of flood management planning efforts. At the regional level, meeting transcripts, council reports, internal

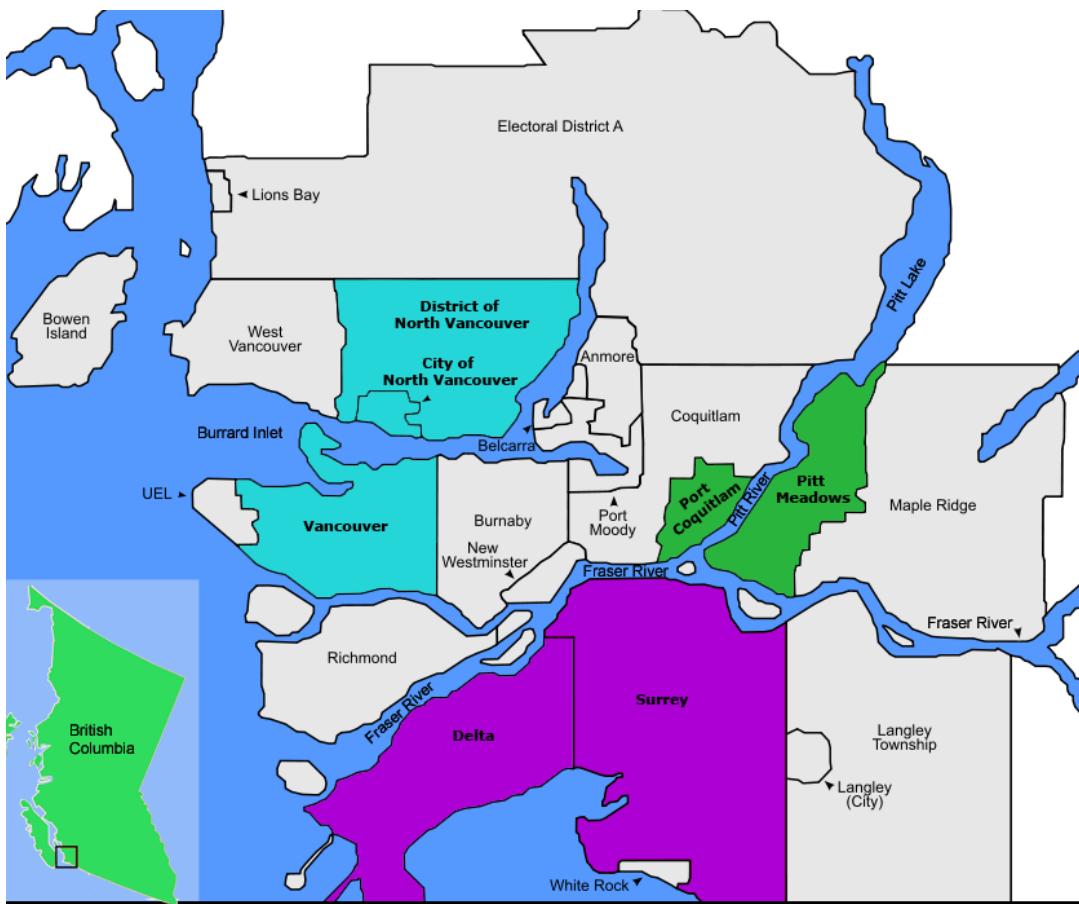
memoranda, official government documents, and media reports were gathered. These documents were analyzed with the goal of determining the legal context, the institutional and organizational architecture, the temporal scale and spatial scales of planning efforts, stakeholders involved and the responsible parties.

Document analysis was pivotal as an overview of the complexity of flood management regulation, its diversity and lack of standardization across the region, as well as limited regional and provincial oversight of municipal approaches. While official documentation offered a better understanding of the institutional and organizational architecture of hazard management regime in the region, for a deeper level of knowledge and understanding I needed to move beyond documentation (Yin, 2003), which was accomplished through an exploratory case study. During this phase I actively attended regional meetings and interviewed 15 participants at the municipal, regional and provincial levels, which allowed me to further focus my inquiry (e.g., hazard of focus, interview guide questions, case selection, etc.).

3.4.2 Case Selection

The cases for the study were selected based on two main criteria: 1) geographic context / regional hazard exposure (river (freshet); river (freshet) and coastal floods/SLR; and primarily coastal floods/SLR); 2) hazard mitigation and general planning context (resilience planning initiatives; reliance on dikes versus no dikes; state of climate change adaptation planning). The geography in the selected municipalities ranged from a low-lying flood prone agricultural community dependent on dikes for its safety to a mountainous residential suburb and a densely populated urban core with no dikes. In addition to hazards faced and existing flood management strategies, the identified municipalities range in size and growth rates. Regarding the state of climate change adaptation planning, the selected municipalities vary from the advanced (Vancouver and Surrey) to moderate (District of North Vancouver) to less advanced (Pitt Meadows).

Collectively, the seven cases constituted three analytical sub-regions within the region for the purposes of my study, as presented in Figure 3-2. The three sub-regions can be contrasted in terms of the degree to which new/emerging risk (SLR) is influencing institutional responses within the traditional flood management regime.



Study sub-regions (municipal case-studies):

- [Green square] The Fraser River, freshet (Pitt Meadows and Port Coquitlam)
- [Purple square] The South Fraser, freshet and sea-level rise (Delta and Surrey)
- [Cyan square] The Burrard Inlet, sea-level rise (Vancouver, District of North Vancouver, North Vancouver)

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Figure 3-2 Study region, sub-regions and municipal cases

The Fraser River freshet (FRF) sub-region (presented in green) is subject to river flooding which can be exacerbated by tidal influence. For the purpose of this study the FRF region includes two municipalities: the medium sized City of Port Coquitlam (CoPC) and the territorially large but sparsely populated City of Pitt Meadows (CoPM). The two municipalities are separated by the Pitt River and bounded by the Fraser River to the South. Both are dependent on standard and non-standard dikes¹ for flood protection.

¹ A non-standard dike, or agricultural dike, is one that does not meet Provincial design standards, where: a) to be constructed to the elevation of the flood of record (1894) plus two additional feet (0.6 meters) of freeboard; b) to be constructed with appropriate side slopes (i.e., 2:1 river-side slopes and 2.5:1 land-side slopes, depending on dike height) for stability during high water; c) to be maintained free of large trees and woody vegetation that could cause a breach in the dike during high water (CoPM, 2016).

The Burrard Inlet (BI) sub-region (turquoise) is subject to sea level rise (SLR) (City of Vancouver (CoV), District of North Vancouver (DNV), and City of North Vancouver (CNV)). As the subsequent chapters will illustrate SLR was the primary focus for this sub-region regarding novelty and challenges of the emergent planning regime. While very different with respect to their size and development patterns, all three are subject to SLR and, compared to the other case studies, are not reliant on existing dikes for flood protection (with some small exceptions). DNV and CNV are also subject to other flood hazards (including creek floods) given their terrain and proximity to the mountains. For CoV the freshet risk was extensively studied and classified as minimal (CoV_E).

The South Fraser or double-hazard sub-region (purple) is subject to both freshet and SLR. For the purposes of this study this sub-region includes Corporation of Delta (CoD) and City of Surrey (CoS). The South Fraser region contains a lot of low-lying agricultural land, and is home to unique ecosystems and growing commercial and residential developments. It is vulnerable to both freshet and coastal risks. CoS and CoD have both developed regional, national and international reputations with regards to climate change mitigation and adaptation planning.

Detailed information about each case study is presented in Appendix D. Presented by the sub-regions, the profile of each municipality includes the following information: general community characteristics (geography; history, demographics, urban development patterns and drivers of change; organizational profile; regional role); flood hazards and risk; flood management and regulation (including structural and non-structural measures); and emergency management approaches. Some information on regional-level involvement is also presented.

3.4.3 Interviews

Expert interviews refer to a systematic approach to synthesize subjective judgments of experts and to make explicit their tacit knowledge and wisdom, based on their accumulated experience and expertise, including their insight into the limitations, strengths and weaknesses of the published knowledge and available data (Slottje, et al., 2008). Local and regional governments are experienced risk managers, particularly with respect to the provision of their services and maintaining their capital assets (roads, bridges, buildings, pipelines, water and waste water facilities, etc.) and are used to dealing with a variety of planning horizons since the lifecycles of these assets range from twenty years to a century or more (NRCan, 2007). It is through this context that local governments are well situated to address impacts from climate

change within their decision-making frameworks as an additional risk related to their provision of municipal/regional services (NRCan, 2007). Given the uncertainty of climate change related risks at the local/regional level, expert interviews can provide additional useful insights to policy makers and planners (Mills, 2008). This information can be used as an additional resource to assess risks and provide useful information to decision-makers (Ogden and Innes, 2007) and provide a richer diversity of opinion compared to a consensus summary (Morgan, 2001).

3.4.3.1 Interview procedures

Interviewing was one of the most rewarding and insightful parts of the dissertation process, with mini-culminations of months of research and preparation distilled in approximately 5400 minutes of personal communication with 60 participants. At the beginning of the interview, I introduced the participants to the purpose of the study and explained the consent form and asked how they would like to be identified for the purposes of this study. All the interviews were recorded with participants' permission. The majority of interviews lasted for about 1.5 hours with the shortest one just over 30 minutes and the longest one nearing three hours. Five interviews were conducted over the phone due to participants' location or scheduling issues.

The response rate to interviews was high for most sub-cases with a few exceptions outlined below. I was aiming to have at least three interview participants per municipality, totalling nine to 10 participants per sub-region. I was successful in securing this response rate for all municipalities with an exception of CoPC (only two interviewers participated, one of them being the Mayor). In addition to two interviews, three survey responses were recorded for Port Coquitlam. This additional data enabled keeping it as a sub-case.

The City of Richmond had to be dropped from the proposed sub-case study list due to inability to recruit enough study participants (one interview with Director of Engineering). However, I draw on this interview in my thesis as it provides important contextual information for the sub-region and region in general.

The interview protocol was developed based on the literature review and conceptual framework, my previous work experience, and communication with researchers who had done somewhat similar studies and who shared their interview guides with me. The interview guide was refined after the exploratory case study. The interview questions related to the participant's background, to organizational culture and problem-solving mechanisms, flood management regimes at the organizational and regional levels, institutional capacity, learning, and

collaboration and leadership. Two guides were developed for the interview: one for flood management professionals (FMP) and one for elected officials to reflect the respective scope and the nature of their contribution to the flood management regime. The FMP interview guide was adjusted depending on the scale of interviewing (municipality vs. province). The interview guides are available in Appendix B.

The interview scheduling and administration process was conducted over a period of over two and a half years, with the first interview conducted on October 12th, 2012 and the last interview on May 20th, 2015. In total, 60 interviews were conducted. The interview scheduling process itself was educational with regard to the organizational cultures and hierarchies involved. It ranged from open sharing of resources, contacts and further introduction to municipal staff to requesting questions in advance to review before agreeing to participate, to requiring pre-approval for participation from superiors, to being able to participate on an anonymous basis only. I found that communicating with the Office of the Mayor prior to inviting the municipal staff was often a successful strategy, particularly in smaller municipalities.

The exploratory case study enabled identifying key flood management professional communities: engineers, planners and emergency managers. This allowed me to develop an interview guide that would be specific enough to address nuances in understanding and contributing to the flood management regime among the professions, yet general enough to capture the broader organizational and contextual background within which it unfolded.

I tested the refined interview guide with two municipal staff. These were the longest interviews (over 2.5-3.5 hours). I further refined the questions for more efficient data collection. This strategy was successful, and the majority of the interviews were within 45 minutes to 1.5 hours' range. Once an interview was completed I wrote down some initial reflections and highlights in my research journal.

I included elected officials as part of this study because of their ability to reflect upon the larger picture of municipality-wide approaches to resilience planning and trade-offs involved between sp-R and gen-R planning and investments. I was also interested in the political dimensions of resilience.

I interviewed two Mayors during the exploratory case study, and these interviews allowed me to further refine my questions to ensure that I could collect enough data to answer the research question within a short timeframe given their busy schedules. Surprisingly, much of

the interviews lasted for over an hour with the shortest interview at 32 minutes and the longest 1 hour 34 minutes. Throughout the interviewing process with elected officials, I was struck by their openness, accessibility, and generosity with their time.

The two interviews with former Premiers of British Columbia gave a very unique perspective on the interplay between the municipal and the provincial levels given the participants' expertise and experience. Additionally, I obtained a recording of a meeting of four former Mayors with the media: Clint Hanes, Chilliwack; John Les, former Chilliwack Mayor and former MLA and cabinet minister; George Ferguson, Abbotsford and Sylvia Pranger, District of Kent. The 2013 flooding in Southern Alberta prompted the retired mayors to meet in Chilliwack with the media calling for a coordinated, and multi-stakeholder approach to flood prevention. This recording is used for contextual purposes.

3.4.4 Survey Design and Procedures

A targeted regional survey was developed capture a regional perspective in addition to the qualitative data collected through interviews with municipal staff of the seven case studies. I developed a regional survey with a focus on some of the emerging findings from my qualitative analysis. Survey questions included hazard priorities (flood and others) and flood experience; general hazard mitigation/flood management approaches and specific tools implemented/perceived as effective at the municipal and regional levels; regional networks of learning, collaboration, influence; regional interdependencies; barriers to regional collaboration; knowledge generation (consultants used) and sharing; and public engagement strategies. I also asked questions around knowledge seeking mechanisms in novel situations, organizational approaches to handling of climate uncertainty, among others.

I designed and administered the survey based on some of the best practices recommended in the literature with a particular focus on using a web survey to collect data on hazard mitigation practices (Miles, 2014). I consulted with regional and international experts on the topic. I refined the survey instrument based on pre-testing with experts.

The final section of the survey included questions about collaboration, learning and influence between the municipal and regional, provincial, federal actors, NGO, research institutions and professional communities. It allowed me to better understand the pattern of collaboration, learning and influence between the municipalities and key organizations. Through multi-scalar policy analysis and semi-structured interviews, I identified 82 organizations that

played a role in flood risk management in the region. These ranged from municipal departments to regional, provincial, federal actors, critical infrastructure sectors, NGOs, research institutions, critical infrastructure sectors, communities of practice (online and face to face) among others.

The survey was reviewed and pre-tested prior to administration. Once finalized, the survey was reviewed by three regional level experts who had a good understanding of flood management issues in the region (an NGO, a regional consultant, and a law firm). Subsequently, the survey was tested with two municipal staff who provided detailed feedback.

The targeted web-based survey instrument was sent to 60 stakeholders in the region. In total, 33 people filled out the survey, recording 32 responses (two staff filled the survey together). This resulted in a 55% response rate, which includes all of the main municipalities with an exception of the Village of Anmore, Village of Belcarra, Bowen Island and White Rock (which is understandable given their small sizes and limited planning capacity).

A major gap from the regional perspective is that none of the invited First Nations participated in the study. In an attempt to receive a higher response rate, phone calls to the First Nations and Band offices were made. I tried contacting Chiefs, public works staff and technical staff directly. Some of the technical staff responded stating that they required permission from their superiors to participate. No responses were recorded.

The survey was open for approximately six months with 94% of participants providing their responses within the first two months of the administration period. Table 3-1 presents a breakdown by participating professions.

Table 3-1 Survey responses by profession

Response	Percentage	Count
Engineering	41%	13
Planning	22%	7
Emergency management	22%	7
Environmental Planning	9%	3
Fire service	6%	2
Other, please specify...	3%	1
Total Responses		32*

*In one of the municipalities two municipal staff (an engineer and a planner) filled out the survey together.

3.5 Data Analysis Procedures

Mixed methods used in this study allowed for collection of diverse and rich data.

Documents allowed for better understanding of the governance and institutional context of this

study and helped to identify gaps to explore. An exploratory case study allowed me to sharpen and narrow the interview questions and identify key target groups for the study. Interviews with flood management professionals allowed for an in-depth exploration of the dynamics behind sp-R and gen-R planning within engineering, emergency management, and planning professions. Interviews with elected officials situated sp-R planning within the broader decision making and prioritizing of investments in resilience at the municipal and regional scales. Building on these data collection efforts, the survey allowed me to test some hypotheses in a more structured way and also helped to explore the organizational and institutional architecture of flood management and planning in the region.

3.5.1 Analytical strategy

I aligned my analytical strategy with the governance scales for analysis, starting with the lowest (municipal). I organized my data into interview sets from the seven sub-cases. I read through them looking for commonalities and differences in perspectives depending on the professional community within each sub-case. I coded the data according to the broad categories of the conceptual framework such as human capital, social capital, learning, collaboration and maintaining options. Each of the categories generated a number of codes: for example, for social capital (networks, regular meetings, interactions, face-to-face, communities of practice, and so on). It became evident that the categories are overlapping, for example networks can also refer to learning networks while face-to-face meetings can refer to ‘more effective learning’. Table 3-2 presents broad analytical framework.

Table 3-2 Analytical framework

Specific Resilience Questions	General resilience features	Process indicators and mechanisms	Operationalization/evaluation/measur ements and data
What are some of the key historic antecedents of current sp-R planning process across scales of governance?	General resilience is rooted in history.	Incorporation of socio-ecological memory and historical knowledge or, more generally, a long-term perspective (e.g., Redman et al. 2004, Diamond 2005, Fisher et al. 2009, Schoon et al. 2011, Cooper and Sheets 2012 in Redman, 2014) into the analysis of current flood management regime.	Drawing on policy documents over time and historical literature combined with interview data, I examined sp-R approaches over time and traced key decisions faced at the time, trying to understand why alternative paths were (not) chosen or failed and analyzed how they influenced (enabled or constrained) options for enhancing gen-R in the future.
How does sp-R planning contribute to building social capital and political influence for acting regionally?	Building and deploying human and social capital (including political influence)	Social capital is important aspect of adaptability (Pelling and High, 2005; Ostrom and Ahn, 2009, Pretty 2003; Crona, 2008). Multi-level social networks, leadership, trust and mobilization of social memory drawing on previous or anticipated ‘crisis’.	Levels of investments in personnel training, networking, conferences, regional forums of collective action for developing political influence. Presence of relationships-based learning and problem-solving. (survey and interviews).
How does sp-R planning contribute to accessing new knowledge, developing new understanding about organizational or regional issues and experimentation ?	Fostering experimentation and learning	Informal collaboration linking people and organizations with different knowledge systems (Hahn et al., 2008); leadership (a requirement for formation of learning environment that accepts continuous testing and change); formal forums and “shadow spaces for learning” (Pelling et al., 2003).	Leveraging knowledge: Accessing and applying new knowledge; Access to external information and resources (inter-municipal, regional, provincial and online/international forum, participating and developing shared platforms; experimenting within organization and with external partners/stakeholders; formal vs. informal spaces for learning (survey and interviews)
How does sp-R planning contribute to inter-organizational and regional ability to self-organize and collaborate in exploring and maintaining diverse options?	Maintaining/g/ increasing options through collaboration and investing in response diversity (“redundancy”) and reserves of resources	Supportive governance mechanisms: multilevel governance systems, flexible institutions: poly-centric, cross-level institutional and organizational linkages among communities, government agencies and NGOs (Ostrom and Ahn, 2009; Hahn et al., 2008; Bodin and Crona, 2008). Resource and information pooling and sharing, risk sharing, investing in partnerships for increasing redundancies.	Evidence of creating effective partnerships; Breaking silos (professional, horizontal and vertical (municipality-region-province). Existence of bridging organization(s) that provide space for collaboration, value formation and innovation (Hahn, 2006). Freshet/SLR planning regimes connections and overlaps (but not too tight to avoid maladaptive management actions across regimes) (survey and interview data).

For the individual sub-case analysis (three to five interviews for seven sub-cases (municipalities)) I focused on developing case descriptions. I coded individual interviews within each municipality, describing the general organizational characteristics and also teasing out the organizational sp-R—gen-R mechanisms at the municipal level. Unless a permission was given to use the name directly, the interview quotes that are presented in this thesis are coded according to the organizational affiliation and numbered in the sequence of interviewing for that specific organization (e.g., first interview from the Ministry of Environment is coded as MoE_1). For municipalities, the interviews are coded using municipal acronyms and professional affiliation. For example, City of Surrey Fire Chief (CoS_FC).

For sub-regional multiple case analysis, I worked with two to three cases per sub-cases. I looked at commonalities and differences of their approaches to shared hazards, from something as specific as Flood Construction Levels to more general such as organizational and institutional dimensions (structure and location of the emergency management office, reporting structure within departments, the role of broader sustainability plans for specific resilience to floods).

For the regional level cross-case analysis I connected sub-regional sets and regional interviews, looking to answer the questions such as: To what degree does the hazard drive the organizational and institutional approached to managing hazard? managing risk? planning for resilience? These formed the basis of the municipal data and analysis: Appendix D (that presents the cases and data) and Chapter 5 (analytical chapter that focuses on municipal cases and sub-regions). Cross-scalar nested case study analysis forms the basis of Chapter 6. I draw on sub-cases, regional, and provincial interviews to locate the cases within the broader institutional context and theory that frames this inquiry.

Throughout the coding process I differentiated between the manifest codes which correspond with the tangible, easily quantifiable surface content, and latent codes, the underlying meaning behind the information (EPA, 2002). Manifest content refers to the visible surface content (frequency of words or phrases) in an interview (for example, ‘Fraser Basin Council’ or ‘flood construction level’). Manifest codes can be easily tested and are reliable. The disadvantage is its validity given that the frequency of a mentioned word might not be an accurate measure of a particular issue. Latent content represents a specific meaning of a text. Latent content is open to interpretation and has lower reliability and high validity (evaluation of the underlying meaning is an accurate indication of the relation of the text to a particular issue).

An advantage with latent content is that it taps the underlying meaning of communication and its disadvantages are its reliability and specificity (EPA, 2002).

For survey analysis, several analytical options were explored. First, I looked at all the data together to seek surprising patterns and findings that were not obvious or were contradictory with the qualitative part of the research. I then looked at the municipal level data for each municipality to triangulate it with the qualitative data. This was followed by sub-regional analysis of different needs and approaches to sp-R planning based on the differing hazards. Some of the survey data is used in the following chapters for descriptive purposes (for example, how many municipalities experience flood related emergency in the past 3 years). Other questions addressed my research concerns more directly: for example, questions 19 and 20: “In general, how effective do you think the following approaches are for reducing the occurrence of flood events or mitigating their effects?” and “More specifically, how effective are the following flood management approaches as currently implemented in your community?” They allowed for data triangulation as they were interpreted in relation to each other and with the qualitative data.

3.6 Ethical Considerations

This research was carried out in compliance with ethical standards and requirements of the Tri-Council Policy Statement for Ethical Conduct for Research Involving Humans. A detailed description of the research process was submitted to and approved by the UBC Behavioural Research Ethics Board (BREB). All participants were first contacted by email using a standardized letter of invitation. They were informed about the full nature of the study and why they were selected for participation. A consent form was also attached to the email outlining data handling procedures and their right to withdraw from the study at any time. A sample letter of introduction and a sample consent form are provided in Appendix B.

At the beginning of each interview I asked the participants to read the consent form and sign it if they agreed to it. All of the interview subjects agreed to the terms of the consent form and signed it, with the exception of two interviewees. They asked me to provide a transcript of the interview prior to signing their consent form, which was provided via email.

3.7 Conclusions and Reflections on Studying Regional Practices

In this chapter I outlined the research design and research strategy, data collection methods and analytical strategies that I used to investigate the relationship between sp-R and gen-R in MVR. The study employed a mixed methods comparative embedded case study design.

In total, seven sub-case studies were selected based on the geography, hazards faced, organizational/planning and general dimensions (such as small vs. large municipalities, rapidly developing vs. stable). In addition to document review and participation in over 30 municipal/regional meetings on the topic, data collected included semi-structured interviews (N=60) and a structured regional survey (N=33). Interviewees included municipal staff (engineers, planners, emergency managers), regional and provincial authorities and elected officials (Councillors/Mayors and former premiers). This dissertation is a product of an iterative process of data collection, analysis and writing which unfolded over a period of six years.

Overall, studying regional planning practice proved to be a challenging task. There was something that went beyond the individual interviews, the group of municipal interviews, beyond the regional planning procedures, plans and strategies. It was the relationships across levels of governance, the shared negotiation of meaning, and collective construction of reality.

Over the past six years, I was fortunate to observe, attend and actively participate in dozens of meetings, regional symposiums, public consultations, expert meetings, regular collaborative meetings, emergency management regional meetings, scenario planning and others. These observations allowed me to understand the regional planning background and identify current issues as well as such characteristics as professional representation and gender distribution of regional planning networks; level of participation and interest; power relationships and decision-making mechanisms; and the general climate for learning, problem solving mechanisms and level of support and cooperation within municipalities and regionally. A lot of what was observed became tacit knowledge that may not manifest itself directly in the subsequent pages. Although every effort was made to make my learning process transparent and accessible to the reader, I realize that I bring a number of biases and assumptions to the study. Throughout the study, I tried to maintain my focus on evidence, paying careful attention to surprises and contradictions (across the cases, sub-regions and qualitative and quantitative data).

Throughout this process, it would be misleading to present myself as a removed, unbiased researcher who maintained a distance between the research subject and me as a person. The positioning and the influence of my research became quickly evident at the initial stages of data collection. After one of my first interviews with a participant, I was invited to attend one of the regional stakeholder meetings. It was one of the initial meetings of a regional, informal group of planners, emergency managers and engineers. The group was formed in response to a need for

regional learning and collaboration in the area of climate change adaptation that went beyond the existing formalized networks and committees. At the meeting, after much deliberation, the participant in the group that I had recently interviewed said they were intrigued by the interplay between ‘specific’ and ‘general’ resilience. They suggested that instead of forming a general ‘climate change adaptation’ collaborative, the group’s energy and momentum would be more sustained if they focused on a specific issue around which they could mobilize their resources and interest in the collaborative and achieve certain outcomes in a specific domain area. A focus on SLR was picked. I became a regular participant of this collaborative (which was eventually called ‘SLR Collaborative’) and attended the majority of the meetings throughout the two-year period. As a result, this research project became in part a participatory one, especially given the timing and the novelty of SLR planning in the region.

Chapter 4: Research context and institutional profile

In this Chapter I describe the multi-scalar context of my inquiry. First, I review the existing governance structures in the Metro Vancouver region (MVR). I draw heavily on historical and policy materials to describe the geographical, historical and institutional context of MVR. Second, I describe the historical antecedents and the complexity of the current flood management regime. I draw a temporal analytical boundary describing the regime before sea level rise (SLR) became a major sp-R issue in the region. Third, I focus on SLR, a subset of current sp-R regime, as an emerging planning challenge across scales of governance with an emphasis on the provincial scale. This chapter sets the context for answering my research questions in the subsequent analytical chapters.

4.1 Urban Canada

Canada's cities play an important role as economic drivers and homes to a majority of the nation's citizens (over 80%), with more than 64% of Canadians living in urban centres of 100,000 or larger (Clean Air Partnership, 2007). The Canadian economy is inextricably linked to the continuous functioning of its cities; for example, large cities like Vancouver account for over half of provincial GDP (McBean & Henstra, 2003). Despite this, municipalities are not recognized in the Canadian Constitution and are considered to be the "creatures of the province" where the provincial and territorial governments determine powers and sources of revenue, can arbitrarily modify responsibilities (e.g., download) and redraw physical boundaries (e.g., amalgamate) (Hilton & Stoney, 2009).

Increasingly, municipalities are constrained by the escalating costs of service delivery and infrastructure needs incurred by expanding municipal roles far in excess of traditional responsibilities, and maintaining and investing in supporting infrastructure, transportation, housing, and policing and public safety (Big City Mayors' Caucus, 2006, p. 2). In 2007, the Federation of Canadian Municipalities has estimated that Canada's municipal infrastructure deficit is at \$123 billion and growing by \$2 billion annually, faced with the dual problems of declining investment and aging infrastructure (Mirza, 2007). This fiscal imbalance places a growing burden on property taxpayers, straining local services, and forcing municipalities to delay essential infrastructure projects and reduce program spending (FCM, 2011). Under the current system, municipalities collect eight cents of every tax dollar. This results in a heavy reliance on property taxes as one of the main municipal funding sources. Property taxes are

regressive which means those with the least ability to pay carry a disproportionate share of the property-tax burden. The direct dependence of municipalities on property taxes and development can negatively impact land-use decisions by placing developments in hazardous areas to increase the tax base. These disincentives will be an important factor to consider when discussing land-use and natural hazards management as I describe the current regulatory context in the subsequent pages.

Some of Canada's greatest economic opportunities, coastal ecosystems which house growing urban populations, turn climate change vulnerabilities. Although the inhabited coastal area represents only 2.6% of the total land area, Mason (2005) estimated that by 2015 a majority of Canadians (50.7%) will be living within 20 km of the coast or the Great Lakes, with the greatest concentration of people living within 5 km of a shoreline. Managing coastal risks (e.g., floods, extreme weather events, SLR) becomes an incredibly important imperative across levels of governance. For example, globally, Vancouver ranked 15th out of 136 large port cities in terms of the value of assets exposed to SLR (OECD, 2008). This makes forward-looking planning increasingly important but also challenging given the need to anticipate and invest in resilience of expanding and aging urban systems under conditions of decreased investment and increasing vulnerability to hazards and extremes.

Floods are the most frequent and costly natural hazard in Canada. Some recent examples of damaging events include the 2013 southern Alberta floods, where approximately 4,000 businesses and 2,000 homes were directly impacted, more than \$50 million was spent on emergency response, and overall damages were estimated at \$7B (NHC, 2015), adding \$2 billion to the federal deficit (IBC, 2014); and the 2013 flood event in Toronto (nearly \$1B in damages and a disrupted transportation network). A recent study estimated potential damage from a Fraser River flood at \$22.9 billion if the event was to happen in the near-term, and at \$32.7 billion in 2100, while a coastal flood in the MVR from a winter storm surge could result in \$19.3 billion in damage in the near term or \$24.7 billion in 2100 (Fraser Basin Council, 2016).

Flood management is considered to be a shared responsibility in Canada between the federal, provincial, regional and municipal governments and property owners. What follows is the geographical, institutional and policy context of my inquiry with a focus on the regional scale and the distribution of shared responsibility across levels of governance.

4.2 Geographic context

The Metro Vancouver Region (MVR) is located in British Columbia (BC), the westernmost province of Canada. BC is approximately the same size as the combined areas of Germany, France and Switzerland, with a population of 4,720,932 million (BC Stats, 2016). The province is comprised of 28 regional districts, around 160 municipalities and nearly 200 First Nations (about one third of all First Nations in Canada). Nearly 55% of the population (2.5 million) are located in MVR. Of the provincial area, 18% is alpine tundra, snow and ice, and approximately 64% is mountainous (Slaymaker, 1999). Some of the most widespread natural hazards include flooding, forest and wildland urban interface fires, snow avalanches and landslides, among 50 other known hazards (Loski, 2012). The lower mainland of BC is located near the junction of the converging Juan de Fuca Plate and North American Plates and is vulnerable to earthquakes that can trigger additional natural hazards such as liquefaction and landslides (Porter and Dercole, 2011). The BC coastline has a total length of approximately 29,000 km (MoE, 2013) with over 80% of the population of BC living within 5 km of the coast (Manson, 2005). In total, some 59 of 162 municipalities and 14 of 28 regional districts in BC consist of coastal communities or have some direct coastline exposure (MoE, 2013).

The breathtaking beauty of the study region, which lies at the foothills of mountains, surrounded by ocean at the mouth of the Fraser River, is combined with risk. This densely populated region is subject to frequent seismic activity, which puts it at higher risk of catastrophic earthquakes than other parts of Canada. It is also subject to intense rain storms and potentially catastrophic river flooding. The regional climate is influenced by ‘atmospheric rivers’ (also known as the ‘Pineapple Express’), “long narrow streams of high water vapour concentrations in the atmosphere that move moisture from tropical regions towards the poles across the mid latitudes” (PCIC, 2013a, p. 2), and which bring the most extreme rainfall events in the West Coast region that can result in flooding and landslides, and potentially in costly damage to coastal communities (Lemmen & Warren, 2016). At the scale of years and decades, the El Niño/ La Niña Southern Oscillation (ENSO) and the Pacific Decadal Oscillation also result in significant variability in the climate and temperature and precipitation.

Coastal hazards such as storm surge and SLR present short-term and long-term planning challenges. The National Round Table on the Environment and the Economy estimates that SLR of 0.28m to 0.85m by 2100 will cause \$2.1 to \$7.6 billion in damages by 2050 for BC, with most

of those costs incurred in MVR. An estimated \$25 billion worth of real estate (not including municipal infrastructure) would be heavily impacted, with the cost of sufficient structural protective measures estimated to range from \$255 to \$510 million in 2011 dollars (CoV, 2012).

The municipalities that lie at the foothills of the mountains also face numerous creek hazards, landslides and risk of dam breaches in certain locations. The municipalities that lie on the soft soils of the Fraser River delta and are bordered by the ocean are subject to ongoing subsidence, flooding from storm surge and liquefaction in the event of an earthquake. The risks of catastrophic loss from a major flood are highest in the region because it has a large population and important regional, provincial and national infrastructure situated in the floodplains.

4.3 Institutional context and urban governance

MVR, formerly the Greater Vancouver Regional District (GVRD), is comprised of 23 local authorities (21 municipalities, one Treaty First Nation, and one unincorporated area) along with “Metro Vancouver” (MV), the political body and service provider that oversees the local authorities with delegated and distributed authority for flood management, among other responsibilities. MVR is the last non-amalgamated large urban region in Canada. It has been described as “l’exception canadienne métropolitaine” (Smith & Oberlander, 2006, p. 147) with distinctly different decision-making and governance structures compared to other regions in Canada and a rejection of ‘rational’ and neo-liberal planning approaches (Stoney, Hilton, & Krawchenko, 2009). The GVRD came into existence in 1967, incorporating the pre-existing regional bodies that focused on delivering utilities including sewerage and drainage services (1914) and water (1926). The GVRD was renamed “Metro Vancouver” in 2007. According to the official website, MV is both a nonpartisan political body and corporate entity operating under provincial legislation as a ‘regional district’. The three primary roles are service delivery, planning, and political leadership. Core services to municipalities are the provision of drinking water, sewerage and drainage, and solid waste management. The three main areas of planning and regulatory responsibility relate to regional growth (land use through municipalities and transportation), waste management (solid and liquid waste), and air quality management (a delegated Provincial function). Finally, MV serves as the main political forum for discussion of significant community issues at the regional level. The core principles of this ‘non-hierarchical’ partnership are that issues are resolved through consensus, and results are based on coherent regional action and services which 1) respect and reinforce the diversity, character and integrity

of local municipalities; 2) protect the natural environment; and 3) maintain cost effective service delivery to tax payers, among others (Metro Vancouver, 2015).

4.4 Regional planning legacy: Livability, Sustainability and Resilience

MVR has a reputation as one of the global leaders in regional sustainability planning. A regional disaster formed the foundation of this unique regional planning culture and philosophy.

The catastrophic Fraser River flood in the spring of 1948 made regional planning politically feasible among the Lower Mainland's diverse municipalities after dozens of lives were lost and millions of dollars in infrastructure damage convinced many officials of the need for flood plans that transcended municipal boundaries (Harcourt, Cameron, Rossiter, 2007; CSCD, 2015).

Amendments to the *Town Planning Act* in 1948 gave the Minister of Municipal Affairs the power to establish regional planning boards with one representative from each municipality and one from the Province to prepare a "plan for the physical development and improvement [of a region] in a systematic and orderly manner" (*RSBC, 1948 C.96, S.42*) and to provide planning assistance to communities in their areas (CSCD, 2015). In 1949, the Province established the Lower Mainland Regional Planning Board (LMRPB) covering an area from Hope to the Georgia Strait. The Lower Mainland region was a leader in the early adoption of floodplain *risk* management practices in BC (APEG BC, 2011) through its 1966 *Official Regional Plan* (ORP) that called for keeping the floodplains free of urban uses except where historical development existed that would be subject to floodproofing. The Board was dissolved in 1969 and its planning functions divided amongst four regional districts (APEG BC, 2010) including the GVRD created in 1967. Although controversial at the time and short-lived, the ORP has influenced land use planning in the region since its creation and its strategies for managing regional growth remain important to planners throughout the Lower Mainland today (CSCD, 2015).

Over time a specific regional focus on floods has been replaced with more general quality of life aspirations. In the 1970s a regional focus on 'livability', and 'quality of life' as experienced by the residents became one of the key planning regional planning aspirations (Timmer & Seymoar, 2005). 'Livability' and its meaning for the region was articulated under the guidance of Harry Lash, Director of Planning for the region, through a participatory planning model in the early 1970's (Timmer & Seymoar, 2005). It meant to connect day-to-day experiences to long-term planning through finding effective ways to deal with a variety of problems: "Producing a plan and regulations would not be enough. We had to deal with long-

term future livability, but also with people's ongoing satisfaction, their day-to-day experience of living in the region. Tomorrow's livability needed as much attention as the attainment of a better future. The proof of the planning would be in the living." (Lash, 1976, p. 48)

After a short break in the 1980s when regional planning was temporarily eliminated as a statutory function, Lash's vision was updated in *Creating our Future: Steps to a More Livable Region* in the 1990s. The vision, developed through extensive public consultation, called for becoming "the first urban region in the world to combine in one place the things to which humanity aspires on a global basis: a place where human activities enhance rather than degrade the natural environment, where the quality of the built environment approaches that of the natural setting, where the diversity of origins and religions is a source of social strength rather than strife, where people control the destiny of their community; and where the basics of food, clothing, shelter, security, and useful activity are accessible to all" (GVRD, 1990).

In 1995, the provincial government passed into law the *Growth Strategies Act* to encourage regional districts and member municipalities to better prepare for growth and future change in a more integrated manner. It provided a framework for interactive planning between municipalities and a regional district that relied on a cooperative, rather than hierarchical, process (Taylor, 2015). In 1996, the region adopted the *Livable Region Strategic Plan* (LRSP) as its growth strategy in response to concerns over the rapid population growth and threats to the region's quality of life and environmental quality. The Plan focused on protecting the green zone, creating complete communities based on regional town centres, achieving a compact metropolitan region, and increasing transportation choices through a transit supportive and automobile-restrained transportation system. The assumption was that quality of life would be enhanced by creating compact and complete communities surrounded by protected natural areas and agricultural land reserves (Timmer & Seymoar, 2005).

In the early 2000s the *Sustainable Region Initiative* was created as a vehicle to review and build on the *Livable Region Strategic Plan* to continue delivering on social, economic, environmental and economic well-being and 'sustainability'. Unlike previous plans, the initiative relied heavily on the involvement of other partners such as the Business Council of BC, Smart Growth BC, the United Way of the Lower Mainland and the Fraser Basin Council, among others (Timmer & Seymoar, 2005). The emphasis on partnership came as a recognition of Greater Vancouver's highly fragmented political jurisdictional landscape. It was also an opportunity to

review progress and to coordinate and integrate across various planning initiatives. In the words of Johnny Carline, the Chief Administrative Officer of the GVRD: “The three-level Sustainable Region Initiative (SRI) took shape: a commitment first to re-examine our corporate practices in the light of sustainability principles; secondly, to review and coordinate all our regional plans, policies and programs in that same light; and finally, to reach out and build a network of partners and grow a similar region-wide commitment that will result in a truly sustainable region. The SRI is a framework and action plan for present and future Greater Vancouver, based on the sustainability principles of economic prosperity, community well-being and environmental integrity; and a management philosophy that will determine how plans and strategies for tomorrow are developed, adopted, implemented and evaluated” (Timmer & Seymoar, 2005:25). This management philosophy speaks to reflective, collaborative, and learning aspirations of the regional planning culture.

Parallel to this process, in 2002-2003, ‘resilience’ was added as a regional planning aspiration. A globally acclaimed, award-winning 100-year, urban-sustainable plan for Greater Vancouver *cityPLUS* (Cities Planning for Long-term Urban Sustainability) involved over 500 experts and participants from 30 cities across Canada (Timmer & Seymoar, 2005). The project was led by a consortium representing four sectors: a private sector consulting firm, academia, an NGO and the GVRD. The plan embodied resilience thinking by building on Holling’s and Gunderson’s theory. It addressed spatial and temporal scales, the need to understand stressors (such as climate change, population growth, natural resource scarcity, technological developments and globalization) and shocks (earthquakes, floods, fires, terrorist attacks, economic downturns, technological changes, pandemics) *and* their impacts on the quality of life and sustainability of the region. It called for adaptive management that would enable mid-course corrections, learning from experience and failure, and seizing opportunities as they emerged. Adaptive management was seen as the nervous system that would enable the region to respond to shocks and surprises, akin to a living organism using its senses to adjust its behaviour to its environment by remaining alert, seeking opportunities and ensuring its survival (Timmer & Seymoar, 2005).

The ‘resilience’ framework emphasized the region’s ability to enhance the personal and collective capacity of individuals and institutions to respond to and influence the course of economic, social and environmental change even in the face of the unexpected. In other words,

‘resilience’, both specific (floods) and general (to multiple shocks and stressors), has been an aspiration for the region for nearly 15 years. How has this translated into practice? For specific flood resilience planning, under the current model, MVR does not have a single flood management authority for the region; instead, each municipality is the principal authority responsible for flood mitigation, preparedness, and response within their boundaries. The degree of flood risk that municipalities face varies across the region given the diverse topographic, demographic, and socio-economic conditions. Currently, over 300,000 people live in the Lower Fraser River floodplain (Arlington Group, 2010) and over 50 billion dollars is considered at risk to a major flooding event (Richmond Chamber of Commerce, 2014). Two major floods of record date back to 1894 (the largest) and 1948 (the second largest). There is a one-in-three chance that a flood of similar magnitude will occur within the next 50 years (Fraser Basin Council, 2015). There has not been major flooding in the recent history of the region (with the most significant water levels and near-misses in 2007 and 2012).

In the next section I describe and analyze flood management policies and practices across the scales of governance. Drawing on historical evidence and policy over time, I seek to lay a foundation for an analysis of whether the existing flood management regime (focused on riverine flooding) constrains or enables emerging SLR planning.

4.5 Co-evolution of development and risk

The historical development patterns in the region have been contributing to risk. In the past hundred years, the coastal and river shoreline has seen intensive development for industrial, commercial and residential use. Structural measures such as dikes, sea walls, piers, and other armouring have allowed placement of critical infrastructure and commercial and residential developments at sea level and below. The projected rise in sea-level and storm surge are beyond the capacity of these structures, which, by virtue of their design, increase vulnerability as they amplify wave energy and increase wave deflection (Carlson, 2015).

The Lower Mainland region (of which MVR is a part) has \$50 billion worth of development (Richmond Chamber of Commerce, 2014) in the floodplain dependent on the integrity of 600 km of diking, 400 floodboxes, and 100 pump stations (MFLNRO, 2015). Most of the existing dikes do not meet the current minimum provincial standard, and would only provide protection against smaller flood events (NHC, 2014). A large magnitude flood is likely

to affect a significant portion of the region's population, directly or indirectly, and will disrupt local, regional, provincial and national economic activity (Fraser Basin Council, 2014).

In addition to the animated natural hazards profile, the historical positioning of now-aging infrastructure puts the airport, ports, highways, bridges, ferry terminals, oil and gas pipelines, as well as hydro-electricity, wastewater and water systems, and telecommunications networks at risk (Fraser Basin Council, 2014). Some of the region's strategic infrastructure (e.g., the Vancouver International Airport) are also protected by dikes. Four out of five wastewater treatment plants are located in the floodplain (historically gravity-fed wastewater systems which reduce the cost of transporting liquid waste). Industries of national and international significance rely on effective functioning of coastal areas. For example, Port Metro Vancouver (PMV) handles 135 million tonnes of cargo a year, trades \$187 billion in goods, providing 98,800 jobs, \$9.7 billion in GDP and \$1.3 billion per year in tax revenues (Port Metro Vancouver, 2014).

The dependence on structural protection varies across the region. A number of municipalities are heavily reliant on the dikes: the City of Richmond, waterfront areas in New Westminster, Port Coquitlam, Port Moody and White Rock, as well as farmland in Pitt Meadows, Delta, and Surrey (Figure 4-1). In the City of Vancouver, landmark waterfront areas such as Stanley Park and False Creek are also reliant on structural protection. SLR could also threaten the food security of the region given that over 4,600 hectares of farmland in the Lower Mainland are located within one metre of sea level (MoE, 2013).

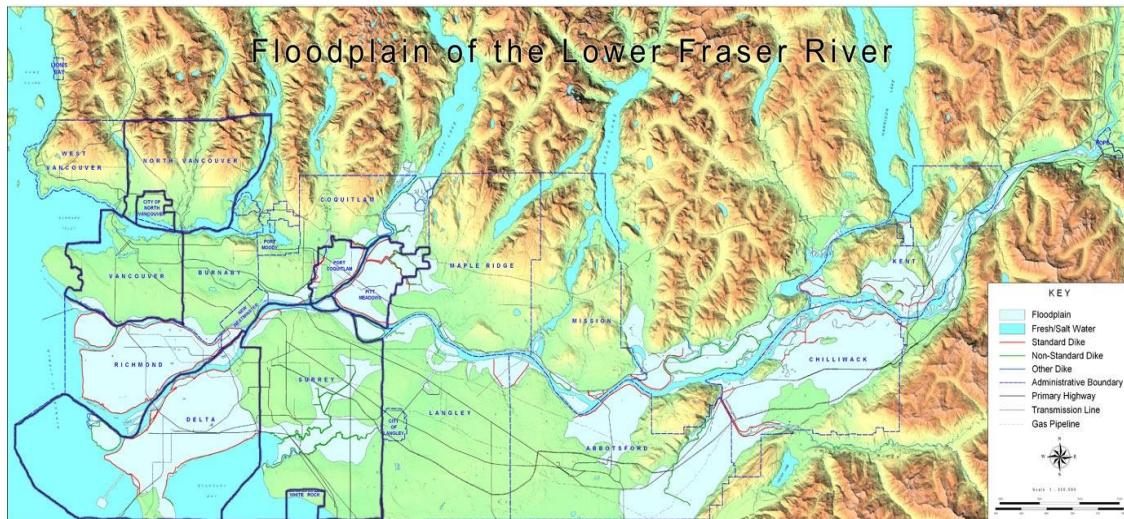


Figure 4-1 Floodplain of the Lower Fraser River with selected case-studies highlighted. Fraser Basin Council. Used with permission

The map above presents only freshet floodplains and does not account for SLR and tidal influence on freshet floods. SLR presents a new regional planning challenge. In addition to flood-specific concerns and extreme events, it has much broader general impacts, some of which are listed below (Barron et al., 2012; Crawford, MacNair, & Tatebe, 2013; Forseth, 2012; Lemmen & Warren, 2016):

- Food security: salinization of Agricultural Land Reserves (ALR) due to dike breaches and the formation of a salt wedge expanding up the Fraser Delta may make some crops non-viable as soon as 2020. This is a serious concern for municipalities such as Delta, which currently produces 26.1% of gross farm receipts in MVR.
- Economic vitality of the coastal areas and associated sectors, including developed areas, infrastructure, major transportation hubs (PMV and Vancouver International Airport which support 71,000 jobs in BC (approximately 221,000 jobs overall in Canada) and contribute more than \$34 billion in total economic output), waterfront amenities, and a large portion of the ALR near the coast line.
- Biodiversity loss in shoreline ecosystems (SLR will squeeze high marsh lands against the dikes becoming a low marsh or mud plain ecosystems and losing half their biodiversity).
- First Nations livelihoods: warming water temperatures, ecosystems changes and threats to species (e.g., decline in fish stocks) and threats to traditional foods and medicines, the increased risk of extreme events, loss of economic opportunities, and changes to the biological systems that they depend on (e.g., migration of animals, birds and insects) will disproportionately impact First Nations livelihoods, food/water security and socio-cultural assets.
- Population displacement: approximately 245,000 people in the region live in floodplains at risk from SLR.

These impacts show how flood hazards are contributing to multi-sectoral challenges with a broadening scale of impacts that places a disproportionate amount of risk on certain population groups. These diverse impacts highlight that in addition to planning for flood resilience, there is a need to plan for a general ability to deal with change. How responsive is the current flood management regime to accommodate this broadening scope? In the next section I review some of

the historic policy responses to identify the antecedents of the current flood management regime to set up a context for the subsequent analytical chapters.

4.6 Flood management regime: an overview

British Columbia has a diverse profile of flood hazards for rivers (e.g., river and stream floodplains; spring freshet; rainfall and rain on snow floods, landslide and debris flow) and coastal flooding (storm surges, tsunami and SLR). Residential development is permitted in the floodplains throughout BC, subject to local floodplain designation and construction regulations (e.g., flood construction levels, the registration of a flood protection covenant on title, among others). For flood management purposes, the 200-year flood² is used in BC to define the flood risk area, and divides it into two zones: 1) the floodway, where further development is discouraged, and 2) the flood fringe where flood-proofed development is possible (APEG BC, 2011).

For thousands of years the First Nations have been living in the region in coastal areas for access to food and water transportation, including the use of ‘winter villages’ and migratory patterns to accommodate seasonal opportunities and hazards. Upon arrival, the European settlers established their settlements along the rivers (the floodplains³), the most fertile soils and in low-lying coastal areas (the flattest terrain in BC) (MNFLRO, 2013). Throughout the years, these settlements have grown into larger communities and major urban centres with MVR as the most densely populated region in BC. The historical development patterns and the way the flood management regime has developed throughout the past century provide some useful insights into current and future risk. I review the history of flood management in BC in the next section prior to outlining the current flood management regime.

² The standard design flood in British Columbia is the “designated flood” with a 0.5% chance of being exceeded in any given year (APEG BC, 2011) which “means a flood, which may occur in any given year, of such magnitude as to equal a flood having a 200 year recurrence period interval, based on a frequency analysis of unregulated historic flood records or by regional analysis where there is inadequate streamflow data available. Where the flow of a large watercourse is controlled by a major dam, the designated flood shall be set on a site specific basis.” (Reference: MELP Procedure Manual 06-09-04.07 in Ministry of Environment, Lands and Parks (1999)). The criteria was originally based on the 1894 flood event which affected a broad area of southern British Columbia as the largest flood recorded in modern times. (Estimates of the return period for this flood vary depending on gauge analyzed and period of record but it falls in the range of about 1:160 to 1:200 years.)

³ Floodplains are areas that experience periodic flooding from nearby rivers, lakes, streams, and the sea (MFLRO, 2012a).

4.7 History of flood management in BC

The history of flood management in BC provides an important context for this study as it highlights some of the antecedents of the current regime. An analysis of the history shows that the overall regime can be characterized as reactive (driven by crisis events, such as the extensive flooding events of 1948, 1972); favouring structural approaches (such as river and sea dikes); undergoing continuous changes, and cuts to programs, staff and funding at the higher levels of federal and provincial government; and increasingly downloading responsibilities to the municipal level.

The history of dikes in this region dates to the late 1800s when farmers built protective structures to protect their properties from routine freshet flooding (Loski, 2011). As time went by, the dikes were built higher and higher and the water inside the dikes became increasingly an issue as the dikes kept the rain water in. To address this need, an extensive, interdependent drainage system was created (City of Pitt Meadows, 2015) in addition to the dike system.

Appendix C presents key programs, impetus for their creation, the focus of the program (structural vs. non-structural; hazard vs. risk), a brief description and the level of government responsible for the program. A defining event, the devastating 1948 flood, was the impetus for a more controlled approach to diking through the creation of the Fraser River Board and the establishment of the *Dike Maintenance Act*, which provided a framework for the roles and responsibilities of the province and diking authorities (Loski, 2011; APEG BC, 2011). From 1968 to 1995 an *Agreement Covering a Plan for Flood Control in the Fraser Valley* resulted in the federal-provincial *Fraser River Flood Control Program* (FRFCP) under which the majority of current flood works were constructed. The 1972 flood served as a catalyst for the *Floodplain Development Control Program* (1975 to 2003), *Floodplain Mapping Program* (1975 to 1994), and the creation of the River Forecast Centre, an organization dedicated to monitoring the Fraser River (and the only surviving legacy of those provincial programs (MNFLRO_1)). Under the FRFCP diking was a provincial responsibility and a more coordinated and funded approach was used. This approach was terminated in 1998 and municipalities were left with the dikes and distributed diking authorities (MNFLROa, 2015). This resulted in an erosion of the quality of diking protection (below the 200-year flood event standard) and a number of orphan dikes (that do not meet the standard and do not have a responsible care taker assigned to them) (COS_E1; MNFLRO_1; COS_E2).

Analysis of this history shows several dominant trends. The flood management regime in BC can be characterized as responsive (with new organizations and programs established and changes to the regime adopted when the need was high) but also reactive (driven by crisis events such as extensive flooding in 1948, 1972, 2007), with major programs and funding being allocated *post hoc*. The list of the programs terminated over time shows a variety of approaches at the federal, provincial and regional levels to manage floods. It also shows continuous cuts to programs, staff and funding, especially at the provincial level from 2003 on (MNFLRO_1) and a resulting decrease in oversight from the provincial government. Investment in structural approaches (such as dikes) dominates compared to non-structural programs.

A notable exception federally is the *Flood Damage Reduction Program* (1975 to 2003), which was created with an objective to reduce major disruptions to regional economies and reduce disaster assistance payments (Environment Canada, archived page). The program was created with an explicit recognition of the limitation of structural approaches to floods given that, despite millions of dollars allocated during 1950-1980 by federal and provincial governments, flood assistance payments continued to escalate:

Projects of this kind are expensive to build and maintain and they are no sure guarantee against disaster. Dikes and dams can be overtapped and channel capacities exceeded making the inevitable flood worse. Structural measures often inspire a false sense of security, thereby encouraging further development in flood prone areas. Moreover, this approach, as well as disaster assistance payments, has the general public paying for the benefit of the few who choose to live in known flood risk areas (Environment Canada, archived page).

The FDRP represented a significant change in approach “from an ad hoc structural response to flooding to a more comprehensive approach focusing on prevention and non-structural measures. It was also more equitable” (Environment Canada, archived page). The FDRP was carried out jointly and under cost sharing agreements with the provinces. The three main initiatives in BC were the *Floodplain Development Control Program* (1975 to 2003), the *Floodplain Mapping Program* (1975 to 1994), and the creation of the River Forecast Centre (Loski, 2011).

The *Floodplain Mapping Program* ensured that once a flood risk area was mapped and designated, neither federal or provincial governments would build or support (e.g., with a

financial incentive) any future flood vulnerable development in those areas, and zoning authorities were encouraged to zone based on flood *risk* (Environment Canada, archived page). New developments placed in the floodplain would not be eligible for disaster assistance. Under this program, more than 900 communities have been mapped and designated across Canada, including all major urban centres except the lower mainland of British Columbia (Environment Canada, archived page). The program ended in 2003 and the maps remain as unsupported legacy documents (APEG BC, 2011).

Regionally, a notable historic example of a non-structural approach is the *Official Regional Plan* (ORP) of the Lower Mainland Regional Planning Board (LMRPB). The Board was created in 1949, covering an area from Hope to the Georgia Strait following the catastrophic flood of 1948. The Board developed a comprehensive dike system and created a flood plan in 1966 (CSCD, 2015) that championed risk-based approaches to floods (APEG BC, 2010). Drawing on general planning objectives of moving towards “orderly development”, “most suitable land utilization” and “a sound regional economy” (p. 3) the plan called for keeping the floodplains free of urban uses except “where committed to urban development through early settlement, in which case further development for URBAN uses shall be contingent upon floodproofing” (LMRPB ORP, 1966, p. 3). Floodplain development would be possible for uses that would suffer least from flooding, thereby minimizing the public and private expenditure for flood protection, and minimizing losses resulting from periodic flooding. The LMRPB was dissolved in 1969 and its planning functions divided amongst four regional districts (APEG BC, 2010).

Another surviving non-structural, land-use based provincial initiative, the Agricultural Land Reserve, is not specific to flooding. The reserve was created in 1973 to be overseen by the Agricultural Land Commission (ALC), an independent provincial agency. Some floodplain areas of BC (and the majority of floodplains in MVR) are classified as part of a provincial zone where farming is recognized as the primary use. Despite past and present pressures to develop floodplains for uses other than agriculture, the ALC has had a considerable effect in preventing development within agricultural floodplains (ALR, 2008; APEG BC, 2011).

In 2003 and 2004 major legislative changes allocated a greater responsibility to local governments for flood management, which resulted in considerable variation of local responses.

In the subsequent sections I describe the current distribution of flood management responsibilities across the provincial, regional and municipal levels.

4.8 Flood Management as a shared responsibility

Currently in BC, responsibility for flood hazard management is seen as a shared responsibility between the various levels of government (e.g., federal government on First Nation Reserves, the provincial government on Crown lands and local governments). The Federal government provides funding and shares infrastructure as well as assistance with flood response and recovery costs through Disaster Financial Assistance. The Province provides enabling legislation (in a form of guidelines and technical studies) and cost-shared and other funding programs. The bulk of local implementation of flood-related policy (e.g., land use planning and zoning, building flood protection structures, emergency planning and response to flood related events) is primarily the responsibility of local governments. Under current legislation in BC, land use is regulated by local governments through an Approving Officer (typically a municipal planner or an engineer appointed by the council but in an independent role due to statutory powers that can refuse a subdivisions approval if he/she considers it to be against public interest) (MoE, 2013), provincial approving officers, and provincial land officers responsible for Crown land (MFLNRO, 2012).

A number of provincial statutes outline legislative provisions concerning flood hazard management. The key statutes consist of the following legislation: *Local Government Act* (LGA); *Community Charter*; *Land Title Act* (LTA); *Dike Maintenance Act* (DMA); *Drainage, Ditch and Dike Act* and *Emergency Management Act*. Figure 4-2 provides a succinct overview of key BC legislation and responsibilities across scales of government. I draw on this figure in the subsequent analysis of the legislated regulatory tools used for flood management at the provincial, regional, district, and local government levels.

B.C. Legislation	Key Elements	Key Provisions	Responsible Party
<i>Local Government Act, RSBC 1996</i>	Regional Growth Strategy	Under S. 849, regional growth strategy objectives can include protecting environmentally sensitive areas and achieving settlement patterns that minimize the risk associated with natural hazards.	Regional Districts
		Under S. 850, the purpose of a regional growth strategy is to guide decisions of social, economic and environmental growth for a period of at least 20 years.	Regional Districts
		Under S. 852, a regional growth strategy can be mandated by the provincial Minister of Community, Sport and Cultural Development.	Minister of Community, Sport and Cultural Development. This provision was exercised once - for the Comox Valley Regional District
	Official Community Plan	S. 875 includes statement of objectives and policies to guide land use planning, S. 876 covers bylaw process, S. 877 covers content including land use restrictions due to hazards or environmental sensitivity, S.878 addresses regional context statement.	Local governments (municipalities and regional districts)
	Zoning bylaw	S. 903 provides authority for local government to regulate land use. Regulation includes siting, location of uses on land, different uses, servicing standards, minimum areas and regulation of density. Also included is the power to prohibit any use in a zone.	Local governments (municipalities and regional districts)
	Floodplain bylaw	S. 910 addresses designation of a floodplain by local government bylaw, role of Provincial Guidelines, and construction requirements in a flood plain including setbacks and minimum building elevations.	Local governments (municipalities and regional districts)
<i>Land Title Act, RSBC 1996</i>	Subdivision approval	S. 85(3) allows Approving Officer to refuse subdivision approval if he considers it to be against the public interest. S. 86 allow a subdivision to be refused if the land is subject to flooding and other hazards. The Approving Officer may require a report by a professional engineer or geoscientist concerning how the land can safely be used as a condition of subdivision approval with the report included in a restrictive covenant on the land title. The conditions under which a subdivision is approved are also included in the Land Title Act.	Approving Officer - typically municipal planner or engineer appointed by Council but with independent role due to statutory powers. Approving Officer is Ministry of Transportation and Infrastructure employee in non-municipal areas (i.e., electoral areas) and smaller municipalities.
	Registration of covenant	S. 219 can include limiting conditions necessary for the safe use of land as required by a Building Inspector, Approving Officer or local government. A covenant can also be used for a save harmless provision where the owner accepts the risks of development and indemnifies government.	
<i>Community Charter, SBC 2003</i>	Building Inspector	S.55-56 gives authority to the Building Inspector to require a qualified professional to provide a report specifying the means by which the land can be safely used for the use intended prior to a building permit being issued. The covenant must be registered on title with the report concerning safe use provisions.	Building inspector for local government
<i>Dike Maintenance Act, RSBC 1996</i>	Regulation of Dikes	S. 2 provides for flood protection dikes to be subject to the written approval of the Inspector of Dikes. This includes changes in elevation or any other works. A technical review is undertaken to ensure Provincial Guidelines are met.	Inspector of Dikes (provincial government employee)
<i>Emergency Program Act, RSBC 1996</i>		Covers emergency planning for the provincial government and for local governments. Disaster Financial Assistance is administered through the Provincial Emergency Program.	Provincial government and local governments

Figure 4-2 British Columbia's key flood management legislation MoE, 2013. Used with permission

4.9 The Role of the Provincial Government

Within the shared responsibility framework, historically the provinces have played a significant role in flood management: “Under the Canadian constitution, flood plain management essentially falls under the jurisdiction of the provinces, as they are primarily responsible for water resources and land use matters” (Environment Canada, archived). In BC, the provincial *Integrated Flood Hazard Management Program* is intended to minimize flood impacts and increase public safety through land use management and floodproofing, engineering works (dikes and dams); and emergency preparedness, response and recovery (MNFLROa, 2012):

Provincially, these flood management functions are distributed among several key ministries. The Ministry of Forest Lands and Natural Resources Operations (MFLNRO) oversees flood safety and diking. The Ministry is responsible for flood protection legislation in BC such as the *Dike Maintenance Act* and *Flood Hazard Area Land Use Management Guidelines* (the Guidelines), among others. MFLNRO provincial land officers manage crown land. These officials must consider the Guidelines when selling or leasing crown land (MFLNRO, 2012).

Emergency Management BC (EMBC), formerly within the Ministry of Justice (moved to Ministry of Transportation and Infrastructure in 2015, with a designated Minister of State for Emergency Preparedness), is responsible for emergency management (e.g., planning, response and recovery from flood emergencies). Currently, it also allocates funds for flood mitigation through the provincial *Flood Protection Program* (FPP) which is co-funded through the Federal Building Canada Plan, Infrastructure Canada.

The Climate Action Secretariat (CAS), Ministry of Environment (MoE), is a central coordinating secretariat across government in partnership with citizens, communities, industries and businesses. It oversees the implications of climate change and has been actively involved in securing funding (e.g., from federal agencies such as Natural Resources Canada) and developing SLR materials for the province in partnership with other ministries and stakeholders.

The Ministry of Transportation and Infrastructure (MoTI) serves as an approval authority for flood prone areas in rural areas (with a focus on flood *hazard*) (APEG BC, 2012) with MOTI approving officers regulating subdivision development within regional district areas, outside of municipal boundaries. Under Section 86 of the *Land Title Act*, these officials must consider flood hazards as part of the subdivision approval process (MFLNRO, 2012).

The Ministry of Community, Sport and Cultural Development (MCSCD) has a general function to work with local governments to build vibrant and healthy communities that are well governed, liveable, safe, economically resilient, socially and environmentally responsible (MCSCD, 2015). The Ministry is responsible for the legislative framework for local government, certain land-use bylaws, and plays a role in facilitating regional growth strategies.

The ministries collaborate under the hazard-specific *Flood Response Plan*. This plan describes the approach to coordinating activities to manage response to flood emergency. It includes the description of roles and responsibilities of various levels of government, provincial ministries and agencies and other stakeholder groups.

4.10 The Role of Regional Districts

The local government system in BC is comprised of municipalities, regional districts, and improvement districts (MCSCD, 2015). As Figure 4-2 illustrated, regional districts also play a role in flood management. In MVR, the historical 1948 Fraser Valley flood is what brought this region together and highlighted the need for regional planning when a devastating flood levelled communities along the river and washed away agricultural land (Harcourt, Cameron, & Rossiter, 2007). However, hazard mitigation has not been a regional or provincial priority (Slaymaker, 1999) and there has been a continuous reduction of federal and provincial responsibilities for things such as flood mapping programs, dike financing and provincial oversight of municipal land use and development as the historical overview has demonstrated. What is the role of regional districts in this process?

According to MCSCD website, the local government system in BC is unique in Canada because, in addition to the 162 municipal governments, it is comprised of 27 regional districts. The creation of special purpose regional entities was viewed as a solution to the fractious interests and short-sighted planning of ward-centric and fragmented systems (Timmer & Seymoar, 2005). Regional districts are modeled as a federation composed of municipalities and electoral areas, each of which has representation on the regional board. The regions are governed by a board of directors composed of appointees from municipalities and a director elected from each electoral area. The districts are financed through resident fees paid for the services provided. Regional districts provide a political and administrative framework for three basic goals: 1) providing region-wide services such as regional parks and emergency telephone services such as 9-1-1; 2) providing inter-municipal or sub-regional services such as recreation

facilities where residents of a municipality and residents in areas outside the municipality benefit from the service; and, 3) acting as the general local government for the electoral areas and providing local services such as waterworks and fire protection to unincorporated communities within the electoral areas.

Regional districts can provide a broad range of services (with the exception of roads and policing), which are determined by the regional board with the support of the electors. The breadth of services varies with each regional district according to its circumstances and local opinion. Regional districts are the planning jurisdiction for electoral areas and can adopt zoning bylaws and official community plans. In addition, regional districts can have a region-wide planning role by developing a regional growth strategy. The regional growth strategy can address hazards and risks as part of the broader regional objectives.

Given these governance arrangements and the flexibility in the services that regional districts can provide, there is variation across BC in the role of regional districts in regional functions including flood management. Within regional district areas, outside of municipal boundaries, MoTI Provincial approving officers regulate subdivision development, and under Section 86 of the *Land Title Act*, these officials must consider flood hazards as part of the subdivision approval process (MFLNRO, 2012). Some districts such as Cariboo Regional District in Northern BC are remote, large, hazardous (from forest fires to floods to the Mount Polley mine spill), underfunded (low tax base), with few resources and staff and lack of technical expertise, yet have significant hazard management expectations placed on them. On the other hand, MVR (well-resourced and densely populated) has a limited role in regional flood management. The role of key strategic regional planning mechanisms such as the *Regional Growth Strategy* (RGS) and Regional Context Statements (documents which link municipal *Official Community Plans* (OCPs) to the RGS) in regulating land use and regional hazard management is discussed in detail in Chapter 6.

4.11 Regional Emergency Management Planning

In Canada, emergencies are managed first at the local level. If needed, local authorities request assistance from provincial or territorial governments. In turn, the province or territory may seek assistance from the federal government. The responsibilities of the three levels of government are outlined in the Table 4-1 below.

Table 4-1 Emergency management responsibilities according to the level of government (Public Safety Canada, 2011; City of Surrey, 2008)

Level	Responsibilities
Municipal	Establishing and maintaining an emergency management organization, bylaws, etc. as required under the legislation; preparing and maintaining local emergency plans; Declaring a Local State of Emergency when required; Analyzing hazards, risks, critical infrastructure, and business continuity; Responding to emergencies within their own jurisdiction; Training staff and volunteers in emergency preparedness, response and recovery; Identifying the need for and developing relationships, agreements, and memorandums of understanding, etc. with others.
Regional	Assist in responding to emergencies that cross municipal boundaries or have impacts or demand for response that exceed the capability of a member local government; Coordinate multi-jurisdictional response or cross-jurisdictional response to emergencies; Assist in building relationships, planning for responses to region-wide emergencies and determining roles and responsibilities before such events take place.
Provincial	Coordinating and supporting local authorities during response; Coordinating and allocating resources when required, based on provincial priorities; Ensuring and facilitating communications between local, regional, provincial, federal government agencies and with external stakeholders.
Federal	Prevention and Mitigation Work with provincial governments and stakeholders to promote disaster prevention and mitigation using a risk-based and all-hazards approach. Emergency Preparedness Work in collaboration with other federal departments and provincial governments to strengthen national emergency preparedness, through planning, support to training, the exercising and testing of emergency management arrangements and plans, and sharing lessons learned from events and exercises. Responding to Emergency Events Provide assistance if requested by the provincial government Recovery from Disasters Provide financial assistance to provincial governments through the Disaster Financial Assistance Arrangements (DFAA).

In MVR, regional emergency planning is organized through an Integrated Partnership for Emergency Management (IPREM), an intergovernmental partnership between the Province and MV (on behalf of its members). IPREM was formed to coordinate regional emergency management planning activities with a vision for “a disaster-resilient region where all levels of government and key stakeholders work together seamlessly” (IPREM, 2009). Established in 2009, IPREM’s role is to facilitate multi-sector cooperation between private and public organizations involved in emergency management. This model for regional coordination of emergency management planning for the Lower Mainland was adopted to better ensure that

regional services and infrastructures are properly addressed in the context of potential “cross-municipality” disasters. The effectiveness of the system has not yet been tested in a large scale regional disaster.

4.12 First Nations

It is important to mention the inequitable spatial and social distribution of flood risk and vulnerability in the region. A significant number of First Nations communities is located in floodplains unprotected by the dikes (Fraser Freshet Masterplan, BC MFLNRO, 2011). Partially this is due to the historic importance of access to watercourses for fishing, hunting and transportation but more importantly this socio-spatial inequity is the result of Canadian governments’ colonial policies that forced on-reserve locations, often on lands seen as sub-standard for colonial settlements. The reserves are not subject to governance by the municipalities or the Regional District and are governed by the Squamish Nation, Musqueam Nation, Tsleil-Waututh First Nation, Tsawwassen First Nation, Semiahmoo Indian Band, Kwikwetlem First Nation, Katzie First Nation and Kwantlen First Nation. Qayqayt First Nation and Hwlitsum First Nation do not have a land base. Most of Musqueam, Tsawwassen, Semiahmoo, Tsleil Waututh and Squamish First Nations lands are close to sea level (MoE, 2013).

In 2009, Tsawwassen First Nation became a Treaty First Nation member of MV when a treaty signed and ratified by the Government of Canada, the Province, and Tsawwassen First Nation came into effect. This was the first urban treaty in the province and the first to be reached under the BC treaty process. The treaty also provides Tsawwassen with self-government jurisdiction, an expanded land base, and the tools to participate in the sustainable economy. Tsawwassen also became a Treaty First Nation member of the GVRD (now MV).

Despite my efforts to interview the Tsawwassen First Nation representatives (the Chief or Technical staff) as part of this study and my numerous attempts to invite other First Nations technical staff and community organizers to participate in the regional survey, I was not able to include their direct perspective in this work. The First Nations were also largely absent from the regional stakeholder meetings in which I was able to participate. In the following chapters, I will discuss the relationship between municipalities and First Nations from a municipal perspective only. This is a very important area of future work given SLR projections and distribution of risk and vulnerability and First Nations rights and title.

4.13 The municipal role in the flood management regime

Municipalities in BC operate under the *Community Charter* which recognizes them as an independent order of government within their jurisdiction and enables them to provide a wide variety of services that are reflective of their community's needs and desires (MCSCD, 2015). There are four classes of municipalities in BC, which are based on population but have the same authorities: village; town; district; and city. There are 162 municipalities in BC with a wide range in population (from small villages of 250 persons to large cities of over 650,000) and geographic size (from 60 hectares to 155,000 hectares) (MCSCD, 2015).

Under the current regime, municipalities are responsible for planning and land-use with respect to hazards, preparation for, and response to flood events and are the main owners and responsible entities for engineered flood works (i.e., the diking authority) (MoE_1; MNFLRO_1). With regards to land-use, municipalities have the following authority under the current regime (MFLNRO, 2012): 1) Develop flood hazard area bylaws without provincial approval, but they 'must consider' provincial policies and guidelines; 2) Grant flood hazard area land development exemptions provided that the exemptions are consistent with provincial guidelines, or a suitably qualified professional engineer/geoscientist certifies that the area in question can be safely developed for its intended use; 3) Establish the requirements for subdivision in flood prone areas. These requirements can include engineering reports assessing flood hazards and restrictive covenants.

4.13.1 Legislative change in 2003/04

A major shift in policy with regards to municipal responsibilities occurred in 2003/04. Legislative changes to the *Land Title Act* and the *Local Government Act* removed the role of the province for floodplain designation and approval, shifting this authority to municipalities. Responsibilities were transferred for flood hazard area land use management, granting the authority to exercise a degree of discretion in developing municipal policies for zoning, development permits, subdivision approvals, bylaws, and building permits through the statutory authority. This resulted in new opportunities for municipalities but also new risks (e.g., liability).

The current BC legislation does not require local governments to adopt flood bylaws. Stevens and Hanschka (2014) found that only 33 of the 159 municipalities in BC have adopted a flood bylaw and only 22 additional municipalities have included flood risk management provisions in their zoning bylaws. The *Local Government Act* section 910 requires local

governments to ‘consider’ the provincial guidelines when adopting a bylaw. However, there is lack of alignment/clarity within the regulation especially around the Guidelines that must be considered but do not have to be adhered to. The mechanism for getting this approval from the province is not clear, meaning that structures built subsequent to a local government making a designation under Section 910 might not be eligible for assistance (Carlson, 2013).

4.14 Spanning boundaries: The Fraser Basin Council.

The Fraser Basin Council (FBC) is a non-governmental, not-for-profit organization that facilitates and coordinates regional and watershed action on flood management. Created in 1997, it is dedicated to advancing social, economic, and environmental sustainability throughout the 240,000 square kilometres of the Fraser River Basin (Fraser Basin Council, 2015). The Fraser River is the longest river in BC, running for 1,400 km from the Rockies to the Salish Sea. The Basin contains 21 million hectares of forest land, half of BC’s agricultural land and many producing mines (Marshall, 2010). The river has been impacted by over a century of population growth, urbanization, development and pollution and by the 1980s the health of the river was in jeopardy. The origins of FBC are closely connected to leadership at the local level. Gordon Campbell, then a Mayor of Vancouver, and John Backhouse, then a Mayor of Prince George, challenged each other to clean up their parts of the river (Fraser Basin Council, 2015). The joint challenge showed the need for coordinated action along the river and across jurisdictional boundaries. Through a number of partnerships across the federal, provincial, and municipal levels of governments and related programs and organizational transformations, eventually the Fraser Basin Council was born. The FBC facilitates collaborative action among various levels of government, the private sector, and civil society to solve complex, multi-jurisdictional issues in the Fraser Basin, to take advantage of opportunities, and to strengthen the capacity of institutions and individuals to deal with emerging issues that threaten the overall sustainability of the Basin, while minimizing duplication (Boothroyd et al., 2010). FBC is funded by contributions from the federal, provincial and local governments in the Fraser Basin, contributions from corporations, individual and foundation donors, and contracts for the delivery of short-term projects and multi-year programs. It strives to remain “impartial, transpartisan, independent, and non-political in its primary role as an advocate for sustainability” (Marshall, 2010, p. 117).

Since 1998, the FBC has overseen the Joint Program Committee (JPC) for Integrated Flood Hazard Management, an ongoing regional forum for dialogue on flood management. It

serves as a platform for regular meetings to share critical information, collaborate and build consensus, and develop management strategies that take into account a regional perspective and shared priorities that extend beyond the individual interests of its 34 municipal, provincial, federal and other members. FBC also managed the BC Regional Adaptation Collaborative (RAC)—21 collaborative projects across the province supporting decision-making on water allocation and use, forest and watershed management, flood protection and floodplain management and community planning.

In 2007/8 with funding from the BC Ministry of Environment, FBC initiated a review of legislative changes based on input from affected stakeholders. A detailed survey was sent out to all local governments, Ministry of Transportation Approving Officers, Crown Lands Management Officers (responsible for Crown land disposition in the Integrated Land Management Bureau), flood safety staff in the Ministry of Environment, and applicable private consulting engineers and geoscientists. The survey resulted in 106 responses from nearly half of the 157 municipalities, and over 40% of the 27 regional districts in BC. Some of the key findings of the study are summarized in Table 4-2 below.

Table 4-2 Key findings from 2007/08 review study (Arlington, 2008)

Questions	Percentage - yes
Flood hazard management is an issue in the community	90%
Local government has a bylaw that regulates construction in flood hazard areas	80%
Work experience in flood management: more than 10 years	56%
Flood hazard management occupies no more than 20% of the workload	89%
Use of consultants to address flood hazard management issues	75%
The legislation and related management tools were sufficient to adequately manage flood hazards	< 32%
The current legislative requirements are clearly defined	< 48%
Have the 2003/04 legislative changes improved the effectiveness of flood hazard management?	
Yes	15%
No	35%
Don't know/Not sure	50%
Have the 2003/04 legislative changes made the regulatory environment for flood hazard management more efficient or timely?	
Yes	16%
No	26%
Don't know/Not sure	58%

The findings show that flood management was a prominent issue addressed by experienced staff as part of their workload, while consultants played a significant role. There was

lack of confidence in current legislation and flood management tools. Notably, the majority of participants answered ‘no’ or could not comment on whether 2003/4 changes improved the effectiveness of flood management or made the regulatory environment more efficient or timely.

The discussion of the current flood management regime indicates a complex, fragmented governance system that has maintained a degree of path-dependency and reliance on structural protection, historic co-evolution of development and risk, decreasing amount of oversight and support (technical and funding) from higher levels of government and increasingly diverse municipal responses, given the lack of clarity within the provincial legislation. How responsive is this regime to an emerging SLR challenge?

4.15 Sea level rise: a fundamentally novel planning challenge?

In addition to river flooding, creek flooding and intense rain storms, the study region is subject to an increasing rate of sea level rise (SLR). SLR and storm surges can lead to a very diverse set of impacts such as damage to coastal infrastructure, property loss from erosion, habitat loss, decreasing biodiversity, saltwater intrusion into coastal aquifers and loss of cultural and historical sites (Fraser Basin Council, 2015d). SLR on BC coasts is occurring at a lower rate than the global average of 17 cm/century due to tectonic changes with structural uplift occurring on the west coast of Vancouver Island and subduction occurring in the Strait of Georgia (MoE, 2013). The historic SLR changes along the BC coast range from 9.8 cm/century for Prince Rupert (located on BC’s North coast) to 2.0 cm/50 years for Vancouver to -16.8 cm/century for Tofino (located on the west coast of Vancouver Island) (MoE, 2013). In MVR, some areas are experiencing subsidence of alluvial soils in the Fraser River estuary. For example, West Richmond, located in a municipality that is one metre above mean (average) sea level, (City of Richmond, 2015) is expected to face 1.2 m of SLR by 2100 (including land subsidence of approximately 1-2 mm/year) (AusencoSandwell, 2011). The significant range and diversity of geological processes that influence these rates present a planning challenge for developing province- or region-wide adaptation strategies and necessitate context specific approaches to planning and management.

Climate models for BC project a continuing rise in frequency and severity of extreme weather events with major impacts for communities, infrastructure and industry and magnified risks in low-lying coastal areas from SLR and increasing storms (Hartford, Vaderville and Church, 2008; McBean and Henstra, 2009). As an example of manifest changes, emergency

management personnel described the 2006 southern BC windstorm as the most destructive storm event for hydro and phone infrastructure in BC's history; a symbolic event revealing a steady trend of increasing costs of extreme events recorded by BC's Provincial Emergency Program (PEP) from an average of \$10 million per year during 1999-2002 to \$86 million per year during 2003-2005 (Hartford, Vaderville and Church, 2008).

These trends show that addressing climate change impacts will necessitate an effort from engineering, planning, and emergency management as well as political support for long-term investments. The province also recognizes that it will require collaboration and coordination across levels of government (MoE, 2014) and provision of an enabling framework for achieving local governments' objectives. In the subsequent sections I review the framing and guidance provided by the province for the SLR challenge with an emphasis on key drivers that ignited discussion and action in the region.

4.15.1 Emerging SLR regime: the role of senior government as a trigger for action

The Province played an important role in triggering SLR planning and action at the local level. I review some of the key materials produced by a number of provincial ministries and stakeholders to characterize the overall provincial approach to SLR. These include studies, technical guidance, evaluation reports and toolkits. Similar to the approach used to analyze the history of flood management, I provide a summary of these in chronological order over the study period (2007-2015) in Appendix C. Where necessary, I provide information on the most recent developments for freshet floods to establish an explicit connection between the two hazards (freshet and SLR) and the related responses. I also provide the names of the commissioning agency and consulting groups involved.

During the period of 2008-2014, some of the key provincial guidance for SLR has included the following materials:

- information about relative SLR along the BC coast (Bornhold et al. 2008);
- preliminary guidance on including this information in coastal dike design (elevation) and flood construction levels (AusencoSandwell, 2011);
- a proposed uniform methodology for coastal floodplain mapping that accounts for SLR (Kerr Wood Leidal, 2011);

- a study on the financial costs of adaptation (sea dikes and alternative strategies) (Delcan, 2012);
- a SLR Adaptation Primer for Canada's south coasts (MoE, 2013);
- a study on the effects of SLR and climate change on Fraser River Flood Scenarios (NHC, 2014).

These informational and guidance materials were intended to inform planning and management decisions in coastal areas. Two of these, *Climate Change Adaptation Guidelines for Sea Dikes & Coastal Flood Hazard Land Use* (Ausenco Sandwell, 2011) and *Cost of Adaptation – Sea Dike and Alternative Strategies* (Delcan, 2012), ignited the discussion. Both studies were commissioned by MFLNRO and I discuss them and the response to them below and in Chapter 6. As Appendix C illustrates, MFLNRO and MoE played a critical role in commissioning these studies. CAS, MoE, played an important role in securing NRCan funding as part of the BC Regional Adaptation Collaborative. FBC played a role in administering and coordinating some of the studies. The majority of the work was done through a number of consulting companies.

In 2011, the Province released proposed amendments to the 2004 Guidelines that would reflect SLR. The Guidelines recommended planning around a 0.5-metre rise for developments with design life spans up to the year 2050, and 1.0-metre of sea level rise up to the year 2100 (Kerr Wood Leidal, 2011). The guidelines, in an unprecedented way, provided an affirmative ‘policy’ number of 1.0-metre sea level rise by 2100.

The Cost of Adaptation – Sea Dike and Alternative Strategies significantly raised the profile of SLR as a critical policy issue and ignited an active collective discussion in the region. The study provided an estimated price tag of \$9.47 billion for the adaptation measures for the selected 33 shoreline reaches to accommodate the provincially indicated 1.0-metre of sea-level rise in the coastal area of the region. The cost estimate provided intended to help to define the scale of the work ahead as a first step in developing a regional flood protection adaptation strategy.

As illustrated above since 2008 there has been an increased amount of provincially initiated guidance on SLR. As a result, while a number of municipalities have chosen to actively address SLR within municipal planning and to accept the Provincial guidelines, others chose to proceed as usual, at least for the time being, preferring not to invest their resources to protect

themselves from specific low probability/high consequence hazards (such as an earthquake-related breach of the dike), as this would take away resources from other more immediate high-priority municipal objectives. Some municipalities decided to conduct their own in-depth studies before making any commitments. The diversity in municipal responses to climate change was not limited only to their responses to the Provincial guidelines but also the mechanisms they used to address flood management (sp-R) and the degree to which these mechanisms were deployed to address the threats of climate change (gen-R).

4.16 Concluding Summary

This chapter set the historical, governance, regulatory, and institutional context for my inquiry.

First, I explored governance and the institutional profile of MVR as informed by a historical perspective on regional planning and culture and the co-evolution of development and risk. As discussed, it was the devastating flood in 1948 that made regional planning a possibility in this region. As history shows, the region was an early adopter of a progressive, risk-based approach to managing floods as a review of the 1969 *Lower Mainland Regional Planning Board's Official Regional Plan* showed. An explicit focus on floods disappeared from the regional radar as the region committed to more general planning aspirations such as livability (from the 1970s), sustainability (early 2000s) and, most recently, resilience (since 2002/03). Hazard mitigation has not been a regional or provincial priority (Slaymaker, 1999) and has seen a continuous reduction of federal and provincial responsibilities such as flood mapping programs, dike financing and provincial oversight of municipal land use and development.

Second, I described the complexity of the current flood management regime in BC, its history, policy development and the powers and responsibilities of key organizations involved at the municipal, regional and provincial levels. This overview showed that the overall regime can be characterized as responsive but also reactive (driven by crisis events, e.g., the extensive flooding events of 1948, 1972 and 2007); favouring structural approaches (such as river and sea dikes); undergoing continuous changes, and cuts to programs, staff and funding at the higher levels of federal and provincial government; and increasing downloading of responsibilities to the municipal level. It showed that the current level of flood protection (e.g., dikes in MVR) does not sufficiently address the existing flood risk. Given the insufficient knowledge base of flood risk in the region, governance challenges and the inadequate level of flood protection, how can

this region plan for SLR, which will not only exacerbate the existing challenges but also pose new ones (e.g., loss of lands)? The new challenges are much broader than protecting land and property from seasonal floods and span from loss of signature waterfront areas to a loss of biodiversity and the ability to produce food in the region, among many others.

Third, tracking key changes, policy decisions and planning documents during the study period (2007-2015), I explained how the freshet-oriented flood management regime responded to the SLR challenge. This coalescent narrative of the ebbs and flows of flood management policies and shifting responsibilities shows the complexity of planning for sp-R and sets a context for an exploration of gen-R planning. I concluded the chapter by demonstrating how the emergent SLR regime was propelled by the province, BC RAC, and partner organizations, gaining significant momentum from 2013 onwards by making SLR a prominent regional issue, and a signature policy issue in BC.

In the next chapter, I focus on analyzing sp-R—gen-R relationship at the municipal scale.

Chapter 5: Understanding the relationship between Sp-R and Gen-R at the municipal scale

5.1 Introduction

In this chapter I focus on the relationship between sp-R and gen-R planning at the municipal scale (Table 5-1). I first set the scene for this analysis by describing the regulatory context within which sp-R planning takes place (Section 5.2). I then characterize sp-R by identifying key *tools* and *processes* used for flood management and planning at the municipal level (Section 5.3). In subsequent sections, I explore the relationship between sp-R and gen-R at the municipal scale through three main dimensions. The first one, the role of planning process for gen-R was hypothesized at the outset of the thesis (Section 5.3). The other dimensions were discovered as part of this inquiry: the role of organizational dimensions for gen-R (with a focus on social capital and ability to self-organize and collaborate (Section 5.4) and learn (Section 5.5)), and the role of decision-making processes for gen-R (with a focus on the ability to maintain options) (Section 5.6).

Table 5-1 Chapter 5 at a glance

Areas of inquiry	Key themes	Sec.
Characterizing sp-R at municipal scale: What are the key elements of sp-R at the municipal scale?		
Key sp-R tools and processes	Site/area specific vs. general land use tools	5.2
Characterizing sp-R—gen-R: What is the relationship between sp-R and gen-R at the municipal scale?		
The role of planning process for connecting sp-R to gen-R	Official Community Plan Sustainability planning Climate change planning	5.3
Building human and social capital, self-organization and collaboration	Physical geography, waterbodies and hazard types Organizational dimensions: size of the organization, organizational cultures	5.4
Learning, monitoring and experimentation	Types of knowledge used Learning mechanisms for incremental vs. transformative change	5.5
Maintaining options and building reserves of resources	Investing in sp-R vs gen-R: fiscal trade-offs Maintaining options across spatial scales Maintaining options across temporal scales	5.6

Table 5-2 presents some general characteristics of the municipalities that, in addition to hazards and existing flood management strategies, range in size, growth rates and political power within the regional district, among other characteristics.

Table 5-2 Municipal profiles

Municipality	CoV	DNV	CNV	CoPC	CoPM	CoD	CoS
Population	605,071	86,396	48,770	56,347	17,965	99,863	507,000
Population density, persons/sq. km	5,249	525.1	4,073.8	1931.3	205.0	554.4	1,479.9
Regional growth share	12.9%	0.9%	1.5%	1.9%	1.1%	1.6%	37.2%
Land Area, sq. km	114	160.76	11.83	29.17	86.51	180.11	316.41
Percent share of land area, Metro total ¹	4.0%	5.7%	1.4%	1.0%	3.1%	6.5%	11.1%
Agricultural land (muni/regional share)	0.6%/ 0.1%	0	0	8.7%/ /0.5%	55.9%/ 9.0%	46%/ /15.2%	31.5%/ 18.6%
Floodplain (% of overall municipal land area)				45%	86-95%	100%	33%
Dikes, km (approx.)				17	64	61	100
Number of directors ² /Voting strength	7/31	1/5	1/3	1/3	1/1	1/5	5/24

¹ Metro Vancouver's 2006 Generalized Land Use by Municipality Net Land Area - excluding dedicated road right-of-way and water (Metro Vancouver, 2006)

² Number of Directors on the Regional Board—Voting Unit: 20,000 population. Number of Directors (voting strength/5); Voting Strength (population/voting unit). Population including people residing on Indian Reserves certified by the Minister as of Dec 31, 2012. These figures are used to determine the number of Directors on the Regional Board and their voting strength during the calendar year 2013 in accordance with Section 783 of the Local Government Act (CSCD, 2012)

This chapter draws on the detailed descriptions of each of the municipal case studies (based on the document review, interviews and survey data) presented in Appendix D. The information in the Appendix D is organized into three sub-regions: 1) the Fraser River freshet (FRF) sub-region (Port Coquitlam and Pitt Meadows); 2) the Burrard Inlet (BI) sub-region (City of Vancouver (CoV), District of North Vancouver (DNV), and City of North Vancouver (CNV)); and, 3) the South Fraser (Corporation of Delta (CoD) and City of Surrey (CoS)). The profile of each municipality presented in Appendix D includes the following information: general community characteristics (geography; history, demographics, urban development patterns and drivers of change; organizational profile; regional role); flood hazards and risk; map (where available); flood management and regulation (including structural and non-structural measures); and emergency management approaches. Additionally, information of organization arrangements and structures and regional-level involvement is presented.

5.2 Setting the scene: characterizing sp-R

As discussed in detail in Chapter 4 and Appendix D, under the current regime, municipalities can employ a range of tools and processes for sp-R planning, of which some are legislated and others are optional (Figure 5-1). Legislated tools and processes are levers used by

the various institutions with influence on the flood management regime across governance scales (municipal, regional provincial), spatial scales (e.g., from site- or municipality-specific FCLs to Regional Growth Strategy) and temporal scales (from 3-year term electoral cycles to 100-year infrastructure lifespans). At the municipal scale, optional tools (dotted lines) present mechanisms by which municipalities address the gaps in the legislated framework. It is important to note that Figure 5-1 is based on the pre-interview governance analysis and is a starting point for characterizing the sp-R activities in communities.

From an institutional adaptability perspective, legislated tools can enhance or erode sp-R and gen-R, especially once the scale of the issue being governed outgrows the capacity of the governing framework. Figure 5-1 situates the legislated provisions and tools within the multi-scale governance regime and the spectrum of whether they are general (broadly based, e.g., regulate scale-specific land-use) or site/area specific. In the analysis that follows, Chapter 5 focuses on the municipal scale while Chapter 6 focuses on multi-scale governance with a focus on the regional scale. As the subsequent discussion will show some of these policy levers present a complex causal relationship and grey areas as to what is optional or legislated and their influences on both sp-R and gen-R. For example, according to provincial guidelines municipalities ‘must consider’ provincial guidelines when developing their flood policies. However, as analysis in Chapter 5-6 will show, the lateral (across the region) and the vertical (multi-scalar) understanding of ‘must consider’ offers a grey area for (un)implemented sp-R policies.

In what follows, I begin with answering my first research question: what are the key elements of sp-R at the municipal scale? I characterize sp-R by describing the current governance context, planning processes, and tools. These range from flood-specific, site/area specific to more general land use and decision-making tools and processes.

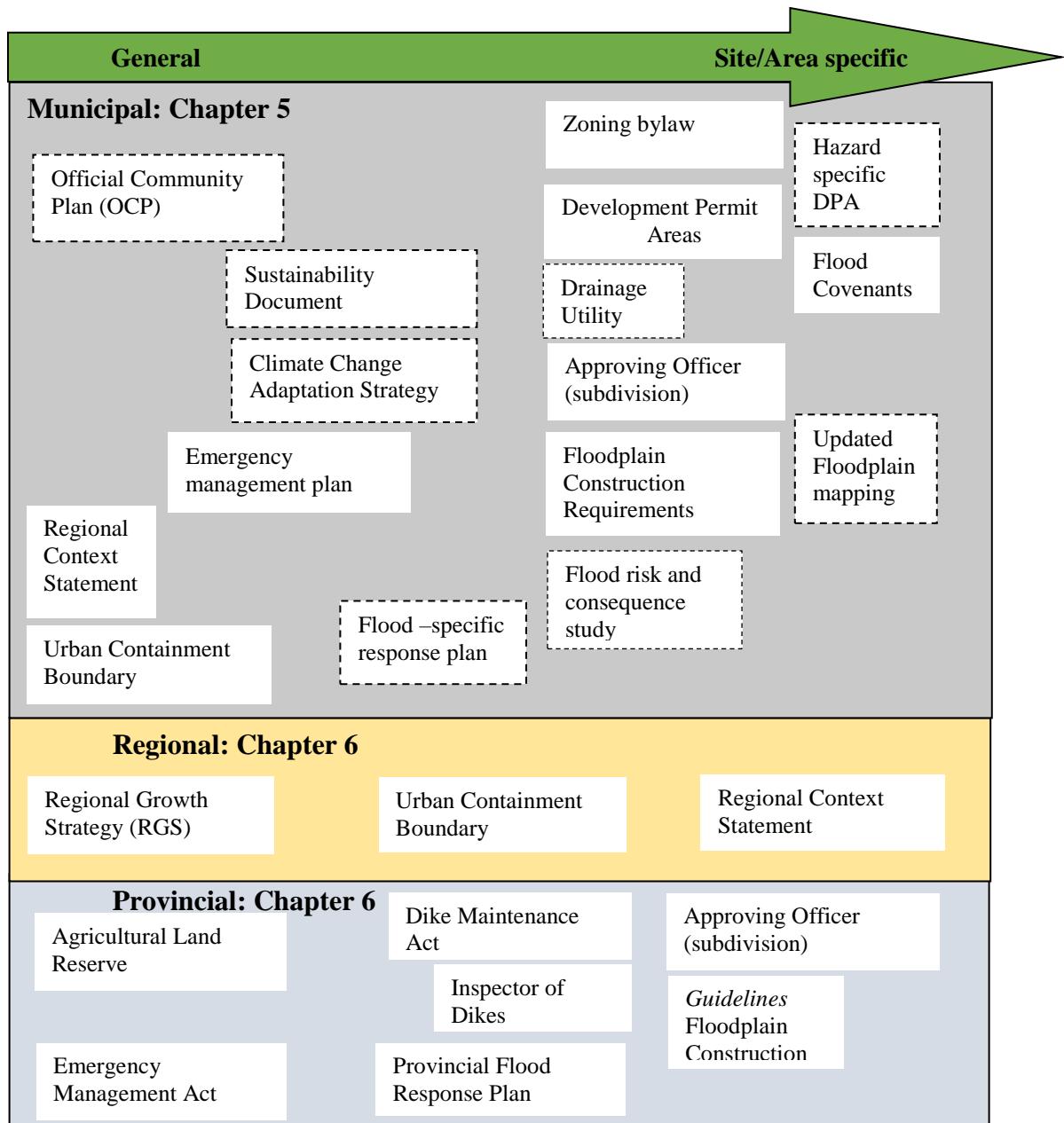


Figure 5-1 Legislated and Optional Tools and Processes (adapted from Arlington group, 2011)

5.2.1 Characterizing sp-R: spatial heterogeneity across cases and sub-regions

Interviews revealed a strong degree of diversity of sp-R processes and tools reflecting spatial heterogeneity and differing hazards faced by municipalities (see Appendix D; Table 5-3 below).

Table 5-3 shows that only a limited number of tools and processes were used consistently by the municipalities. Even within the consistently used tools (e.g., flood plain maps), the quality

and how current they were strongly varied across the region (see Appendix D). Within the optional tools, an increasing use of Flood Risk and Consequences studies to guide planning was present signaling a move from hazard-based to risk-based sp-R planning. CoV and CoS have completed their CCA strategies and CNV completed CCA plan by using ICLEI-Canada planning framework.

Table 5-3 Summary of municipal tools used to manage sp-R

Tools	CoV	DNV	CNV	CoPC	CoPM	CoD	CoS
Floodplain mapping	✓	✓	✓	✓	✓	✓	✓
Flood zoning bylaw	✓ ¹				✓		
Development Permit Areas (DPA)		✓	✓				✓
Hazard-specific DPA		✓	✓				✓
Drainage Utility					✓		
Flood Construction Levels	Updated, 4.6	Site-specific	Updated, 4.5 m elevation	Not updated, PoCO map	Lowered		
Green infrastructure	✓	✓	✓	✓	✓	✓	✓
Registration of Covenants	✓	✓	✓	✓	✓	✓	✓
Flood risk and Consequences study	✓	✓	✓			✓	✓
Flood Response Plans and Strategies				✓	✓	✓	✓
Recovery Framework/Plans				✓			
Climate Change Adaptation (CCA)	CCA Strategy (adopted in 2012)	In progress	CCA Plan, (adopted in 2013)				CCA Strategy (2013)
High-level sustainability document	Greenest City Action Plan			EnviroPlan			Sustainability Charter
Official Community Plan	Community Charter	✓	✓	✓	✓	✓	✓
Regional Growth Statement/Regional Growth Strategy	✓	✓	✓	✓	✓	✓	✓

¹“Designated Flood Plain Standards and Requirements”, amendments to the Zoning & Development By-law

These diverse and highly contextualized municipal regimes resulted in a significant variation of sp-R regimes across the three sub-regions. In the South Fraser sub-region for the City of Surrey (CoS) and Corporation of Delta (CoD), coastal and river floods were both familiar hazards. The long historic interdependence between farming and diking shows the unique institutional capacity within the agriculturally strong municipalities of CoS and CoD through an active role of the Districts and Dikes and Drainage Advisory Committee. CoD ran a multi-year project on SLR visualization with federal and academic partners with an active engagement from the Mayor's office and staff. It has also approved some of the most regionally controversial developments in a floodplain subject to SLR. CoS showed a remarkable transformation from the reputation of a crime-ridden suburb to becoming a sustainability and resilience leader in Canada and internationally, with a robust sp-R regime that proactively addressed coastal and freshet risk. CoS heavily invested in studies to ensure evidence-based decision making with numerous studies on the way and active participation in regional discussions and forums at the time of the interviews.

The primarily freshet oriented regimes of Pitt Meadows (CoPM) and Port Coquitlam (CoPC) were somewhat removed from the recent regional discussions and forums and relied on business as usual approaches. CoPM has been turned down for funding due to low population base despite their 90% flood plain base. To address funding shortages and escalating flood management costs, the City introduced the unique drainage utility that creates dedicated funding for flood management purposes. CoPM initiated an innovative recovery planning process that was unique to the region. Overall, SLR was not mentioned by the interviewees as an issue that is being addressed at the planning level, despite the tidal nature of the river and the largest freshwater tidal lake in North America (Pitt Lake).

Within the Burrard Inlet sub-region, the interviews revealed an active exploratory and solution seeking stage process for SLR implications. This process unfolded at the municipal level and intra-municipal level through a number of mechanisms and forums which will be analyzed in the subsequent chapters. This sub-region is home to some of the regional leaders in the field of natural hazards risk management and adaptation. DNV was the first municipality in Canada to establish a community-defined risk tolerance criteria for natural hazards. This work was recognized internationally by the 2011 United Nations Sasakawa Award for Disaster Risk Reduction. CoV is home for the ambitious “Greenest City Action Plan” as part of which it

produced the first climate change adaptation plan in BC. CNV is known as a regional leader on smart growth and one of the first Canadian municipalities to adopt a district energy service. CoV and CNV were the first two municipalities in the region to raise their Flood Construction Levels (FCL) in response to the provincial guidelines. CoV, as a Charter city, was able to amend their building by-law, zoning by-law and rescind the “Flood-Proofing Policies” and replace them with the “Designated Flood Plain Standards and Requirements”. CNV amended the 1995 Sewerage and Drainage Utility Bylaw to introduce new Flood Construction Levels. All of the three municipalities either completed their climate change adaptation strategy (CoV and CNV) or were in the process of developing one (DNV). Development of these strategies were supported using a five-milestone planning framework from the International Council for Local Environmental Initiatives (ICLEI-Canada).

Along these diverse hazard priorities, needs, and capacities, case studies showed a lack of standardization across the region with regard to approaches to managing floods: from the very well-resourced municipalities such as CoV that have been able to leverage their Charter City status to address changing flood risk needs (by implementing changes to building by-laws, as well as leverage funding and partnerships) to CoPM that have been consistently turned down for funding due to low population base despite their full dependence on dikes. The case studies also reveal internationally acclaimed leaders in the field. CoD actively participated in a multi-year multi-stakeholder project on SLR visualization with federal and academic partners with an active engagement from the Mayor’s office and staff. It has also since approved developments in the floodplains. DNV – after a tragic event that killed one person in their house – has completely reconfigured their approach to natural hazards planning through an active stakeholder engagement, establishing a ground-breaking process for identifying community risk tolerance criteria and gaining an international acclaim, have also concentrated their town-centre developments in floodplains. In other words, sp-R policies were less about restricting the development in the floodplains, and more about developing in the way that can accommodate existing and changing risk through a mix of site-specific and more general planning tools and processes, as discussed in the next section.

5.2.2 Characterizing sp-R at the municipal level: from site-specific to general land use approaches

Diversity is considered to be key to resilience. One of the key limitations of sp-R is an overreliance on a specific approach to manage resilience which calls for a diversification of strategies, processes, practices, and tools used to regulate risk. For example, the Dutch risk-based approach called ‘multi-layered safety’ calls for redundant and overlapping flood resilience functions that connect structural protection, land-use planning and emergency response and recovery capacities. Hegger et al. (2014) call for flood risk management that includes flood risk prevention (including land-use planning), flood defense, flood risk mitigation, flood preparation, and flood recovery. As widely agreed upon in the literature, resilience of coastal communities in practice will require a diverse and interconnected range of adaptive actions: hazard identification and risk assessment, comprehensive emergency management, land use planning, shoreline retreat, greenhouse gas mitigation actions, and adaptations to climate change through strategic environmental and ecosystem protection, continuously updated and improved climatic design values, and changes to infrastructure codes and standards among others (Beatley, 2012; Tol et al., 2012). The need for diversified, multi-tool, layered approaches for sp-R was stressed at the staff and political levels, as these two sample quotes demonstrate:

The specific outcomes of floods are unpredictable, so I believe a series of redundant measures from planning and land use to dikes and local property protection should be considered. Indefinite insurance instead of protecting floodplains doesn't appear to be sustainable (SP_17).

[We need] a coordinated watershed approach and the overall health of the basin... [it's] apparent when you see how new knowledge has helped shape how we deal with [flood management issues]. For instance, we're not just going in and digging and removing gravel all the time. We're not just armouring the banks and **there's not just one silver bullet approach to flood management so it's going to take a combination of approaches for a full mitigation strategy** (CoC_Councilor).

While BC has a unique institutional capacity for sp-R guidance and tools available to municipalities as discussed in Chapter 4, few studies have recently evaluated the effectiveness of these from the practitioners’ perspective (e.g., Arlington, 2007). In order to better understand the diversity and redundancy of sp-R processes and tools used across the region, I compare aspirational “what ought to be done?” with “what is being done?”. The following responses to two survey questions in the on-line survey that I conducted with 33 regional experts (section

3.4.4) are interpreted together to make connections between the general approaches to sp-R (such as land use, structural, nature-based approaches, etc.) and those actually implemented in the surveyed municipalities. Figure 5-2 shows a ranking of *approaches* considered ‘effective’ and/or ‘very effective’ for reducing flood risk. Land use was ranked as the most effective approach (97% positive ranking (61% for very effective and 36% for effective)). Natural flood protection (defined as floodplain protection, watershed management, beach and wetland preservation, riparian buffers and forest management) and structural projects to control floods (dikes, seawalls, reservoirs, storm water management systems, and channel modification) received a nearly identical score of 86.7 and 87.1 respectively. Combined, these three response categories show a balanced understanding of approaches options needed for flood management that align with best practices presented in the literature (Beatley, 2012; Tol et al., 2013).

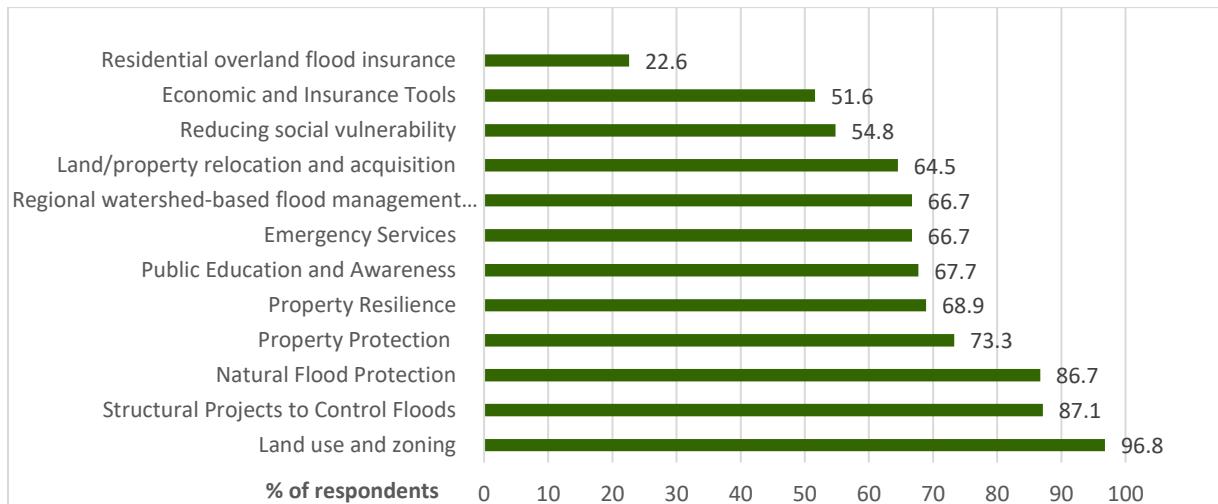


Figure 5-2 Combined positive responses (effective + very effective) to question: "In general, how effective do you think are the following approaches for reducing the occurrence of flood events or mitigating their effects?"

Regional watershed-based flood management strategies (such as watershed based storm runoff and drainage management, monitoring land use in the watershed, and avoiding mitigation efforts that would have a negative impact downstream) were in the lower end of the mid-range among ranked approaches. Interestingly, several survey respondents stressed the importance of *implementation* that goes beyond a *strategy* mentioned in the survey, to measure effectiveness. While watershed-based flood management approaches are lacking in the region, the 1996 Fraser Board report outlined the benefits of establishing a river authority to oversee river maintenance, as opposed to dike maintenance, which is a fragmented local responsibility. As Lyle and Mclean

(2008) suggest in their analysis of flood policies in the Lower Fraser River floodplain: “there has been no move to long-term large-scale planning for the region. Senior level governments need to aid in the co-ordination of flood management through the creation and funding of watershed institutions, which is key to decreasing flood losses in the long-term. Co-ordination and co-operation amongst different issue groups will provide impetus to initiate publicly supported, multi-purpose projects, which can provide an array of flood control benefits” (Lyle & Mclean, 2008, p. 102-6). Although Canada does have examples of regional watershed-based institutional changes that provided overall general co-benefits in addition to flood management (such as protection from extreme events, water management, drought control and so on) these changes tend to occur *ex-post* catastrophic events (e.g., the 1954 Hurricane Hazel in Ontario and the 2013 Southern Alberta floods).

The third lowest ranked approach was ‘reducing social vulnerability’ (defined in the survey as “addressing the needs of vulnerable population groups through programs not specific to flood management”). The relatively low score for effectiveness of social vulnerability reduction to increase sp-R was surprising given the importance of this domain highlighted in the interviews and will require further investigation in future studies. The least effective tools were the economic tools such as insurance (at the time, no residential overland flood insurance was available in BC and in Canada with an exception of few areas in Calgary) and other incentives. The lack of economic incentives to address flood risk is a recognized issue in BC and in Canada in general.

Figure 5-3 presents responses to the question: “How effective are the following flood management approaches as **currently implemented** in your community?” Within the implemented tools, only 5 out of 14 tools listed in the survey received 50% and above for positive ranking. Among the top effective implemented tools were Flood Construction Levels (86% positive), floodplain mapping (73% positive and the lowest for “don’t know + neither nor” category at 10%), flood response plans (70% positive and the highest ‘very effective’ tool at 27%) and Flood Risk and Consequences study and other engineering reports (69% positive). The least effective tool by a large margin was the Regional Growth Statement/Regional Growth Strategy (20% positive, 66% neither/nor + don’t know and 10% ineffective). Tools and approaches identified in the literature with the highest potential for connecting sp-R to gen-R (e.g., green infrastructure co-benefits for maintaining options over time) also surprisingly ranked

low despite the fact that most municipalities had some elements of green infrastructure implemented (I explore this in detail in section 5.5).

Overall, these graphs show that while land use was ranked as the most effective tool in general at 97% (Figure 5-2), when it comes to implementation, general land use tools, such Regional Growth Strategy and OCPs (adopted by the majority of municipalities), fail to meet their potential for sp-R effectiveness. This speaks to the implementation gap (Coaffee & Lee, 2016), identified widely in the literature between the existing knowledge and tools and the barriers that prevent it from reaching the potential. Overall, site/area specific (e.g., Flood Construction Level) and flood specific tools received significantly higher ranking for sp-R than more general land-use or planning tools (as shown by the arrow on the left side in Figure 5-3).

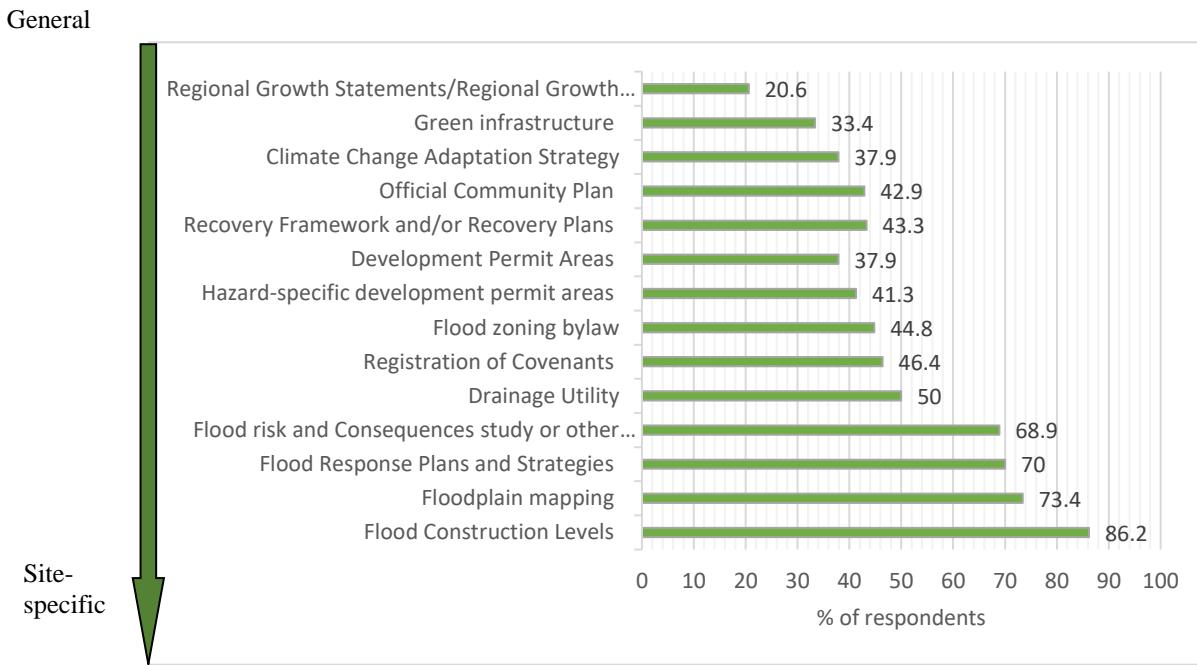


Figure 5-3 Combined positive responses (effective + very effective) to question: “More specifically, how effective are the following flood management approaches as currently implemented in your community?”

While diversification of sp-R approaches and tools can make vulnerable urban regions more resilient to flooding, enhancing sp-R through alignment may require new flood risk governance arrangements or changes in existing ones (Hegger et al., 2014). Scale plays an important role in this process and requires situating municipal sp-R tools and processes within the multi-scalar governance regime. The Province in the official media release referring to the work on regional collaborative flood management strategy highlighted the need for developing

options that can be implemented at site-specific, community and regional levels to ensure a comprehensive approach to flood management (British Columbia, 2016). In addition to tested tools and practices in planning and physical design, institutional arrangements that would enable communities to prepare for and organize around new threats and enhance *human and social capital* to permit patterns of sharing, helping, and cooperation is required (Beatley, 2012). Active *collaboration and learning* between engineers, planners, emergency managers, politicians, the public and private sectors will determine the outcomes of resilience planning processes (Coaffee & Lee, 2016). In other words, a better understanding of the relationship between sp-R and gen-R is required. To better understand the role of the planning process and its contribution to gen-R, I focus on key municipal planning processes.

5.3 The role of planning tools and processes for connecting sp-R and gen-R

As the previous discussion indicated, municipalities have different processes and tools by which they can address climate change, regulate their land use, and reduce the risk of natural hazards and floods. Canadian communities (Aylett, 2014) and BC in particular (Picketts, 2015; Picketts, Curry, & Rapaport, 2012) are well known internationally for their ability and preference to integrate climate planning as part of their daily operations and into existing documents rather than standalone plans (e.g., Official Community Plan). I discuss the role of plans and planning in general, and focus specifically on the role of official community planning, sustainability planning and climate change planning as promising domains for connecting sp-R and gen-R.

5.3.1 Official Community Plan: a process and an outcome

At the municipal scale, an Official Community Plan (OCP) is key planning process and document that guides the long-term vision for community development by determining the land use options. OCP has a procedural component - a multi-year comprehensive planning process that includes public participation and cross-departmental collaboration – and an outcome component – the actual plan that serves as a blueprint for community development.

The OCP is an integrative document that works in conjunction with other municipal plans to ensure that the community develops in a coordinated manner and that services are provided effectively and efficiently. OCPs have the potential to be the key mechanism to outline land use planning tools and policies that help limit community vulnerability to flooding through bylaws, zoning, development permit areas and other policies and practices. If adopted, an OCP must include statements and map designations for the area covered by the plan with respect to seven

subject areas including restrictions on the use of land that is subject to hazardous conditions or that is environmentally sensitive to development. Due to the significant impact on land use values, the identification of hazards and the restrictions on these hazardous areas are based on detailed engineering studies (Arlington, 2011).

Interviews showed that the planning and updating process behind the OCPs provide an opportunity to introduce new concepts. In some cases, the OCP updates served as an opportunity to introduce hazard mitigation and climate change language to long term planning, thus paving the way for municipal-wide action on adaptation. Examples included an introduction of policy options such as mitigation, adaptation and ‘resilience’ (DNV_PS2; DNV_EP; CNV_CAP) as well as streamlining a new line of thinking: “just start putting it in all of your plans and... people get used to the idea” (DNV_PS2). In the CNV example, situating and referencing adaptation and health, the two new lenses for CNV throughout the OCP (CNV_CAP) served as a mechanism to mainstream these policies across municipal departments and plans. In the words of a municipal interviewee during a provincial policy review: “It was also the adoption of our OCP that had specific language around climate change adaptation and mitigation contained within it that gave us, as staff, the freedom to move forward with starting a more formal process of developing an adaptation strategy” (MoE, 2013). The importance of the ability to use an existing framework provided by the OCP as a foundation for municipal champions to build on and give climate change adaptation approaches legitimacy was also highlighted (MoE, 2013). Having plans gave municipal staff a certain degree of confidence in their ability to address a specific challenge through ‘the right planning considerations and tools’ (DNV_PS2).

The process behind OCP updates also serves as a mechanism to implement learning from a neighbouring municipality, as this mutual learning and exchange from CNV and DNV illustrates: “...out of that OCP process we will update our zoning bylaw and it will be our zoning bylaw that will be the development permits. Right now we have development permits for streamside. We’re proposing to introduce different hazards. The District [DNV] has that for both flooding and slope stability. So we’re going to follow that model” (CNV_EP). An environmental planner from DNV suggested: “The City of North Van actually done a really good job for the most part of integrating it in their OCP... it’s the strongest environmental message they have right now, is climate change adaptation in their OCP” (DNV_EP). Studies suggest that OCPs have been ranked relatively positive for their ability to address sp-R. Provincially, the 2008 BC-

wide review (Arlington, 2008) found that 37% of respondents provided a positive ranking (excellent 10% and good 27%) while 29% deemed them as acceptable as a flood management tool at municipal level (the rest were ranked as: ‘needs improvement’ – 9%; ‘not acceptable’- 1%, ‘not applicable’- 23%, and no response -10%). For this study in 2014, the OCP was ranked as the 9th lowest tool among 14 tools evaluated for effectiveness: 43% positive ranking (25 % for effective + 17.9 very effective; 32% - ‘neither/nor ineffective’; 7% - ‘ineffective’; 0 – very ineffective, 14.3 – ‘not implemented’; 3.6 – ‘don’t know’).

These municipal self-assessments need to be situated within a regional perspective. There is a significant variation within the region for OCP adoption and updates that range in dates from 1979 to 2014. Regionally, this results in ad hoc responses to managing flood risk through OCPs. For example, CoR adopted its first OCP in 1986, updated it in 1999 and in November 2012 adopted the 2041 OCP Bylaw 9000. In Burnaby, an OCP was adopted in 1998 and updated in 2014. A closer look at the content of OCPs reveals further limitations of OCPs as an effective risk reduction tool across the region. Peters (2000) noted that “in general, OCPs do not appear to have been effective in directing development away from the floodplain” (in Lyle and McLean, 2008:102-3). The LGA gives authority to local government to make the decisions; however, the Act does not obligate local government in any way to designate floodplains or to zone the land appropriately. Thus, local governments have few legislated incentives to make ‘intelligent’ land use decisions that will reduce the long-term costs and damages associated with flooding (Lyle and McLean, 2008). Stevens and Shoubridge (2014) conducted a detailed analysis of OCPs and found that they lack not only consistency with regards to updates, but they vary greatly in the quality of their factual base, generally lacking in hazard related factual information, goals, and policies and in mechanisms to promote plan implementation. While the OCP update process provides an opportunity to introduce new concepts, collaborate and learn from neighbouring municipalities (thus contributing to gen-R) the plans lack the implementation capacity to comprehensively address natural hazards risk at the local level. Therefore, they fail to reach the full potential that locally-implemented, well-constructed land use plans have for reducing natural hazards risk (Stevens and Shoubridge, 2014).

5.3.2 Sustainability planning: clarifying long-term planning objectives

Sustainability planning is a promising domain for connecting sp-R and gen-R. While emergency management officers and offices provided a relationship building function to address short-term shocks and multiple hazards (e.g., floods, earthquakes, spills, fires), Sustainability Officers and Offices played an important role in building long term capacity to address stressors (e.g., climate change, SLR, growth issues). Sustainability planning was addressed through a variety of organizational arrangements but unlike the mandated EM function it was seemingly an organizational luxury that only the more resourced municipalities could afford. In CoV and CoS, Sustainability Offices played an important role for building *human and social capital* in their lead role as connectors and facilitators of the climate change adaptation strategy that brought multiple departments together for collaboration. As a senior CoS engineer stated:

The City has a Sustainability Office... The primary document that the City has is our Sustainability Charter. There's also a number of, I guess, children, if you will, associated strategies: a Community Energy Emissions Plan and the Climate Adaptation Strategy... The Sustainability Office acts [as] a coordinator to ensure that the engineering department, planning and development, risk management, economic development, parks, recreation, and culture are all [collaborating]...The Climate Adaptation Strategy has a lot of action items that will be delivered by the engineering department. For the most part it's the flood control systems (CoS_E1).

In CoV, the Office of Sustainability also played a critical role for building gen-R as it coordinated *joint learning and collaboration* bringing staff across multiple departments to a joint planning table (COV_EM; COV_E; COV_P). Initially focused on SLR, the planning process expanded to embrace ‘resilience’ as a framework for synchronizing planning efforts, a ‘silo-buster’ looking for multiple cross-organizational co-benefits of adaptation action and day-to-day departmental operations, planning interdependencies, and maintaining short and long-term options.

One of the key institutional modes of transfer and implementation of sustainability policies was a high-level sustainability vision document (e.g., plan, strategy or charter). Participants emphasized that this document enshrined the organizational values with regards to environmental objectives and programs and was a very important policy support tool that provided clarity for long term vision and implementation, such as sector specific plans. Procedurally, it also provided incentives to collaborate (CoS_E; CoS_ED). For example,

Surrey's proactive action on climate change adaption was enabled by its Sustainability Charter that provided clarity and long-term commitment to action between staff and the elected officials, and was an institutional commitment for the need to maintain options: "It wasn't just some glossy book with some brochures saying here we're doing the right thing, you know? There's some significant action items within that document that council has committed them to doing. So that was a huge step forward on their part. Now [they] basically asked us to answer some of these challenging questions. The next challenge for them will be once we identify potential options...selecting the one, whether it be, adapted to the change, partially mitigated or fully mitigated" (CoS_E)"

A notable example of a broad vision document is Vancouver's Greenest City plan, a product of a multi-year process that engaged 35,000 people, 120 organizations and over 65 staff across the municipality. All five CoV interviewees, from elected officials to engineering, emergency management and planning, noted that having an overarching strategic plan in place significantly eased their department-specific tasks and implementation of adaptation measures for the following reasons: 1) climate change was an accepted issue that the city decided to act on; 2) adaptation planning was a logical continuation of the mitigation work; and 3) the plan provided a framework for collaboration across various departments by aligning the aspirations and objectives around a common vision; 4) the plan served as a long-term political commitment to a certain trajectory thus clarifying expectations between the elected officials and the staff (COV_EM; COV_E; COV_C).

Similarly, for elected officials, creating a broader vision document stitched together the various initiatives with regards to climate change and provided clarity and continuity of action across municipal departments (CoV_C; CoPM_M). As one of the interviewed Mayors put it:

We did our first ever environmental strategic plan under my leadership to ensure that we were addressing climate change issues, both as an organization as well as a community. That has resulted in quite a few changes; both internally, about how we run our buildings and it also bled into our master transportation plan and other community policy documents. It's not that we weren't doing a lot of the work before, it just brought it into a strategic plan which is kind of the highest level document that we can create to guide the community and the organization (COPC_M).

The discussion above demonstrated that in both CoV and CoS sustainability planning served as an effective mechanism for connecting sp-R and gen-R co-benefits (such as increased social capital, collaboration joint learning and mandates to maintain options). However,

sustainability planning remained an institutional luxury available to more resourced municipalities. Within the sub-cases, on the other side of the spectrum were municipalities that decided not to create a specific office to ensure mainstreaming of sustainability policies across all departments. For example, the CNV purposefully choose to not have a sustainability office, preferring to mainstream sustainability as part of the entire City's operations. CoPC created an Enviroplan but got rid of their Environmental Enhancement sub-committee, a controversial move initiated by the Mayor:

We used to have Environmental Protection, I renamed it to Environmental Enhancement Committee (a sub-committee of Council). Last year I got rid of it all together, because...it's not a silo, it's in everything that we do. Let's amend the Terms of Reference for all of the other committees and make the environment part of all of the discussions, instead of having the silo by itself and someone deciding that "oh this policy might have some environmental implications, let's send it over to that committee over there to get their feedback." Well, no, no, no, everything that we do has to do with the environment whether we build a new playground or we're building a new building...It was definitely about mainstreaming and bringing it all together.

While these measures arguably allow for a higher degree of institutionalization of sustainability as a cross-cutting lens, the procedural gen-R benefits of such measures are unclear.

It is important to mention the enabling provincial legislation that provides clarity for municipal action: for example, the Green Communities Act, Bill 27 mandates communities to integrate climate change mitigation targets into their OCP, which was a strong emphasis for creation of Sustainability Offices as an institutional mechanism for addressing climate change mitigation. The connection between climate change planning and its influence on gen-R is discussed next.

5.3.3 Climate change planning: seeking co-benefits between existing and emerging processes

Mitigation and adaptation are the two fundamental policy approaches for reducing the environmental, economic, and social threats posed by climate change. While a lot of mitigation discussion has been focused at the international-national scale, mitigation action makes economic sense at a local-regional scale. For example, urban planners in Alberta have calculated that cost savings associated with increased development density and limited metropolitan sprawl could save \$11 billion in capital costs over the next 60 years and \$130 million in annual maintenance costs (Aylett, 2014). Effective mitigation and adaption planning can result in sustainability co-benefits but this requires establishment of a regulatory framework, institutional

framework and development of clear action plans for realizing implementation (Shakya, 2016). A trend that speaks to mainstreaming of climate change initiatives in Canadian cities is that, rather than only being found in stand-alone documents, climate change is being integrated into other local government plans (i.e., long range, land-use and sustainable development plans) (Aylett, 2014).

Adaptation planning emerged as a policy domain and branch of urban and regional planning in response to the urgent need for reducing the vulnerability of city functions and urban residents to the direct and indirect impacts of climate change. Adaptation policy and practice is ideally positioned to address both sp-R (specific hazards) and gen-R. As outlined in the opening of CoV's Adaptation Strategy: "There is significant overlap between climate change adaptation, mitigation and sustainability measures including those designed to improve greenspace, foster urban agriculture and facilitate improvements in buildings and urban infrastructure. Adaptation more explicitly engages a wider range of issues, particularly emergency management, health and the needs of vulnerable populations in a changing climate" (CoV, 2012:1).

For mitigation planning, Canadian municipalities have benefited from the Partners for Climate Protection (PCP), a partnership between the Federation of Canadian Municipalities (FCM) and ICLEI Canada. Several municipalities in the region were the early adopters of the program. The program offers planning support through a five-milestone process that guides members in setting 'realistic' and 'achievable' GHG reduction targets, developing local action plans, and implementing plans using specific, measurable actions to reduce emissions. The planning progress is tracked through "corporate" and "community" milestones.

In 2010, ICLEI launched its "Adaptation Initiative", which mirrored a five-milestone mitigation program but for creating an adaptation plan. The initial pilot, Building Adaptive Resilient Communities (BARC), has a high participation ratio from the study region: five municipalities (out of fifteen municipalities total in Canada) and Metro Vancouver (among the three participating regional districts). The interviews revealed that ICLEI played an important initial role in the region for adaptation planning; for a small fee it provided a readymade framework for understanding and initiating the climate change adaptation process, a daunting task given the lack of precedents and all-encompassing impacts on infrastructure, urban forests, community health, and emergency preparedness which required addressing the generalized capacity to address change rather than hazard or sector specific actions. In addition to the

planning framework, the network provides access to regional and national platforms where the staff engage in the process of exchange and collective troubleshooting around particular areas of adaptation. A municipal environmental planner observed: “We’re in the Building Adaptive Resilient Communities program, ICLEI Canada...it kind of started, I want to say, this **adaptation industry**. ICLEI does a lot of meetings, national meetings and conferences (SF_EP)”. Regular meetings and opportunities for professional development have contributed to gen-R within and across municipalities by enhancing human and social capital and fostering a network of municipal leaders, in addition to tapping into international expertise and a national network. ICLEI provided for regular interactions between the member municipalities in the region, building social capital among the staff and allowing for ongoing exchange of knowledge and solutions. As a CoV planner noted referring to other municipal champions of adaptation: “Delta, Surrey and North Van are also doing adaptation plans through ICLEI, so we all kind of met through ICLEI” (CoV_P). The ICLEI process requires much broader municipal participation, including engineers, environmental planners, urban planners and emergency managers, among other staff (unlike other regional forums such as the Joint Program Committee of the Fraser Basin Council primarily composed of senior engineers). Surprisingly, regionally ICLEI ranked relatively low for learning but higher for collaboration and influence, which can be attributed to the need for a buy-in, an optional choice and not something that every municipality in the region saw as a priority. This speaks to the limitation of reliance on the external organizations to synchronize regional sp-R planning process.

Many municipal staff and elected officials emphasized that it was mitigation planning that brought them to adaptation planning, speaking to procedural co-benefits of the planning processes. Once municipalities made sense of climate change and the need for organizational action, adaptation planning was a logical extension. As a CoV Councilor observed: “we have the Greenest City Action Plan so it made sense from our perspective that if we agree that climate change is happening and we need to try and mitigate it then we should also understand that it’s happening and there’s a certain level, no matter how we do at mitigating to this point where, we will have to respond to extreme weather events” (CoV_C). Adaptation simply “made sense” and while there was recognition that the municipal emissions reductions meant “nothing” globally (CoPC_M), there was a nearly universally recognized need to be prepared locally for the impacts (SF_EP, COV_P, CoV_C, CNV_P). While the mitigation planning process took years to develop

(e.g., starting in 1995 for CoV and culminating in the work began on the Greenest City plan in 2009), the adaptation process was much quicker to catch up, with a full adaptation strategy being completed for 3 municipalities within 2-3 years. One participant expressed their concern that with the rapid uptake of adaptation planning and resilience, mitigation was pushed to a backseat:

...the switching focus from mitigation to adaptation is relatively new for us and I really grapple with it. I know it's critically important but I sometimes worry that all this new focus on adaptation, resilience, lets a lot of people feel like they're a little bit off the hook for dealing with mitigation rather than seeing it as two sides of the same coin and just as critical one to the other. There seems to be a bit of idea that we've lost the war on climate change. It's coming and now we need to deal with it and do the best we can and by the way there's all these local 'co-benefits' (CNV_P).

As the discussion shows, the externally facilitated processes by ICLEI allowed the participating municipalities to benefit from having an established framework for making sense of climate change impacts and actions needed. It is important to note that participation in the adaptation process itself, while it brought increased awareness on sp-R as well as procedural co-benefits for gen-R (e.g., increased collaboration, learning from international, national and regional examples) it was not sufficient. For example, in CoD, despite their high profile SLR and adaptation visualization work that received international acclaim, no formal adaptation strategy existed and the work being done continued to be driven piece-meal by the engineering department rather than entering the public domain: "...we're working on it, but we don't have our complete climate change strategy out there yet. There's so many day to day things that it's **hard to focus on the bigger picture**. But we are moving it forward". (SF_E). Another staff noted, speaking to the importance of a framework for tracking progress on adaptation: "... you need to package these things into something digestible so, if we have that framework and we commit to updating it and revising it then that's a placeholder for this idea about adaptation" (SF_EP). In other words, the planning process, while important for gen-R benefits such as collaboration and learning, was not sufficient without the resultant plan as it did not allow actions to be implemented or progress to be monitored.

Another important observation is that the municipal organizational cultures directly influenced the adaptation process. For example, in CoS, the Adaptation Strategy was developed by design as a cross-departmental initiative, reflecting the general planning culture of the municipality. A steering committee of six core members was formed that included engineering, risk management, planning (tree planning, long-range planning, and community planning),

parks, and sustainability. The core group facilitated meetings on different topics that would bring in a multitude of staff from the City and some external expertise to discuss topics that ranged from water, to temperatures, trees, risk and health: “So we were kind of the 6 core and then we came up with these other topics...Okay, we’re going to talk floodplain and drainage today. So we’d get together with another group of maybe 20 people to talk floodplain and drainage issues, prioritize issues, and brainstorm. It was not just one meeting; it was multiple. So you had a core group but it also had a bigger [engagement] component” (CoS_E2).

Regionally, the key observable difference between the mitigation and adaptation processes was the level of public engagement and openness: while mitigation plans involved large scale public consultation and engagement, adaptation planning at the time of the interviews was seen as an internal, corporate business continuity-type of objective. In doing so, the planning process did not fully reach the potential for building community-wide ability to adapt through an open stakeholder-driven process, aimed at designing and selecting multi-risk management/reduction options; implementing the chosen options, and evaluating them (Oliver-Smith et al., 2016). The municipalities had to make sense of the impacts, the vulnerabilities, and the options for addressing adaptation first, prior to engaging the public, which meant that at the time of the interviews, the adaptation process remained within the domain of municipal staff and experts. Openness is seen as one of the fundamental operating principles for gen-R (Carpenter et al., 2012), and creating platforms for meaningful public engagement that can then lead to action would be a next needed step in the municipal adaptation process.

In the first section of this chapter I analyzed sp-R tools used by municipalities as a way to characterize municipal sp-R regimes. Overall, at least from a theoretical perspective, it can be argued that the flood management regimes meet the ideals of local resilience planning. The regimes are rooted in local history, responsive to local hazards, and are distinct products of local governance and civic regimes situated within their capacities and limitations. The devolved responsibility for land use, development, risk and emergency management that falls on municipalities under the current regime aligns with the subsidiarity principle which speaks to making decisions at the most local level possible (Wilkins, 2010) by elected officials that are closest to the citizenry (UN Habitat, 2016). However, within this diverse mosaic of sp-R tools implemented, the analysis showed that the general land use tools lack effectiveness in regulating flood risk in the region. This places a higher emphasis on site/area specific tools used within

municipalities. While this framework provides flexibility for adopting locally needed solutions, it reduces opportunities for more strategic region-wide approaches to managing flood risk. This shows that while there is a significant diversity of tools employed (rather than an overreliance on one specific approach), the municipalities do not have sufficient institutional capacity to address sp-R at the regional level through municipal tools, and as ‘creatures of the province’ their actions are enabled and constrained by multi-scalar governance (a focus of Chapter 6).

In the second part of the chapter I focused on the role of three planning processes (OCP, sustainability and climate change adaptation) for influencing gen-R, including procedural benefits for collaboration and learning. I found that OCP served as a vehicle for introducing new concepts such as ‘resilience’ and ‘adaptation’. Yet, it failed to reach its full potential for addressing sp-R. Both sustainability and climate change planning yielded significant gen-R benefits for increasing social capital, collaboration, and learning. I also found that in addition to the importance of the procedural benefits of the *planning process* for gen-R, the actual high level *plan*, the outcome of the planning process (e.g., CoS Sustainability Charter; CoV’s Greenest City Plan) played a critical role as an enabler of sp-R through subsequent policy ‘children’ (COS_E2) such as climate change adaptation plans and strategies as it provided institutional continuity for dealing with changes at the staff and political levels by enshrining collective vision of municipality and provided long-term clarity for planning. In what follows, I move beyond the analysis of sp-R tools and formalized planning processes to further investigate the relationship between sp-R and gen-R at the municipal scale. As the discussion in the subsequent chapters will demonstrate, in addition to the planning tools and processes, it was the organizational dimensions and decision-making processes that determined the relationship between sp-R and gen-R at the municipal scale.

5.4 Understanding the relationship between sp-R and gen-R through organizational dimensions: social capital, self-organization, and collaboration

Ability to deploy social capital for self-organization and collaboration (including political influence) are key to gen-R. For the purposes of this study I explore social capital among FMPs, following one of the classic definitions of social capital as “features of social organization such as networks, norms and social trust that facilitate coordination and cooperation for mutual benefit” (Putnam, 1993). As the discussion below will show at the organizational level social

capital was a major enabler of numerous planning initiatives and contributed not only to collaboration but also learning and ability to maintain options, as a cross-cutting gen-R variable.

Across the region, the survey of sp-R relationships revealed relatively high collaboration across the departments at the municipal level (Figure 5-4). For collaboration, Planning and Development received the highest score (79.3%), followed by Park and Recreation (78.65%), Emergency Management (75.9%) and Engineering (64.5%).

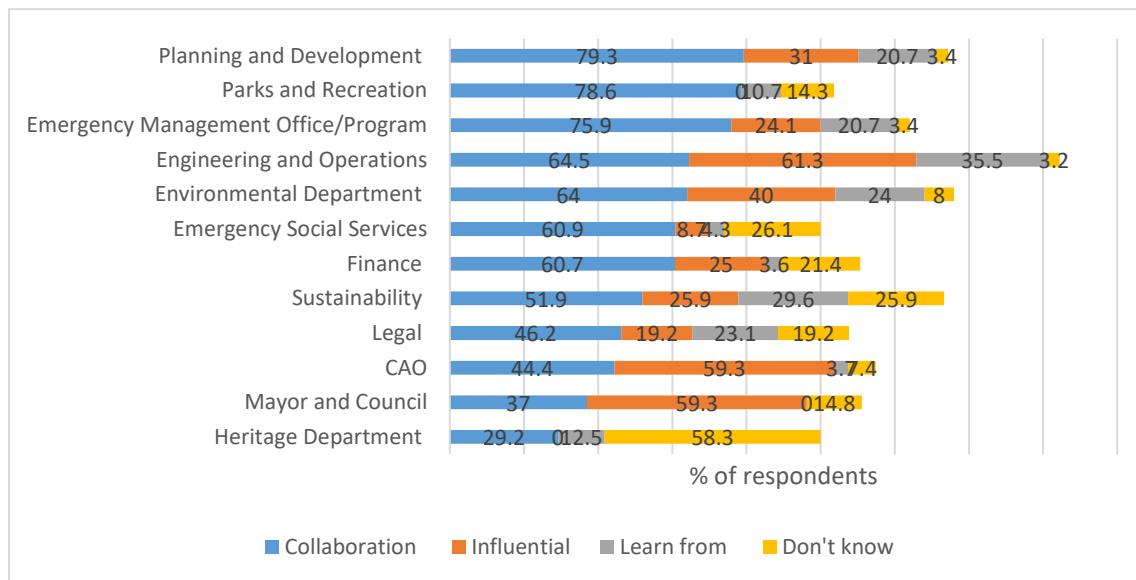


Figure 5-4 Collaboration, influence and learning across municipal departments within municipality

The three most influential departments were the expected Engineering and Operations (61%), Mayor and Council (59%) and CAO (59%). Engineering and Operations also received the highest score for learning (35.5%), followed by Sustainability (29%), Environmental (24%), Legal (23%) and Planning/Development and Emergency Management (both at 20.7%). The lowest scores for sp-R learning were received by the Mayor and Council (0), CAO (3.7%) and Finance (3.6%). Planning and Development received 31% for learning and 21% for influence. Interestingly, Parks and Recreation received the second highest score for collaboration (78.65%) but 0% for influence (unanimous across the region) and only 10% for learning. Engineering received a balanced score for collaboration, influence, and the highest score for learning. As the discussion below will show historically engineering has been the dominant profession for addressing flood management which can come with a specific professional bias toward structural solutions to floods.

In the next section I explore some barriers and enablers for collaboration within and across municipalities.

5.4.1 Collaborating within and across the borders: physical geography, water bodies and hazard types

Interviews and the survey revealed that geography, water bodies and hazard types influenced both sp-R (e.g., planning responses) and gen-R, including collaboration, learning, and ability to maintain options. These influences are discussed at the municipal, sub-regional and regional levels.

Municipally, the specifics of physical geography and the hazard type not only defined the substance of the flood management regime (e.g., established flood management regimes in Fraser Freshet (FF) and South Fraser (SF) regions vs. emerging SLR regime in the Burrard Inlet (BI)), but also influenced the organizational planning responses and cultures. Internally, in the majority of municipalities, flood management was seen as a distributed function primarily between engineering (most established, resourced and influential as described above) and emergency management/fire service (especially for those municipalities that have previously experienced floods). In addition to engineering and emergency management, planners were becoming increasingly involved as champions and negotiators who extended the focus from sp-R to floods to include general organizational ability to adapt to change (gen-R). This involvement was visible at municipal and regional levels. The primary driver behind this broadened scope were the provincial guidelines that ignited conversation around FCLs, a challenge that presented particular novelty for the undiked BI sub-region.

Sub-regionally, the geography of shared hazards, shared land borders and separation from other municipalities by various water bodies played a major role in determining collaboration patterns with neighbouring municipalities and the broader region. In low-lying municipalities (with a historically agricultural base which required extensive drainage), various historically formed committees and forms of engagement were present and influential in setting the direction of flood management policies (CoS_EM; CoPM, CoD_E). Unlike in the BI sub-region, in these municipalities, the hard diking and drainage infrastructure had a historically formed soft local governance component that went beyond government and ensured that the service levels (e.g., flood free days) were met.

At the time of the fieldwork, geography and shared hazards were particularly influential for fostering collaboration and learning in the Burrard Inlet sub-region (CNV, DNV and CoV), on the shared hazard of SLR/coastal flooding, despite the Burrard Inlet between them. Some of the CNV and DNV staff stressed that they thought of themselves as a more united entity compared to other municipalities given their physical separation from the rest of the region:

“...on the North Shore regionally we do [collaborate] because of our geography... We’re separated by Burrard Inlet and the bridges so we tend to just worry about ourselves. I think from a policy perspective I’m trying to apply that...if we all do the same thing, we’re all going to succeed, if we all do it differently we’re susceptible to not succeeding” (CNV_E). As a formal example of this collaboration, CNV and DNV commissioned a joint flood management study that informed their approaches in response to the provincial Guidelines and were also considering joint flood mitigation works. Staff in both municipalities suggested that their Councils also drove collaboration (CNV_P; DNV_EP). In addition to formal mechanisms, informal collaboration and strong social capital were frequently mentioned as major factors for enabling joint work and learning in the BI sub-region (DNV_EP; CNV_E; CNV_P; DNV_PS). This increased collaboration was particularly driven by the uncertainty about how to respond to the provincial drivers, as a CoV planner put it: “I called all the municipalities [in the sub-region]... when we were trying to decide what to do with the provincial guidelines. The City Manager wanted me to do a scan of who was doing what.” Given the novelty of SLR planning staff to staff collaboration in BI sub-region was an important factor for reducing uncertainty and bringing a sense of confidence to their actions:

I know there's a big development going on in North Van. I met with North Van yesterday to see what they're doing. They've done a similar study. They're recommending a much higher [FCL] number as well. (CoV_P).

It was very helpful to talk to Vancouver, West Vancouver, and the District. Even though we ended up going first just because of the urgency or the timing for this particular development it was very useful to have that informal group discuss it, and support it, really. I think that was helpful for everybody. Would have been very difficult, I think, otherwise (CNV_EP).

As an engineer I take professional risk and a responsibility for the decision cause we’re only protecting for today’s situation under the Guidelines. Having other professionals, sort of, struggling with the same issue both with the consultants and the developer: How? What’s the right number? Having that check-in with our neighbours so that council (they’ve got a political decision to make) so if we’re doing something

that's completely different than our neighbours that effects their decision. If we're all, sort of, on the same page that's easier for council to support. (CNV_E).

In other words, provincially legislated change and geography and shared hazards served as enablers of tight and deliberate staff-to-staff collaboration within the sub-region on SLR/coastal flooding that then led to the development of guidance to support political decision making and change in sp-R policies by raising the FCLs.

In addition to joint planning within the BI sub-region, collaboration for emergency management was institutionalized by a regionally unique shared tri-municipal arrangement, organizationally embodied by the North Shore Emergency Management Office (NSEMO) which maintained close collaboration with CoV, despite the Burrard Inlet between them (water bodies were perceived as barriers to collaboration in other sub-regions, as will be discussed below). These learning and collaboration activities drew on formal platforms, shadow spaces for learning and informal social capital (discussed in detail in Chapter 6).

Sub-regionally, given the reliance on bridges in the region for connectivity, several municipalities (e.g., CoPM, CoD, CoR) thought of themselves as ‘islands’ separated from each other by water bodies, thus focusing on collaborating with the municipalities that land bordered them. This thinking was particularly emphasized in a context of emergency management (CoPM_M; COD_M). For example, in Delta Mayor Jackson suggested: “knowing how fragmented our region is, we’ll probably be pretty much left on our own because if we don’t have the tunnel we don’t have the Alex Fraser Bridge, we don’t have the other bridges, we’ll be pretty much cut off from the north side so we’ve got to be pretty much aware of what we’re doing here”. In the SF sub-region, municipalities saw themselves as subject to isolated and localized impacts that did not impact the broader sub-region or region: “If we had flooding in Surrey, there’s a small area but most of it… would affect Surrey. It generally would be kind of isolated. If we have flooding in Delta it affects Delta. Generally, as well with Richmond, if there is flooding in Richmond it affects Richmond, it doesn’t affect Vancouver” (SF_E).

Given this mentality, planning for downstream effects of adaptation measures (Birkmann, 2011) was identified as a major sub-regional and regional collaboration challenge. For example, as a long-serving engineer suggested:

The problem we’ve been having is the rivers don’t just start and stop in Surrey; they start in Langley and getting Langley on board has been a bit of a challenge because they don’t think they have a responsibility downstream …It’s going to be more of a

challenge in the future...We can't have all our land flood so their land doesn't, you know what I mean? Especially with sea level rise we're all going to be flooded anyway, so the challenge will be trying to get our neighbours on board. One time they were but with councils changing... it can be a challenge at times. (CoS_E).

Downstream effects, different land-uses (e.g., residential in Langley bordering with agricultural in Surrey), and changing politics presented challenges for sp-R planning, exacerbated by SLR. Regionally, CoR provides an interesting example of the issues discussed above as the only true island in a geographic sense, separated from the rest of the region on all four sides with no land-bordering municipalities. It is also the most downstream municipality of the Fraser River, and is heavily influenced by the tides. This geography sets CoR apart from the rest of the region. The physical separation also influenced their understanding that sp-R decisions made in CoR did not impact the rest of the region:

Richmond's a little different. The key influence here with regards to water levels outside the dike is tidal....as you get further up river to Mission and Chilliwack, less so. In those scenarios, if you're in Mission or Abbotsford and you're thinking of narrowing the river and creating a bottleneck, well, that might have significant upstream effects. Not so much here and it's not something that we're really considering (COD_E).

Regionally, CoR had a unique reputation in the region for their self-sufficiency and confidence in their approach to sp-R. As a municipal interviewee suggested: "Richmond is silent and they don't really talk to us that much. It's really weird. They think that they've got it all sorted out" (SF_EP). A provincial interviewee suggested: "I probably know what [Richmond interviewee] told you: "everything is fine". Given this somewhat insular reputation regionally, CoR was seen not only as an island in a geographical sense, but also from a collaborative regional planning perspective.

The physical separation by a water body influenced collaboration levels for shorter term inter-municipal emergency management and longer-term adaptation planning. With an exception of the "Hands across the water" program for CoV and the North Shore, the majority of joint emergency planning initiatives across sub-regions focused on land bordering neighbours. Sub-regionally, the NSEMO model was the most advanced institutional embodiment of such collaboration. However, in the SF sub-region recent planning initiatives were also moving beyond neighbour-to-neighbour MOUs into a more sub-regional collaborative space, as Mayor Jackson of Delta suggested: "We're going to be trying something a little bit different. Instead of looking to the north of the Fraser for Richmond and all the others, we're going to try and do

something south of the river. There's a reason for that too because getting across the river, if we have an earthquake or flood or whatever and we have our bridges go out, south of the river is going to be it." This sub-regional self-organizing was seen as a necessity in the absence of leadership from the Mayors at the regional level. While ad-hoc event specific coordination would occur as needed, the mechanisms for building long-term general capacity to respond were absent: "We would coordinate and collaborate [during a flood event] but it's not like we're having mock exercises or anything together and that's where I think the region should probably take some part. It's so hard to get these mayors together and their staff to talk about these things" (Mayor Jackson). Physical separation provided a mental boundary for collaboration and influenced not only emergency planning but also long-term planning where consideration of regional planning interdependencies (the impacts of planning decisions made in one municipality on the broader region) rarely went beyond immediate neighbours. As one interviewee suggested:

As you go further east in Delta and we get close to Surrey we wouldn't design anything that would impede...that would harm them. We think of our neighbours that way. We've done that through some of our storm water planning, some of our dike upgrades and drainage infrastructure. But we certainly don't think about Vancouver or Burnaby. I don't know how...because we're not physically connected. **We're a bit of an island. And economically we're an island** (SF_EP).

In CNV, when asked whether the staff considered regional impacts of their internal flood management and planning decisions, one interviewee suggested: "From the physical things we do here on the North Shore...what does that mean for somebody in Burnaby? We don't think that way" (CNV_EP). Similarly, the Director of Engineering in Richmond suggested that the decisions made in Richmond did not impact the wider region: "Those decisions and how we make those decisions and develop those strategies doesn't really have any regional impact... Surrey has their lowlands, Vancouver has their lowlands on the north arm they can make and again their dike lines are largely established, their decision making on how to address that flood risk on that side of the river doesn't really have any impact on Richmond" (COR_E). In other words, physical geography was central to defining past and current collaboration patterns, a core process for building regional gen-R. Looking ahead, several interviewees (CNV_E; DNV_M) noted that geography will play an increasingly important role over time in determining regional adaptation options especially for low-lying municipalities speaking to a need to shared collaborative approach to developing regional adaptation options.

Overall, a unique exception to land bordering neighbour-to-neighbour collaboration was the Vancouver-Burnaby relationship where, despite their proximity, they did not collaborate as much as expected. This was attributed to different organizational cultures (CoV_EM) including inward-looking cultures (CNV_E). As a former CoV employee reflected: “Looking back to my time in Vancouver, we worked with Burnaby a little bit but mostly just on boundary issues, we didn’t necessarily share information. We were so inward looking, and even arrogant. We were a big organization, a lot of very well-respected experts in their field, so they were really inward looking”. Speaking to the missed opportunities for resource maximization, something that smaller municipalities strived for making them more collaborative, the interviewee further noted: “We have to coordinate things. If I’m tearing up this road it affects them, I need to tell them about it. The flipside is when we tear it up together… they built their water main, we built our water main and together, we’re repaving the whole road” (CNV_E). This quote speaks to the importance of organizational culture as a variable that determines general collaboration levels (gen-R) and thus impacts sp-R policies, a finding that I expand on in the subsequent sections.

Overall, sp-R governance issues at the municipal scale operated based on the principle of subsidiarity, i.e., getting work done at the lowest scale of operation possible, whether site-specific or municipal, or on one-on-one with a neighbouring municipality, as this quote illustrates: “We hadn’t had to build too much infrastructure with neighbours on flood protection. On some of our drainage pipe systems we have, and we came up with agreements and things like that. We typically don’t get Metro Vancouver involved at all…We just do it one-on-one with our local governments, so it works” (CoS_EM).

Regionally, these qualitative findings were strongly confirmed by survey results, where physical proximity played an important role for collaboration, learning and influence. As illustrated in Figure 5-5 below, neighbouring municipalities received the highest score for collaboration (81.5%), influence (18.5%) and learning (37%).

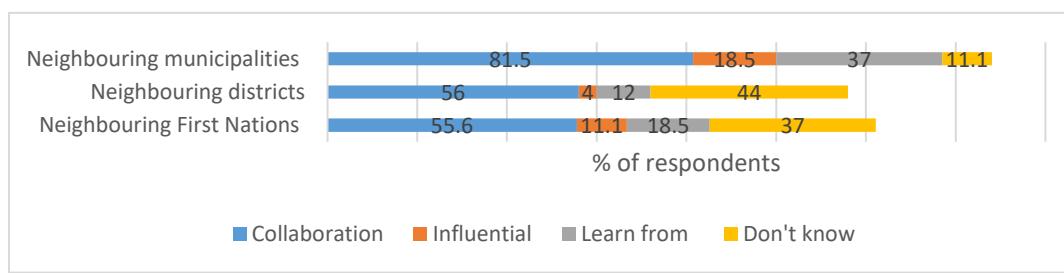


Figure 5-5 Neighbouring entities: collaboration, learning, and influence

Collaboration with the neighbouring First Nations varied across the region and was subject to long-term multi-scalar historical relationship that influenced current sp-R. In Port Coquitlam, the treasured municipal asset of regional value, the PoCo trail (also the dike system), went around the entire community and through the territory of the Kwikwetlem First Nation, also known as the Coquitlam Indian Band. The City and the Nation worked out an agreement that in return for dike management the City gets access on the dikes to complete the loop through their land:

...we have a good relationship with them...but...the provincial government, probably 3 decades ago now went through and put the dike through their land without much consultation at the time. Just did it. It caused a little bit of strain in the relationship in the past. Even with us even though we had nothing to do with it, except for maintain it... there was that 'well, you're government and you shouldn't have done more' sort of thing... With the Chief and the Council that are there now, I don't think that.... why the dikes there is a big issue. We've had a good working relationship. We manage the dike and in return they allow access through their property, their land (CoPC_M).

When asked whether First Nations were part of the planning table for flood management, the Mayor responded: "No, it's separate, because they would have their own emergency preparedness for their own community. We provide some service there, we provide their fire service and other things and if there was ever a larger occurrence then we would all be around the same table, but because they're... half of their community is in PoCo and half is in Coquitlam they have their own community plan" (CoPC_M). However, as described in Appendix D, they collaborated on pre-disaster planning recovery process that engaged multiple departments and organizations across PoCo.

In Pitt Meadows, when asked about their relationship with First Nations behind the dike, the staff suggested, "[The Katzie First Nation⁴ are] the first people we look for, or look at and give warning to. We make sure they're looked after, and yeah, we're close. They're in the EOC too". Similarly, in Delta, Mayor Jackson described the relationship with the Tsawwassen First Nation, the only Treaty Nation in the region: "They sit at our emergency planning table. Because they are so small. They have about 100, maybe 200 people there but of First Nations people

⁴q'eyts'I - the action of a person's foot pressing down on moss.

actually. Say, overall they've got maybe 1500 people that they're really responsible for. So they don't have the expertise. When you consider we've got like 1700 employees here for 100,000 people and how many of those 150 or so and you take away the children there is very few left. So we have all these agreements with them and emergency planning is one of them". When asked whether the agreements were part of a continuous renewal process, the Mayor suggested that yes, and that it was based on needs that changed from time to time. The Tsawwassen First Nation looked after their own planning but CoD maintained the dikes, collaborated on roads, as well as had mutual aid agreements that ranged from fire and police services, adding up to a total of 11 agreements. Overall, the interviews revealed a well-intentioned, somewhat paternalistic relationship with the neighbouring First Nations constrained by a multi-scalar historic context of land dispossession.

As described in detail in Appendix D, sp-R regimes are a product of planning responses to geography (e.g., low-lying vs. mountainous) and hazards faced (flood vs. SLR). However, the analysis identified geographic characteristics (shared hazards, shared land borders) as major enablers for collaboration. In a non-amalgamated region of multiple islands separated by water bodies and connected with infrastructure subject to failures, 'island' mentality was especially projected to an event of emergency. Not only was this emphasized in a geographic sense, but also in a political sense, with the majority of interviewed elected officials stressing that in an event of emergency they would have to look after their own municipalities first. Given this shared understanding, the elected officials pointed to a need for coordination and prioritization from the higher levels of government, an issue discussed in detail in Chapter 6. The 'island' and 'downstream' mentality was also projected to long term planning with municipalities rarely considering the cumulative regional impacts of their flood management or adaptation decisions. Physical geography also impacted the organizational culture, another determinant of collaboration and learning practices as discussed in detail next.

5.4.2 Organizational determinants of self-organization and collaboration

Organizational dimensions can enhance or erode gen-R. The way organizations run their daily interactions, the organizational hierarchy, reporting structure, amount of social capital and trust present, mechanisms and platforms for collective troubleshooting – all of these determine to what extent the organization is able to adapt to new conditions, foster a culture of innovation and

experimentation, or succumb to institutional inertia and path-dependency. As fieldwork illustrated, various municipal departments can be seen as organizations themselves with differing structures, reporting powers and norms and values. For the purposes of this study, a case-study municipality is understood as an interdependent organizational unit that connects multiple departments for a shared goal of maintaining its core functions such as ensuring institutional and fiscal continuity, servicing the residents, and responding to political priorities. Organizationally, the sp-R—gen-R relationship is investigated through the interplay of sp-R practices influence general organizational characteristics (such as culture, repertoires, and norms).

Size mattered for both sp-R and gen-R. It influenced organizational cultures, the internal capacity to respond to and enact change and the resultant sp-R planning responses and gen-R outcomes. Within the seven sub-cases the size of the organizations ranged from 62 staff (including yard workers for CoPM) to nearly 10,000 (6,953 full-time employees and 3,125 part-time employees for the CoV (BC's Top Employees, 2016)). In smaller municipalities, the staff would wear multiple hats: in CoPM the two staff that were identified as the primary experts for flood management issues (engineering and planning) both dealt with it as only part of their day-to-day general professional functions. As Table 5-4 shows, CoPM had the highest service ratio of 1 staff to 289 residents compared to 1/58 in CoD or 1/60 in CoV.

Table 5-4 Staff/residents service ratio

	CoV	DNV	CNV	CoPC	CoPM	CoD	CoS
Population	605,071	86,396	48,770	56,347	17,965	99,863	507,000
Number of staff: full time and part-time (based on available info)	6,953 (3,125)	530	675	600	62	1700	1,774 (2,087)
Service ratio	1/60	1/163	1/72	1/94	1/289	1/58	1/131

This service ratio influenced the degree of specialization of staff as well as availability to participate in regional events, collaborate and contribute to regional studies and learning opportunities outside of their direct work obligations. In larger organizations, a narrower specialization was common, and associated with a different degree of human resource continuity and organizational change. For example, in CoV a dedicated Climate Change Adaptation planner position within the Sustainability Office changed titles and professionals engaged (e.g., from a planner to an engineer) over the 2-year fieldwork timeframe. In CoS, a dedicated Drainage, Environment and Engineering position has been occupied by the same person since 1998. In smaller municipalities staff were more generalist in their professional practice. As a result, “We

rely more on external experts because we just don't have the expertise internally so when we need something we go get a consultant to do that for us." (CNV_E). Given these staff constraints and physical separation, the smaller municipalities such as CoPM did not participate as much in the regional planning discussions and initiatives. When asked about participation in regional groups and other learning platforms and meetings, two key flood management staff (engineering and planning) responded: "Not me personally" (CoPM_E) and "I haven't heard anything actually (CoPM_P)". "No, we're just doing our own thing here really. Looking after our own... our own resources and our own infrastructure" (CoPM_E). This lack of internal capacity served a barrier for the smaller municipalities to participate, to voice their concerns, gain political influence, to collaborate and learn from other municipalities in the region. In other words, this internal capacity barrier served as barrier to accruing the benefits of gen-R.

The size also affected communication pathways, with smaller municipalities benefiting from more direct communication pathways internally and shorter feedback loops from the residents: "The organization isn't as deep. There aren't as many layers so you're talking to people on their front yard and you're talking to Council in the same day. You really do span the whole organization. In a bigger municipality that wasn't the case. You're much more insulated above and below" (CNV_EP). In CoV, the departments were physically distributed across the city, making it difficult to establish connections with departments that did not interface directly, an organizational challenge that had to be overcome for adaptation planning to be fully mainstreamed across departments. This was achieved by educating and getting fellow staff on board, talking about present benefits, linking adaptation actions to capital budgets, and linking and finding co-benefits across departments and projects (International Council for Local Environmental Initiatives, 2013). In addition to efficiency and planning co-benefits, this process enhanced collaboration and learning across city departments, a process that was later replicated for addressing another hazard-specific (earthquake) planning (CoV_P).

Across all sub-cases, organizations, and departments, champions played a critical role in implementing change for both sp-R and gen-R. The interviews identified a small number of champions in the region that were leading at the municipal, sub-regional, and regional levels on sp-R and climate adaptation action. Interestingly, the action was driven primarily by the personal interests and skills, and enabled by the organization. The capacity to foster gen-R by enabling a sp-R planning process that would accrue procedural benefits through collaboration, innovation

and learning was connected to the individual skills and interests rather than embedded organizationally as a property of a system. Interviews with these leaders identified trust and support from their politically stable councils as critical variables for enabling innovative sp-R and climate change action (CNV_P; CNV_E, CoS_E; CoS_EM; SF_EP). The relationship between staff and the elected officials determined the organizational risk appetite for experimentation and the ability to plan for the longer-term. One of the interviewees in the SF region spoke to the various determinants of regional leadership for climate change action:

I think Vancouver will be a leader. They have the Charter, [they] can do a lot of things. I think the City of North Van is going to be a leader. They're starting. The District of North Van because of the people.... West Van ...working on their new dike and coastal walkway...

Watch out for Surrey! Surrey is going to kick some butt. They do well at everything. They're good. They have the money. They have staff who are just great. Everyone has great staff but **when you get the combination of great staff, money, and they have a stable council that's supportive, they can go places** (SF_EP).

This quote highlights several important themes identified in the interviews. First, Vancouver's Charter City status is a unique governance arrangement that enabled implementation of regionally progressive sp-R and climate change mitigation and adaptation actions. Secondly, four out of five cities mentioned in this quote were included in this study which shows that most planning practices that I draw on in this analysis are on the leading edge in the region, as was described in Appendix D. Finally, from organizational perspective, the lean CoS, is a unique counter example to numerously staffed CoV. Formerly known as a crime-ridden suburb, CoS transformed into an award-winning sustainability capital of Canada with ground-breaking innovative planning strategies (e.g., Climate Change Adaptation strategy, the first Biodiversity Strategy in Canada, regional district energy work, etc.). This transformation is regionally unique and deserves a separate section to help identify the organizational determinants of this transformation, as it illustrates the mechanisms behind an effective ability to deal with change (gen-R).

5.4.3 Surrey: a collaborative city that runs lean

The unique organizational culture of CoS is characterized by a high degree of social capital, trust (within staff and between staff and Council) and the relationship-based nature of organizational and community resilience building strategies. This uniqueness was highlighted not only by CoS staff but also other municipal staff and regional actors (e.g., SF_EP;

ACT_SFU). The four CoS staff interviewed attributed this culture to lean operations and an emphasis on collaborative planning (CoS_E1; CoS_E2; CoS_FC; CoS_DFC). The city adopted a collaborative and a participatory planning model where small core groups of staff would take on leadership roles on certain issues and seek feedback from wider audiences (internally and externally) to bring back to the joint planning table enabling polycentric, distributed planning processes:

A lot of studies in Surrey work that way...Our biodiversity study... we have the internal city stakeholder group, which is about five of us and then we have our bigger public, which includes more city stakeholders. So, you do have a core little group but you still have a bigger audience you're trying to get feedback from. We do a lot of our planning studies that way (CoS_E1).

This overall organizational culture and planning and learning methodology not only applied for the long-term plans but was also part of their emergency management which showed a regionally unique integrated interdepartmental organizational culture. As a Drainage Engineer suggested:

...we have a flood strategy, a strategy on earthquakes, we've got different ones going. We have EOC practices where we have mock events with senior management team and a few of us [staff] to try to get you used to "okay if an event happens this is how we set up, this is how it's going to be reacting, these are your roles" and work together...We've been doing it for years. As new people come in, they're integrated into it. We're not as siloed as some organizations probably. **Surrey runs lean.** You've got to have these groups to help support you (CoS_E).

Unlike other organizations where the emergency managers had a dedicated function for building relationships, in CoS emergency preparedness was partially a by-product of highly collaborative day-to-day organizational repertoires: “[Staff] can engage themselves into any sort of scenario that you put them into because they are good at what they do on a regular, daily basis and [can] just take that and apply it to an emergency” (CoS_DFC). Speaking to the city-wide close interaction for emergency preparedness (something that was also noted by the two engineering staff that were interviewed) the Deputy Fire Chief and the Fire chief stated:

...it's important that we have **established relationships, working relationships in our daily routine that we can apply to an emergency.** So that I know our environmental manager by name and by how she's going to react and what her expectations are (CoS_DFC).

We trust each other. We're used to trust... we're used to supporting each other. We're used to putting a problem in the middle of the table. It doesn't matter who it belongs

to – we all own the problem. That's part of leadership and what the environment is here. It's our DNA... (CoS_FC).

When asked about the origins of this culture, the longest serving interviewee stated that: “The city manager, 3 or 4 [managers] ago did a big clearing house of staff back in '96 or '95... then he instituted interdepartmental team building exercises. You wouldn't just let all the engineering go to team-build together, you had to do it with all the other departments” (CoS_EM). The lean operation (limited staff and departmental budgets) enhanced collaboration levels: “You have to depend on your colleagues in other departments to make sure you're doing things efficiently. We don't have a lot of people to rely on so that...promotes collaboration” (CoS_E). This highly collaborative culture had direct benefits for sp-R by, of necessity, engaging a small number of key professionals to search for effective implementation measures. Another engineering staff gave a specific example of such efficiency gains that also contributed to inter-organizational planning co-benefits: “It's the lean thing because none of us has the resources...Sometimes when it's challenging or somebody doesn't have money, it's like: “Okay, can you help purchase this with me cause you're going to widen the road so he'll need to take some of the frontage; this is on a ravine and the stream in there and this would tie in good with our parks”. So, you may have 3 different departments getting together to buy a piece of land. It's that kind of thinking that's a little different.” (CoS_EM)

CoS was also a city with no recent tax increases, and as such was subject to scarcity-driven innovation: “The city went through nine years of zero tax increase, right? ...We boast the lowest taxes in the region but we pay for that... You take it away and it forces you to be innovative or else you wither, right?” (CoS_FC).

A clearly defined vision, strong support and trust from the political leadership were also identified as key to effective staff action on issues related to climate change. As an engineering manager suggested: “There's no uncertainty about what Council's thoughts are on topics and to have them support whether it be the [Sustainability] Charter and its children like the Climate Action Strategy... Therefore, collaboration really isn't that hard when you know our elected officials deem these priorities. It is important to them therefore it is important to senior management team” (CoS_EM). In a small trust and social capital rich organization, these priorities were co-owned from Council down to staff level.

The discussion above outlined some of the key variables behind the unique organizational culture of CoS: organization-wide recognition of the importance of daily staff relationships for planning and operation; a distributed collaborative planning culture that enabled individual staff champions to adopt an area of focus and effectively draw on external and internal expertise and resources; lean operations (years with no tax increase) that required high collaboration and efficiency; and trust between staff and council, including institutionalized, mutually agreed upon frameworks for action such as the Sustainability Charter that reduces uncertainty and enables long-term planning. The organizational culture of this lean, efficient and highly collaborative municipality was a clear outlier regionally. From a theoretical resilience perspective, while lean operation maximizes efficiency, the need for collaboration and innovation, it reduces slack capacity and organizational redundancies that may be required under conditions of stress and crisis. However, empirically, at the municipal scale little evidence of that was identified. The organization had a well-developed capacity to manage short-term emergencies with a strong emphasis on fires (e.g., the historically high ratio of residential fires in the municipality was reduced with death and injuries dropping by 70% and aggregate numbers of fires dropping by 60% following experimental interventions from the Fire Department (CoS_FC)) as well as a well-developed capacity to address long-term risk (by combining flood management, climate change mitigation and adaptation).

Regionally, while Surrey's participation and representation for sp-R was high (deemed as a strong organizational priority (S_EM; S_E) and noted by other regional actors (SF_EP; ACT_SFU; FBC; CoV_P; CNV_EP)), the potential weak link was the lack of regional participation in emergency management activities (CoS_FC; CoS_DPFC), as noted by the representatives of the regional emergency management (EMBC_DPS; EMBC_SRM). This lack of participation not only potentially limited the ability of CoS to benefit from regional planning activities, but also the opportunities for horizontal learning and knowledge exchange that CoS could offer others. This lack of regional participation is partially explained by the differences in organizational sub-cultures (between fire services and emergency management) (CoS_FC; Cos_DF; EMBC_DPS).

This section analyzed organizational dimensions of the sp-R—gen-R relationship, a relatively weakly explored domain of resilience studies. This section showed that several internal (size, capacity, champions, leadership and trust) and external (geography, waterbodies and

hazards faced) factors served as both enablers and barriers in the sp-R—gen-R relationship (Table 5-5). It also showed the nuanced interdependent relationship between sp-R and gen-R. For example, while physical geography, hazards faced and the waterbodies drove the sp-R planning regime, they also had direct impact on patterns of collaboration and learning, with ‘island’ mentality drawing boundaries for these procedural dimension of gen-R. The ability to adapt to change was also influenced by the size of the organization, and the interplay of continuity and change between the bureaucracy and the elected officials. In the next section, I focus on learning.

Table 5-5 Summary of barriers and enablers for self-organization and collaboration

Self-organizing and collaboration	
Barrier	Enabler
Geographic	
Waterbodies in between	Shared land border and shared hazards
Organizational	
Absence of social capital, trust, networks; Absence of champions (political and staff leadership)	Social capital, trust, networks; Champions (political and staff leadership).
Organizational culture, e.g., ‘island mentalities’	Organizational culture, e.g., collaborative, lean CoS
Size of organization (small: limited capacity to collaborate and learn regionally)	Size of organization (small: lean operation, tight feedback and communication pathways)
Size of organization (big: dispersed actors)	Size of organization (big: staff capacity to collaborate in extra-municipal activities)

5.5 Learning, experimentation and innovation

Learning, experimentation and the capacity to innovate are central to the ability to deal with change, gen-R (Pahl-Wostl, 2009; Walker et al., 2009). As Duit (2016:364) suggests an ideal resilient public administration is in many ways different from a traditional Weberian bureaucracy: “it consists of multiple organizational units in non-hierarchical networks with overlapping jurisdictions and cross-scale linkages; it has spare capacity to use in times of crisis; it relies on multiple types of knowledge (e.g., scientific and experience-based) and sources of information; it encourages stakeholder participation; and it uses trial-and-error policy experiments and social learning to keep the policy system within a desirable stability domain”.

The interplay between institutional continuity and change is central for institutional capacity to learn. To understand the role of a gen-R planning process in addressing institutional path-dependencies, it is important to understand the inherent organizational and institutional characteristics that provide stability, encourage innovation, and allow it to meet new challenges

and changing circumstances (Labadie, 2011). As Dovers & Hezri (2010) suggest, the characteristics of successful institutions—long-lived and influential ones—include a balance between robust predictability and adaptability, maintaining public and political support, and sensitivity and responsiveness to multiple (including conflicting) motivations and aspirations (p. 223). Learning can play an important role for institutional ability to deal a specific hazard (sp-R) and with change in general (gen-R).

In this section I focus on key processes that enable single loop, double loop and triple loop learning at the municipal scale with a focus on organizational and institutional barriers and enablers. To analyze the sp-R—gen-R interplay at the municipal level I focus on the following question:

- 1) What are the barriers and enablers for sp-R learning and experimentation at the municipal scale?
- 2) What are some of the leading hazard-specific learning mechanisms at the municipal scale that connect to gen-R?

In the following section, I analyze the enabling conditions for translating sp-R into gen-R outcomes through learning, experimentation and innovation, using examples of some of the innovative mechanisms in the region discussed previously.

5.5.1 Barriers and enablers for sp-R learning

Overall, there was an uneven capacity to learn, experiment and innovate across the sub-cases, especially when it came to translating the sp-R learning process into gen-R outcomes. Similar to collaboration, social capital, leadership and trust (especially between the elected officials and staff) were major enablers of learning that led to action. At the individual level, the most common mechanisms for seeking out knowledge and solutions when faced with a novel situation were relationships-based. These included “consult colleagues in other municipalities, organizations or provincial agencies” (94%), “consult a college that I trust” (78%), and “seek guidance from my superiors” (78%). This speaks to the high level of social capital and trust present in relationships among FMPs. Triangulation (78%) and independent research (75%) prior to making decisions were also reported as widely used techniques which speaks to the rigour that FMPs applied to their daily flood management practices.

For sp-R, a major barrier identified by several participants was lack of expertise in the region on flood-proofing and flood resilience policies (especially with regard to coastal design)

and the need to learn from examples in the Netherlands, Britain and other European countries (CNV_P; CoS_E; CoS_EM; CoS_FC; CoV_P, EC_1). While learning for the impacts of SLR mostly consisted of somewhat familiar coastal hazards (e.g., exacerbation of coastal erosion, saltwater intrusion into coastal aquifers, surface waters, and agricultural lands, inundation of coastal lands, and storm surge flooding during coastal storms (Nicholls and Cazenave 2010; Vadeboncoeur, 2016)), it also presented previously inexperienced legal, economic, environmental, and political risks of both over- and under-adapting (Adger et al. 2005) of choosing ‘what to do, where, and when’ (Butler, Deyle, & Mutnansky, 2016). This required contending with greater complexity and uncertainty than the planning regimes have been able to accommodate historically.

In addressing these challenges, similar governance contexts were identified as key to effective cross-jurisdictional learning. For example, the European countries were perceived as more applicable for learning compared to the US given the differences in flood management governance regimes (CoS_EM), while an earthquake in New Zealand was more impactful for policy learning than an earthquake in Pakistan: “the big earthquake in Pakistan that killed so many people … it’s a totally different geography… not that earthquakes respect geo-climatic zones, but it just looks different, the culture is different, the government… nothing about it look like “oh that’s about to happen here,” right?” (CoV_C). This speaks to the importance of not only hazard-specific learning but the general context of the governance system within which the learning takes place (Dovers & Hezri, 2010).

Inter-municipally, joint flood hazard and/or risk studies and information sharing were the most common form of learning (e.g., jointly commissioned studies by CoS and CoD; CNV and DNV). Cross-municipal coordination was deemed important as it allowed to better understand flood risk from a watershed perspective, beyond individual jurisdictions: “Although we have hard city boundaries, our watersheds are ones that don’t respect those boundaries. We do many of those [studies] with the City of Langley, Township of Langley, and the Corporation of Delta. That’s something that staff work out: we co-fund studies to evaluate or establish the condition of the natural environment and then with our development goals that we each have we can go about to implementing systems to do that” (COS_E). This joint learning, however, did not always translate into joint action. Joint investments in flood protection measures were not as common, with a few exceptions (e.g., the CNV and DNV were discussing a joint flood protection measure

at the time of interviews). As an engineer in Surrey suggested: “We have good working relationships with our neighbours. When you start talking money it’s not always good” (CoS_E). Additionally, several municipalities had long-term relationships with the neighbouring First Nations for dike management and access points (e.g., Tsawwassen First Nation and CoD).

5.5.2 Connecting sp-R learning to gen-R through types of knowledge used for planning

The interview data revealed some of the common types of knowledge used in planning for sp-R (Table 5-6).

Table 5-6 Types of knowledge employed for sp-R planning

Techno-rational/scientific studies and consultant reports	Highly used and accepted as the most valid form of knowledge for sp-R policy-making. Consultants filled in the knowledge gaps that municipalities could not address on their own. Consultants were influential in determining approaches and options for sp-R. Contracted out knowledge acquisition process provided weak incentives for building gen-R such as increased social capital, collaboration and learning outside of client-consultants relationship.
Knowledge co-production	Knowledge generated in partnership with other organizations (academia, boarder stakeholders, citizen task forces). Used for triangulation with an emphasis on <i>process</i> (awareness, relationship, ownership building) which contribute to gen-R (e.g., increased collaboration levels). Present in high resource municipalities such as CoV, DNV, CoD.
Local knowledge and history maintained through human capital	Long-serving staff (e.g., 20+ years in the region (e.g., CoV, CoS, IPREM) served as reservoirs of long-term institutional memory and offered a unique temporal perspective on organizational and institutional learning (e.g., from events that happened elsewhere), the rates of change, and the nature of continuity and change between bureaucracy and elected officials.
Experimentation and innovation	Various mechanisms were employed across the region depending on the professional affiliation (e.g., fire safety preparedness that expended into flood preparedness in CoS), the structure of organizational departments, and the overall departmental or organizational culture and appetite for experimentation and innovation (Appendix D). Ability to experiment and innovate was strongly dependent on champions, as well as financial and political stability.
Analogs and own experience (e.g., direct hands-on operational and management experience)	Staff stressed the need to localize and contextualize higher scale data and solutions from elsewhere. Numerous municipal staff also worked in other municipalities in the region which gave them a comparative perspective as well as ability to bring best practices/learn from mistakes. In larger municipalities, individual interests were a key driver to determining staff specialization area (e.g, SLR), turning them into domain experts and champions.

Traditional Knowledge/Indigenous science	There was no evidence of this knowledge being used within the formal planning regimes.
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The types of knowledge used for flood management (Samuels, 2018; Bergsma, 2018) and the processes by which they were generated (Hahn et al. 2006) had direct implications for gen-R. For example, a universal reliance on scientific evidence and technical studies for making policy decisions resulted in an increasing dependence on external consultants especially given the novelty of SLR planning domain. This outsourced learning process had low incentives for building gen-R within the organization. In some cases (e.g., CoV), the novelty of the planning challenge was addressed through an increasingly diverse set of stakeholders participating in knowledge co-production. This type of learning process, however, was used in the more resourced municipalities which had the time and staff resources to build learning partnerships with external stakeholders (such as universities, professional organizations, etc.) and participate actively in sub-regional and regional mediating platforms.

However, the importance of applying diverse types of knowledge (a factor of gen-R) was stressed by some of the interviewees and included experiential local knowledge and history which enabled a critical approach to using data and knowledge generated at the higher scales (global, provincial) and to applying solutions developed elsewhere (DNV_EP; DNV_PS; CoS_E; CNV_E; CNV_P; CoV_E). This epistemological pluralism (the recognition and combination of multiple ways of knowing that involves promoting the use of all relevant knowledge, perspectives, and viewpoints in a structured, rigorous manner (Healy, 2003 in (T. R. Miller, Muñoz-Erickson, & Redman, 2011)), did not extend to Indigenous Knowledge which was absent within the formal sp-R planning regime at the time of interviews. In examining this absence in future studies, it would be important to note that institutionalized forms of knowledge often provide a justification for existing policy arrangements, but new forms of knowledge can challenge the framework upon which these arrangements rest (Bergsma, 2016).

In this case, the Indigenous community safety knowledges of seasonal weather patterns, ocean currents, and tides that have been present in the region since time immemorial has been actively suppressed by the colonial regime. Yet, as research is increasingly demonstrating Indigenous Knowledge is useful and relevant for DRR and climate change (Gadgil, Berkes, and Folke 1993; Berkes, 2009; Turner & Clifton, 2009; Shava et al. 2010; Schultz & Lundholm,

2010; Hiwasaki, Luna, Syamsidik, & Shaw, 2014; Kelman, Elias, Bates, & Rose, 2008; Mercer, Kelman, Taranis, & Suchet-Pearson, 2010; Shaw, Sharma, & Takeuchi, 2009).

This speaks to the challenge of matching the scale of what is known about the world and the scale at which decisions are made and action taken: for example, large-scale scientific knowledge has little relevance to local decision makers (such as global climate models that are at a resolution that is not useful to subnational decision making), or local, tacit, or Indigenous Knowledge that is not seen as credible by national or international actors (Cash et al., 2006). The general result of this mismatch has implications for the planning regime, given the production of scientific and technical information that lacks salience, credibility, or legitimacy in the eyes of critical players at different levels (Cash et al., 2006). Connecting sp-R learning to gen-R outcomes has a potential to overcome this challenge. In the diversity of learning mechanisms employed across municipalities, one example offers promising guidance in how sp-R learning can deliberately translate into gen-R outcomes.

5.5.3 Double loop learning: the learning process behind DNV risk tolerance criteria

A regionally unique example of translating sp-R into gen-R through learning was the establishment of community risk tolerance criteria (RTC) in DNV. Following a localized traumatic event (a landslide) for the community (see Appendix D for more information), explicit investments in learning on the ground from events that happened elsewhere (e.g., Hong Kong) were made and were connected directly to a community-based participatory process. Central to this process was the creation of the Community Natural Hazards Task Force (a group of eight volunteer residents – half were engineers, a mix of technical and communications people—representing different geographic areas of the community) that served as a linchpin between organizational and community learning:

We educated this Task Force using engineering consultants about natural hazards, risk assessment, mitigation options. We had someone from our finance department come in and talk about the municipal budget process, and we had a public education/outreach specialist come in. The idea with this taskforce was that after 2 months of education, they would then host community meetings and ask the community at-large “where was their comfort level with risk tolerance criteria?” We also did an online survey, and based on two or three public meetings and the survey, the Task Force recommended risk tolerance criteria to Council, which were later adopted as what they recommended, and then staff put together an implementation plan (DNV_PSM).

The Task Force members became the key champions with an explicit task to connect individual (champions), organizational, community and policy learning after a focusing event by setting robust decision-making criteria on how to address hazard-specific resilience. This ground-breaking hazard-specific RTC had subsequently informed general planning processes such as land-use planning, building permit process and the new OCP, which included three new development criteria (hazard-specific DPAs) for landslide, creek hazards and wildfires. The District conducted a series of risk assessments and shared “these findings with the public very openly, and that attitude of openness is really generated from council, and we’re lucky to have it. It gives a huge component to having the community involved” (DNV_PSM). The program that grew out of it became one of the most recognized natural hazards programs in Canada and received international acclaim.

The RTC work was recognized sub-regionally. For the staff in the neighbouring CNV it was one of the most valuable examples of procedural benefits in connecting sp-R to gen-R as it provided a mental anchoring point for sp-R resilience investments (that could be applied across a broad range of potential events, e.g., earthquake, fire, flooding, or slope stability), but also created an explicit threshold, beyond which investments would take away from other causes since “the more you reduce the risk the bigger the price tag”:

While this [conversation] is specific to flood risk and sea level rise and the high profile that that carries, it’s the same terminology... [as] this idea of a risk tolerance. You can’t necessarily protect everything... What’s the right level to pick? Is it the 1 in 100,000 that just came out of the work that the District did on slope stability? Is it something more or something less? We are all trying to reference it... every time I get in my car, here is the risk that I’m going to get hurt. If I’m willing to accept that risk, am I also willing to accept the same kind of risk in some other event? That’s been very helpful for talking to public, when people ask you about it. When you put it in that context they can get it. If I tell them it’s 1 in 200-year chance of occurring, it doesn’t mean anything to them (CNV_E).

The intensive post-event learning had lasting outcomes for the organization and community. Defining a community-based RTC through a participatory process served as a long-term social contract (informed by proactive learning, evidence and perceptions) between the municipality and the residents in their approach to a wide spectrum of hazards and their appetite for risk taking versus risk mitigation. Regionally, it was one of the most innovative transparent decision-making tools for explicitly evaluating the trade-offs between sp-R vs. gen-R. Key factors for the development of this proactive sp-R learning process that enhanced gen-R were the

direct experience with a focusing event that killed a resident asleep in their house, and a recognition of the need to create a transparent community-based RTC that, in addition to being a best practice proactive approach, provided DNV with public and organizational confidence in their approach to hazard and risk management.

Organizationally, key internal enabling factors included a champion and policy entrepreneur (a staff member who was creative and effective in leveraging influence across multiple scales for implementing change municipally), stable and supportive political leadership (including a long-term serving Mayor), dedicated resources for citizen-based and organizational-wide learning, human capital (DNV heavily invests in conferences, learning opportunities and professional development for staff), high collaboration levels (as described in Appendix D, DNV invested heavily in collaboration with external organizations across vertical and horizontal scales that ranged from federal agencies to university and professional organizations among others), transparent and engaging communication with the public and overall high capacity of a well-resourced municipality (e.g., in-house GIS group).

In other words, high gen-R enabled a participatory sp-R process that in turn further enhanced gen-R, which shows that when designed synergistically, these two planning processes can be mutually reinforcing. An important aspect of moving away from a dependence on an individual champion was the institutionalization of the Natural Hazards program that went beyond the initial hazard-specific learning (slope stability) to address other multiple hazards (e.g., floods, fires, earthquake), to engage with the notion of risk (through RTC work) and to proactively seek opportunities for implementing community resilience actions. An important additional co-benefit to addressing sp-R to multiple hazards, is that the RTC also provided a rationale for long-term investments (including a 10-year infrastructure asset management plan) and, arguably, a degree of insulation from political change, a major issue regionally that influences approaches to sp-R and gen-R, and discussed in detail in the next section.

5.5.4 Continuity vs. change: the role of politics and bureaucracy for incremental and transformative learning

Literature on institutional path-dependency and change suggests that over time organizations can become rigid and myopic in the ways they approach learning to accommodate change in their environments. For example, several staff in the CoS attributed the proactive learning culture of the municipality the young and agile nature of the organization: “A new

community, a developing community, we're not entrenched with 'oh this is the way it's always been done'. We're actually encouraged to find innovation, to find new practice, to find efficiencies, [and] say 'yeah, let's try that'. Whereas other municipalities ... their staff may not have those options or abilities that our Council lets us do and encourages" (CoS_E2). By sticking to the chartered course, institutions may become constrained in their learning practices by selectively choosing information that confirms their existing beliefs and neglecting information that challenges the status quo approach, thus inhibiting anticipatory and adaptive learning. To understand the role of a gen-R planning process in addressing institutional path-dependencies, it is important to understand the inherent organizational and institutional characteristics that provide stability, encourage innovation, and allow it to meet new challenges and changing circumstances (Labadie, 2011). As Dovers & Hezri (2010) suggest the characteristics of successful institutions – long-lived and influential one – include a balance between robust predictability and adaptability, maintaining public and political support, and sensitivity and responsiveness to multiple motivations and aspirations (p. 223). Learning can play an important role for institutional ability to deal a specific hazard (sp-R) and with change in general (gen-R).

Across case studies, the enabling environment for learning was strongly influenced by the relationship between continuity and change at the staff and political levels. As Pahl-Wostl (2009) suggests, in an environment where individuals or organizations lack critical self-reflection, selectively seek out information that confirms their existing beliefs (confirmation bias), and never revisit basic values and beliefs provides little or no room for innovation or evolution to higher adaptive capacity through social learning. On the other hand, in a context of political turmoil and changes in basic values and beliefs of individuals and organizations, the direction of progress might become haphazard (*ibid*). This can present a major barrier for resilience investments that require long-term vision, continuous learning, planning and funding to implement them, an approach that fits poorly with the short electoral cycles. The governance regime in BC has acknowledged this challenge by prolonging the municipal electoral term from three years to four in 2014. As "the most significant update to BC's local elections process in 20 years" (Coralee Oakes, Community, Sport and Cultural Development Minister) this change was a necessity because "many municipal issues have become more complicated, so more time is required to plan and engage the community" (Mayor Dean Fortin of Victoria in the Canadian Press, 2014). The change meant to maximize "fairness, transparency and accountability"

(Minister Oakes in Canadian Press, 2014). Political climate is a major influencer of municipal adaptability (Aylett, 2014; Burch, 2014).

Municipally, political climate influenced sp-R learning and had implications for gen-R (e.g., collaboration-based knowledge co-production or outsourced to contactors). Even if none of the survey respondents (0%) reported that they learn from the Mayor and Council's office about sp-R, the elected officials played a role in influencing the general learning processes. For example, several champions suggested the supportive trust-based relationship with the Mayor's and Council office was a major enabler of proactive learning, experimentation and innovation in the sp-R domain (CNV_P; DNV_PS; DNV_EP; COS_EP; CoV_P; COV_EM; COS_E; CNV_E). Some staff suggested that their Councils drove collaborative learning by wanting to ensure that the municipalities were taking a similar approach, especially when a novel situation arose: "We [neighbouring municipalities] are all working together. As I said that's the number one question that comes up at council is "are you guys working together? Are these things aligned?" (DNV_EP).

Inter-municipally, this inter-organizational learning (peer-learning and review) was present in the majority of sub-cases with of the FMPs suggesting that they learn from other municipalities first. As one of the survey respondents put it: "Look to what cities are doing that have more resources and the political will. Start moving on small actions that make sense while planning the more novel actions" (SR_14). This learning mechanism, partially driven by an informal inter-municipal peer review process and competition and partially by individual champions' personal interest, experience, and networks, was one of the central mechanisms for horizontal implementation of innovative practices as well as for gaining and leveraging political influence. Another participant stressed the benefits and the downsides of this peer review process that could enable or constrain innovation: "Ultimately these decisions are all political; we're just making recommendations, politicians actually decide. They usually ask 'what's everybody else doing?' So, it's sort of built in. Cause they want to check, cause if they're doing something that's completely different, they need to know it, they need to be prepared as to why they're doing something completely different. Which is good and bad, you know, keep doing bad things cause everybody else is doing the bad things" (CNV_EP). As this quote demonstrates, peer-based learning can both enable and create a barrier for action for sp-R.

Both SES literature and disaster studies call for triple-loop learning that leads to major transformation of existing resource governance and established management systems. For example, this can happen following large scale disturbances such as disaster events that mobilize public engagement and thus hold promise for transformative change (Birkland, 2004; Birkmann et al., 2010; Pelling & Dill, 2009). However, unlike the transformative change emphasized in the literature, some of the participants stressed the importance of incremental change as an opportunity to build resilience, especially as part of day-to-day routine planning decisions:

It's really crucial in our roles to be highly aware of the opportunities for improvements and to be incremental about it is fine. One of the faults that I see sometimes in planners...there's a sexiness to master planning....but there's a utopian quality to it that's removed from the reality of how most decisions are made on a municipal level... It's much more complex. It's much **more incremental and much more chaotic**...if you can find those small opportunities for advancement...it's the sheer weight of all those tiny decisions. All those tiny opportunities that you've helped to move forward that change the way our built environments are constructed and change society...there's a real beauty to our profession (CNV_P).

Some municipal engineers also perceived small steps towards investments in sp-R (e.g., partial dikes upgrades that do not ensure full flood protection (CoD_E) or FCL that do not meet future risk (CNV_E)) as progress, as it helped to move forward and focus some resources and attention on sp-R. The enabling legislation and guidelines at the provincial level (1m by 2100) played an important role in this progress:

Even though it's incremental and it won't fix or solve the problem, I think it helps to move it forward, even just the incremental improvements in terms of flood construction levels or also just in terms of dike improvements. Even though it's not comprehensive and it doesn't solve the problem, it starts us down the path and it increases the awareness. For example, we did a large pump station upgrade and the Province said "well...as part of the design you need to account for this". So, we just went a little bit further, we raised the dike... it doesn't solve the problem of the whole dike by any means but at least in one short section we've done some of the dike raising. We won't have to do it so much; it will just be more of a maintenance activity in that particular area... (SF_E)"

More importantly, a point highlighted by several interviewees is that these incremental steps enabled by the changes in provincial guidelines allowed for a shift in focus to *planning and design* as opposed to simply maintaining the existing approach: "...from a planning perspective we can start, and a design perspective, and then implementation we can start doing things incrementally that say we're looking forward" (COD_E). Similarly, staff at CoS, CoR, CNV,

CoV, and DNV saw redevelopment as a major opportunity for incremental increase of sp-R over time (by raising development and infrastructure). Even if it did not address the risk fully, it maintained options by adhering to principals of adaptive design and management: “On redevelopment... when houses come in now and they are in one of our floodplain zones, they have to be built to the higher elevation. When we redo a road in a floodplain zone what we’re trying to do is get that road raised up, it may not be raised up to flood elevation but raise it up, start flood designing some of this infrastructure” (CoS_ED).

Within the resilience framework, these incremental learning-by-doing strategies employed by municipalities qualify as a ‘change at the margins’ strategy (Handmer & Dovers, 1996), characterized by acknowledgement of the problem, discussion of its potential implications, and promulgation of the reforms that do not challenge the fundamental root causes of the problem but address the symptoms instead. This is the most common type of response to environmental change, hazards and risk (Handmer & Dovers, 1996). The emphasis on changes at the margins (e.g., site/area-specific raised FCLs and/or dikes to a higher-level rather than explicitly consider retreat as a strategy for certain areas), holds the potential of creating a false sense of security and a perception of a sufficient action, which would hinder addressing the fundamental assumptions in the operation of the system that has led to the problem in the first place.

These responses are being shaped by what is perceived to be politically and economically prudent and feasible in the short term rather than by the nature and scale of the threat itself. While having obvious advantages, often described as ‘practical’, ‘realistic’, ‘balanced’, and ‘pragmatic’ this approach only reduces vulnerability in the short term, putting off the need for a major change, which is likely to become increasingly urgent (Handmer & Dovers, 1996). As observed by (Butler et al., 2016) this behaviour consistent with years of natural hazard mitigation research: communities are likely to continue to follow incremental low-regrets strategies until significant catastrophes arise that raise the salience of climate change-induced hazards. However, as research illustrated, even when those catastrophes arise, “communities will most likely eschew the higher political and financial costs of risk elimination through avoidance and retreat, favoring instead conventional risk reduction strategies of accommodation and protection. This will be especially true in built-out urban areas that have few opportunities to employ avoidance strategies and where retreat will be massively expensive. So long as capital protection

and accommodation initiatives can be expected to have net benefits within their design lives, communities are likely to continue to kick the metaphorical risk elimination “can” down the road” (Butler et al., 2016, p. 329).

Given this incremental piece-meal approach, where would the transformative change come from in the absence of large scale events in the region? Similar to the discussion above, political will and buy-in is often cited as a necessary enabling internal mediating mechanism for enhanced sp-R, multi-hazard mitigation and climate resilience investments. Supported by the elected officials, it was staff-level champions that were leading action. Increasingly, the resourceful and leading municipalities such as CoV, CoS and CNV were adopting adaptive management approaches by building in flexibility to adjust as more information, studies and degrees of certainty were becoming available and, instead of focussing on a silver bullet approaches (e.g., dikes), looking for aligning multiple planning process for seeking out the optimal sets of solutions for the evolving sp-R process:

I'm trying to get the studies finished so we have better ideas on elevations for 100 and 200 years and then we got to work with our group again to try to change our **zoning bylaws**, change some of the way **we design in floodplain areas**, right? So that we can do that, we're also looking at the **impact of low impact development on storm drainage**, what kind of role will that have in the future with the changing rainfall? Will it have a role or is it going to become redundant because there's too much water? Our **infrastructure – how resilient is it?** Do we have to **change our design practices and building practices** so that we are more [resilient]? Some of it is coming, it's just... we don't have enough information to take it all there yet. I think we're doing as much as some of the US is doing but there are some tough parts coming.” (COS_ED).

This example illustrates some of the features of the third type of resilience outlined by Handmer and Dovers (1996), ‘openness and adaptability’. It is characterized by the ability to adapt to the consequences of change and uncertainty, rather than resist them. The underlying structural causes of the problem are identified, the options are explored and basic operating assumptions are fundamentally challenged and changed. An openness to radical change to social structure and institutional arrangements can lead to a redistribution of power, address the root causes of vulnerability and allow for maximum flexibility in dealing with the threats and surprises. The potential negative features of this strategy include loss of optimizing capacity and greater chances of making maladaptive change.

Handmer and Dovers’ typology of resilience provides a framework for analyzing the continuum of strategies between stability, marginal adjustments and profound changes. An

explicit application of this framework to municipal practices can aid the process of decision making under the conditions of uncertainty by acknowledging the components of the systems that should be maintained as is, changed at the margins or changed qualitatively and the trade-offs between these strategies. One key dynamic in this process of institutional learning was the interplay between fast moving barriers and enablers such as politics, and the slower barrier and enabler of bureaucracy. Inevitably, investing in sp-R practices or gen-R outcomes requires trade-offs across multiple objectives. These are discussed in detail in the next section.

5.6 Maintaining options: managing sp-R and gen-R trade-offs

Maintaining options (e.g., investing in redundancy (“response diversity”) and reserves of resources for future adaptability), a key factor for gen-R, comes at a cost. Decision-making for resource allocation involves trade-offs. The discussion in this section addresses the hypothesis that a high degree of emphasis on sp-R erodes a system’s gen-R, because it 1) creates path-dependency of creating potential solutions by diverting limited financial and staff resources from alternative solutions and options, for example, by investing in certain actions (esp. technocratic approaches to risk reduction such as dikes); 2) commits resources to a single cause (e.g., flood protection) which diverts resources from supporting general objectives (e.g., organization, community); 3) adopts a specific ruling decision-making criterion (e.g., economic efficiency or fiscal equivalency) that discounts other values (e.g., social or environmental); and 4) creates opportunity costs in the future by reducing the capacity to maintain options over time. The discussion below will analyze enablers and barriers for sp-R and gen-R in municipal responses, showing the empirical complexity and nuanced trade-offs being made at the local level, where the majority of planning and risk and resilience building takes place.

5.6.1 Provincial barriers and enablers for municipal action

Municipal interviews revealed two major regulatory drivers for sp-R action: reduced scientific uncertainty and putting a price tag on adaptation. These drivers had an enabling and a constraining effect on the municipal action as well as unintended consequences.

Reduced scientific uncertainty: in 2011, the Province released proposed amendments to the 2004 guidelines that would reflect SLR. The guidelines recommended planning around a 0.5-metre rise for developments with design life spans up to the year 2050, and 1.0-metre of sea level rise up to the year 2100 (Kerr Wood Leidal, 2011). The proposed amendments were released without advance consultation with municipalities. The interviewees suggested that the guidelines

released did not carefully account for municipal implications of this guidance (e.g., land use, planning, zoning, property tax impacts, liability). The lack of consultation created a heightened sense of uncertainty despite the fact that the guidelines, in an unprecedented way, provided an affirmative ‘policy’ number of 1.0-metre sea level rise by 2100 that reduced scientific uncertainty. This spurred an active sp-R discussion in the region, through the established and the emergent formal and informal platforms and channels, fostering gen-R such as collaboration, learning and an active conversation about the ability to invest in and maintain options over time at the municipal level.

Putting a price tag on adaptation: The interviews revealed that it was the “Cost of Adaptation – Sea Dike and Alternative Strategies” study that significantly raised the profile of sea level rise as a critical policy issue and ignited an active collective discussion in the region. The study provided an estimated price tag of \$9.47 billion for the adaptation measures for the selected 33 shoreline reaches to accommodate the provincially indicated 1.0-metre of sea-level rise in the coastal area of the region. The expensive vision at the end of 2100 was unveiled but without being provided the opportunities for interim incremental steps, a common municipal decision-making process. The guidelines also resulted in additional costs and work for municipalities for having to commission studies that would prove the provincial position otherwise. As one interviewee cautiously stated which echoes the general sentiment of the majority of interviewed municipal staff: “We weren’t really consulted in the guidelines… which we expressed… let’s say some regret. We could have added some value to that especially given the additive work that we’re doing after the fact with them” (CoS_E). In the words of one of the survey respondents: “Whilst the province provides some guidance on SLR, the downloading of responsibility to research, fund, gather expertise and data and implement coastal flooding land use policies and regulations has created uncertainty, cost and staffing implications for our municipality” [SR 12]. The lack of awareness between the provincial and municipal level was noted by one of the provincial interviewees as well: “They [the staff at the responsible provincial ministry] didn’t particularly understand what that meant for local government liability and so that did cause a significant problem” (MCSCD_P).

The study also raised the prominence of the multi-hazard interface issue, putting price tags on the seismic upgrades needed to for the dikes in an event of an earthquake. As a result, while a number of municipalities have chosen to actively address SLR within municipal planning

and to accept the Provincial guidelines, others chose to proceed as usual, at least for the time being, preferring not to invest their resources to protect themselves from specific low probability/high consequence hazards (such as an earthquake-related breach of the dike), as this would take away resources from other more immediate high-priority municipal objectives. Some municipalities decided to conduct their own in-depth studies before making any commitments.

The provincial Guidelines were a major driver for action in the region. However, instead of enabling a more consistent region-wide sp-R planning, they further diversified responses across the region and within the sub-regions, putting an additional pressure on human and financial resources. However, these two drivers also had direct influence on gen-R as it forced a longer-term thinking about the ability to maintain options along fiscal, spatial and temporal scales, as discussed below.

5.6.2 The cost of maintaining options: balancing fiscal trade-offs

Fiscal trade-offs directly responded to the proposition at the outset and were the result of organizational awareness that putting resources to a single cause (protection from a specific hazard, e.g., flood or earthquake) could reduce the amount of resources available for other general purposes. In this section I review the municipal tools and processes that enabled or constrained the process of maintaining options. This section is organized by sub-regions of the inquiry.

5.6.2.1 Double-exposure SF sub-region

In the low-lying and diked *double-exposure SF sub-region*, for CoS, CoR and CoD, addressing both freshet and coastal floods was a familiar task that was managed through the tools and processes outlined in Appendix D. The novelty was the requirement to address seismic risk as part of dike reinforcement which was opposed through rigorous scientific evidence combined with managerial strategies that ensured that municipalities were not required to spend a significant amount of resources for a single cause (seismically reinforced dikes to meet the new provincial guidelines) that would erode their overall capacity (human capital and staff time, financial resources) to deal with other priorities. The resourceful municipalities such as CoR and CoS invested in more detailed and contextualized studies that considered fine-level downscaled projections to provide scientific evidence for their positions on the infeasibility of such investments. Municipalities developed creative and innovative ways for presenting evidence against sunk costs for sp-R investments by introducing combined probability approaches (an

approach proposed by a consulting firm that then spread across the sub-region), and stressing that investments for a worst-case scenario did not make sense since the areas behind the dikes would most likely be destroyed. By investing in safe-to-fail (raising the neighbourhoods behind the dikes in CoR; implementing measures to ensure speedy recovery in CoS) rather than sinking millions into ‘fail-safe’ protection as recommended by the Province, municipalities showed a balanced understanding of sp-R vs. gen-R trade-offs.

Moving toward best practices resilience-based approaches, CoS also differentiated investments in sp-R based on infrastructure lifespan, the level of critical functions, and the required recovery time/time to rebuild the infrastructure. In other words, at the municipal level, evidence of moving from hazards-specific deterministic approaches towards approaches that were risk-based (e.g., based on the impacts on commercial and residential assets behind the dikes) and resilience-based approaches (e.g., developing robust area specific emergency response and recovery strategies) was present. However, these approaches were constrained by the [dis]incentives at higher levels of government.

The provincially proposed measures (e.g., seismic dike enhancement) for increasing regional public safety showed clear limitations when positioned against the empirical complexity of municipal decision-making and the nuanced trade-offs involved. In resolving these trade-offs, several trends can be noted. The phased approach to adaptation *over time* was stressed. These temporally distributed responses included an incremental raising of the neighbourhood over time, combined with effective flood response measures reflective of the needs of the day (e.g., properties raised above the road level so that roads would flood but houses stay dry). The phased approach was also used for hard infrastructure protection i.e., building the dikes to protect from the current risk rather than raising them now to ensure protection in 100 years. The release of the provincial studies forced a new line of thinking and justification around design standards and design criteria such as safety factors. In addition to life-safety as the number one priority, the FMPs were increasingly including speed of recovery and the overall economic health following a disaster event as a factor to consider as part of their risk mitigation investments. Additionally, a change in service provision levels for historically established practices (e.g., the number of permitted flood days for agricultural lands in Surrey) were also being considered. In other words, municipalities were undertaking a multiple-objective staged approach to making decisions around maintaining options for long-term flood management. This showed an evolved

understanding of sp-R strategies that went beyond protection from a hazard to designing infrastructure and response and recovery systems that can absorb and recover from an event. Planning played a critical role in this temporally distributed capacity to adapt as a bridge that connected sp-R action with gen-R over time. Within these approaches, there were clearly pronounced differences with the sub-regions, reflective of their historical development patterns, existing institutional capacities, current priorities but also, the degree of novelty of the planning challenge.

For example, the CoR Director of Engineering stressed that what was perceived as a true SLR planning novelty in other municipalities in the region for them was part of day-to-day ‘business as usual’ practices: “You can look at a lot of communities where flood protection hasn’t really been that much of an issue...and won’t become a problem until that sea level rise occurs...In Richmond, it’s always been an issue so it’s just day to day business for us, really...So in terms of capital funding strategies for us...it’s not really a big change from what we’ve always done”(CoR_E).

This ‘business as usual’ approach in addition to the existing historically-rooted sp-R institutional capacity could be partially attributed to the creation of a flood-specific utility to fund sp-R. Unlike most municipalities in the region, CoR had a dedicated drainage utility to provide funding for their flood protection system “to exceed today's needs and meet future needs” (CoR, 2014). Started about 10 years ago, at \$10 per parcel, the initial charge increased to over \$100/year. It provides a funding stream of about \$10 million/year that goes directly into funding capital projects, improving drainage systems, dikes and the pump stations (one major pump station upgrade/year was a 4-million-dollar project) (CoR_E). For a municipality where flood risk was a prominent issue, a flood protection utility was framed along the lines of other utilities and was seen as a common benefit:

Most municipalities typically get established as water districts. That's really the first level of coordination of interested parties or land owners...So the established models we have for water service operation of the water utility, sanitary utility are kind of models that we wanted to emulate for flood protection. Obviously building the dike and providing flood protection and drainage is something that has **common benefit** to all land owners and residents, so it fits very well with a funding mechanism whereby those charges go to those land owners. That's what we did (CoR_E).

This CoR ability to finance sp-R was noted across the sub-region as an effective mechanism for financing sp-R in a way that did not erode the ability to address other

organizational priorities. An engineer in a neighbouring municipality noted that this dedicated fund might place CoR ahead of other municipalities in the sub-region (SF_E) with regard to their ability to manage sp-R across spatial and temporal scales. Another environmental planner in the region noted this utility as an example of municipal-scale sp-R innovation: “[CoR] got a utility tax to fund dike improvements. That’s pretty novel”. (SF_EP)

5.6.2.2 Fraser Freshet sub-region

In the FF sub-region, the provincial drivers did not create a similar splash. The Director of Planning and Development for CoPC suggested that they were at the initial phase of reviewing the provincial guidelines and declined participation in the study, suggesting that the municipality will be engaging with other formal regional groups to explore sp-R issues. CoPM staff (engineering and planning) and Mayor simply suggested that given their limited funds they were not able to address the Guidelines: “At this time there are new standards for the dikes...but the City doesn’t have enough money and nor does the Province to do all that work. It would be millions of dollars” (PM_E).

Yet, a regionally little known about sp-R fiscal tool (unlike the more frequently mentioned CoR drainage utility) was implemented in CoPM, a municipality heavily dependent on dikes for protection. Monitoring and adaptive management played an important role in this process. In this low-lying, agriculturally based municipality, sp-R costs (e.g., drainage and irrigation, maintenance and capital costs) have been escalating at a rate greater than other municipal services (12%/year over the last 5 years). The city recognized that investments in sp-R to floods were taking away from other general organizational and community priorities. This was recognized to be unsustainable over the long-term (CoPM, 2008). As a solution to address this funding deficit, in 2008, CoPM adopted a utility approach to funding drainage infrastructure that captures the full cost of operating the system. Self-sustaining long-term funding is generated from a drainage utility established by a bylaw and is made up of two parts: a utility charge based on assessed value of the property and a levy, which is either a flat rate for residential properties or a charge per area for rural and commercial properties. Prior to the adoption of this, the drainage utility was funded through a transfer from general revenue, where the main revenue source is property taxes.

The interviewed staff suggested that this utility was explained well to the public and was generally well received (CoPM_E; CoPM_P). Public communication materials specifically

emphasized that increasing spending on drainage costs could impact other civic priorities, such as maintaining roads and buildings, funding special community events and constructing recreation facilities. In other words, this utility was introduced to avoid spending a significant amount of resources on sp-R at the expense of gen-R. The articulated community benefits included less frequent flooding in the long term; an opportunity to start saving for future work on major drainage infrastructure; environmental protection improvements; maintaining stable tax increases over the long term; and increased transparency of the government that allows for public input and scrutiny on capital investments. In other words, the municipality made a clear case for enhancing both sp-R and gen-R through this utility.

Surprisingly, across the region, despite universal complaints about funding sources for sp-R among municipal staff (identified as the largest barrier for sp-R action at 100% of the municipal respondents), with an exception of CoR and CoPM, this type of specific-purpose financial tool that allowed to maintain options for sp-R was not widespread in the region. Yet, it provided a reserve of resources, both financial (funding to maintain infrastructure) and institutional (funding for studies, planning, etc.) for sp-R that did not erode funding for general municipal priorities, as was theorized in the propositions guiding this research. However, arguably, the specific-purpose nature of this funding could potentially lead to a lock-in and maintaining of status quo approaches rather than exploring alternative options for sp-R.

5.6.2.3 The Burrard sub-region

In the *BI sub-region*, the necessity to address SLR presented a truly novel planning challenge, which was particularly acute for planners and engineers given the design implications of the provincial Guidelines. Unlike the previous two sub-regions, in this generally undiked sub-region, an opportunity existed to look at multiple options for developing sp-R rather than investing in already existing path dependent solutions. The case-study municipalities have increased flood construction levels (FCL⁵) and have been actively exploring urban design

⁵For CoV, the amendment to Vancouver Building By-law requires an FCL of 4.6 m which can be achieved by the structural elevation of the floor system of the building, fill, or a combination of both. The City of North Vancouver has amended its Sewerage and Drainage Utility Bylaw to require an FCL of 4.5 m. The District of West Vancouver has adopted an interim FCL of 4.5 m for all main living and bedroom areas. Storage and recreation rooms may be lower than this FCL if there is a report from a Qualified Professional that confirms these rooms may be safely used if built below the FCL. Additionally, the District of Squamish requires an FCL of 5.0 m for small infill or redevelopment projects. Larger projects require site-specific flood hazard assessments by a qualified professional), urban design interface issues, etc. (WCEL, 2014; ACT, 2014). DNV chose not to adopt a universal

interface issues (including a regional urban design charrette organized by the SLR Collaborative), building specific adaptations (dry proofing and wet proofing); as well as looking at soft armouring, green shore initiatives and some internal discussion about long term large scale flood protection (e.g., flood gates). Unlike DNV, where an FCL is determined based on a site assessment from a Qualified Professional, CNV and CoV adopted a fixed FCL for all developments subject to (future) flooding.

Given the absence of large scale dikes in the BI sub-region, the discussion focused primarily on the increased FCLs and their significant impacts on urban design, infrastructure interface and public realm implications. The urban design challenge required a raised urban environment that went against the ethos of planning culture that relied on walkability, accessibility and placed a high value on an overall experience of the streets. As a true novelty for the sub-region, this sp-R challenge was addressed through increased levels of collaboration, drawing on the existing and latent social capital across departments within the municipalities and across municipal boundaries (CNV, DNV, CoV and West Vancouver), thus directly contributing to gen-R. Another institutional manifestation of capacity to self-organize and leverage political influence among the staff was an emergence of a new informal Sea Level Rise Collaborative (SLR Collaborative) supported by regional non-governmental organizations (ACT-SFU and WCEL), which will be discussed in detail in Chapter 6. As a planner at the CoV reflected on the novelty of the design challenge: “No one’s done this in the province, hasn’t provided an example of how to do it” (CoV_P). Another planner reflected on the design challenge and solutions available: “I’ve heard that in Richmond...they have buildings at a lower level, right up to the street. The buildings aren’t being setback and there’s ramps and stairways inside the lobbies in order to get people to a higher level... You would have someone in a wheelchair, walker, stroller

FCL relying on site-specific requirements and Qualified Professionals instead. As illustrated in the Context chapter, the District had a set of hazard-specific development permit areas, a tool that was being implemented by some neighbouring municipalities. In Pitt Meadows, a developer was granted an exception after they raised concerns regarding the height of the proposed townhomes in comparison to the height of the existing on the other side of the road built to a flood construction level (FCL) of 5.33 metres, which is a lower flood construction elevation than currently required by bylaw (FCL of 5.75). The developer was granted an exemption to the requirement to comply with the City’s Floodplain Designation and Construction Control Bylaw given the statement from Geopacific Consultants Ltd. that the land may be safely used for the intended use a requirement for the property owner to register a restrictive covenant on title to the subject property saving the municipality harmless from all loss and damages that might occur as a result of the granted exemption (City of Pitt Meadows, 2013).

having to take a different pathway into the building and then the people taking the stairs... You would have to have larger lobbies... in order to get the space for a ramp that's at the proper slope. I would be interested to see that. I just heard through the grapevine" (CNV_P). While a short ride away, the way the initiatives in CoR were talked about on the North Shore illustrated through this quote shows the amount of *organizational distance* between the sub-regions which served as a barrier to collaboration. While low-lying CoR had been gradually raising their neighbourhoods for some time, CNV was considering this as an option to enhance protection for their new developments.

In CoV, rezoning and redevelopment was an opportunity to take early action on climate change and at the same time maintain options in the future. As a staff member interviewed at the early stages of planning described:

Knowing that we have this work and knowing that there's a lot of development coming up in [coastal floodplains], it's like taking advantage of an opportunity and **also about trying to keep our options open**. We're starting to look more strategically at what are the more strategic options for SLR and for erosion? [So] that we **don't just tie our hands having some protective measures** (CoV_P).

In developing an adaptive approach that would keep their options open, CoV took a staged, proactive and collaborative approach to learning about the options and determining the FCL in response to provincial guidelines. Shortly after the release of the Guidelines, CoV staff began encouraging interim FCLs 1 metre above existing levels (~4.5m). While it is unclear how the interim number was developed, it served as a mental adjustment signal of the coming change and allowed the City to work proactively with the development and building community to understand impacts and prepare for change. The City collaborated with the Urban Development Institute, the Association of Professional Engineers and Geoscientists of BC, the Architectural Institute of BC, engineering and surveying professionals, the Real Estate Foundation, Port Metro Vancouver, among other organizations, to determine their approach. CoV was also an active participant in the SLR Collaborative which allowed them to continuously consult with neighbouring municipalities on an informal but organized basis. As noted in CoV flood policies for the most part, these groups supported the City's proactive approach and in several cases the development industry has taken a leadership role by implementing the City's recommended interim FCLs of 4.5m. The City stressed a need for a balanced approach given the multiple trade-offs involved in balancing flood resilience with general demands on public space: "Maintaining

public safety and protection of property is the priority of flood-proofing standards, but it must be balanced with streetscape continuity, urban design and accessibility principles” (CoV, 2014a:6). In addition to raising the FCL, CoV developed a coastal risk strategy and flood hazard maps showing flood depth and extent for multiple scenarios, potential damages, economic loss and population displacement for each scenario that informed the new flood by-law. Unlike the previous by-law, the new by-law also included a map, thus adding clarity to defining the flood prone areas. The City explained the relationship between flood mapping and potential impact on property prices and insurance given a potential backlash against this initiative, a concern for the City with multi-million-dollar waterfront properties: “As this FCL change is triggered by new building or major reconstruction projects, as opposed to being retroactive, it will have a negligible impact on the overall cost of building projects. The Insurance Bureau of Canada has signaled that where flood insurance is available (flood insurance for residential buildings exists in Canada only for flooding caused by sewer backups whereas commercial properties have access to overland flood insurance) they do not expect increased FCLs to change flood insurance premiums. Research on house values shows that actual flood events cause impacts on insurance premiums rather than the location of the home being included in an expanded flood zone; therefore, we do not expect that the publishing of a flood map will impact home values” (CoV, 2014a:6).

Throughout this process and into the future, a need for continuous learning, implementation of site-specific solutions and strategies for seeking committed funding from higher levels of government was stressed: “[r]esponding to SLR is complex as estimates of the amount and timing of the rise vary as do the shorelines and the site-specific risk of flooding around the City. The options available to respond to SLR include raising FCLs, altering shoreline park design; major infrastructure investment such as those New York City, London and Venice are undertaking. While complex, there is time to plan for SLR and staff are recommending **a phased approach to allow for learning and area specific solutions**”. (CoV, 2014b:3). The City also explicitly stressed the need to leverage political influence at the higher scale of governance: “Both the Federal and Provincial governments have signaled that this is an important issue by providing financial support and participation in the City’s study, however there is no identified funding for, or consolidated Federal or Provincial department working on,

responding to SLR. Staff will continue to work with the appropriate Departments and Ministries at the Federal and Provincial government to gain support” (CoV, 2014b:3).

The discussion above illustrated several important aspects of the relationship between sp-R and gen-R in CoV. The City’s approach stresses a need for a diverse set of tools that connects site-specific approaches to general policies while maintaining options in the future. The planning processes encouraged strong collaboration levels, active learning (including adaptive management) and experimentation (e.g., adopting an interim FCL number) and an on-going need for gaining political influence at the higher scales of government. In other words, for COV an SLR-focused sp-R process lead to multiple positive outcomes for gen-R.

In general, flood management aside, managing growth, affordability, market pressures and low tax expectations from the public present challenges for municipalities. Several mechanisms exist to allow municipalities to recover some of the costs of community growth and change as part of a (re)development process that could also be applied to fund sp-R. BC legislation allows municipalities to impose Development Cost Charges (DCCs) for certain off-site services (water, sewer, drainage and roads and park land) to maintain acceptable levels of service (MCSCD, 2014). Hazard mitigation could be included as part of these charges; as one provincial interviewee suggested: “I would like to see DCCs for [hazard] mitigation. I think they should be included, plain and simple.” (EMBC_3). Local Government Act Section 904 allows zoning bylaws to include the option of additional (bonus) density subject to specific conditions, which can include providing amenities. Unlike DCCs, which can be *imposed*, community amenity contributions (CACs) are *negotiated* between the applicant/developer and local government as part of a rezoning process. CACs can include affordable housing and financial contributions towards infrastructure that cannot be obtained through DCCs, such as recreation facilities or a fire hall. Since CACs increase the cost of a project, it is important to consider who ultimately pays for these additional costs, and how they may affect housing supply and affordability, especially in areas where land is in short supply (MCSCD, 2014: 14). CACs allow residents to see tangible benefits from new development: “Because the development, of course, has impacts, the community amenities are sort of the lubrication to development review process whereby the public and the politicians can see that there’s a corresponding and direct benefit back to the public that they wouldn’t otherwise see” (CNV_P). The long-term nature of SLR presents a unique opportunity and a challenge for municipalities to act on the future risk today,

but at the cost of amenities in the present. In negotiating the trade-offs between long-term stressors such as aging population vs. SLR, municipalities have to make decisions about allocating the CACs to something visible and expected (e.g., a recreation centres) vs. investing in future flood resilience:

It's very, very challenging for most municipalities. They see that infrastructure is aging...with an aging demographic in a lot of communities, there needs to be revitalization, rehabilitation of, for example, recreation facilities. How can you afford to do that if developers are paying higher construction costs in order to meet higher FCL and are not able to contribute as much in terms of amenities... that the public might otherwise expect to see as a benefit coming out of development? (CNV_P).

CNV provides a unique opportunity to investigate sp-R vs. gen- R trade-offs being made as part of the planning process (the development approval, OCP rezoning and community negotiation) which determine the incremental area-specific co-evolution of development and risk and the ability to finance and to maintain options over time. In CNV, the release of provincial Guidelines coincided with a review process for “Harbourside”, a significant waterfront development with four square vacant blocks. This process particularly relates to the following proposition: “a high degree of emphasis on sp-R erodes a system’s gen-R by committing resources to a single cause (e.g., flood protection)” which diverts resources from supporting general objectives”.

Given the timing of the development and the changes in provincial legislation, the City wanted to get their “policies nailed down for flood protection in order to apply it to that development” (CNV_E). This required an interdepartmental collaborative planning effort within the City: Engineering, Parks and Environment group (responsible for the actual physical flood protections, all the works, and the maintenance of infrastructure) and Community Development/Planning group (responsible for land use implications). At the time of the interviews CNV was “playing a bit of catch up” (CNV_P) on flood management. Through a joint CNV and DNV study, CNV found out that their FCLs (at 3.5 metres) did not meet the risk of today let alone SLR issues of the future. Given the new provincial guidelines, a 5.2 metre FCL was recommended, which resulted in a significant planning challenge for the City:

We had a really substantial development go forward. It was 12 acre rezoning, an OCP amendment, they were a bit derailed part way through their development application because relatively late in the game were told that they needed to meet a 5.2 FCL or potentially higher. They just happened to be the ones hitting up against the timing

constraints. Because they're right on the waterfront it was considered that we needed to do well in that example (CNV_P).

This required that the City and the developers come up with 1) a flood management strategy that allowed for a design that could deal with *flood risk of today* as well *SLR over the coming century*, and 2) reconciled the impacts of these *flood-specific* measures with *general* implications for community (such as financial, design, social). With a flood-specific objective in mind, the initial concept from the developer suggested raising the whole neighbourhood to a level that would protect it from 100 years of SLR, as well as storms of today. The proposed approach ended up with a series of challenges: if built, the proposed 4 city blocks would be 2 metres higher than the entire surrounding neighbourhood, a measure that may not be needed for the next 50 years, raising fiscal, urban design and equity issues:

That was a very, very difficult number for the politicians to hear, for the development community to hear, for the design community to hear. There's a lot of issues relating to how one property relates to other properties. Some properties can rise and leave other properties...in a hole. There's all sorts of design issues that are affected. Your experience walking down the street, your experience interacting with the street and the sidewalk potentially being at one level and the buildings being significantly raised because of the new FCL. There were quite a lot of discomfort with the proposal to go from 3.45 FCL...right up to 5.2 metres (CoV_P).

After negotiation between Engineering, Planning and the developer, council and staff agreed on a middle ground of 4.5 FCL, which dealt with *the current flood risk* with an expectation that a new number and additional flood protection measures would be necessary in the future (CNV_P; CNV_E): "We can't protect against all flooding. So how can you minimize the damage and disruption from a flood versus making sure it never ever happens? So somewhere in the middle is the right approach" (CNV_E). This staged approach allowed for some protection for today while also considering the ability to maintain options in the future:

Doing a little bit of each: raise the neighbourhood a little bit – it's easier to deal with that today. Then we end up with, say, a 1m high flood protection area in the future vs. the option of trying to do 2 m of raising the elevation today and all of the problems that come with that... Or don't do anything and end up with a 2m dike in the future...We can deal with wave effects through protection of way you design the shoreline; you can even put up barriers. There's a **range of options** to deal with that in the future. Rather than **pick a single way to deal with this by elevating the whole neighbourhood we ended up at this middle ground** (CNV_E).

One of the main reasons for searching this middle ground were the financial implications for community amenity contributions (CAC). A search for a compromise required a close collaboration between the City and the developers:

At first [the developers] really balked at that and then at a certain point they embraced it, found design solutions, and found a way forward, and engineering and planning were with them in trying to find a way forward but weren't necessarily happy with the urban design solutions that they'd found in order to address this challenge. Then the public and the politicians were really balking at the solutions that they've come up with because of the urban design impacts, because of the cost impacts. Because of **the perceived or actual reduction in community amenity contributions that would result from the development because so many construction costs would be dedicated to meeting a 5.2 FCL**. That is actually probably one of the main reasons why" (CNV_P).

The fiscal, design and aesthetics trade-offs of sp-R measures were also compounded by equity implications of the proposed design, especially negative impacts on people with disabilities:

One of the big difficulties for building and planning staff, is that **resiliency to the future seems to be running right up directly to accessibility issues for the present**. It's not just aesthetic and design issues, it's really about meeting requirements for people with disabilities and mobility issues...How that affects social relationships, social interactions. We find that very, very challenging as planners...groups like the North Shore Advisory Community on Disabilities really struggled with that and said "no, you're creating a divided public realm". We also struggled with it as staff, because it would mean fewer narrower sidewalks...more incursions into the right of way, less room for things like bicycle lanes (CNV_P).

A number of participants spoke some of the design challenge of meeting the new provincial guidelines (CoV_P, CNV_P, COS_E; WCEL_1). The challenges identified ranged from impacts of elevated sites on urban design/aesthetics and experience of the streetscapes, impacts of everyday immediate livability, the divided public realm, conflict with the planning ethos that relies of aesthetics of the streetscapes, issues with accessibility and inclusivity and accessibility issues for elevated floors among many others. In other words, sp-R objectives went directly against general community livability objectives.

In the negotiating these fiscal, equity, and design trade-offs, market forces and developers play a critical and understudied role in the co-evolution of risk and development. Limited space, housing unaffordability, yet high demand for waterfront/water view properties, and municipal reliance on property taxes as their main income source drive development in hazard-prone areas and define the ability to maintain options at the municipal scale:

...Calgary, Alberta, all of rebuilding where they were in the flood zone and their policy says you can't build there. Yet the pressures, they let them build there and then the tax payer is rebuilding them because the houses got damaged. I think that's the hard part... **ignoring it or not doing either, non-structural or structural.** You got to do something. **And I'm worried that we're going to try to rely on structural and that it's something we can always do later** (CNV_E).

Developers and development pressures play a role in defining options for sp-R through design solutions and willingness to pay for them. As a planner in CoV stated: "The developers had some consultants look at what are the options. It sounds like they're coming up with interesting options, like a whole bunch of options... sacrificial first floor, or you build a floor much higher" (CoV_P). From a design perspective, the different FCLs across the region, different requirements over the use of subterranean space, the inability to locate electrical/mechanical rooms below grade had implications for buildings and required additional consultation and development of options. Yet, adaptive measures could block off elements of the streetscape leading to the loss of leasable area. The trade-offs had to be made between the aesthetics of a building (e.g., floor-to-ceiling windows) and adjustments to climate change (e.g., increased demand for air conditioning) (Heideman, 2016: 16-17). In a region where housing affordability is a major issue, consideration of climate change and implementation of adaptive measures that results in more costs for developers can get transferred to the buyer further increasing unaffordability and inequity. In general, at the numerous regional events that I attended the developer community was the elephant in the room. They are highly influential but rarely, with a few exceptions, discussed or engaged, with the majority of the engagement happening at the direct municipality-to-developers interface, which makes a regional transparent approach difficult. Risk transfer was also identified as a major issue: once the development is completed, the risk is transferred to the owners, municipality and the tax payer. This speaks to a major limitation of the fiscal accountability for risk transfer which rarely identifies or quantifies which stakeholders bear the risk and which contribute to its construction: "Risk becomes objectivized or else externalized somewhere into the commons, meaning that risk constructors are not answerable to risk bearers... disasters [triggered by natural hazards] are rarely submitted to a deep 'forensic' analysis in order to reveal causal processes and risk generators" when compared to technological accidents (Lavell & Maskrey, 2014). Foundational risk reduction measures such as land use zoning, building codes and environmental regulations are influenced by, activities that privatize short-term gains, increase short-term electoral benefits and transfer

the resultant risks to other sectors spatially and temporally (Lavell & Maskrey, 2014; Oliver-Smith et al., 2016). As Levin et al. (1998) suggest, the reach of markets and governments does not always extend as far as is necessary to build the desired resilience in social systems which requires stronger accountability and transparent decision-making mechanisms, including the trade-offs between sp-R and gen-R.

The development community was highly observant of the changes happening regionally, including FCLs. As a staff in a neighboring municipality suggested that following Harbourside development (FCL that only met risk of today in CNV rather than by 2100), the developers in DNV were also asking for a more ‘relaxed’ standard: “their question was could we [DNV] relax it too and we said ‘no’... The developers are always going to build to what the least... everyone is always going to build to the least standard cause it’s cheapest. If you set the bar and say that’s the bar that’s what you have to do” (DNV_EP). Raising the figurative and the literal bar for FCL also presented a challenge for municipalities themselves by having to follow their own standard: “We’re finding that already in trying to do design work in a waterfront area for city lands and city projects, there’s consideration of trying to vary the 4.5 FCL and of course, there are people at the City and staff that are really balking at that. **How can we vary it for ourselves and not for the private development community?”**(CNV_P). Recognizing that development and redevelopment present a significant opportunity for incorporating sp-R measures, CNV were planning to address the FCL through their zoning bylaw to address it during land development discussions (CNV_EP).

Resilience measures need to be context specific to be able to accommodate the needs and values of each community, yet from a regional perspective it is the consistent, equitable, and mandatory policies that are key to systematizing sp-R policies at the municipal and regional levels. This is where diversity is not necessarily a positive characteristic of the sp-R regional regime. The discussion above shows the difficulty in aligning the diverse context-specific approaches to sp-R across sub-regions, key governance challenge for a strategic and consistent regional approach to sp-R. The devolved responsibility for flood management, the nature of provincial guidelines and the non-amalgamated governance context allowed for this context-specificity, with each municipality choosing an approach that works best for them. However, regionally a danger lies in a lack of standardization whereby the developers may choose to build in a municipality that has the lowest standards for flood protection in their attempt to maximize

usable space and profit, thus concentrating flood risk in certain regional sub-pockets.

Additionally, a historic reliance on structural measures and the recent flood-free living caused intensive development across the region and some of the participants expressed a concern that this pattern of overreliance may continue in the future, a future that is distinctly different from the past. As a CNV engineer stated:

I worry that everybody just jumps to a structural solution: the gate or the berm or the dike, everywhere. I'm worried that we're not going to do that well. There's a lot of places that retreat is the option and that 20 million-dollar waterfront home might not be worth 20 million dollars in 50 years. Hopefully we can get support for the FCL throughout the region that we don't get the developers leaning on the politicians to do something different because... there is so much money involved (CNV_E).

The discussions above represent a measured and advanced approach to future risk employed by municipalities in the BI sub-region, an evolving negotiation between fiscal, design, equity and social trade-offs of today and the ability to address risk and maintain options in the future. It shows that this undiked sub-region is considering alternative approaches to flood risk rather than solely relying on building dikes in the future.

However, the approaches outlined above are similar to the diked sub-regions in that they are still primarily based on *protection strategy* by keeping the water out rather than building and changing public expectation to living with water (accommodate) or starting to seriously consider a retreat for certain sections. In Handmer and Dovers (1996) terms, these strategies are still resistance-based (solutions designed for change at the margins) rather than transformative change. Some international examples offer alternative solutions. For example, HafenCity in the old harbour of Hamburg, along the river Elbe in Germany can offer some insights as one of the largest rebuilding projects in Europe in the 21st century. It has transformed the formerly inner-city port fringes into an adaptive urban environment by allowing flooding that stays resilient to high water, with waterproof parking garages, a network of emergency pedestrian walkways 20 feet above the street, and no residential units at the ground level. The landscaping in the parks is specifically designed to withstand storm surge, either by floating as the waters rise, or by incorporating lots of hard surfaces that only need to be washed off when the waters recede: "The intensive reciprocal interaction between land and water can be regarded as unique, for HafenCity will not be surrounded by dikes, nor cut off from the water. With the exception of the quays and promenades, the total area, i.e., streets, parks and development sites will be raised to 7.5 to 8

meters above sea level. This creates a new, characteristic topography, also maintaining access to the water and emphasizing its typical port atmosphere” (HafenCity Hamburg Projects, 2010: 5). One of the fundamentals of the project is “to see urban development as a learning process” ensuring an ability to recognize changes in the environment and to be able to respond and directly contributing to gen-R through sp-R measures.

This summary of findings shows the diversity of needs and responses to sp-R issues across sub-regions and municipalities. The discussion shows an uneven distribution of the degree of novelty and capacity to address external and internal changes across the sub-regions. The discussion above showed how the municipalities have navigated the relationship between investments in sp-R (resilience to specific hazards) and their general objectives, and investigated the strategies that municipalities in various sub-regions employed to maintain options over time, a key factor for gen-R. Driven by external enablers from higher scale (provincial studies and guidelines) and internal enablers (awareness of the high costs of sp-R that was compromising gen-R) the discussion showed that the proposition that “sp-R erodes a system’s gen-R, by committing resources to a single cause (e.g., flood protection) which diverts resources from supporting general objectives (e.g., organizational, community)” was indeed empirically supported. Municipalities were highly aware of this trade-off and either actively resisted it by providing counter arguments to these single-purpose approaches recommended by the province, or developed locally implemented strategies to address the sp-R deficit that was taking away from ability to adapt, gen-R. Evidence of moving from hazards-specific deterministic approaches towards risk-based approaches (e.g., based on the impacts on commercial and residential assets behind the dikes) and resilience-based approaches (e.g., developing area-specific emergency response and recovery strategies to accommodate a safe-to-fail approach) were present. However, these approaches were constrained by [dis]incentives at the higher levels of government.

In this section I explored the municipal-level ability to maintain options and build reserves across space and time, a key determinant of gen-R. Overall, I found that the municipal ability to maintain options is determined by (dis)incentives provided from the higher scales of governance. I identified key trade-offs and mechanisms used to ensure that investing in, designing and implementing sp-R measures did not erode municipal ability to meet general priorities and objectives. These include fiscal, equity, design, spatial and temporal trade-offs.

Fiscal trade-offs were a direct recognition of the growing costs of sp-R and its impacts on the general ability to manage change (gen-R). *Equity* trade-offs are the result of the competing priorities of multiple uses of public realm. For example, faced with a need to increase FCLs for a new development, CNV staff realized that increasing flood resilience to a provincially mandated level to meet future risk of SLR would create a divided public realm through elevated construction. This would negatively impact certain sub-groups of the population, such as people with disabilities. Several *design* trade-offs were identified. Planners were concerned with urban design implications such as numerous interface issues between the proposed flood-elevated developments and the existing developments (CNV_P; CoV_P; SF_EP; CNV_EP). Some of these were related to infrastructure design criteria. The engineers, in addition to the established design for life safety, were beginning to implement strategies ensuring a fast recovery to maintain the overall economic health of the areas (CoS_EM; CoS_E; CoR_E). *Temporal* trade-offs were driven by the need to invest today in the resilience of future. This came at a direct cost (investments) as well as aesthetic costs such as changes in built environment that would not be needed for the next 50 years (e.g., raised neighbourhoods). Working with infrastructure lifespans and asset management strategies to ensure an adequate level of safety and adopting an adaptive approach were identified as mechanisms to address these temporal trade-offs. *Spatial* trade-offs showed that in a region where space is limited, a pressure exists to maximize the profit from the use of that space from the private sector while also maximizing usable space to keep the housing costs down, thus putting adaptive measures in direct competition for space. Public space also has a number of existing competing objectives, so adding adaptation further increases demands on the already limited space.

A consistent finding across trade-offs was the lack of structured, consistent and transparent decision making processes. While there was a highly rigorous scientific base for determining the options, the majority of municipalities did not have a defined explicit internal process or methodology developed for evaluating the trade-offs. An exception to this were the City of Pitt Meadows and City of Richmond that have adopted utilities to cover their flood specific needs to ensure that the general funds would not be eroded by the increasing flood specific needs.

The discussion above presented a nuanced understanding and framing of trade-off involved between sp-R and gen-R. These trade-offs were being made by the FMPs, political

leadership and by communities through a sequence of bureaucratic, political and (to a more limited degree) public engagements. FMPs played a crucial role in informing the politicians about options available and trade-offs involved but it was the politicians who made the decisions. In an absolute majority of cases, municipal staff relied on rigorous scientific studies that would to the best available knowledge at the time downscale global and regional projection to inform management options at a local context.

5.7 Conclusions

In this chapter, I identified several mechanisms that influenced the relationship between sp-R and gen-R at the municipal level. I focused on key procedural determinants of gen-R identified in the literature and outlined in the conceptual framework: ability to deploy human and social capital for collaboration and self-organization; ability to learn, monitor and experiment; and ability to maintain options and increase reserves of resources. What I found is that in addition to planning process, sp-R and gen-R were related through organizational dimensions and decision-making for resource allocation.

Through a detailed empirical analysis, I highlighted the diversity of distinct needs, capacities, and responses of municipalities across the sub-regions to internal drivers (e.g., escalating sp-R costs) and external drivers (e.g., changing hazards; provincial guidelines). Municipal sp-R was enabled and constrained by multi-scalar governance and was subject to regulatory, contextual, and organizational barriers and enablers. For gen-R, municipalities enacted various planning mechanisms that allowed to maximize procedural benefits of gen-R and depended strongly on organizational and cultural/behavioural factors such as leadership and trust. Some exceptional examples of this included learning process for DNV's risk tolerance criteria and CoS's staff-driven, collaborative, polycentric and distributed planning processes.

In the first section of this chapter I analyzed sp-R tools and processes used by municipalities as a way to characterize municipal sp-R regimes. The chapter demonstrated that municipalities used a wide range of tools and processes to achieve sp-R objectives that range from site-specific tools to general land-use regulations to structural and green infrastructure approaches. This diversity of approaches used is aligned with some of the best practice approaches presented in the literature that call for multi-layered systems of protection, with built-in redundancy and diverse, scalable elements, which can fail safely in the event of an extreme event, and yet provide benefits during normal operating times. However, this diversity also

shows a need for a more coordinated regional approach, in the sense that reactive and autonomous adjustments to changing flood risk undertaken by individual municipalities may accumulate long-term costs for the region.

I found that municipal regimes are rooted in local history, responsive to local hazards, and are distinct products of local governance and civic regimes situated within their capacities and limitations. Within this diverse mosaic of sp-R tools implemented, the analysis showed that the general tools lacked effectiveness in regulating flood risk in the region, placing a higher emphasis on site/area specific tools used within municipalities. While this framework enabled flexibility for adopting locally needed solutions, it reduced opportunities for more strategic region-wide approaches to managing flood risk. As a result, the municipalities did not have sufficient institutional capacity to address sp-R at the regional level through formal municipal tools and processes. To better understand the role of the planning process on gen-R, I examined three formal processes, such as OCP, sustainability and climate change adaptation. These three processes and associated tools showed a varied effect on procedural benefits for collaboration and learning across the cases. I found that in addition to the importance of the procedural benefits of the *planning process* for gen-R, the actual outcome of the planning process, the high level *plan* (e.g., CoS Sustainability Charter; CoV's Greenest City Plan) played a critical role as an enabler for action (e.g., climate change adaptation plans and strategies) as it provided a framework of institutional continuity for dealing with changes at staff and political levels by enshrining collective vision of municipality and providing long-term clarity.

In addition to existing and widely used tools, the chapter showed that adapting to climate change will require re-evaluation, development, and regular updating of planning practices across departmental and organizational silos to reflect changing needs of municipalities. Changes in municipal sp-R practices were enabled by provincial regulations (including devolved responsibility for flood management, new technical studies and evaluation of potential costs of adaptation) but action remained constrained due to insufficient funding (inability to address the scale of changing risk on their own) and the constrained ability for transformative change given the dependence of municipalities on the higher levels of government as “creatures of the province”. Municipal sp-R practices were constrained by physical barriers (water bodies) that then led to mental barriers (e.g., island mentalities that limited the levels of collaboration and learning) thus disrupting connectivity, reinforcing path-dependency barriers (commitment to a

certain approach sp-R, such as dikes) and maintaining organizational barriers (including organizational cultures within municipalities and across the professions).

The analysis of learning at the municipal scale showed several major themes. Political climate strongly influenced the capacity to learn at the individual, organizational and institutional levels. By supporting sp-R learning, the elected officials enabled several procedural gen-R benefits such human capital development, increased social capital and collaboration and ability to openly discuss and pursue sp-R options available to municipalities. While municipal staff were most effective in single and double loop learning (including small events locally such as DNV's landslide that lead to the creation of risk tolerance criteria), they lacked the capacity for a transformative triple loop learning to question the very foundation of the governance regime, as it is determined at the higher scales of governance.

The analysis of the ability to maintain options showed a nuanced understanding of fiscal, equity, spatial and temporal trade-offs. In some municipalities, proactive and innovative mechanisms were created to ensure that investments sp-R objectives did not erode the overall capacity of the municipality to deal with change (gen-R) such as CoPM and CoR. While there was a depth and nuance to identifying the types of trade-offs, examples of transparent and systematic decision-making methodology for evaluating them were very limited. The consideration of trade-offs remained within the municipal boundaries with no mechanisms to evaluate sub-regional or regional actions.

Throughout the chapter I focused on exploring the barriers and enablers in the relationship between sp-R and gen-R. I present a summary of the findings, including key barriers and enablers across the analytical axis in Table 5-7 below.

Table 5-7 Summary of Chapter 5 findings

Contextual and organizational dimensions of sp-R	Self-organization and collaboration	
	Barrier	Enabler
	Waterbodies in between	Shared land border and shared hazards
	Island mentalities, lack of planning for downstream effects	Champions (political and staff leadership)
	Lack of social capital and networks	Social capital and networks
	Size of organization (small: limited capacity to collaborate and build social capital regionally)	Size of organization (small: tight feedback and communication pathways)
	Size of organization (big: spatially dispersed planning actors, low social capital)	Size of organization (big: surge capacity to collaborate and learn regionally; human capital (staff with sp-R specialized knowledge))
		Clear mandates and equitable policies
		Scarcity/lean driven collaboration and innovation
Learning processes	Learning, monitoring and experimentation	
	Lack of social capital, trust, leadership	Social capital, trust, leadership
	Dominance of techno-rational and engineering knowledge	Human capital (experience, long serving with local and experiential knowledge)
	Peer-learning and review	Peer-learning and review
	Political changes	Supportive political climate
	Lack of recent experience with disasters	Focusing events/local disaster
	Disaster events (elsewhere); diverted attention	Disaster events (elsewhere); raised awareness; on-the ground peer learning
	Bureaucracy and institutional path-dependency	Bureaucracy (institutional memory)
	Size of organization (small: limited capacity to learn regionally; reliance on consultants)	Size of organization (big: capacity to learn regionally; human capital (staff with sp-R specialized knowledge))
Decision-making for resource allocation	Maintaining options	
	Provincial regulation (e.g., lack of consultation; lack of clarity)	Provincial regulation (reduced scientific uncertainty, putting a price tag on adaptation)
	Historical path-dependency; lock-in.	Political and staff leadership/ policy entrepreneurs
	Political change	Stable political climate, trust and buy-in from political leadership
	Fear, temporally removed benefits of resilience investments	Novelty of the planning challenge
	Lack of structured decision-making processes to evaluate trade-offs	Financial stability enabling risk-taking and long-term planning
	Limited space (site, streets, area, municipality, sub-region)	Staff effectively communicate the issues to get political traction

The analysis of empirical evidence showed a complex relationship between barriers and enablers for translating sp-R practices in gen-R. Social capital played an important role across sp-R practices analyzed, as a supra-category of gen-R rather than a stand-alone category as suggested in the conceptual framework. Similarly, human capital and champions (at staff and leadership levels) played an important role across sp-R practices. Across professions, municipalities and sub-regions, champions played a critical role for moving the sp-R agenda forward. In doing that, they would often leverage their social capital, ability to collaborate, ability to learn and ability to imagine alternative options. From a systemic change perspective, the reliance on key champions and policy entrepreneurs for setting regional resilience agenda was a weak institutional link, as it maintained agent-based specificity instead of institutionalizing it through other means (such as formalized network of practice, a climate resilience alliance, or an inter-municipal committee (Moloney & Funfgeld, 2015). Municipalities themselves lacked the resources for this level of self-organizing. In its absence, gen-R indicators such as ability to self-organize to maintain options, to gain influence at the political scales was left to mediating and external institutions as will be discussed in the subsequent chapter.

I also found that some of the same factors that constrained sp-R (e.g., path-dependent bureaucracy) could also enable it (e.g., bureaucracy and long-term institutional memory). Some barriers reinforced one another (Burch, 2009), creating substantial inertia behind proactive gen-R investments (e.g., fear combined with the lack of structured decision making to evaluate options across temporal and spatial scales). As the discussion in the subsequent chapters will show, without the appropriate additional resources what could be seen as local empowerment becomes direct downloading on already overstretched municipal budgets that have to cater to the immediate needs of their residents and electorate (for example, housing and policing rather than long-term adaptation).

Across municipalities a conversation about living with periodic or constant flooding in the region and transforming expectations around that was limited. The ‘protect’ approach was still a clear choice of preference but increasingly measures around ‘accommodate’ (such as raised FCL) and some conversation among professionals themselves retreat was taking place. Some of the examples included a combination of structural protection with an appropriate land use and site-specific flood protection measures such as FCLs. An emphasis on site-specific measures and/or specific project-based measures while allowing for highly contextual solutions

limits an opportunity to engage with more strategic resilience planning. To fully reach the potential of systems-based approach to resilience would require connecting the multiple scales of urban and regional resilience. These could include buildings that are able to handle water, landscape and design measures that connect site-specific measures to neighbourhood-wide modular systems that would then feed into the city-wide measures and strategies that address co-benefits and connect previously separate resilience initiatives (e.g., emergency management, engineering, planning and design, public health and so on). Ultimately, these measures could connect to regional watershed monitoring to ensure that individual municipal plans are aligned with the overall approach to regional planning.

Given these opportunities, what are the barriers and enablers for regional gen-R planning within the multi-scalar governance system?

Chapter 6: Multi-level governance of sp-R and gen-R: the role of institutions, barriers, and resilience mechanisms

6.1 Introduction

In this chapter, drawing on theories of institutional change, learning, and governance of multi-scale systems, I answer the flowing question: What is the relationship between sp-R and gen-R at the regional scale and across multiple scales of governance? To answer this question, I explore the patterns of collective action that enhance or restrict organizational and institutional capacity to plan for sp-R and gen-R across multiple scales. I focus on perspectives expressed by individual flood management professionals (FMPs) embedded within social, professional, and inter-organizational networks as individual actors play essential roles in providing leadership, trust, vision and meaning through social relations such as actor groups, knowledge systems, and social memory (Folke, 2006). I focus on social capital and networks as they tie together the adaptive governance system (Folke, 2006). I focus on multi-scale governance, as adaptation policies can be a source of contestation for political actors operating across hierarchies of scale (Iwanciw, 2004), and, as demonstrated by Tompkins (2005), the tensions can be reflected by contrasting ideologies, emerging through the interplay of top-down command and control risk management and local self-organized adaptation (Pelling & High, 2005).

At the metropolitan level, this interplay has been central to the long-running debate on how to best govern the metropolis. Historically, the core of the argument resided between the ‘reform’ school of thought that called for a centralized top-down effort to maximize efficiency and reduce costs (e.g., through an amalgamated unified government) vs. the ‘public choice’ perspective that supports decentralized, polycentric, and context-specific regional governance (e.g., Ostrom, Tiebout & Warren, 1961). Regional planning, defined here as a process designed to regulate, manage, and control potentially competing priorities of city-regions (i.e., land use, growth, environmental protection, air quality) based on a collective vision for a specific geographic area, can vary significantly as a function of regional governance form. Growing cities and their growing demographic, fiscal, and environmental challenges and opportunities have resulted in a key question for urban regions world-wide: how to effectively match the existing and emerging problems with an institutional system that is capable of managing those (Phares, 2004)?

Governance rather than *government* emerged in response to the growing complexity of governing regions in a globalizing and multi-scale context. In particular, adaptive governance that can support “the evolution of new governance institutions capable of generating long-term, sustainable policy solutions to wicked problems through coordinated efforts involving previously independent systems of users, knowledge, authorities and organized interests” (Scholz & Stiftel, 2005, p. 6). As discussed in the literature review, planning plays an important role in defining the ability to deal with change and planning policies, practices, and tools can serve as a barrier and an enabler for this ability (Lynch, 1990; Healey, 1999; Inam, 2005; Innes & Booher, 2010).

As illustrated in Chapter 4, in BC’s multi-scalar flood management regime a major shift in policy occurred in 2003/04. Responsibilities were transferred to the local government for flood hazard area land use management, granting the authority to exercise a degree of discretion in developing their own policies for zoning, development permits, subdivision approvals, bylaws, and building permits through the statutory authority. Legislative changes to the Land Title Act and the Local Government Act in 2003 and 2004 removed the role of the Province for flood plain designation and approval, shifting this authority entirely to local governments which can now make decisions on where and how to develop without direct provincial oversight. This devolved responsibility could be seen as advantageous in the light of subsidiarity principle which calls for decisions to be made at the most local level possible (Wilkins, 2010) by elected officials that are closest to the citizenry (UN Habitat, 2016). As Kumar, Burton, and Etkin (2001, p. viii) suggested as part of their expert panel review on flood mitigation in Canada: “There is a growing recognition that responsible decision-making with respect to flood risk management should be taken at a local level and move to higher levels of government only when local capacity is exceeded. It is in the nature of flood problems that provincial and federal government assistance will always be required, but such assistance should be carefully designed to support and not undermine local authority and leadership. The effectiveness of various cooperative arrangements in managing flood risk should be carefully reconsidered”.

Under the current regime, the Province is responsible for setting guidelines for municipalities, such as the Flood Hazard Area Land Use Management Guidelines published under the Environmental Management Act. These Guidelines were intended to assist local governments in identifying and designating flood hazard areas. However, the 2004 Guidelines were designed to address periodic flooding events (e.g., caused by spring floods of the Fraser

river), and not permanent inundation due to sea level rise (SLR). Since 2008, as illustrated in Chapter 4, the province provided some guidance for SLR including information about relative SLR along the BC coast (Bornhold, 2008), preliminary guidance on including this information in coastal dike design (Ausenco Sandwell, 2011), guidance for professionals on flood hazard and risk assessments in a changing climate (APEG BC, 2012), flood plain mapping guidelines (KWL, 2011), and adaptation processes guidance (Arlington, 2013). It was the *Cost of Adaptation – Sea Dike and Alternative Strategies* that significantly raised the SLR profile as a critical policy issue and ignited an active collective discussion in the region.

These provincially enabled policy drivers required municipalities to rethink their current approach to flood management and as part of that process reconsider the relationship between flood management specific objectives vs. general community priorities. I conducted my interviews shortly after the release of these drivers which provided a unique opportunity for analyzing the process that inform the sp-R—gen-R relationship.

Throughout this chapter I focus on the following research questions as applied to multi-scale governance with a focus on the regional scale (Table 6-1).

Table 6-1 Chapter 6 at a glance

Areas of inquiry	Key themes	Sec.
What are the barriers for sp-R at the regional scale?		6.2
What is the relationship between sp-R and gen-R at the regional scale and across multiple scales of governance?		
How does sp-R planning contribute to human and social capital and political influence across the region?	Social capital as a mechanism for overcoming inter-municipal barriers	6.3
How does sp-R planning contribute to the ability to learn and access new knowledge regionally?	Knowledge co-production: spotlight and shadow learning Role of consultants Role of regional and provincial organizations in monitoring and evaluation	6.4
What regional-level mediating institutions contribute to gen-R processes?	The role of boundary organization	6.5
How do historic sp-R planning decisions influence (enable or constrain) ability to maintain options for enhancing gen-R in the future across the region?	Provincial drivers for change Sp-R financing as a barrier for gen-R Gen-R financing: moving beyond government	6.6

This chapter is structured around the conceptual framework. As identified in Chapter 2, gen-R could be increased across organizations, institutions, and networks by building and

deploying human and social capital (including political influence); fostering learning, experimentation, and ongoing monitoring/evaluation; and increasing or maintaining options.

In this chapter I analyze institutional mechanisms that regulate regional planning and their influences on sp-R and gen-R. I begin with the analysis of barriers to collective action on sp-R at the regional scale. These barriers are used as a framing mechanism for unpacking the findings of the inquiry along with the conceptual framework. I then analyze enabling mediating institutions that allow sp-R and gen-R planning at the regional scale, seeking out counter-mechanisms to path-dependency and capacities to self-organize and address institutional inertia through proactive planning. In the final section of this chapter, I connect historic multi-level governance of sp-R with current dynamics to analyze the institutional reserves for gen-R, including the institutional ability to maintain options across the scales of governance.

6.2 Barriers to regional collaboration on sp-R

In this introductory section I briefly focus on the least significant and the most significant barriers as identified through a targeted regional survey of municipal practices of flood management and adaptation planning (N=33), consisting of municipal engineers, planners, environmental planners, emergency managers, and Fire Chiefs across MVR.

Figure 6-1 presents the results to the following question: “Which of the following are barriers to regional collaboration for flood management?” The participants were provided with a list of barriers identified during the literature review and the interviewing stage and were asked to rank the barriers as ‘most significant barrier’, ‘barrier’ and ‘not a barrier’. For illustration purposes, ‘most significant’ and ‘barrier’ were combined in Figure 6-1. The arrow illustrates the trend that, on average, the significance of barriers goes up with the level of government.

The two most significant barriers, ‘lack of resources for capital expenditures’ (100%) and ‘limited municipal resources and capacity’ (94%) were the most expected based on the interviews and literature review. The interviewed municipal staff were unanimous in that it would be impossible to address current and future flood risk without financial support from higher levels of governance. In the sections that follow, by combining survey and interview data, I investigate these barriers throughout the chapter by analyzing the historical, organizational, and institutional determinants behind them.

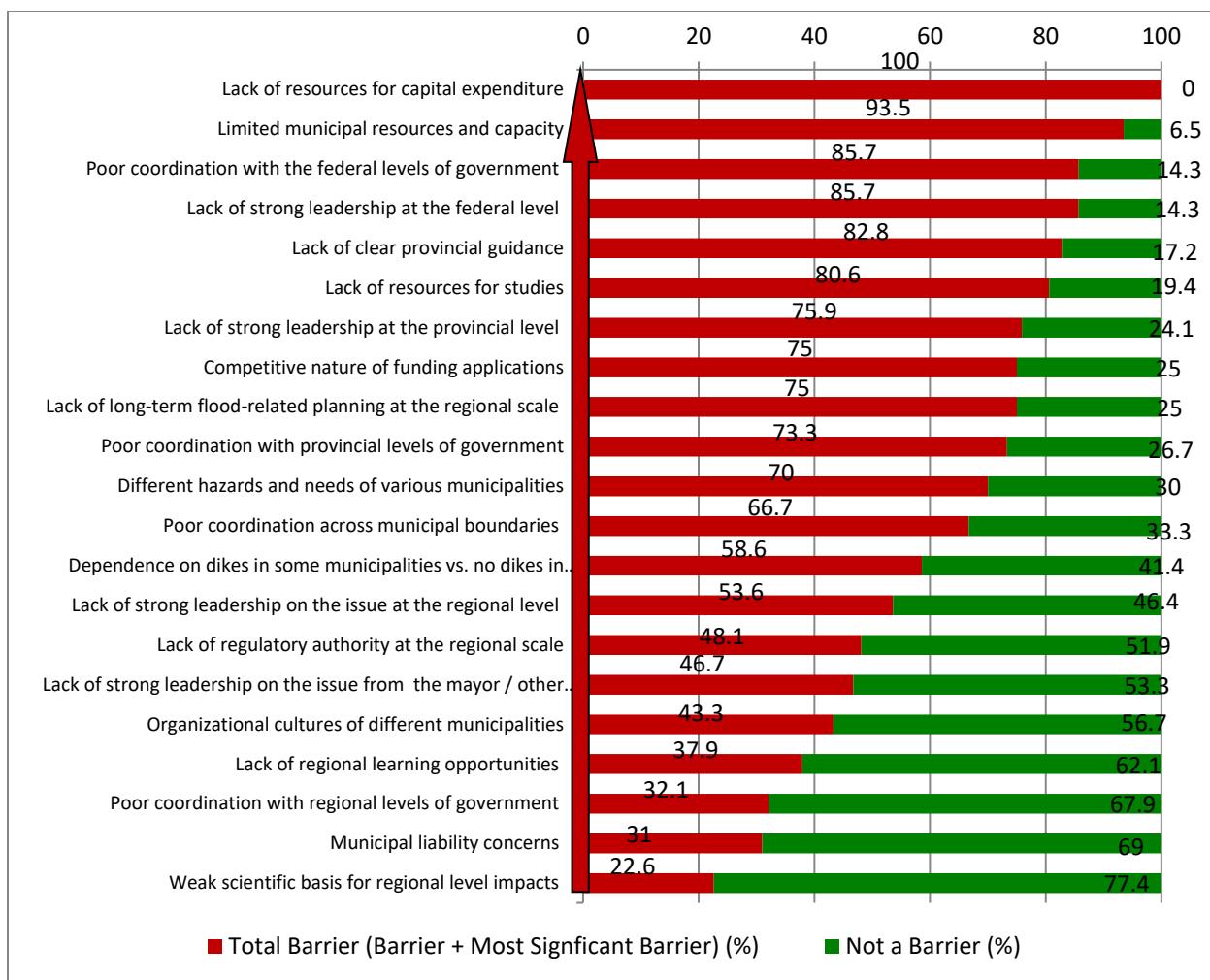


Figure 6-1 Barriers to regional collaboration on flood management

The survey also clearly revealed the multi-level governance nature of the barriers. Lack of leadership across the scales of governance was identified as a major barrier that decreased with the scales of governance: federal level (86%); provincial level (76%); regional (54%), and municipal level (46.7%). Clearly, municipal respondents had expectations around the enabling context for sp-R action from the higher scales of government. Lack of coordination was a particularly significant barrier at the federal (86%) and provincial (73%) levels.

In addition to confirming some of the most expected barriers, the survey also revealed some surprising findings indicating that MVR has moved beyond some of the commonly cited barriers. For example, lack of regional scientific level data and a need for better regional models to create a baseline for further planning and specific adaptation measures, a common barrier identified in the literature (Bissell, 2010; Frommer, 2013; Handmer & Dovers, 2007) and lack of

regional learning opportunities (Innes and Booher, 1990; Chang, McDaniels, Fox, Dhariwal, & Longstaff, 2014; Termeer et al., 2011; van Buuren, Driessen, Teisman, & van Rijswick, 2014) were identified as some of the least significant barriers.

Liability, a commonly cited concern at the municipal scale (CoV_P; WCEL_1; CNV_P; DNV_EP; CNV_E, SFU_ACT) as both a major driver and inhibitor for action, regionally was identified as the second least significant barrier. Throughout the interviews, liability has been identified as a double-edged sword for either pro-actively addressing flood management issues or choosing not to address them. As a CoV interviewee put it: “It’s good in that the legal department has certainly had a clear opinion that we should do something. That helps persuade the organization that there’s a liability risk. I hate to say that’s one of the driving forces, but...”.

Liability was identified as a multi-scalar risk transfer issue. Another interviewee speaking to the regional situation suggested that “a lot of municipalities seem to be really scared right now about the liability that they might incur by establishing where the hazard areas are so their preference is to not find out because then they can go to the provincial and federal governments and say, “oh we didn’t know we need to be bailed out” (EC_1). The 2003/04 legislative change enabled a quicker development approval process by reducing provincial oversight and technical support, but that also downloaded the risk onto municipalities. Several long-serving professionals saw this as problematic for overall public safety and the costs that a taxpayer would have to bear in the event of a catastrophic flood. However, this was also seen as a positive change by others as it enabled development decisions to be made at a local scale (SF_E). Importantly, as the survey results suggest, the liability issue did not prevent municipalities from action on sp-R at the regional level.

The survey also clearly revealed that sp-R was not only a municipal resource issue (top two barriers) but a multi-level governance issue. As an arrow in Figure 6-1 illustrates, the significance of the barriers goes up with the governance scales. The following categories received some of the highest scores: lack of strong leadership at the federal level and poor coordination with the federal levels of government (tied for top 3rd place barrier at 86%); lack of clear provincial guidance (top 4th at 83%); lack of strong leadership at the provincial level (76%); and poor coordination with provincial levels of government (top 7th at 73%). Sub-regionally, for the SF double-exposure sub-region, lack of federal leadership and poor coordination were clearly some the most significant barriers, which is understandable given the

amount of nationally-significant infrastructure concentrated in this region, with several interviewees stressing that they will be unable to address these issues without assistance from the federal levels. The SLR sub-region (the only undiked sub-region) had the highest relative score for dependence on dikes vs. no dikes being a barrier for regional action on sp-R. Historically, there was a strong regional path-dependency for structural solutions but the undiked BI sub-region had an opportunity to investigate alternative options to sp-R. In the FF sub-region, barriers connected to the higher scales of governance (both provincial and federal) had some of the highest relative scores.

Lack of resources for studies (82% overall and the highest score in the DE sub-region) and the competitive nature of funding (highest in FF sub-region, home to some of the smaller, less resourced municipalities such as CoPM) were also among the top barriers and will be discussed in detail in the subsequent sections on learning (6.4) and maintaining options (6.6), respectively. Interestingly, most barriers related to the regional governance structure were identified as mid-range barriers: ‘poor coordination with regional level’ (32% - barrier; 68% - not a barrier); ‘lack of regulatory authority at the regional scale’ (48% - barrier; 52% - not a barrier); ‘lack of strong leadership on the issue at the regional scale (54% - barrier; 46% - not a barrier) (Figure 6-1). The only barrier identified in the upper range was related to the institutional capacity for long-term planning “lack of long-term flood-related planning at the regional scale” (barrier – 75%; not a barrier – 25%).

These regional barriers are central to this inquiry. I address them in detail in the next section by situating them within the analysis of gen-R across governance scales. In doing so, I explore whether SLR planning process could build on the existing planning processes and general organizational characteristics of regional planning. More specifically, is there a sufficient institutional capacity within the regional governance system to address SLR? The majority of interviewees answered ‘no’ to this question, especially when assessed within the capacity of formal institutions, such as Metro Vancouver. I explore this capacity against the backdrop of the antecedents of the current multi-level sp-R governance regime and general dynamics of regional planning. As the discussion will show, politics and the political will had been influential for both.

Once these regional governance-specific barriers are unpacked, in the remainder of the chapter I continue to use the barriers to frame my analysis. The most significant barriers for each scale are presented at the outset of the section. I draw on the conceptual framework: human and

social capital; capacity to learn; capacity to self-organize and leverage political influence; and ability to maintain options, to analyze institutional characteristics of a multi-level governance system for sp-R and gen-R. I find that in addition to formal mechanisms across the scales, informal, boundary, and mediating mechanisms and institutions functioning at horizontal and vertical scales play a central role for both sp-R and gen-R.

6.2.1 Planning in MVR: an exemplar collaborative model or “responsibility without authority”?

Top regional-scale barrier:

‘lack of long-term flood-related planning at the regional scale’ – 75%

Historically, lack of a regulatory authority at the regional scale did not prevent successful regional planning initiatives. Throughout its history, with planning mandates ranging from legislated hierarchical power to no power to an advisory role, the region relied on informal processes rather than legal relationships (Artibise, Cameron and Seelig, 2004). As described in Chapter 4, some of the most challenging issues typical for metropolitan areas worldwide such as accommodating population growth, erosion of the natural assets and air pollution were planned for based on decentralized consensus seeking regional collaborative models that relied on intermunicipal partnerships rather than a hierarchical top-down mechanism.

Today, in the region framed by the steep mountains incised by creeks and rivers and the ocean to the North, the mouth of a river delta with soft low-lying soils and the ocean to southwest, and floodplains of the monumental Fraser River to the east, virtually no vacant land exists for developing settlements in hazard-free zone. As described in Chapter 4, a complex multiscale governance system regulates land use in MVR through mechanisms and plans developed and implemented at different spatial, governance/jurisdictional and temporal scales (e.g., municipal OCPs, Regional Growth Strategy (RGS), the provincial Agricultural Land Reserve (ALR) and Treaty- and non-Treaty First Nations). To regulate these competing uses, the regional growth strategy (RGS), *Metro 2040* (adopted in 2011), is a key regional planning mechanism that seeks to balance long range regional planning goals (e.g., accommodating population/employment growth, focusing commercial and housing development in Urban Centres, protecting agricultural and environmental lands, and supporting sustainable transportation forms). However, these multiple goals and objectives that contribute to regional gen-R result in competing and conflicting policy priorities distributed across spatial, temporal, and governance scales. For example, ensuring economic prosperity requires a solid supply of

industrial lands; increasing housing stock requires intensifying land uses in urban centres and near transit; and ensuring environmental protection requires consistent application of policies to all stakeholders and municipalities, while adaptive measures require space and land, across industrial, residential and environment-centered land uses.

In negotiating these tensions, “responsibility without authority” as a MV regional planner put it was seen as a principle barrier to effective regional governance: “We don’t have the funds, we don’t collect the money, but yet we’re the ones expected to deliver. That’s what we hear from municipalities quite a bit: “well, if we take these things on, where’s the financial resources to go with it?” (MV_P). The interviewee stressed that MV could learn from neighbouring regions on how to finance green space acquisition that could result in multiple planning co-benefits: “If you look at the Capital Regional District, they have four times the levy for green space acquisition than we do in Metro Vancouver. Four times. And yet we don’t seem to be able to convince those that need to be here that we can even put that out to referendum and ask. They didn’t go right to that amount. I think they increased it by referendum … and then overwhelmingly got support for it because people could attach what the money was going to *specifically*, and they supported it, as opposed to it just going to some general levy or something in the ground that they couldn’t relate to. Then they went back and increased it again… they’re at, like, \$24/a head annual levy that goes towards green space protection and acquisition. So, there is appetite out there. It’s just trying to push our region to take that initiative on…there just other things that seem to always be top of agenda” (MV_P).

In negotiating these regional tradeoffs, RGS, as the main regional mechanism to enact long term vision that aligns local needs with regional aspirations, theoretically holds the potential to be one of the most effective gen-R management tools that considers multiple stresses such as population growth, changes to transportation needs, land uses, and public safety, among others. The process behind the RGS also contributed directly to gen-R metrics as described by the Chair of the Metro Vancouver Board: “I think the best example of [regional] cooperation is the recently adopted Regional Growth Strategy, which is an OCP for the whole region. It has to be unanimously adopted, not just by the regional Board of Directors but by each council, right? People get very passionate about urban planning in their own backyard. So, if we can pull that together around the region then we can almost pull together anything”.

RGS serves as the foundation to numerous regional initiatives that, if implemented, could contribute to regional capacity to deal with change. For example, “Connecting the Dots: Regional Green Infrastructure Network Resource Guide” provides solid arguments for the multiple benefits of a regional integrated approach to green infrastructure. It provides examples of connecting natural and engineered green infrastructure for multiple uses such as industrial, high density, medium density, rural, agricultural, and green spaces. The RGS and the “Connecting the Dots” guide use *connectivity* as one of the main planning principles. Regionally, the principle of connectivity has been used for regional planning since the 1975 Livable Region Plan which established the foundation for conserving and connecting greenspace in the region while balancing population growth and economic prosperity. The plan was an adaptive document and was regularly updated to respond to the changing stressors and regional planning context. These principles of connectivity and adaptive management are reflective of best practices for resilience planning (Ahern, 2011).

After *Metro 2040* was adopted in 2011, municipalities were required to update their Regional Context Statement (RCS) to show the alignment of municipal-level policies with regional goals and/or actions needed for this alignment over time, where inconsistencies were present. The review process by the MV staff seeks to ensure general consistency with the goals, strategies, actions, and the parcel-based regional land use designations in *Metro 2040*. In a dispute resolution procedure MV would carry responsibility for most of the costs. By mid-2015, the Board had accepted RCS from 18 local governments (Metro Vancouver, 2015).

While representing a unique collaborative planning model, previous studies (Burch, 2011) indicated that regional planning could not be imposed (i.e., the Livable Region Strategic Plan could not be enforced because no power resides at the regional level (only local and provincial). The RCSs were meant to fulfill this gap as a binding agreement between municipality and region. When asked whether RCSs have been effective, the Chair of the Metro Vancouver Board responded:

They have to be. They’re the legal binding document to tie the OCP and the RGS together. Without those neither of them are worth the paper they are written on. Hence, why we have an issue with Langley right now. We disagree with the interpretation of their RCS, they think one thing, we think another. We disagree and we’re going to court over it, we are going to let a third party decide who is right. Whoever is right, we will just move on but without that, they would have just done

their thing and we would have been upset and we would have wrote them letters and they would continue to just do their thing.

Despite this potential and promise of RGS as a regional mechanism for resilience planning, a comparison of 2008 BC-wide study (Arlington, 2008) with this study reveals that FMPs did not consider RGS to be an effective tool for sp-R. In 2008, when compared to the other fifteen flood hazard management tools, the RGS at the time received one of the highest negative ratings of 21% (not acceptable plus needs improvement). As one of the participants put it, speaking to the ineffectiveness of sp-R tools:

Growth Strategies Act - Liveable Region Plan has not been effective in controlling or limiting floodplain development (i.e., Richmond has rapid transit and is a de facto growth concentration area). Geotechnical Reports - `Safe for Use Intended` is open to interpretation by individual professionals. Covenants - don't prevent damage and in most cases will not reduce flood damage claims to senior government. Drainage Ditch and Dike Act - obsolete - to be repealed in 2010. Floodplain Maps - badly out of date for most of province, or lacking altogether for parts of the Fraser Valley (Arlington, 2008, p.22).

Another participant stressed the lack of effectiveness for addressing existing flood risk: “RGS does not have sufficient regulatory power to be effective tool other than for future planning” (Arlington, 2008: 55). Similarly, in the 2014 survey for this study, among the tools evaluated RGS was ranked the lowest for its effectiveness to address sp-R with just 17% for ‘effective’ and 3.4% (1 participant) as ‘very effective’. As one of the respondents suggested in comments to the survey: “The Regional Growth Strategy could be a good tool however it often overlooks important hazard issues which may negatively reflect on a local community. Thus, controversial issues are often omitted i.e., riparian corridors etc” (Q 20/C1). Overall, despite the six-year gap and the revised RGS between these two surveys, the results are similar (Table 6-2), speaking to the limitations of RGS for flood-specific objectives.

Table 6-2 Regional growth strategy assessment

BC 2008	Excellent	Good	Acceptable	Needs Improv.	Not Acceptable	Not appl.	No response
	1%	3%	16%	15%	6%	58%	14%
MVR 2014	Very eff.	Effective	Neither/nor	Ineffective	Very ineff.	Not impl.	Don't know
	3.4%	17.2%	48.3%	10.3%	0	3.4%	17.2%

I turn to history to better understand the general factors that contribute to this lack of regulatory capacity for sp-R at the regional scale. Overall, compared to other provinces, municipal governments in BC had maintained significant autonomy and power relative to the

provincial government, and individual municipalities have tended to maintain a ‘fierce independence’ from one another (Artibise, Cameron and Seelig, 2004:195). This resulted in an intermunicipal governance model based on ad hoc incrementalism where intermunicipal institutions were created only where the continued delivery of a service by municipalities alone was unfeasible (Cameron and Karlsen, 1992). As one regional planner put it, perhaps this moment had not been recognized regionally for sp-R to floods (at the time of interviewing): “What we’ve seen in other areas and with other topics is if you can create the political will then things will follow. And you really have to show the need and the value. Maybe that’s just something that we haven’t been able to do yet. Have we made the case to say a regional approach [to floods] is essential? It’s essential or do municipalities really feel like “you know what, we’re the ones doing things on the ground and so we should just do what we’re doing and not waste our time and that’s it” (MV_P).

While politically nascent, institutionally, several existing planning processes were filling this regional sp-R governance gap. For example, Integrated Storm Water management (ISWP) and liquid waste management (LWP) were reported by interviewees as effective mechanisms for a regional-scale action on sp-R that lead to gen-R outcomes (inter-municipal learning, collaboration, and maintenance of options):

Examples of really strong collaboration...the liquid waste management... it's something that Metro Vancouver has jurisdiction over so they have strong mandate to support it. The *process* of developing the most recent iteration of the plan was quite robust in terms of stakeholders and expert input...they came up with a very robust forward-looking strategy and it has some teeth in terms of the municipalities needing to come up with their own reciprocal actions to implement it (WCEL_1).

In addition to region-wide collaborative planning, the ISWP process created an opportunity to rethink current approaches to storm water (historically treated as waste) as a resource (e.g., recharging ground water (WCEL_1, MSCD_1)) and renew practices around storm water flood management in general:

Starting from scratch...taking a step back and rather than just saying “here’s our pipe system, is it adequate? Let’s put in a bigger pipe”. Going back and say looking at it from the whole community perspective and saying is there a way that we can manage storm water in a better way that doesn’t just look at infrastructure but also looks at community values and environmental values and long-term planning looking at those newer green infrastructure/blue infrastructure ideas...So that’s kind of the goal that ISMP is trying to move us towards that approach a little more” (CNV_CAP).

In other words, a regionally required planning process enabled a pro-active approach to storm water management that offered an opportunity to address historical path-dependencies, initiate multiple objective planning process to maintain options over time. This process demonstrated the potential that carefully designed sp-R processes can have for gen-R outcomes.

It is important to note that this process was effective because it was a regulatory requirement, as noted by a senior CoV engineer: “If somebody says they want us to do a special project on something like design guidelines for this sewer system, we don’t have the ability to do that, we don’t have any capacity to do that. We don’t even have the capacity to run a consultancy to do it, you know? The only reason we’re doing these storm water management plans is cause they’re a regulatory requirement” (CoV_E). Through enforced regional collaboration and active review of existing practices and infrastructure supporting it, the ISMP process enabled strengthening the sp-R – gen-R connection by design, as part of a regulated, collaborative, regional learning initiative that allowed them to reconfigure approach to storm water while maintaining options in the future across municipal and regional scales.

While this example illustrates MV’s role in the governance of storm water (which contributes to overall flood risk), many interviewees stressed a significant gap in regional governance for SLR: “From a legal perspective the main issue is...that the authority to manage the flood hazards is sliced and diced among a number of different jurisdictions. It’s very difficult for one entity to effectively manage their flood issues on their own. Metro Vancouver itself doesn’t have any jurisdiction over flood management so there’s no obvious way to deal with it on a regional basis” (WCEL_1). The nature of SLR also added complexity to the already weak regional flood governance: “It’s a different type of challenge. Whereas there’s more expertise obviously in dealing with Fraser River freshet and processes would have been in place to deal with that, sea level rise is changing the game completely in terms of what needs to be done because the water is coming from different direction, it’s in different places than it was before” (WCEL_1). This observation, voiced by several interviewees across scales of governance, was strongly supported by the survey, suggesting that the highest regional governance barrier was the lacking institutional capacity for long-term flood-related planning (barrier – 75%; not a barrier – 25%). To better understand how this regional barrier relates to governance processes at the municipal and provincial scales, I further unpack the barriers along on the conceptual framework (human and social capital; capacity to learn; the role of mediating institutions for capacity to

self-organize; and ability to maintain options) to analyze the multi-level governance system for sp-R and gen-R.

6.3 Overcoming inter-municipal barriers: the role of human and social capital

Barriers:
Different hazards and needs of various municipalities: 70%
Poor coordination across municipal boundaries: 68%
Dependence on dikes in some municipalities vs. no dikes in others: 59%
Organizational cultures of different municipalities: 43%

Several contextual inter-municipal barriers were identified in the high mid-range (above).

The scores for barriers show the limitations of relying on a quantitative approach only and need for triangulation. For example, the survey results align with the qualitative findings in Chapter 5 that the different geography, needs, and historic approaches to sp-R (e.g., dikes) are indeed barriers for regional action. However, while organizational culture received a relatively low score at 43%, qualitative analysis showed that it was a significant horizontal barrier.

Furthermore, this barrier was spatially distributed. As the sub-regional analysis of the barriers demonstrated, the double-exposure region (CoS, CoR, CoD) considered this to be a more significant barrier than the other two sub-regions. Furthermore, certain examples such as differing cultures between City of Burnaby and CoV (as was highlighted in Chapter 5) could potentially serve as weak links in overall regional collaboration.

Several human capital and social capital-based informal mechanisms were identified that enabled overcoming some of these inter-municipal barriers. For human capital, the region benefited from highly-skilled, educated, and experienced FMPs. Among survey participants, 63% had more than 10 years of experience (Figure 6-2). Some of the interview participants had 30-35 years of experience. Across the scales (e.g., CoV, CoS, IPREM), and province (EMBC, MNFLRO, MSCD) these long-serving staff offered a unique temporal perspective on organizational learning (e.g., from events that happened elsewhere), the rates of change, and played an important role as the holders of long-term institutional memory that transcended political changes and departmental re-organizations. Regionally, it was common for professionals to move within the municipalities as part of their career growth (53% of survey respondents have previously worked in another municipality in the region). A by-product of this horizontal movement of human capital was regional knowledge transfer, especially for procedural and organizational dimensions rather than specific hazards, given the differing

geographic and hazard profiles of municipalities. Many interviewed staff also lived in a municipality different from where they worked. While this presented a commonly shared concern in an event of an emergency (due to the potential inability to reach their work location due to bridge and road disruption), this movement of human capital across sectors and across the region gave practitioners a better understanding of issues faced, an understanding of the region as an interconnected organism that functioned beyond municipal boundaries.

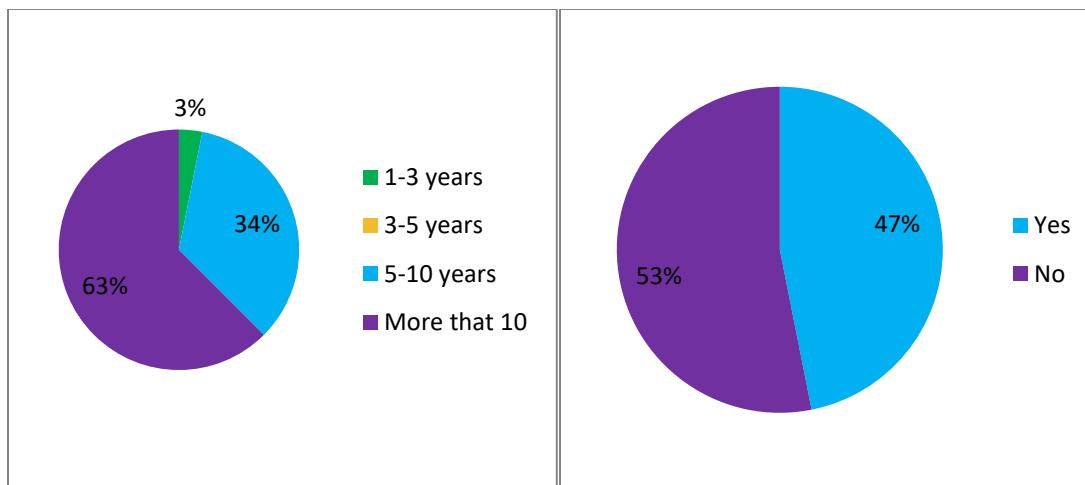


Figure 6-2 Human capital: work experience (in this field of work) (left) and work experience in another Metro Vancouver municipality prior to current position (right)

With regard to social capital, informal relationships with former colleagues were mentioned as a common resource to draw on when faced with a novel situation such as planning for SLR. As one staff member from CNV put it:

The City of North Van and the District have a very good relationship. We're so close... they surround us. It's helped that I used to work there [DNV]. There is that connection. Similarly, with Vancouver I used to work there and so the one fellow who is part of their climate, their sustainability office, he and I went to school together. **So those personal connections help with the coordination.** And the same interests. We're all facing the exact same issue (CNV_E).

In this section I briefly discussed human and social capital as a separate analytical category to ensure consistency with the conceptual framework. I will draw on the role of social capital throughout this chapter as it was identified as one of the central determinants of gen-R, including learning and capacity to self-organize, as the subsequent sections will show.

6.4 Learning for resilience

Barriers:
lack of regional learning opportunities – 38%, 4th lowest barrier
lack of resources for municipal studies - 81%

The capacity to learn is central to resilience. Learning as a normative goal has been a focus of both scholarship and practice in planning, disaster resilience, SES studies, and public policy. These fields acknowledge the importance of social, institutional, and policy learning where collaboration, joint decision making, and the participation of multiple stakeholders contribute to the initiation of self-organized learning processes (e.g., Armitage, Marschke, & Plummer, 2008; Folke et al., 2005; Birkmann, 2003; Friedman, 1987). In this section I seek to answer the following questions: How does sp-R contribute to learning at different scales of governance? What mechanisms and platforms are used for accessing and co-creating new knowledge for sp-R regionally? How does this influence gen-R?

As discussed in Chapter 5, while several examples of unique innovative practices to support both sp-R and gen-R were identified at the municipal scale, few mechanisms existed for horizontal or vertical transfers of these innovative practices throughout the region. An important indicator of a shift from sp-R *government* to multi-scalar sp-R *governance*, is the finding that within the top ranked (above 25%) 30+ organizations for learning (out of 82 listed in the survey), only four were at a municipal scale: municipal engineering/operations and sustainability departments (within municipalities), neighbouring municipalities and local NGOs (at a municipal level in general) (Figure 6-3). The rest were located across the horizontal and vertical scales of governance and included government, research institutions, and professional associations. This clearly shows that the regional capacity to learn needs to be unpacked across multiple scales, a focus of this section.

While regionally the lack of *regional* learning opportunities was identified as the second lowest barrier, the survey revealed that nearly 81% of respondents identified lack of resources for *municipal studies* as a barrier to effective regional action on sp-R. More resourced municipalities commissioned *Flood Risk and Consequences* studies that allowed to gain a better understanding on how to move beyond the historically dominant focus on *hazard to risk*.

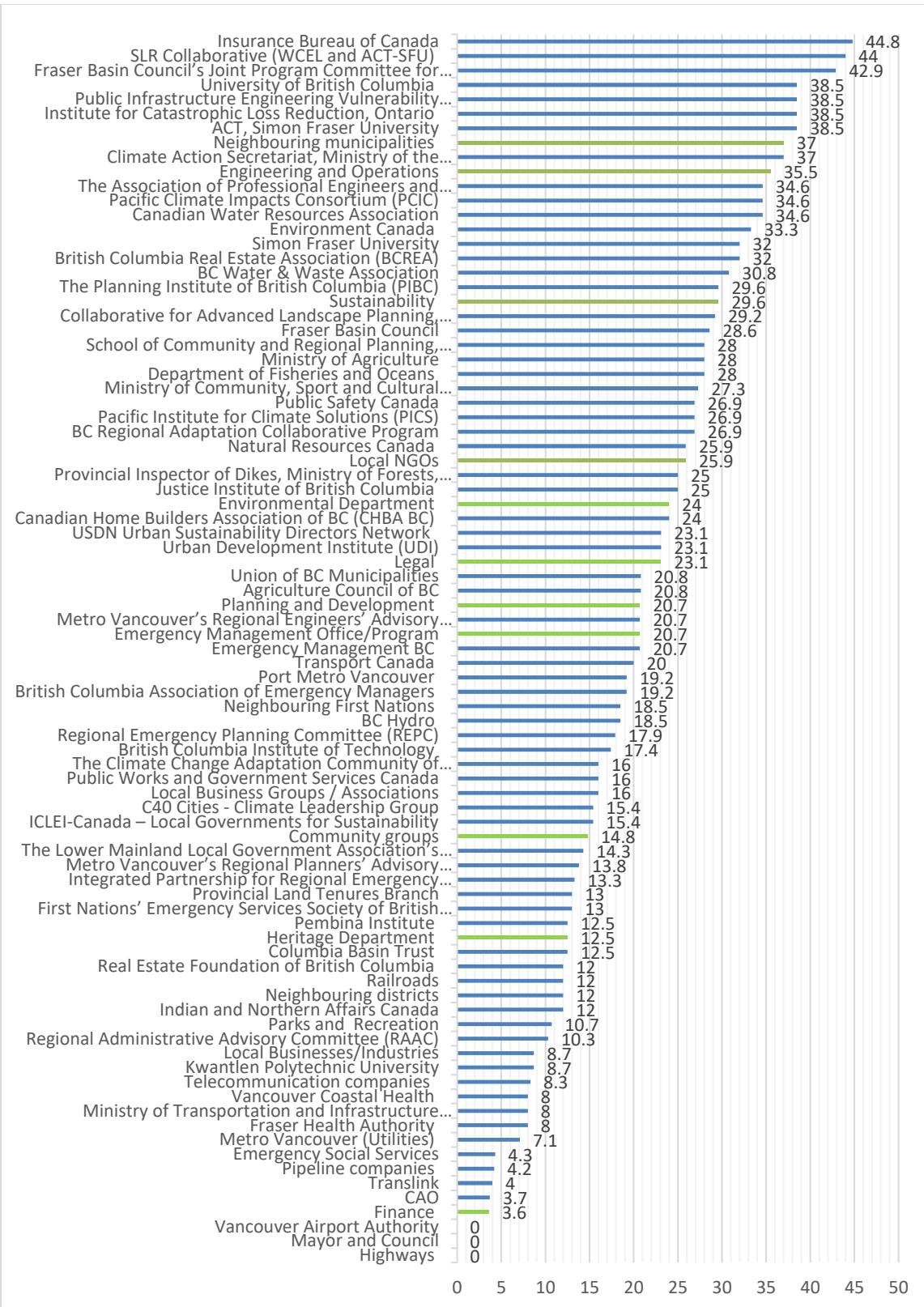


Figure 6-3 Ranked responses: “Which of the following organizations do you learn from for flood management issues?” (% of respondents)

Moving from hazard-based planning to a more comprehensive risk-based planning allowed considering economic and development dimensions across several scenarios that served as a knowledge base for enhancing response diversity and strengthening resilience. Despite this process, several constraints existed on the path to investigating options for resilience planning. Lack of funding for studies also limited adaptation imaginaries, as allocating funding for studies to develop long-term options was a challenge that competed with the immediate needs of municipalities (SF_E; SF_P; CoPM_P). Imagining and planning for long term adaptation options was an organizational luxury that only resourced municipalities could afford. Several respondents suggested that current funding mechanisms funded *engineering solutions* rather than *planning process* or studies for identifying options (EC_1; MSCD_1; CoS_E; WCEL_1). The relatively inexpensive investment in studies, research and planning options could significantly enhance the capacity of municipalities to broaden their menu of adaptation options.

In the remainder of the section I focus on learning as it pertains to multi-level and regional governance of sp-R and procedural benefits for gen-R. These include knowledge co-production and shadow spaces for learning and reflective institutional learning and the role of boundary organizations for multi-scalar learning.

6.4.1 Knowledge co-production for sp-R as a mechanism for building gen-R

Interviews revealed that joint learning with non-governmental organizations and research institutions was increasingly growing in the region, especially at the municipal scale (CoV_E; CoV_P; CoPC_EPO; DNV_EM; DNV_EP; NSEMO_1; CoD_EP; CoD_E), at the regional scale (FBC_1; WCEL_1; ACT_SFU), and to a lesser degree at the provincial scale (EMBC_2).

For both sp-R and gen-R the most important finding regionally was the uneven level of investments by municipalities in learning initiated at the higher scales. For example, resourced municipalities such as CoV, DNV, CoS, CNV invested heavily in regional participation to acquire both sp-R knowledge but also enhance their gen-R: “We’ll go out and seek professional assistance on these [issues] and then staff over the course of time in leading these assignments have built up their education. We’re very active in all the educational seminars and workshops that are either put on by ICLEI, FBC, the Province...many have participated or presented at these” (CoS_E1). This investment of staff time in regional knowledge sharing platforms across

multiple scales also was a significant advantage for those municipalities not only in advancing their sp-R knowledge but also in enhancing their gen-R by building their social capital and leveraging their collective influence. As another CoS staff put it: “Some [consultants] come and try to pitch things to [us] “oh yeah, we can do that” and they’re not... as up to speed as the local governments are... What’s been happening is we’ve been sitting like on the SFU ACTS, meeting with the Province, the Fraser Basin Council, directly on these [regional platforms] ... Consulting does not know we’re doing that. Consulting does not know we have these talks and so ...**we’re actually further ahead than they are in terms of what’s happening regionally**” (CoS_E2).

Horizontally, the “copy and paste” learning was used as part of municipal organizational repertoires and served as a common regional mechanism for adoption of new policies. This speaks to openness in the overall sharing in the region, an important factor for gen-R. As one of the participants put it: “I believe in sharing good ideas. I’m always responding to requests from colleagues to share copies of, even draft copies of policy we’ve created. I urge them to just cut and paste and change things a little bit for the municipalities... We can share and so-called ‘steal’ anything we’ve done” (CNV_P). When ‘stealing’ solutions from elsewhere, the FMPs demonstrated a best-practices rigour in applying these solutions to the local context. For example, within the realm of learning from other jurisdictions, several municipal FMPs stressed the need to question the applicability of solutions developed elsewhere (e.g., following disasters) in the local context:

I just talked with Portland about their twin bucket sewage disposal system for emergencies, which they got from Christchurch. They have a pamphlet on composting waste... I think our stuff in BC was just grabbed from somewhere else. They [Portland] actually studied what was done in Christchurch, and said “It doesn’t work here cause our soils are different, so we have to do this” ... No one in BC has ever had the “wow that poo composting isn’t going to work here” conversation, right? There is that danger of grabbing stuff [without] having the opportunity to test. (DNV_P)

Another DNV staff suggested collaborating with external partners not only brought more rigour to results but also ensured mutually beneficial multi-scalar resource pooling/maximization (DNV_PS). Drawing on academic knowledge lead to collaborative knowledge co-production. Academic and research institutions ranked at a higher end for the ‘learn from’ category (UBC (38.5%), ACT-SFU (38.5%), PCIC (34.6), PICS (26.9%). The Institute for Catastrophic Loss Reduction in Ontario also gathered 38.5% given their regular presence in the region through a variety of projects. At the same time, these organizations ranked relatively low for influence.

From a pragmatic procedural perspective, academics brought funding, time, and research from other jurisdictions that municipalities could not conduct on their own.

At the municipal level, the spare capacity and resources to address novel planning challenges were limited, which encouraged involving a broader base of stakeholders. When asked about whether a sufficient institutional capacity to address issues like SLR existed in the region, a senior long-serving Vancouver engineer suggested⁶:

No. Vancouver is making a huge effort to try and do some of it on a shoestring. A couple of people, a couple of studies and luckily, we've managed to harness a lot of brainpower pro bono, just because scientists are interested in it and want to contribute. But all of this planning tends to happen off the side of desks. It's quite extraordinary that we have a couple of people actually working on this...Very, very rare, because even within my division, which is responsible for the water and sewer systems, this is not our primary focus by any means. **Our primary focus is operating and maintaining the existing system and this very long-term planning and large-scale sort of optimization we struggle to pay any attention to, you know?** (CoV_E).

Speaking to a lack of capacity at the municipal level to fully engage with novel, interdisciplinary resilience planning projects, a senior CoV Engineer stated: "So there's actually a good opportunity for academia to help a lot more, if you look at it the climate change work that's such a new area that it has been a necessity get a lot of help from academia, but we haven't traditionally done that for other areas that are more sort of ... routine" (CoV_E). The novelty of the climate change adaptation challenge presented an opportunity and nearly a necessity to access new knowledge and reach out beyond the normally used internal and consulting expertise. This resulted in an expansion of the stakeholders that were part of knowledge co-production (Armitage, Marschke, & Plummer, 2008; Dovers & Hezri, 2010), a collaborative mode of knowledge acquisition that taps into multiple forms of knowledge with a potential to establish a more robust baseline for planning.

A need for broader partnerships was echoed at the provincial level to enhance praxis connections and to maximize resources: "[We] need to connect in with researchers and academics. We need to have that nexus – that theory of practice – in order to become a true profession [emergency management] and to understand how we can always keep getting better, and always keep getting better with less" (EMBC_2).

⁶ Note that that this interview took place at the early stages of CoV's adaptation process. Since then, the City has invested a significant amount of financial and staff resources and enhanced its collaborative approach.

However, despite the benefits, several interviewees stressed the need for an on-going rigorous questioning of relevance and accuracy of this co-produced knowledge, speaking to the need of active testing, and knowledge translation including downscaling, localizing and contextualizing data provided at the higher scales (e.g., the Province, PCIC, and academic partners) to make it locally practically relevant (CoV_E; CoS_E1; CoS_E2; CoV_P). This included questioning science, theories and methodologies to make them locally relevant. Within the relevant local knowledge category, the interviewees stressed the importance of historical knowledge, direct hands-on operational experience, climatic/meteorological expertise, and solutions relevant to the region:

... Being scientists you have to be able to question the science and the theories behind the science to try to understand how you make it relevant for you. I know for rainfall [PCIC] only took the rainfall to into the '90s...which really bothered me because...they had the cut off... another critical decade and a half that our work showed has actually more relevance. Also, showing rainfall for a region from Victoria to the North Shore when the distributions are 100s of millimetres different doesn't really help, you know? Trying to take some of that science to more of a local level is a challenge. It's not to say that science is bad... it may still not be to the level that we can apply it properly or to answer the things we need (CoS_E1).

One senior engineer gave a specific example where due to their experiential knowledge of storm surge patterns through wind-surfing he was able to question the direction of a study that would have had significant planning implications for CoV:

It's trying to understand **real local effects** of things (storm surge, wave effect...). I'm a wind surfer. I follow storms and I know what happens out there. ... that crossover between personal interests and the sciences... I've been able to question...the work, which is very academic and theoretical and say, "You know what? That's not the way it works here. The wave effect doesn't actually align with the storm surge because the big waves in that part of the city are from high pressure systems which depress the water level and the storm surge is from low pressure systems. So you shouldn't model them concurrently; they're separate incidents (CoV_E).

By drawing on multiple knowledge systems across scales (from global to local) and triangulating the information (academic, consultancy-based, internal city staff work, and personal knowledge), CoV was able to establish a reliable enough scientific base to move quickly on their planning actions: "By bringing together just personal interests plus our climate change work we're doing, and academia we've... made a lot of progress quite quickly. That first adaptation study, the best part about that was that we managed to engage with people at UVic

and UBC and so on and connect them with practitioners and focus their work somewhat to be as relevant as possible to the community” (CoV_E).

Another important role potentially assigned to academia was around the [uncomfortable] truth telling. As one consultant in the region put it: “It’s difficult for the consulting community because our clients are municipalities. You’d be very difficult to put down on a piece of paper that the best thing to do would be... to buy out the homes. That’s something that’s not easy to tell a client, right? So it just doesn’t get said, maybe that’s where the academics come in because... you can say that, right?” (EC_2).

Similar to the municipal level, within the techno-rational expert domain, the dominance of engineering knowledge compared to planning, was raised by a number of interviewees:

I think there is some capacity in the consulting community to help, at least with the more science-y stuff. There doesn’t seem to be much capacity in the planning community. I’m struggling with some of the work that has been done by the planning, the people who are seen as the forerunners in the planning stuff for this. It’s very... 20 years ago kind of thinking around the problem. Their planning responses and ideas are very much still diking and a few non-structural measures thrown in there may be...raised floor elevations but you rarely see [retreat identified as an option] (EC_1).

This difference between technical knowledge vs. planning solutions influenced both sp-R and gen-R. For sp-R, as highlighted by a provincial interviewee: “There’s a difference between doing technical study that says how high should the dike be and looking at a planning solution. I think they can be quite different things” (MCSCD_1). In a regime dominated by engineering guidance a bias for structural solutions was maintained through core provincial guidance:

... It’s a really fine point in planning law about how you talk about guidelines. The words really do matter and in providing technical information about the dikes there wasn’t a lot of information given about other ... non-structural alternatives. I think we’ll find that that a lot of non-structural will be used. We can’t afford to dike everything and there isn’t enough money to do that, it just isn’t possible (MCSCD_1).

Overall, despite the increasing diversification of knowledge sources beyond internal municipal studies and consulting reports, the techno-rational expert driven knowledge system was firmly maintaining its supremacy across the scales of governance. Direct citizen participation that influenced policy direction (rather than general consultation which the region is known for) remained limited, with the exception of the DNV task force; however, even there the task force was mostly made up of retired engineers (DVV_M; DNV_PSC). Flood management and climate change adaptation were largely seen as internal domains for experts rather than a

domain that required active public participation. When contrasted against the mitigation planning process (e.g., with CoV engaging over 35,000 people), this lack of public engagement in knowledge co-production and co-identification of options to adapt was particularly noticeable.

Another significant finding within the regional learning system was the absence of Traditional Knowledge of the First Nations on the unceded territories of which the region resides within the formal planning process across the scales of governance. When asked about accessing knowledge beyond more common expert driven knowledge, one regional actor responded:

It's very much in the realm of flood management professionals. It's taking a really long time for people to start seeing climate change as a kind of thing they have to holistically plan for. First Nations actually individually are very concerned... because they're so in touch with the species that their Nations have grown up relying on and knowing... species that denote their tribal identity... They're very distressed because they're seeing really major changes in behaviours of those species and the timings of seasons. They're losing the ability to find and access their traditional customs food gathering and harvesting. In the Lower Mainland, the Musqueam, are very focused on restoring their coastal habitat because they're really trying to keep their culture intact. Their culture is very much based on coastal interaction (SFU_ACT).

Similar to the municipal scale, Indigenous knowledge as a source of resilience (Kirmayer, Dandeneau, Marshall, Phillips, & Williamson, 2011; Newton, Paci, & Ogden, 2005; Simmons, 2012; Turner & Clifton, 2009) was a largely untouched resource across the scales of governance.

Overall, the discussion above shows that driven by the novelty of the SLR planning challenge, the region demonstrated an increasing trend towards knowledge co-production, especially among the more resourced municipalities and organizations (NGOs and research institutions). The need to scrutinize and make academic knowledge relevant was strongly expressed but the additional resources and the legitimacy that this collaboration brought was seen as a welcome addition to the ongoing work by municipalities and the province.

A distinct feature of resilience literature is its engagement with non-linear system dynamics calling for re-conceptualizing learning as a linear process of knowledge acquisition that leads to action, such as correcting managerial errors and adjusting management routines. By emphasizing the need for multiple-loop social learning (Lee, 1993; Armitage, Marschke, & Plummer 2008; Löf, 2010), it calls for going beyond correcting errors in current practices to questioning the routines themselves, and the conceptions and worldviews shaping those routines (Schultz & Lundholm, 2010). Learning for resilience can be seen as a multiscale, iterative, political, cultural, and social process that facilitates choices between alternative futures where the

desired ‘end-states’ cannot be specified, because present knowledge is not and cannot be adequate (Schultz & Lundholm, 2010) given the environmental, political and social uncertainties of risk. In this fluid context, learning must be focused on open-ended critical thinking and reflection, incorporate numerous knowledge systems, and feed directly into the adaptive governance process. As the discussion above demonstrates, some of these qualities were increasingly present in the region among the interviewed leading FMPs. As mentioned at the outset of this section, overall, regionally, lack of regional learning opportunities was the fourth lowest barrier at 38%. Sub-regionally, this barrier was significantly lower in the Burrard Inlet, the SLR sub-region, explained by the deliberate investments of the Mayor and Councils and staff in learning and unique sub-regional organizations dedicated to convening regular learning sessions in inter-municipal and sub-regional platforms (e.g., SLR-Collaborative, “Hands over the water”, working groups etc.). Given the significance of these learning platforms for both sp-R and gen-R, I address them in detail in the next section by focusing on explicit (spotlight) and shadow spaces for learning.

6.4.2 Spotlight and Shadow spaces for learning: Working Groups, Committees, and Collaboratives

Institutional analysis can highlight both the formal and informal aspects of social and organizational relationships (Pelling & High, 2005), including learning. In addition to formal mechanisms of learning and exchanges, shadow spaces (Pelling, High, Dearing, & Smith, 2008) hold the potential to create enabling conditions for learning processes to affect institutional change. One such mechanism is connecting communities of practice through boundary people (with bridging ties) and boundary objects (such as meetings or documents created with the purpose of bringing communities of practice together) (Wenger, 2011). Informal collaboration in allows linking people and organizations with *different knowledge systems* (Hahn et al., 2008), enabling sp-R knowledge co-production with procedural co-benefits for gen-R. Within this broad literature on learning, little research has investigated the relationship between individual learning and the underlying communication pathways and institutional constraints through which adaptive capacity and action is negotiated within and between organizations (Pelling & High, 2005) across the scales of governance. In other words, what types of knowledge inform sp-R and how can sp-R learning translate into gen-R across the scales?

In this section I focus on two modes of organizing for learning: spotlight learning – explicit spaces for collective learning that are visible, subject to control, management and accountability through public institutional frameworks, and shadow spaces for learning – the space of informal interaction that lies outside of but interacts with formal institutions and relationships (Pelling et al., 2008). An ideal balance between the two systems can give shape to relational space lying at the boundary between stability and instability, regularity and randomness, a space of ‘bounded instability’ (Pelling et al., 2008), that allows novelty to emerge, but with connection to and continuity with existing practices and earlier innovations. These two modes highlight separate features, but in practice organizational realities arise from the interpenetration of shadow and canonical forms (Pelling et al. 2008).

In understanding the institutional architecture of this interplay, literature suggests that shadow systems might contribute most to learning and innovation in organizations when they are recognized but allowed to have a life of their own (Pelling et al. 2008). Armitage, Marschke, and Plummer (2008) suggest that in formalized collective platforms actors mainly engage in bargaining rather than open innovative discourse; they defend their entrenched positions and no resources (time, money) are available for experimenting and visioning which constrains enduring and effective higher levels of learning. On the other hand, learning in shadow spaces that has no connection to the formal policy arena has little capacity for influence. The appropriate balance between strengthening the linkages between policy cycles and learning cycles without destroying the capacity to innovate and learn of the latter has been an enduring question within the institutional learning literature (Armitage, Marschke, & Plummer, 2008; Pahl-Wostl, 2009; Pelling et al., 2008). In what follows I review three models with a different balance of these key ingredients of collective and institutional learning: a working group approach, issue-specific committees, and a collaborative.

A working group (WG) approach was identified as one of the most common methods used in planning for flood and climate resilience at the municipal, sub-regional, and provincial levels. The WG approach is relatively informal and relies primarily on the judgment of a selected group that may be exclusionary (such as a limited core network of government stakeholders assembled to analyze planning choices behind closed doors) or inclusionary (may include a more diverse set of stakeholders, such as nongovernmental organizations, neighborhood groups, business owners, private sector developers, academics, and others).

At the municipal level, several municipalities had climate change adaptation related WGs with floods as one of the main foci. As discussed in Chapter 5, different forms of self-organizing were present across municipalities with an objective of coming together for learning and engaging broader stakeholders as needed.

For example, in CoD, a WG represented multiple departments such as engineering, planning, environmental planning, among others. In addition to the WG, the Mayor of CoD also frequently used issue-specific committees as a mechanism for engaged in-depth learning on a novel planning challenge, creating a spotlight space for learning after engaging in more informal exploratory work with supportive elected officials: “Usually what I’ve done is sat down with my people that are on my Council first of all. Usually I’ve got 3 or 4 of us that run together. We have similar values; we don’t always vote the same but we have similar values. If I can identify what the problem is and make sure that I have a support on Council if I have to go to them for something whether it’s money, a conference, new staff, bringing in other consultants or whatever the case may be...I have to ensure that they are amenable to what it is I’m estimating or contemplating”. Once this political support was in place, the Mayor would turn to the staff: “Then I usually go to senior staff. If it has to do with engineering I say to our CAO “I would like you, the engineer, somebody from environment, one of the technical committee, and parks and rec or whoever it is” and I’ve got this question that I like to pose to everybody and how they solve this...I want somebody look into this and see **what other communities are doing or other countries are doing** so that we can address this in some way”.

In addition to this horizontal learning, for high profile issues, this mechanism in CoD would further expand to create a vertical intergovernmental committee to access knowledge from multiple scales of governance, as illustrated for an issue with coal trains:

We’d set up an intergovernmental committee. We’d invite people from the Province, the mental health officers, Surrey, White Rock, us, some of the people from the coal ports ...Brought everybody together, put a big report on the council table and said this is what I have heard, this is what is coming from the people and I have to respond to the people... Senior staff is going to lead it. **It’s not going to be a political leadership, it won’t be me leading it as a politician cause that can take things, especially in an election year and it will not be the other councillors either because we don’t want it to be political. We want it scientifically based** (Mayor Jackson).

The Mayor was clear to identify the science-based apolitical focus of the initiative to ensure that this spotlight learning with an objective to inform the public did not get influenced by

the election process or results. However, in other issue-specific committees, leveraging political influence across multiple scales of governance was the main mechanism for advancing municipal vision and priorities: “When I first got elected in 2001 I said we’re going to save Burns Bog⁷… It was broken up into all kinds of pieces; it was owned by people in Europe, the States … this is when I did the politics thing. I brought all the politicians from the province, the federal, the regional government and us and I said park your politics at the door because we’re going to buy Burns Bog somehow… It took me 4 years but with the help of all the people and my staff we got it done” (Mayor Jackson). As these examples illustrate, a combination of spotlight and shadow mechanisms allowed for municipal innovation and cross-scaler learning.

At the sub-regional level, the North Shore Emergency Management Office (NSEMO) hosted the North Shore Climate Adaptation Working Group to bring together staff from the three municipalities who were focusing on preparing for climate change. NSEMO’s climate change interests were greater storms and SLR so joint planning and collaboration was needed to mitigate negative impacts while creating efficiencies. The WG brought together diverse professionals from the three municipalities and increased understanding across professional silos and organizational sub-cultures. As one engineer put it: “…I’m always struck by the amount of social support that they [EM] consider. Cause in my world that’s not part of what I deal with. Yet that’s probably the most important part of all of this. I think that’s the piece that brings them to the table: is it’s not just how much water can I fit under the bridge or how big a pipe do I need, it’s when bad things happen how do we take care of people” (CNV_E). Speaking to the procedural co-benefits that go beyond specific hazards, the interview continued: “…as we get hotter and hotter days, some people are not able to take care of themselves during that. So the same support we have for a [flood] emergency could be the same support you have for people when it’s really hot. It doesn’t have to be at a disaster, so I think that’s why [NSEMO] at the table” (CNV_E). An environmental planner, a WG participant stressed the importance of this collaboration and the role that the WG played in this process:

We’ve really come a long way… Before, because it’s an emerging field of work… everybody was kind of starting to grapple with this new area, but trying to do it on our

⁷ the largest green belt in MVR, the largest raised bog ecosystem on the west coast of the Americas and the largest undeveloped urban landmass in North America covering about 4,000 hectares (Corporation of Delta, 2014c.). The Bog has been called “mother’s nature’s own solar powered coastal defence” (Bellamy, 2005).

own. Now that there has been a big realization... if we don't work together is not going to be effective...A solid grasp on the benefits of working together. **I think that we've set it up well, structure-wise, to work together. The Working Group ... the City of North Vancouver, the District of North Vancouver, the District of West Vancouver, and North Shore Emergency Management Office all working together as a team to look at climate change adaptation**, including having our communication staff at the last meeting to look at messaging. **Looking at the North Shore as a sub-region** and realizing that people are going to live and work in different places, we don't want to have City of North Vancouver saying that the biggest concern about climate change is this and us saying something different and people getting confused; well, who is right? We don't want to introduce uncertainty into people's understanding but we want to stick with the bare facts, we want to make sure that they are locally relevant, we want to use locally relevant photos, we're going to use locally relevant examples, we want to be very accurate in what we say so not to just take things from somewhere else and use it... but also to say locally **we can have a really big benefit to gain on this and thinking it through, working together that we can actually be a pretty resilient [sub-region]** (DNV_P).

The extended quote clearly shows the benefits of the collaborative process that allows to build on social and human capital, maximize resources, enhance and streamline learning and communication processes, and discuss and potentially jointly implement adaptation options, especially at the sub-regional scale. Regionally, NSEMO participated actively in regional committees and working groups such as the Integrated Partnership for Regional Emergency Management (Steering Committee; Regional Concept of Operations committee; Hazard, Risk and Vulnerability Committee), Regional Emergency Planning Committee Transportation Community Awareness and Emergency Response program, and Regional Group Lodging volunteers, a consortium of Richmond, Vancouver, and North Shore Emergency Support Services volunteers. NSEMO's tri-municipal servicing and governance model allowed for a more synchronized sub-regional planning and a broadened regional reach and participation. By adopting a bridging position between municipal, sub-regional and regional scales, NSEMO played a mediating role in translating sp-R planning in gen-R.

Although the model is unique to the North Shore given the shared hazards and the geographic separation of the three member municipalities from the rest of the region by the Burrard Inlet, this model could be considered for other sub-regions with shared hazards as an opportunity to align planning efforts and enhance resource maximization. As mentioned in the previous chapter, several informal initiatives were being pursued in the realm of emergency management at the intermunicipal level in the South Fraser region. However, they lacked the NSEMO's institutional capacity that was developed through a formalized tri-municipal

arrangement. This arrangement served as an institutional lynchpin for connecting sp-R to different hazards to an overall capacity to collaborate, learn, and respond to multi-hazard events, contributing to the gen-R of the sub-region.

At the provincial level, the novelty of integrating the existing flood hazard regime with the emerging SLR regime was also initially addressed through an informal inter-ministry WG. The group, which eventually got formalized into the BC Provincial Flood Hazard and Climate Change Working Group represented key units across the provincial government with responsibility for different aspects of sp-R. As a participant from the MoE described:

We have a little working group that meets to discuss these issues and figure out how the programs can work together. There are four ministries involved that have some role in flood hazard management. There is MNFLRO has a flood safety section, so that group is responsible for the Dike Maintenance Act and approvals under the Dike Maintenance Act as well as technical support, well... . .there is not a lot people to provide technical support, but that group would be the keepers of the Guidelines for floodplain development. Then there is EMBC, which does the emergency and handles some of the funding programs for flood mitigation. Then there is the Ministry of Community, Sport and Cultural Development, which works with local governments on planning and does a lot of engagement with local governments and then there's Ministry of Environment which has Climate Action Secretariat as well as the Water Protection and Sustainability branch, both of which have some role in terms of thinking about flood policy in light of climate change (MoE_1).

When asked about the timing of the creation of this group an interviewee responded, referring to the technical reports on SLR and the anxiety that they generated at the municipal level: “A couple of years, probably since about 2011... when the technical reports were released. It just became clear that in light of climate change and sea level rise it would probably be good if we got together and talked about some of the issues that we might need to deal with. It has been a good exercise” (MoE_1). The group was created to overcome some of the barriers across multiple scales (including horizontally across the silos within the provincial government) for addressing sp-R to floods under the changed climate, as noted by another member of the WG: “I’m working with an interagency team...the first thing is to complete a publication about what some of the issues are, some of the barriers, some of the opportunities, do a bit of an inventory of all the tools that are available for local government. We also have some other work that we’re trying to do in terms of legislative change, and policy updates because of climate change (MCSCD_1)”. The interviewee stressed the informal nature of this initiative:

It's an informal committee ... We're working at the technical level. We haven't gone up the chain yet because... until you have some ideas or solutions or changes... It's like with anything whether it's flood or something else, you get your hopes in order, come up with some ideas, and then [move] forward.

It's actually breaking down the silos, as opposed to the Minister of Environment doing their thing and then telling us about it after the fact... we recognized at the staff level that we need to work together to sort this out and we don't necessarily always agree... but we agree at a staff level that we need to this (MCSCD_1).

At the provincial level, while a clear outcome of the WG efforts was shared inter-ministerial understanding of challenges and opportunities for policy and institutional merging of the existing freshet regime with emerging SLR, as well as increased social capital through regular meetings and collaboration, these informal mechanisms could not overcome the organizational barrier, a core challenge for effective provincial inter-ministerial collaboration.

This public safety function is in basically a Forestry Ministry, in Resource Development Ministry. What are we doing here? The whole issue of water management... I've seen how many different reorganizations now happened, but this is the one that makes the least sense. There are managers and staff in this office that work in the regions and even though they are deputy inspector of dikes and I am the Inspector of Dikes I have absolutely no authority over what they do. I have authority over the content of what they do and I can advise, but in terms of work planning and priority setting I have no authority. Within our own ministry, we have major barriers to functionality, and although at personal level everyone gets along fine, there are definite organizational barriers... and a good part of it is because we don't fit the model of what this ministry set up to do. There's many different arguments about how you can organize government differently but the EMBC flood protection program and this program at minimum should be in the same ministry under the same assistant deputy minister if not director. They should just be lined up and working together whether it's this ministry or that ministry or environment... but the functions need to be lined up so that so that the resources [are aligned] and so that it makes sense. We have very limited resources working on flood management mitigation in the provincial government as a whole. Why not line them up so they work effectively?

The distributed flood management function was a product of multiple ministerial path-dependencies and politically driven reorganizations rather than based on a functional capability, oversight, or resource maximization criteria. As the interviewee suggested, while there are adequate personal relationships and sufficient amounts of contact among the responsible ministries (strong bridging social capital), including through the informal WG, organizational design at the provincial level constrained effective interagency action on sp-R.

These organizational deficiencies at the provincial level were also reflected in the regional survey with municipalities rating some of these provincial impediments to effective

regional action in the medium-high range: ‘poor coordination with provincial levels of government’ (73%); ‘lack of strong leadership at the provincial level’ (76%) and ‘lack of clear provincial guidance’ (83%).

What the discussion above shows is that across the scales of governance, WGs allowed the participants to create a shadow space for individuals and sub-groups within organizations to experiment, communicate, learn and reflect on their actions in ways that can surpass formal processes within policy and organizational settings (Pelling, High, Dearing, & Smith, 2008). Empirical evidence suggests that formation of informal networks and shadow spaces for learning at the early stages of policy change are essential as they allow key leaders to prepare a system for change by exploring alternative system configurations and developing strategies for choosing among possible futures (Pahl-Wostl, 2009). These relational attributes of organizations and policy regimes are central to developing gen-R as they enable robust responses not only to unknown shocks and trends associated with climate change, but also the inter-penetrating uncertainties of organizational, economic, social, and political change (Schneider, 2004; Pelling, High, Dearing, & Smith, 2008). This approach also offers a potential method for measuring adaptive capacity that focuses on *process* rather than output, enabling proactive adaptation (Pelling et al., 2008). The flexibility of the WG approach can foster comprehensiveness, allowing for diverse participation across scales of governance from local to federal (Hamin, Gurran, & Emlinger, 2014).

Despite these benefits, WGs are also prone to numerous shortfalls as identified by Ellen, Yager, Hanson, & Bosher (2016). The informal nature of the decision-making process while allowing for flexibility can result in less rigour in decision making (Berke, Lyles, & Smith 2014) with participants analyzing data selectively, resulting in plans that often fail to adequately consider the merits of a wide range of initiatives, and instead prioritizing consensus-driven and more easily achievable choices (Berke, Lyles, & Smith 2014; Ellen, Yager, Hanson, & Bosher , 2016). Another common concern is that WGs are often sector specific, thus limiting cross-sector collaboration and resulting in departmental competition over resources rather than coordinated and comprehensive planning efforts (Lyles et al. 2014). An important feature of the discussed WGs was that, with an exception of issue-specific intergovernmental committee in CoD, the majority of these WGs were horizontal, e.g., within and between municipalities or within Provincial ministries, raising questions of representation and effective learning across the scales

that goes beyond horizontal shadow spaces. There was one exception that spanned the boundary across the governance scales, an example that deserves an in-depth analysis.

6.4.2.1 SLR-Collaborative: sub-regional issue-specific collaborative network

The Sea Level Rise Collaborative (SLR-C) was an example of an effective sub-regional shadow space facilitated by NGOs - West Coast Environmental Law (WCEL) and Simon Fraser University's Adaptation to Climate Change Team (SFU-ACT). As mentioned in the Methodology chapter, I was an active participant of the Collaborative over two years of fieldwork in the region which allowed opportunities for participant observation.

Regionally, among NGOs and research institutions, SLR-C received one of the highest scores for learning (44%); the second highest score for collaboration (44%); and although relatively low, the second highest score for influence at 24%. Despite its sub-regional focus, only 40% of the respondents regionally did not know about the Collaborative. This is a remarkable achievement for a very young and informal collaborative space. What was behind this success?

Unlike the WGs above, SLR-C had a clear sub-regional focus (initially focusing on municipalities in the Burrard Inlet), a focus on a specific hazard (SLR), and it spanned both the informal safe shadow spaces for learning and had connections to formalized policy regimes through municipal champions and regional actors. The idea of SLR-C originated as a result of joint work done by the WCEL (NGO) on a guide for climate change adaptation in collaboration with the Province funded through a BC Regional Adaptation Collaborative (funded by the federal agency NRCAN). The guide was intended to develop resources for local governments and was developed with the ministry and a group of external collaborators from around the province, primarily municipal adaptation champions. The final product consisted of examples around the province on how to make communities more resilient to CCA. In addition to this output, there were procedural benefits of stronger social capital and collaboration between WCEL staff and municipal champions.

As a result of this work, three findings influenced the way the WCEL designed their further involvement with municipalities on CCA in MVR. These included:

- 1) co-benefits between green infrastructure and community resilience:
“green infrastructure was somehow in alignment with making a community more resilient to climate change adaptation”;
- 2) temporal fit of local level planning:

“local governments are actually in some ways **well positioned to deal with climate change impacts** because they do have **forward looking plans**... We don’t have a 20- year plan for the province generally for how we’re going to deal with land use”; and

- 3) the problem of fit between institutions and the problems that they manage:

“**... the scale of the problem not matching the jurisdictional boundaries.** It was clear that in order to effectively address climate change impacts (capacity, the actual physical jurisdiction over the problem, resources available)... that local governments **really were going to have to collaborate** if they wanted to address climate change effectively and certainly managing flood issues fell into that category of problems that was bigger than the scale of governance that’s available...at the local level to manage the problem” (WCEL_LC).

WCEL and SFU-ACT hosted a workshop and invited staff from local governments, MV, NGOs, and academics to brainstorm potential ideas for regional collaboration:

We understood that they were having conversations informally. But there was no forum for them to really have that in a more **systematic and regular way**. So we had this meeting with them, we had a short visioning session and then we talked about some possible solutions. We presented some models of collaboration from elsewhere and by the end of the day there was a strong feeling amongst those in the room...that the issue that they really needed to collaborate on was **sea level rise**. **That is was an area where they had immediate concerns and problems they couldn't resolve and it also didn't have a home anywhere else** (WCEL).

This choice of a specific hazard within a specific sub-region was crucial to the subsequent effective functioning of SLR-C. The organizers were strategic about the engagement of municipal *champions* and *boundary spanners* and “didn’t try to invite staff from every single local government in the region. The motivation wasn’t to try to trigger action, it was to try to facilitate better collaboration amongst those who were already acting, with the thought that others would presumably follow if there was some nucleus going forward” (WCEL_1). An action plan followed with items ranging from information sharing (municipal studies) to devising a more formal collaborative method (e.g., potentially collaborating on some of the more regional risk and vulnerability assessments) with a motivation to avoid duplication and ensure resource pooling.

Following a major provincial game-changing trigger, the release of the *Cost of Adaptation* study, SLR-C took a back seat as the more established formalized platform FBC JPC took central stage for collective action. This showed an adaptive nature of the network that convened and dissipated in response to the external triggers to avoid duplication and

participation fatigue. However, there were unmet needs remaining within formalized institutions and there was a need to identify areas of collaboration that were not going to be addressed, at least initially, by the FBC process, especially within in the Burrard Inlet sub-region.

The combination of pre-existing social capital, trust, and solutions/challenges sharing as part of regular face-to-face interaction through municipal and sub-regional working groups (such as SLR-C) played an important role in determining a more sub-regional approach to Flood Construction Levels (FCLs). At the time, this was a key challenge for local governments in the sub-region given the numerous trade-offs involved, as described in Chapter 5. As an engineer in CNV suggested: “... it was very helpful to talk to Vancouver, West Vancouver, and the District, and even though we ended up going first just because of the urgency or the timing for this particular development it was very useful to have that group [SLR-C] that informal group discuss it and support it, really. I think that was helpful for everybody. Would have been very difficult, I think, otherwise” (CNV_E). This was echoed by the organizer suggesting that the municipal staff recognized that action on raising FCLs was needed but also recognized that “they were going to have trouble getting their councils to support it unless they said, well, City of Vancouver is doing this and District of North Vancouver is going to do this now and District of West Vancouver is going to do it, so it was that kind of informal process but I think that was...useful” (WCEL_1).

In addition to face-to-face learning, the organizers invested in creating an institutional record of changing policies and practices. A living document was created that documented flood management and mitigation policies and plans related to SLR and CCA in member municipalities with an objective to share progress on integrating climate change information into planning on an ongoing basis to advance shared objectives. The benefits of this collaboration were later included in and leveraged in official reports. For example, as reported in CoV: “Vancouver City staff participated in and helped to lead a regional collaborative for municipalities without dikes to address flood hazard management, which was coordinated by the Fraser Basin Council and the Burrard Inlet Collaborative. Many municipalities, including North Vancouver, Surrey, and West Vancouver are also increasing FCLs to similar levels proposed in this report and are actively planning to prepare for sea level rise through raising dikes and other measures” (CoV, 2015).

With a clearly defined sp-R focus, SLR-C was explicitly designed to fill the sub-regional learning gap that other formal institutions in the region were not able to fill: “In terms of

municipal collaboration, some of it happens through the Fraser Basin Council but it's on a bit too high of a level for them to really work with each other on planning and collaboration, so that's why we at ACT with the partnership with WCEL, both of us funded by the Real Estate Foundation, convene the Sea Level Rise Collaborative specifically to facilitate collaboration, among municipal planners" (SFU_ACT). Staff to staff collaboration also allowed to maintain an apolitical focus on solutions: "I think the Collaborative... is also a useful place to discuss an issue that can quickly become quite politicized and, turn it into questions about which land are we going to protect? Where should we retreat? How much is everything going to cost? But **to keep it at this level among staff; it was mostly solutions focused**" (WCEL_1). Collaboration and joint learning were seen as key outcomes for the Collaborative. These Gen-R building processes also enabled exploring and maintaining options (another key feature of gen-R) available to municipalities by leveraging external resources from FCLs discussed above to larger ecosystem-based flood resilience approaches:

...ecosystems are losing out because they're already getting squeezed between development and the coast and now if we have to cover up the coast by putting in reinforcement, then ecosystems will just disappear and with them their adaptive benefits such as water buffering floods through, soil integrity and green ecosystem responses. We're trying to make sure that ecosystem based responses are a significant factor in the Collaborative and we've got the money from the climate change adaptation project at the University of Waterloo which is funded by Intact Insurance to put into a green shores pilot project in North Vancouver (SFU_ACT).

In addition to mobilizing collective action and gaining influence horizontally, SLR-C worked across the vertical governance axis to better understand barriers and enablers of the existing flood regime to accommodate the emergent SLR regime:

One of the areas that we've been working on with them is identifying... how the existing flood management legal regulations work or don't work in terms of enabling effective responses to rising sea levels in terms of new developments and ultimately redevelopments. We've worked with the group to try and crystalize exactly what the concerns are based on their experiences with actual waterfront developments and waterfront development proposals and then to present those to the Provincial government, and try to work out some way to potentially modify the regulations given that the Provincial government has shown some interest in doing that. We don't have any concrete results for that yet and we're just about to have another meeting with the Province to discuss that (WCEL_1).

Once the policy base and joint knowledge co-creation process to address information gaps had matured, SLR-C also organized a solutions-focused event, an Urban Design Charrette

that brought together municipal, regional, and provincial staff, consultants, design experts, and academics for creating joint design solutions. When asked about the successes of the Collaborative, the organizer stated that it enabled filling a major planning gap regionally given the wide-spread and pervasive implications of SLR, unlike other hazards: “Just creating a forum that was **specific to this issue of sea level rise**, which doesn’t have a legal home anywhere and it **crosscuts across a number of different related issues as does climate change generally**. **Sometimes these crosscutting issues are hard to manage because there’s no specific way to address it**” (WCEL_1).

The work in the BI sub-region was acknowledged by other municipalities and other boundary organizations (FBC_1; SF_EP). For example, an interviewee in the SF sub-region noted the importance on sub-regional work for the wider region, especially for expanding on adaptation imaginaries:

There’s the North Shore banding together... to talk about different approaches to coastal defense, which I think is really important because we need to consider that for a variety of reasons, dikes are not that great for the environment...For where we are, we know we’re going to have to increase the dike height and we can do that but eventually - we’re going to have to increase the footprint and so that’s either going to take up intertidal area or farm area, both of which are very sensitive. If there are any other approaches that can delay or reduce the need for a bigger footprint that would be much appreciated (SF_EP).

The direct accounts from the organizers, participants, and observers presented above demonstrated the extent to which a sp-R focused initiative can enable gen-R by increasing collaboration levels, mutual learning (among champions, organizationally, and institutionally), political influence, and capacity to self-organize, and maintain options. How did such a young informal institution become a major enabler of both of sp-R and gen-R?

The informal nature of the collaborative allowed a focus on knowledge co-creation and dissemination, and learning-by-doing through regular sharing of solutions. As observed in the literature (Armitage, Marschke, & Plummer, 2008), these informal shadow networks are essential in early stages of policy change to allow champions to prepare a system for change by exploring and maintaining options and developing strategies for choosing among possible futures. SLR-C was such a mechanism: a combination of a shadow network of local and regional champions that enabled joint fact finding and visualizing a direction for addressing SLR sub-regionally. A combination of external factors (necessity to act in response to provincial

guidelines) and internal factors (e.g., major municipal developments in the floodplains), required reconfiguration of the existing policies through development of a joint understanding of options available. As noted by several interviewees, the success of the Collaborative was determined by a **specific sub-regional** and a **specific hazard focus**, a deliberate and collective choice of the participants.

Once a focus on SLR and Burrard Inlet was defined, the collaborative grew to include other municipalities subject to SLR, moving beyond the original focus on DNV, CNV, and CoV and spilling beyond MVR boundaries, being responsive to the issue of fit and unconstrained by a formalized jurisdictional structure. However, a lack of formalization can also be an issue for policy change. For example, while social learning has significant potential for change (Pahl-Wostl, 2009), it may remain at the level of non-binding discourse without leading to major structural changes unless appropriate processes exist that support the extension of the actor network, codification of new routines and practices or formalization of new rules (Armitage, Marschke, & Plummer, 2008). These authors set the following normative criteria (Table 6-3, left column) that determines whether a process qualifies to be called a “learning cycle” to support double and triple-loop learning. I summarize the findings about SLR-C in the right column to analyze whether the collaborative meets the triple-loop learning criteria.

Table 6-3 Connecting sp-R and gen-R through a learning cycle for SLR Collaborative

Attributes of a ‘learning cycle’	SLR Collaborative
At least partially informal network of actors with regular meetings. Informal implies that rules, composition, boundaries (who is involved and what is included in the analysis open, leadership is allowed to emerge) are not formally prescribed. The mandate is open and the results are not immediately formally binding.	Regular meetings, limited to the practitioners and boundary spanning experts (academia, NGO) but not the public, reaches across horizontal and vertical governance scales, rules of operation were determined by the group to accommodate a specific policy issue. No formally binding rules, rather contextualized municipality-specific solutions based on sub-regional knowledge sharing and co-creation of solutions.
Must be an issue specific network and activities—formed to deal with a specific problem and is open and willing to explicitly experiment with a range of alternatives approaches.	SLR-specific network created for a specific sub-region, open and willing to experiment within the boundaries of legislative requirements. As an inter-municipal initiative, the practitioners lacked the ability to rewrite the rules at the higher scales, limiting their potential to reach triple-loop learning.
The network qualifies as a community of practice with joint and shared practices and tangible products. It develops an identity, history and a	As a community of practice that operated over the observed two years, the network continued to draw in new staff following HR changes (e.g., maternity leaves, staff changes). Long-term institutionalizing and survivability of the network was dependent on the organizers (host NGOs). However,

body of shared knowledge which goes beyond individual participants.	social capital continued to be mobilized to inform local practices and to mobilize and seek political influence at the regional and higher scales, speaking to the procedural benefits and contributing to the gen-R of the sub-region.
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SLR-C clearly fits the criteria to be qualified as a ‘learning cycle’, and can be seen as a policy instrument triggered by limitations within the formal policy network and designed to fill the institutional gap in the governance system. As a decentralized operation, the informally co-created solutions were implemented independently to fit local circumstances (e.g., different FCL heights and mechanisms for implementation) and would then circle back for group feedback. SLR-C was also a safe space for voicing shared concerns about future adaptation options (which can quickly become politicized) and expanding on adaptation imaginaries. Some participants informally voiced concerns that the sub-region may opt-out of a large-scale solution to managing flood risk such as a gigantic flood gate, seen by the participants as a very limited approach as it would allow delaying action at the present day and would also lead to a long-term maladaptive lock-in (CNV_EP; COV_P). As a shadow space for collaboration and learning, SLR-C had a strong distributed mandate within the individual municipalities and an open sub-regional agenda that enhanced the sub-regional capacity to collaborate and build social and human capital, to monitor, experiment (within legislative boundaries) and learn. In other words, this SLR-specific Collaborative was one of the strongest sub-regional examples of connecting sp-R to gen-R through procedural and substantive benefits.

However, despite its effectiveness, as an inter-municipal sub-regional informal initiative, SLR-C lacked the ability to rewrite the rules at the higher scales, limiting their potential to reach triple-loop learning by transforming the core operating rules of the multi-scale governance system. While the SLR-C organizers were working with the Province on this specific objective, it was too early to examine the success of this initiative at the time.

Long-term, the survivability of SLR-C seemed dependent on the facilitating organizations (which had their own agendas and were dependent on external funding (e.g., Real Estate Foundation of BC)), which posed a risk to the longer-term institutionalization of this collaboration. As an adaptive network that fulfills its purpose at a specific time for a specific cause while contributing to the gen-R of the sub-region, what mechanisms can further strengthen

the linkages between formal policy cycles and informal learning cycles without compromising the capacity to innovate and learn?

Some relevant international examples could inform the further steps. In Australia, the necessity to build adaptive capacity at the local scale led to alternative forms of networked and informal governance through creation of Climate Change Alliances (Moloney & Funfgeld, 2015). These alliances served an important adaptive capacity building role at the councils and communities' level. This was achieved by facilitating institutional interactions across multiple scales: horizontally across councils and vertically between federal, state, and local levels. Regional scale risk assessments, mitigation, and adaptation strategies served as a foundation for action. In addition to substantive learning, opportunities for reflexive learning were created between members and wider stakeholders, across scales, through knowledge exchange, learning, and advocacy. This process represented and encouraged adaptive and integrative forms of governance (Moloney & Funfgeld, 2015), representing a somewhat more formalized and institutionalized approach that the further operation of the SLR-C could learn from. Some of the elements of this form of arrangement existed as part of the Fraser Basin Council's flood management initiatives (discussed in detail in Section 6.5).

In the next section I explore another key learning related variable – ability to access new knowledge across multiple scales.

6.4.3 Accessing new knowledge: the role of consultants and qualified professionals

Ability to access new knowledge from diverse sources is an important factor for both sp-R and gen-R. Across the scales of governance, one of the main mechanism for accessing new knowledge was through consulting companies. In 2008, the Province hired a consulting company to conduct a survey that found that a large majority (75%) of survey participants relied on consultants to address flood hazard management issues, with a majority using a Qualified Professional⁸ (QP) for a building permit or subdivision, while 30% made use of a consulting study (Arlington, 2008).

⁸ A “QP” is a professional with appropriate education, training, and experience, fully insured and in good standing with the relevant professional association.

Contracting consultants was seen as an effective learning mechanism as it allowed to build on the experience of other communities and externalized some of the costs because “consultants learn from their other projects for their other clients. So then when we do proposals and stuff we get to review and pick what we think is the best value for the city and a lot of that value is based on their past experience for other people. So rather than us having the growing pains, hopefully some other communities have maybe paid for those growing pains” (CoS_E2). Having the consulting industry involved allowed for knowledge transfer from other communities across North America and internationally with extensive history of flood control (e.g., the Netherlands and Denmark). Having access to “the variety of ideas and concepts” through consulting industry was “awesome because different people look at things differently” (COS_E1) preventing “inbred” knowledge (e.g., “gang mentalities” within professions (e.g., fire or police (SF_FC; SF_DFC)); farmers relying on flood knowledge from a neighbouring ‘farmer Joe’ (EC_2); or municipalities looking at other municipalities in the region first and potentially replicating mistakes).

However, the increasing role of this consulting knowledge as a primary source for sp-R planning had an uneven impact on gen-R across the region. For example, in more resourced municipalities, the consulting knowledge brought in the “pieces” (e.g., information on rainfall, seismic, or sea level rise hazards) that the staff then would weave together into a strategy that they would try to scope out before commissioning the studies: “Because I find they don’t know everything about how everything works or all the components or all the politics” (CoS_E1). In smaller municipalities, there was larger reliance on consultants for studies *and* strategies. Smaller municipalities also had a hard time securing the quality expertise needed, often settling for what was available or working with the same consultant over the years (e.g., CoPM) which ensured continuity but potentially also limited options and access to new solutions. As noted in the 2008 provincial policy review by one of the municipal respondents: “Need [a] list of professionals who can help. Also more guidance as to what the engineers charge is fair or not. With high demand for services they tend to pick and choose who they want to work with and smaller municipalities are out in the cold” (Arlington, 2008, p. 26). In other words, access to consultants was an equity issue, with smaller municipalities being more reliant and less able to scrutinize what they received.

The majority of municipalities turned to consultants when faced with a novel situation and a need for science and specialty knowledge. For example, in CoS, given the small staff numbers, the relationships built with consultants were a source of continuous learning lubricated by social capital developed over time: “we don’t do a lot of our own stuff in house; we hire out consultants and so getting external advice. When I [started working on] the environment portfolio I knew nothing about contaminated sites so I trained a consulting firm to be my expert for me so I could phone them up and ask any stupid question at any time” (CoS_E1). This general approach to accessing new knowledge was applied to various specific planning domains. For example, engineering departments looked for specialty engineers to sign off on a project, such as a geotechnical engineer to sign off on slope stability or a structural engineer to sign off on bridges or retaining walls: “Especially in a smaller municipality... I’m a professional engineer... my role is really to provide a sort of oversight and coordination and when can we make a decision ourselves and when do we need to go get some external professional expert to provide advice” (CNV_EP).

As part of the regional survey I provided a list of commonly used companies that were identified through the interviews. The participants were asked the following question: "Which of the following consulting firms does your organization rely on for flood management information and/or analysis?". The companies represented different expertise (Figure 6-4); as one survey participant put it: “Different firms have different expertise. Some do more study works while others are more design and construction. Not all firms listed above have the same expertise nor advise on the same issues but they all do flood related projects.” The regional survey shows two clear leaders, Kerr Wood Leidal (KWL) at 63% and Northwest Hydraulic Consultants (NHC) at 56% followed by Associated Engineering at 30%.

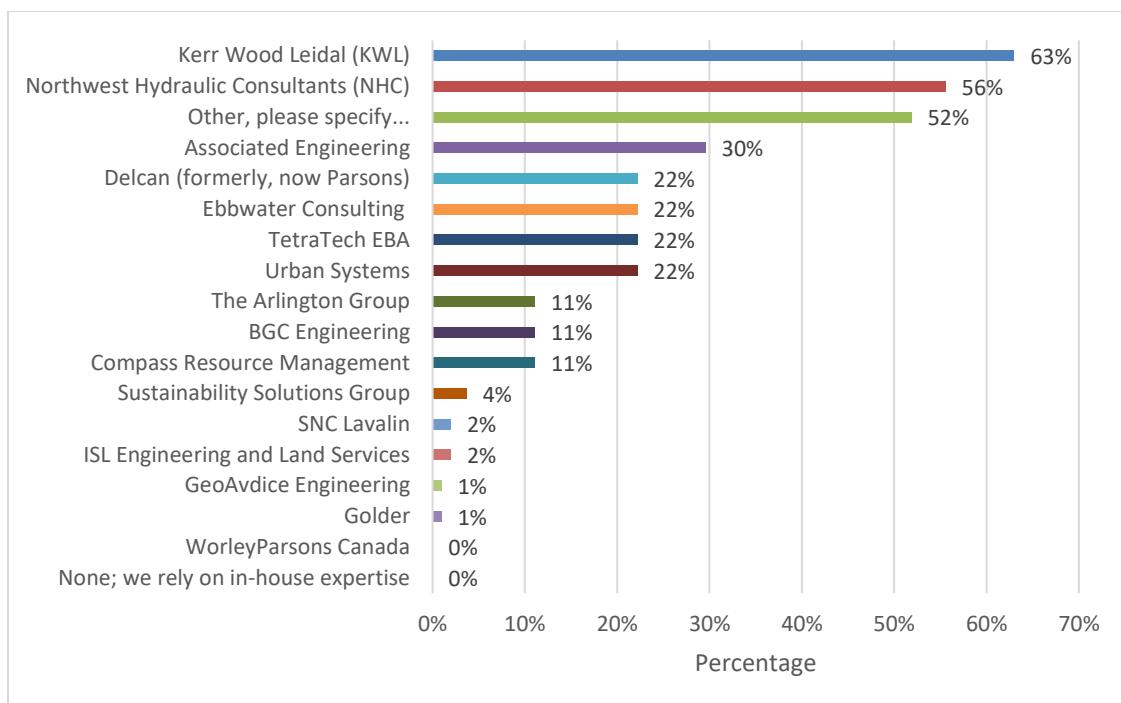


Figure 6-4 Consulting firms used for flood management information and/or analysis

The two leading companies also provide a significant amount of services for the provincial government and other regional stakeholders. For example, NHC worked on the two key projects for Phase 1 as part of the Fraser Basin Strategy development - a flood vulnerability assessment for the region and an evaluation of present dikes to withstand a major flood. They also helped with the development of the strategy to enhance protection for communities along the Lower Fraser River from Hope to Richmond and on the coast from Squamish to White Rock. A municipal engineer in a managing position expressed a concern about the potential knowledge capture, speaking to the need to maintain a more diverse knowledge base: "...at the very basic level use the same consultant who worked for the provincial government to create the guidelines. So that's one of my concerns is that we've all taken a different flavour but it's really, it's only one set of... one study that's actually setting the bar for us (CNV_E)."

The concerns around the role of QPs and consultants were also clearly expressed in the 2008 policy review. Concerns were raised around professional judgment criteria, for example for "use safely as intended": "A geotechnical engineer must certify that a building can be used safely. What does this mean? It can be damaged, but not cause injury? What about structural, electrical, mechanical engineer reports?" (Arlington, 2008, p. 26). Quality assurance and more accountability were also raised as a major concern: "Regulating construction in flood hazard

areas is the most cost-effective approach to flood hazard management if it is used correctly. The use of QPs can be useful provided that the quality of work submitted is of the appropriate standard, particularly where it is blindly accepting by the approving authority. There needs to be better quality assurance mechanisms in some jurisdictions" (Arlington, 2008:26). More accountability was called for: "More accountability for 'QPs' who submit substandard reports and recommendations, and local authorities or approving officers who approve questionable developments" (Arlington, 2008, p. 27).

Given this increasing role of consultants in flood management process and in the light of a need for changing professional practices due to climate change, several professional associations in BC have responded by enhancing their guidelines for professional practice. These institutional changes theoretically can serve as an indirect mechanism for enhancing regional capacity to deal with change, achieved through professional associations and guidelines for changes in consulting practices. This was a much-needed move, as described by one of the municipal engineers:

We need to bring the industry a little further ahead. I've seen it happen with low impact development; it took awhile to bring the developers' consultants up to speed and even some of our consultants cause **you don't understand the whole picture**. I think that's the next phase... maybe some of these [regional] talks you're seeing... you need to pitch them to the industry [not local governments]. That's where the Canadian Water Resources Association or the BC Water and Waste Association come into play. There's planning institutes, too (CoS_E1).

Unlike engineering, several planning interviewees mentioned they did not see as much action coming from the planning professional organizations (e.g., PIBC), which did not release their statement until spring 2017. Moving beyond the more technical and engineering concerns of sp-R approaches, for negotiating the ethical, technical, and planning issues of changing professional practices, the mediating institutions and regional groups played an increasingly important role, which also signaled a move from government to governance (CoS_E1; CoS_E2; CNV_E).

It is important to note that these trends described in a specific domain of public safety and sp-R, are indicative of the overall general trends of overreliance on externally produced knowledge by the province. A 2017 *Oversight at Risk* report based on a survey with 403 provincial government scientists (a 35% response rate) in 10 provincial ministries (excluding EMBC but including MoTI, MoE, MFLNRO) by a non-partisan Evidence for Democracy group

in collaboration with Professional Employees Association vividly illustrated the potential negative effects of outsourced research and decision-making to external professionals given the risks of conflicts of interest and a regulatory capture, which arises when the professionals are employed by the same industry the government is required to regulate. The survey found that 57% of respondents believed that the government's increased reliance on external rather than ministry staff is compromising their ministry's ability to use the best available evidence in decision-making; 71% said they have witnessed a decrease in research capacity in their ministry and/or branch over the course of their tenure in the BC government; 68% believed that there are insufficient resources to effectively fill their branch or ministerial mandate; and 71% think that capacity changes negatively impact their ability to produce scientific/expert reports and documents. This general capacity reduction had a direct influence on their specific domains, with 59% stating that capacity changes negatively impact environmental research/regulation within their purview.

Similar to the concerns voiced by the interviewees in this dissertation, Haddock (2014) documented cases where professionals themselves showed concerns regarding a lack of checks and balances in the state of the current professional overreliance. As capacity to generate new knowledge by the province was reduced and increasingly large portions of the scientific mandate was outsourced to external professionals, changing the role of ministry scientists significantly: "both government and external scientists appear to feel that the growing role of professional associations in governance does not adequately or appropriately address the public good" (Oversight at Risk, 2017:). This shows a nuanced relationship between gen-R (capacity to learn and access new knowledge) on sp-R.

In summary, under this current regime of reduced oversight and technical capabilities from the province due to budget cuts and staff reduction over the last few decades (MNFLRO, COS_E1, COS_E2, COD_E) use of consultants to access new information and conduct studies, while QPs filled the gap for reviewing technical factors and determining sites as safe for their intended use. This system of land use and development approvals required a high degree of site-specific analysis of many variables that relate to hazards and thus arguably allowed more flexibility. It also externalized liability from municipalities to consultants and arguably, resulted in a piece-meal, site-specific approach to land use and planning presenting a major challenge for a regional approach to sp-R. The requirement to secure a QP's assessment for a development

approval not only externalized municipal liability risk but it also disproportionately transferred risk to the consulting community and their insurance companies. As one senior municipal engineer stated: “You can have individual consultants that write a report and how much, from a liability perspective, do you go back to them? Well, you’re going to wipe out a consultant who gave his best judgment at that particular time that was paid \$1000 or \$2000 dollars for the report and he’s supposed to take on the liability of millions and millions of dollars or his insurance company” (SF_E). This externalized reliance reduced learning and oversight capacity at the provincial level. At the municipal level, by externalizing the knowledge generation process to the consulting community, the municipalities were not able to gain the gen-R benefits that a learning process can bring, such as increased human capital that stays within the municipality, increased collaboration levels (as part of the knowledge co-production) and ability to explore options on a continuous basis. This reliance on consultants also reduced monitoring capacity and eroded evaluation capacity, another key process that connects sp-R to gen-R.

6.4.4 Role of regional and provincial organizations in monitoring and evaluation

Monitoring and evaluation that directly inform future planning serve as a foundation for evidence-based adaptive management. For sp-R, monitoring changes in flood hazards and risks provides a foundation for planning activities and sp-R investments. For gen-R, in the context of climate change, monitoring and evaluation can be carried out for *outcomes* and *process*. Evaluation can include metrics to evaluate effectiveness, assess efficiency, understand equity, provide accountability, assess outcomes, improve learning, and improve and compare programs and activities (Pringle, 2011). From a policy perspective, monitoring and evaluation can provide justification for increased or decreased funding, can enable gaining of political influence and momentum, can inform a better understanding between co-evolution or risk, development, and adaptation measures, and identify unintended consequences and mal-adaptation. The temporal benefits of systematic monitoring and evaluation allow for timely interventions based on an ongoing learning process (e.g., where, when, and to whom do the key learning messages need to be articulated?) and enable dealing with long timelines as an iterative process that tracks progress (Moloney & Fünfgeld, 2015).

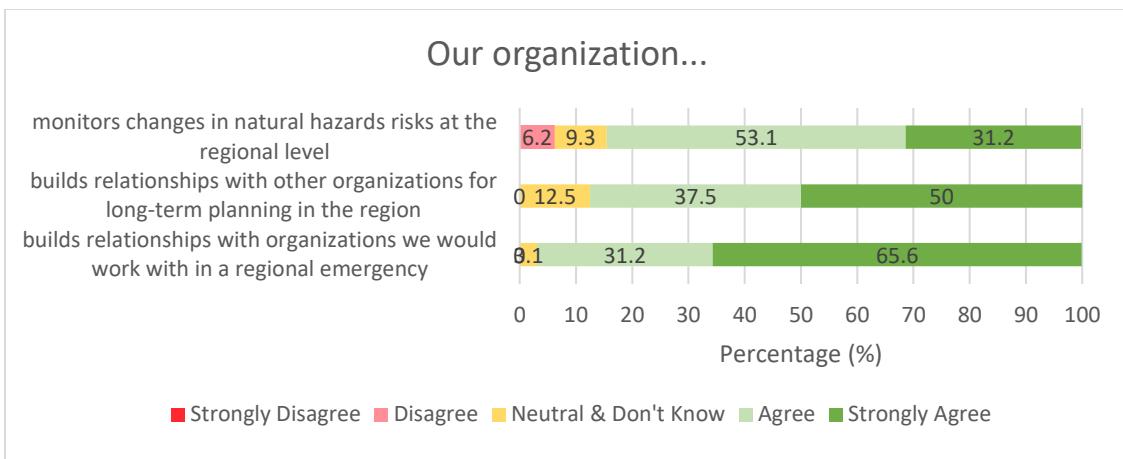


Figure 6-5 Monitoring and relationship building among municipalities

Chapter 5 identified an uneven monitoring capacity within the case study municipalities. Some of the leading and resourced municipalities (e.g., DNV, CNV, CoS, CoV) had a strong capacity for monitoring ongoing changes to flood hazard and increasingly flood risk (e.g., flood risk and consequences studies and adaptive management approaches such as regularly updated core documents based on the changed context). Regionally, as Figure 6-5 demonstrates, the majority of the respondents stated that their organizations monitored changes to hazards at the regional level (84%). However, as Chapter 5 illustrated, few mechanisms existed to account for regional impacts of municipal hazard management decisions. Similarly, as the discussion at the outset of this chapter demonstrated, at the regional scale the current governance system lacked the capacity for a systematic approach for region-wide flood risk monitoring and management.

Theoretically, Metro Vancouver's (MV) Regional Growth Strategy (RGS) holds a potential for effective regional monitoring. The RGS sets out five goals for achieving a vibrant, diverse, prosperous and sustainable region: 1) Create a compact urban area; 2) Support a sustainable economy; 3) Protect the environment and respond to climate change impacts; 4) Develop complete communities, and 5) Support sustainable transportation choices. Goal 3 “Protect the Environment and Respond to Climate Change Impacts and Strategy” includes a more specific Strategy 3.4 “Encourage land use and transportation infrastructure that improve the ability to withstand climate change impacts and natural hazard risks”. Through its annual report *Progress toward Shaping our Future*, MV assesses its progress in achieving the objectives set out in 2011 and provides baselines and reports on performance measures for regional goals and strategies. Monitoring, review, and evaluation are required to ensure progress on implementation of measures aimed at reducing natural hazard risk (Vella, Butler, Sipe, Chapin,

& Murley, 2016). Integrating resilience thinking into strategic planning and management can be done by creating reporting frameworks for monitoring that are continuously updated with information as new knowledge and understanding becomes available (Quinlan et al., 2016). Monitoring and continuous evaluation are also key to progress on gen-R (Walker, Abel, Andries, & Ryan, 2009). At the time of writing, Strategy 3.4 was the only one that had no performance measures. The Regional Context Statements (RCS), a subsidiary regulatory tool of the RGS showed variation within the content and amount of detail across the region. Overall, the majority of the statements provide excerpts from existing policies within the OCP framed around the five required themes. In the absence of clear regionally established performance metrics for this policy domain, Goal 3.4 risks remaining a ‘copy and paste’ exercise of the existing statements from the OCPs. Given these limitations, what role does the RGS play for reducing natural risk in the region?

Regionally, MV had a strong capacity (tools and processes) for monitoring change for the regional metropolitan socio-ecological system for a variety of stressors ranging from population growth to land use patterns. However, despite the effectively monitored changes that had direct implication for sp-R (e.g., land use), the organization struggled to effectively communicate the degree of change to the public and, in a governance model driven by consensus, MV lacked enforcement authority to directly address these changes.

Public perception around the state of green space in the protected areas and the overall discounting of cumulative effects of losses in the urban area was identified as a barrier to effective action: “People look around and they see the North Shore mountains and the mountains in Coquitlam and see so much green that they feel that they’re in a very, very rich environment. That’s fine and it’s great that we have protected watersheds but that doesn’t change what’s happening within the urban area and at the lower elevations” (MV_P). While over 50% of the region was protected “only because our boundaries stretch way out back behind our reservoirs” the losses in the urban area were “staggering”. As a pilot of the MV’s sensitive ecosystem inventory (which showed all of the identified regional sensitive ecosystems, types of habitats and gave a quality rating) illustrated: “...just testing to see how long it’s going to take us to update this information showed some staggering losses in ecosystems that I think are really going to blow people’s minds. Over the four years like tens thousands of hectares are gone. ...I don’t think people necessarily understand the impacts and impacts going forward in the cumulative

sense of things, that little bits here, little bits there, it really, really does add up.” This loss had direct implications for sp-R and gen-R: “We’re losing ecosystem services having to replace them with grey infrastructure that costs a lot more money and requires a lot more maintenance. It’s a direction I don’t think most people really want to go but I don’t think they’re really faced with the decision or a way to make their wishes known… a way to really grapple with that” (MV_P).

Despite these monitoring tools and staggering results, the organization was struggling to communicate the value of their work and determine the format for meaningful public engagement given the general challenge of identifying regional constituency in a non-amalgamated region and the diverse municipal characters. As the Chair of the Metro Vancouver Board suggested: “It’s really hard. How do you have the meaningful discussion about any of these topics with 2.4 million people?...If I had something that’s intimate to people - a budget meeting, about your taxes, about what’s going to come out of your pocket [in my municipality]... I get 5 people out. So how can I have a regional planning discussion with 2.4 million people...? I’ll get 200 people out. It is a lot but it is sure not that much of a percentage. We’re trying to figure that out. It is a tough one”.

Monitoring that would inform adaptive management was seen as key for effective management of the socio-ecological system: “Once we have some of that [regional data] and we’re able to project out, we can continue on this path of how we’re going about things or we can set new targets and adjust our policies and add piece to our policies and things will change (MV_P). However, MV lacked an evaluation process for goal 3.4 related to natural hazards and climate change. Additionally, despite the tools and the knowledge, MV did not have the enforcement capacity, running into the ‘responsibility without the authority’ barrier identified at the outset of this chapter. As one regional actor put it: “If you think about the areas that Metro Vancouver has jurisdiction, Metro Vancouver doesn’t really deal much with developers and that’s where all of this action is happening in a sense. So, that to me seems to suggest that Metro Vancouver is not the most likely home for this increased, or enhanced governance [for flood management and sea level rise]. At the same time, the local governments themselves are really... are really puny actors, unfortunately, realistically, in terms of the politics” (WCEL_1).

At the provincial level, the 2003/04 changes in provincial legislation reduced the level of provincial oversight over the development process in the region. Provincial monitoring capacity had been defunded over the years due to budget cuts, staff (technical, scientific) cuts and

program terminations as identified in Chapter 3, with few institutional legacies surviving (e.g., River Forecast Centre). In addition to the eroding quality of physical infrastructure, the continuous cuts and reductions to the provincial program have also significantly eroded the remaining institutional infrastructure. Monitoring capacity, a key to maintaining gen-R, has been eroded in both physical and institutional terms. As one interviewee involved with the monitoring of the Fraser River described the loss of the process, relationships, and eventually accuracy and buy-in in the on-the-ground river monitoring:

Some of them were farmers and some were municipal engineers. Some of them were gages that actually read stuff in real time and came through the Internet but it was in 2007, it wasn't that long ago...we had like 4 gages that were like [that]. **The rest of them were read by people but that created quite a lot of capacity around that model**...but unfortunately that all dissipated after I stopped forecasting and [it] went to the ministry and they now use it for forecasting but they weren't doing the checking part so it lost... buy-in into the forecast itself because they started making mistakes. People didn't believe it anymore. Just the act of spending an hour with every municipality before we started the forecast, explaining what we were doing and we needed them to help us that kind of thing **that was very good for capacity building.** (EC_1).

Yet, historically, at the provincial level, a significant amount of institutional resources was dedicated over time to monitoring, evaluation, and reflective learning. Termination of major programs would often be accompanied with a provincially initiated review of the outcomes and recommendations for moving forward. For example, the 1996 Fraser Board report provided an in-depth analysis of *FDRP* and the impact of the program and its shortcomings. The report made a number of suggestions that could have potentially altered the flood management regime of today. The report highlighted residual risks such as dike failure due to an earthquake, dike overtopping or breaching during prolonged high water combined with a continued development of a floodplain as a growing unfunded liability. The report suggested that this liability should be funded by residents of the floodplains, especially those who choose not to floodproof as opposed to relying on higher levels of governance for disaster assistance. The report also outlined the benefits of establishing a river authority to oversee river maintenance, as opposed to dike maintenance which is a local responsibility. Most these issues remain unaddressed within the current regime but with a higher level of development, more people, and assets growing in value located in the flood risk zones. Given these studies, it is somewhat surprising how few recommendations have been taken up.

More recently, the emerging SLR regime triggered several actions to enhance institutional capacity for reflective institutional and policy learning at the provincial level, as identified in the previous chapters. In addition to the technical studies and preliminary guidance described in Chapter 4, several reflective policy analyses and evaluation materials were commissioned to examine whether the existing flood management regime was fit for changes, including internal regulation-driven changes such as the 2003/04 legislative changes and external drivers such as the emergent SLR issue. In 2008, the FBC commissioned a study called *Flood Hazard Area Land Use Management: Review of Flood Hazard Area Land Use Management in BC* that evaluated the 2003/04 legislative change and its impact on the implementation of flood policies at the local level (Arlington, 2008). Another report commissioned by the BC Real Estate Association, *Flood Protection Strategies in British Columbia* (Arlington, 2010) provided an overview of the current legislative provisions for flood protection with a focus on key legislation (Local Government Act; Community Charter; Land Title Act; Dike Maintenance Act; Emergency Management Act); as well as funding sources and federal and provincial policies for flood protection.

Another report, *Evaluation of BC Flood Policy for Coastal Areas in a Changing Climate* (Arlington, 2014) was commissioned by MoE and provided a review of the existing policies and their fit for an emerging coastal regime. It specifically evaluated whether current flood management policies and programs supported or hindered adaptive decision making, with a goal of suggesting appropriate measures that would facilitate action within the provincial coastal flooding-related policies. The report was commissioned with an explicit recognition that the existing policies were not designed with SLR in mind and that, given the risks associated with climate change, it would be important to examine whether these policies would support adaptive actions (Arlington, 2014). The analysis focused on the provincial government's roles and responsibilities with respect to flood management: administering funding programs, regulating dikes, managing flood emergencies, and issuing land use planning and flood mitigation guidance (Arlington, 2014). A foreword written by the inter-ministry WG stated that “The challenges posed by sea level rise further increase the importance of intergovernmental collaboration to address current and future coastal hazards” (Arlington, 2014:vi).

This high-level overview combined with a more detailed discussion in Chapter 4 shows several trends in how the province has been monitoring change and evaluating capacity to

address SLR within the existing freshet-oriented regime. Three main types of guidance were developed: 1) technical studies and preliminary guidance; 2) policy evaluation materials; 3) adaptive capacity building and toolkits. The first category primarily focuses on better understanding of sp-R, while the second two have potential to influence both sp-R and gen-R.

Overall, Sp-R guidance was more influential compared to gen-R guidance. As the interviews demonstrated the technical and specific guidance was significantly more known about among municipal FMPS, compared to the evaluation and capacity building materials. This was also noted at the provincial level as one interviewee put it an issue specific guidance was more successful in gaining attention rather than general planning and implementation guidance: “There’s been more success talking about a particular topic like sea level rise, dikes... rather than planning and implementation generally” (MCSCD_1).

The majority of the documents, even the technical ones, suggested that an increased level of collaboration and *coordination* across the region and levels of government will be necessary to address current and future coastal hazards. It can be argued that SLR had triggered a more proactive and coordinated approach across the ministries, with CAS playing a central role in this coordination due to a unique bridging position (by design) and ability to attract federal funding. The federally funded and provincially executed program, the BC Regional Adaptation Collaborative (BC RAC), was a major driver for creating the new technical studies and guidance materials, which fueled the SLR discussion and action in the region. It has also further enabled collaboration across government departments and non-governmental organizations. It is important to note that BC RAC ranked fairly modestly for influence by municipal FMPs (8%), which could be explained by the limited knowledge of the interconnectedness among the policy change levers. This speaks to the need for triangulation when evaluating policy triggers and outcomes across multiple scales of governance.

Another noticeable trend, in an increased move from *government* to *governance*, several other players (e.g., BC REA) actively contributed to the discussion and evaluation of the existing flood management regime, which speaks to a broadening group of actors involved in policy influence. Overall, a significant barrier—lack of local government involvement in creating or consulting on the proposed guidance, with some exceptions (e.g.,: surveys conducted by FBC in 2008, and focus groups/workshops conducted for the Arlington (2014) study) – was identified. Not only this prevented from building gen-R benefits as part of the collaborative learning process

across the scales, it also created suboptimal sp-R guidance that did not fully consider the actual needs of municipalities. A regional participant of this policy review reflected on the generality of it: “The Provincial government had its own process of reviewing the flood policy and the flood management regulations...that process seemed ... more generalized... it seemed like it didn’t actually address the concrete issues that the local governments were facing. They were able to describe some of the things that weren’t working or that were causing them difficulties but it didn’t really get down into the specifics of what [needs] to be changed and where they were grappling with the issues precisely in terms of actual developments” (WCEL_1). This lack of engagement and consultation and understanding of local needs by the province has been a persistent barrier expressed in interviews and the survey and observable in the documents analyzed.

Overall, as discussed in the previous section, the reduced provincial oversight and technical capacity of the current regime resulted in a reliance on external consultants to advise local governments on flood hazard and management options. The province also depended on consultants for creating their guidance materials. While there was some diversity displayed among the technical studies and guideline components reviewed, for the evaluation component and adaptive capacity building the Arlington Group dominated the market, as the discussion above has shown (also see Appendix C.2). While potentially beneficial for consistency, recruiting the same consulting firm (although with other partners) can limit the knowledge base and methods employed used in policy evaluation.

In the fields of disaster resilience, capacity to monitor, evaluate, and learn can be extend to disaster events that happen elsewhere. A commonly used mechanism at the municipal scale, it was most effective when accompanied by direct post-event on-the-ground learning trough staff exchange, especially for implementing single and double loop changes. However, the provincial level interviewees were skeptical about the ability to learn from events that happened elsewhere.

I don’t see much learning going on. You know, actual learning, no. We try a little bit, we have a senior engineer from Alberta government come to one of our provincial meetings... the Fraser Basin Council is going to invite somebody like that to maybe talk to our politicians. That would be good but [in] my observation, you almost have to hit people in the face (MRLNRO _1).

Another provincial employee speaking to the multi-level governance context suggested that learning from events elsewhere would depend on federal-scale learning and changes:

No, I don't think there's been any specific changes in BC. The different parts of government that deal with flooding and with disaster response and recovery are paying attention to the experience that Alberta is having and certainly hoping to learn from it and also waiting to see what the federal government response is. Because a lot of the funding, both for infrastructure in general and for disaster recovery, if the disaster is big enough, comes from the federal government and the way that the federal government chooses to deploy its funding will influence how the provincial government chooses to deploy its funding as well. So there are rumours that things may be changing at the federal level and so it's really waiting and seeing (MoE_1).

In planning for the unexpected, Taleb (2016) suggests that a major impediment to enhancing capacity to deal with change comes from an excessive focus on the known and the tendency to learn the precise (specific facts, specific outcomes of certain events) but not the general. Focusing on the specific post-event facts, rather than general meta-rules is a common pitfall of the crisis and emergency management profession. For example, specific learning from events often comes in lists of tangible action items (e.g., changes needed to the backflow valves following large scale floods in Calgary). However, this focus on single-loop incremental learning thorough direct implementable small actions has the potential to prevent individuals from looking at the bigger picture that would allow to re-write the overall rules of sp-R. Several interviewees questioned using the Calgary floods as an example: if a flood of this scale was predicted in this area, why weren't any proactive changes made to land-use (SF_E; MNFLRO_1; COC_C)? In a context of perceived safety, long-term divestment from disaster mitigation accumulates long term costs:

Generally, what we find from a flood risk perspective is that we're reactionary... We look at New Orleans, we look at Calgary, we look at some of the floods in Quebec...the risks in some of those places were known. It was flagged, but to put big dollars aside to address it's really hard to do...it's a very hard decision to say "oh flooding" when it doesn't happen for a very long time or an earthquake doesn't happen for a very long time. But one day, something probably will happen and that's when the large, more catastrophic event occurs, that's when the damage is really...that's when we pay for it (SF_E).

Public perception of it, until it actually happens, like in Calgary, suddenly they're spending billions, right? [It] cost them billions but they're spending, depending on how much they get approved, at least a billion on new mitigation, designing it and constructing it, as we speak. That would have never been on the books without the flood. Yet, that flood was fully predictable, wasn't that big an event, it was modelled ahead of time, but the political decision to spend that money to mitigate the recognition of the issue doesn't happen until it gets into the public psyche (MRLNRO_1).

The majority of the participants stressed that while events elsewhere raised awareness, lack of direct recent experience with disasters was seen as a barrier to big transformative leaps in the region until you have “the Katrinas of the world” (CoS_E1), which even led to “conversations behind closed doors with people wishing for a natural disaster because of the windows for change that have come up as a result” (SFU_ACT). Numerous interviewees across the levels of governance stressed that it would take a major focusing event *in the region* to increase investments in mitigation which tended to happen ex-post, despite the ex-ante knowledge and need, a finding commonly noted in the literature (McConnell & Drennan, 2006; Scanlon, 2001).

In this section, I provided an overview of the learning mechanisms that influenced sp-R and gen-R across the multiple scales of analysis.

For sp-R learning, solid qualitative evidence exists on the movement from flood government into flood governance, as illustrated in Chapter 4 through policy analysis, in Chapter 5 through municipal sub-cases, and in this chapter through multi-scalar analysis of sp-R learning processes. Modes of learning and learning processes unfolded across horizontal and vertical governance axis, spatial scales, across public, private, and non-governmental sectors. However, consultants played a significant role for accessing new information at the municipal, regional, and provincial levels, a trend which called for a more regulated professional ethics to respond to changing climate.

Provincial level learning was somewhat constrained by the federal level and the programs that they supported or cancelled. For example, the federal-provincial programs such as FDRP served as an institutional memory mechanism for retaining provincial knowledge, long-term planning, and continuity. With its termination, this capacity was largely lost. Once certain sp-R capacities were removed, reinstituting them back was nearly impossible due to competing immediate priorities, politics, public perception, and optimistic bias (commonly mentioned barriers for re-investing in flood mitigation).

I found that the novelty of sp-R (SLR) drove a more proactive collaboration and learning through various shadow space mechanisms. In the process, these mechanisms contributed to gen-R (such as increased social capital, collaboration levels, capacity to learn, and ability to explore and maintain options). However, despite successful examples, the informal nature of these informal mechanisms (primarily formed at an apolitical staff level with some external

stakeholders), meant they lacked the ability to directly influence the formal flood management regime. For example, one of the most effective mechanisms for learning at a sub-regional level that directly contributed to gen-R, the SLR Collaborative, while effective in co-designing distributed solutions for municipalities (double loop learning), could not enact the triple loop learning which would require changes to the overall governance regime and the reliance of the municipalities on the province for funding sp-R solutions. Similarly, at the provincial level an inter-ministerial WG was effective in conducting regular meetings to ensure an apolitical focus, and to increase mutual understanding of barriers and opportunities. However, it could not overcome the main organizational barrier: the way flood management was structured, a fractured distribution across the ministries which was subject to path-dependency and numerous organizational and political transformations rather than purposeful design based on sp-R functions. Mediating institutions played a role in overcoming this barrier as discussed in the next section.

6.5 Ability to self-organize and collaborate: the role of mediating institutions

Institutions that mediate the relationship between socio-ecological-technical systems and flood risks play a central role in the governance system's ability to adapt to an uncertain and changing conditions (Crawford, 2010). Within the broad spectrum of mediating institutions, 'boundary institutions' have a particularly promising potential for connecting sp-R to gen-R. Boundary institutions focus on issues at the interface of science and policy through the creation of boundary objects (e.g., policy assessments, conceptual models), mediating between policymakers and scientists, and operating at the forefront of both research and policy (Guston, 2001). Miller (2001) further unpacks this definition by referring to social arrangements, networks, and institutions that increasingly mediate between institutions of 'science' and institution of 'politics' – understood as labels for distinct processes that are becoming increasingly intertwined, especially under the climate change agenda. When boundary arrangements where science and politics intertwine become formalized, these may be referred to as boundary organizations (Hoppe & Wesselink, 2014). Within the municipal climate change adaptation realm, boundary organizations can also serve as a critical tool to connect science with action on the ground though ongoing support (Graham & Mitchell, 2016). In addition to organizations, individual 'boundary spanners' play an important role in making decisions concerning information gathered and turning it into action. In understanding the boundary

spanning roles, knowing how an individual or an organization is embedded in the structure of a network allows to better understand its influence: some may act as bridges between groups (boundary spanners), others may have all of their relationships within a single clique (e.g., with a sub-regional focus), some actors maybe part of a tightly connected group, whereas others can be completely isolated from this group (Kapucu, 2006).

Graham and Mitchel (2016) point to an empirical gap in the literature on understanding how partnerships at sub-regional scales can more effectively foster adaptation action. Given the growing importance of this policy domain it is surprising how ‘little is known about how to create successful boundary organizations, how they relate to their constituents, and the most effective boundary management approaches and on-the-ground administrative strategies’ (Parker and Crona (2012, p. 263) in Graham and Mitchell, 2016). Within this gap in the literature, a better understanding of how sp-R planning facilitated through boundary organizations can create procedural benefits for gen-R (collaboration, learning through co-produced knowledge, gaining political influence, expanding co-produced adaption options etc.) can offer additional planning guidance for urban resilience.

Regionally, the Fraser Basin Council (FBC) played an important role in facilitating partnerships and shared platform for developing a pre-crises capacity and understanding regional interdependencies. As one of the leading formal mediating institutions, FBC Joint Program Committee focused on building long-term adaptive capacity to address stressors by investing in regional capacity to plan for, manage, and adapt to changing flood risk.

6.5.1 Spanning boundaries: the Fraser Basin Council.

Fraser Basin Council (FBC) was identified as one of the central boundary organizations for regional action on anticipatory planning and flood management.

The survey revealed that, among the existing regional groups that facilitate flood management at the regional scale, the FBC was the leading organization that enabled collaboration and learning with regards to regional flood management. It received the highest score for regular collaboration (64%), 39% for influence and 43% for learning. Fraser Basin Council’s Joint Program Committee (JPC) for Integrated Flood Hazard Management was the main long-running regional scale institution that served as an ongoing regional forum for dialogue on flood management.

Over the years, JPC served as a leading platform for regular meetings to share critical information, collaborate and build consensus, and develop management strategies that take into account a regional perspective and priorities that extend beyond the individual interests of its 34 municipal, provincial, federal, and other members. FBC has no decision-making authority, regulatory authority, or legislative jurisdiction in flood management and relies on members to implement the consensus-based strategies and joint projects developed at the JPC. In this process, education is FBC's primary role: to raise awareness about the issue, to help inform decisions around flood management, and to facilitate an inter-jurisdictional multi-stakeholder process by bringing together different orders of government and other organizations to identify common issues and concerns and challenges and in some cases to work on collaborative projects, working towards common solutions.

Although originally created to serve the needs of the river basin management, the organization has been responsive to the changing needs of its members and has fully embraced the need to address coastal flooding. For this specific purpose, the organization raised nearly \$0.5 million from its members and interested stakeholders to enable the creation of a regional flood management strategy (with contributions starting from \$5,000 for some of its member municipalities). At the time of the interviews all but 4 local governments have signed on which was primarily explained as a financial constraint issue. According to FBC this reflects "a serious, unprecedented commitment by the federal government, the Province of BC, 25 Lower Mainland local governments, and other public and private sector organizations to work together on flood protection measures that will safeguard the region as a whole" (Fraser Basin Council, 2015).

The strategy was developed in two phases. The first phase focused on developing a better understanding of flood hazards, identifying flood vulnerabilities, and assessing flood management practices and policies from a regional perspective. Subsequently, from 2016 onward, FBC sought to complete the strategy development that would set out options for funding and implementation. An important departure from previous regional collaborative work was a focus on *risk* rather than *hazard* and an explicit acknowledgement of regional interdependencies:

The three initial projects [are] really exciting because they are going to show the *risk*. One project is all about risk and the damages and consequences. One project is about inventorying our infrastructure and our floodplain policies between all the local governments and different utilities etcetera, which, I think, will show a lot of the holes in the region. The third one was relooking at Fraser and some of the flood elevations

... taking some of the climate change stuff and others of us who've already done other modelling put it in to try to show how bad a picture it could be. So using those levels for the infrastructure levels and then the infrastructure levels, for the risk levels, taking those 3 key studies, merging the results to show the vulnerabilities in the region... I think it's really **one municipality can't save the region, really, if somebody fails, we all fail** (CoS_E1).

In general, from a municipal perspective, FBC was seen as a good institutional home for developing a regional strategy given its non-partisan nature: "... there's politics there but not the same as you would get like if it was at Metro Vancouver or something, right?" (CoS_E2). Historically, FBC also had a reputation of being able to resolve issues as they arose in a collaborative and responsive way. For example, a few years ago when funding was terminated for debris traps, an issue that was seen as minor and politically unimportant by the province, municipalities came together through FBC to work out a collaborative solution given the potential impact of debris floods: "it is a big deal because there's tons and tons of wood that would come down and affect all of the communities, affect our dikes, affect everything else" (SF_E). More importantly, unlike most of the other organizations, by having a basin-wide focus, FBC was perceived to have the right institutional fit for the scale of the issues that it was dealing with, especially given the diverse needs across the basin:

[FBC] are talking to people throughout BC, looking at the whole of the basin. Systems are integrated...it's important that being in Delta you also understand the context of where we're at the outlet of a river system that is massive. It covers an area of about the size of Great Britain, all of Great Britain draining down and it basically comes out at Richmond, Delta, Surrey. It's useful to have a bit more of a broader understanding of what that whole system is. The problems are slightly different depending on where you are. There's big sediment problems, there's gravel removal problems in the Abbotsford-Chilliwack area, there's flood problems there but more related to the river and the size of the river. When you get down to the lower end of the river we're dealing more with ocean and river problems and sediment...It's good to have the broader picture. That's one of the aspects at FBC, if there's an issue that affects a number of municipalities (SF_E).

Similarly, speaking to the issue of institutional fit that goes beyond the regional focus and even Canada, another participant noted: "Every one of our neighbouring communities in the Metro Region, well beyond Metro Vancouver, and that's why it needs to extend beyond... it's not kind of a regional thing because it includes Squamish, Chilliwack, can extend into the United States. So the Fraser Basin Council I think they're well established to do that" (CoE_1).

A number of municipal participants saw FBC as an advocate for gaining funding from the higher levels of government given the important economic function that the region serves for

Canada. In this representative quote, an engineer in SF region stressed the importance of coordinated action across multiple scales:

People may not understand that **the flooding problem has regional and provincial and national implications**. We are the main port, for most of Canada, in terms of Western Canada and so if we lose the rail lines for weeks or months it's going to have huge economic implications. Therefore, you need someone to present the case to the broader community. That's partly what the Joint Program Committee does...they can make the case to the federal and the provincial governments that this is a shared problem and resources should be applied to share this. It's not just the local government. That's where a lot of value is provided. If you work in a coordinated way, there's probably more opportunities for funding to come through (SF_E).

FBC in turn was seeking to gain political influence at the higher scales of government by engaging with prominent actors such as the former Premier Mike Harcourt:

We're kind of are focused on a combination of climate and change and our unique geography, potential for flooding, we're kind of starting to invest in... we're inching towards a plan. I'm going to be seeing David Marshall, Fraser Basin Council, I helped them to get going in the '90s, to talk about how do we get financial commitment in the billions to increase the level and strength of the dikes and pumping system and deal with surges on the Strait of Georgia (Mike Harcourt).

In addition to accelerated collaborative municipal-level planning, the emergent SLR regime mobilized some key critical infrastructure players such as Port Metro Vancouver (PMV) and Airport Authority. A major player⁹, PMV, had been a member of JPC since its establishment. Recently, PMV also joined all the technical meetings which resulted in more active involvement and became their main avenue for regional engagement for flood management. When asked about the impetus behind this more active participation, SLR was identified as a primary driver: "Fraser Basin Council, their role is flood management and working with the Province and try and bring unity and try a more proactive way of dealing with floods. Mostly to do with freshets and mostly to do with Fraser River, but now there's the added entity of climate change. Sea level rise does impact the Fraser River and flood management is a concern. That's the impetus behind all this that we're doing now" (PMV_1). Additionally, climate change as an issue that entered public domain was also putting pressure for action (PMV_1).

⁹ Nearly 70% of municipal FMPs indicated that they collaborate with PMV with PMV ranking as the 6th highest organization for collaboration overall and as the highest ranked for a non-municipal level collaborator.

From a planning perspective, a more proactive engagement was also driven by a search for consistent regional approach. With PMV neighbouring sixteen municipalities that have differing approaches to flood management, consistency was seen as key to coordinated regional action. FBC was seen as a central platform for this coordination.

PMV interviewees acknowledged that a search for a consistent approach was a dynamic process where FBC was seen as a key mediating institution among other several players, such as Metro Vancouver and others: “That’s the beauty of Fraser Basin Council or Joint Program Committee which is... they’re all stakeholders” (PMV_1).

In other words, JPC served as one of the main platforms for inter-jurisdictional, multi-stakeholder regional collaboration. As a unique boundary spanning organization, it was able to overcome some of the common barriers for translating sp-R processes into gen-R outcomes: it was responsive and pro-active to changes in the needs of its stakeholders, its participants had longer-term institutional memory (through its core stakeholders and FBC staff), and it had the right institutional fit for the scale of the issue which enabled addressing sp-R from a more system-wide perspective.

As a non-partisan organization, FBC was seen as a more neutral platform to express stakeholder’s interests. It was also seen as an educator and a champion of local needs with a potential for gaining political influence at the higher levels of government. With a proven record of providing a platform for solving on-going and emerging issues, FBC had a positive reputation in the region with few municipal FMPs questioning directly whether it had sufficient institutional capacity to address SLR as a regional issue.

However, several concerns and criticisms were raised, especially from regional actors and actors at the higher scales of governance. Several participants suggested that they were contributing to FBC because there was “no other game in town” (MRLNRO_1) and it was in the absence of any other models or knowledge of any other models (PMV_1), that FBC seemed to be achieving some benefit for developing a regional strategy. However, despite the inherent benefits of this process that contributed to gen-R (e.g., learning, collaboration levels, investing in maintaining regional options) the benefits for sp-R were being questioned given the inherent weaknesses of this collaborative, consensus-based organization:

I don't think [FBC] will succeed in a way we need it to succeed...a great organization in terms of getting people to talk, but not a great organization in terms of accomplishing things. They **don't have the legislative authority, they don't have funding**, other than the contributors, and they can never really get major funding that way. They have an inherent strength and an inherent weakness and this regional flood strategy... What they have is getting people to talk and that's always a step, but it will never go anywhere unless the Province—and it is the Province, it's not the federal government—steps in and says okay we're going to lead this thing and it's going to run a certain way and we use FBC to help us with our communications and set up the meetings because there's huge amounts of that needed, right? They can fulfil a really useful role but they **can't lead an initiative like that and to actually accomplish stuff** (MRLNRO_1).

Similarly, another provincial staff member actively involved in sp-R expressed doubts about FBC's capacity to develop a regional strategy given its limited authority and the political issues among diverse municipalities:

...a system of flood protection needs to operate as a system... A flaw in the current flood management regime is that there is no official way of taking a regional and strategic approach to ensuring that the various parts of the dike system, for example, are maintained and operating the way that they ought to be so that you avoid dike failures that could impact more than one municipality... it makes sense just in the same way that watershed management makes sense. The challenge is that there is no official government entity that does that for that region...Fraser Basin Council is a boundary organization leading this initiative, which I think has a lot of merit... [but] it remains to be seen whether or not the entities involved can agree to a governance model and all of the sort of political aspects of how it would be arranged... I think FBC is doing a great job of facilitating the conversation and even organizing some local studies that will benefit multiple municipalities. A truly regional approach might be challenging just given that different municipalities have different interests and it could be a challenge to get them all to agree and to commit to some kind of long term plan. I think that is where the main challenge lies (MoE_1).

Another major downside of FBC identified by provincial interviewees was the perception of a sufficient level of action on sp-R that it generated, an action that was not possible by design given the lack of legislative powers: "I kind of have a love/hate relationship with [FBC] in the sense that I like what they're trying to do and the fact that they do get people to talk together and those [are] extremely useful, but **they've allowed various senior executives and politicians to get off the hook for what they're responsible for at the provincial level** and that's been a huge draw back, cause they can say "Oh, Fraser Basin Council's doing it", but they're not doing it, they cannot do it but it gives the perception of it". Rooting their evaluation in previous examples, the interviewee stated: "...that is precisely what happened in 2003/2004. The executives in the Ministry and the politicians whenever they were accused of downloading on

local government they said well we've given over a million dollars in one cheque to the Fraser Basin Council to develop floodplain maps, and this and that, of which they spent the money and did a few things, some useful things. Again, it was sort of almost more to create an excuse saying, well, we're looking after municipalities, we've given FBC a million dollars to develop tools so that they can do these things and it became the escape clause to avoid the criticism of the changes (MRLNRO_1)". Similarly, to the 2004 situation described by the interviewee, in 2014 the Province allocated \$1 million to FBC to assist with the implementation (Phase 2) of the regional flood management strategy (Province of BC, 2016). While it may seem as a substantial amount, it barely reaches the cost of an average house in Vancouver.

At the municipal scale, representation was seen as another barrier for the sp-R process to reach its full gen-R potential for collaboration, learning, and maintaining options. As identified by several interviewees, JPC was primarily comprised of senior engineers, so in this exclusionary structure the communication of potential solutions and negotiations as part of JPC were being filtered out by the participating staff:

I'm not part of the JPC because that's for higher level folks (SF_EP)

There are silos in terms of the senior engineering professionals who meet to discuss flood hazard management, e.g., the JPC, but don't engage with their colleagues, e.g., planners. So you get silos of information amongst staff and practitioners (SP_17).

More recently, reflecting changing professional practices and the scope of hazards, the meetings were attended by some planners as part of the conversation which spoke to the recognition of the expansion of flood management as part of the general development process rather than flood protection.

For learning, despite the high collaboration and influence scores, the long running, well-established regional scale JPC surprisingly ranked one point lower (43%) compared to a limited in geographic scope SLR-Collaborative (44%). As Armitage, Marschke, & Plummer (2008) suggest, in formalized settings such as JPC, stakeholders mainly engage in bargaining (defending entrenched positions) rather than open innovative discourse partially due to lack of resources (e.g., time, funding) being available for experimenting and visioning. Combined, this constrains effective higher levels of learning, a barrier that was less constraining for a more inclusive SLR-Collaborative. This point was also highlighted by one of the SLR-collaborative organizers:

Our municipalities are so independent from one another, they're all competing with one another, they all have different levels of demographics and income, they have very little standardized help for regional collaboration from the higher levels of government, so it's a really difficult prospect for them...the Sea Level Rise

Collaborative...that's a direct reflection of the total lack of institutional capacity for regional collaboration and government at the municipal level. Municipalities say they are not helped by Metro Vancouver, they're helped more by the Fraser Basin Council, but even the Fraser Basin Council doesn't have the capacity to help them at this level we're trying to do which... acknowledges their individual capacities, but help communicate with each other in a really in-depth way, and tailor resources to their needs (SFU_ACT).

Overall, due to the lack of implementation capacity and general orientation towards the lowest common denominator, the FBC was firmly positioned as a platform to share rather than a platform to lead. The leading municipalities were frustrated by the slow collaborative pace and the less detailed FBC's studies, given their own significant individual investments in studies. Commenting on the defunded provincial capacity, scope, and timing of coordination efforts, a senior engineering manager noted the time lag between the individual municipalities' progress and regional collaboration timeline organized through FBC:

The Province... we're trying to work with them but they have limited staff and budgets so a lot of our work now is being coordinated (coordinated is the best word I'd say) through the Fraser Basin Council for whatever concerns or issues or challenges we may have – Surrey as a City. The only challenge is... the timing, the cost, and basically what the priority is to all the various communities. Some cities invested a lot of time and effort and therefore money into this and maybe some of our other neighbours haven't. So, we as a city have to decide when we work with FBC are we content with their schedule and their scope or is it work that we're going to have to do on our own, recognizing that maybe FBC will also do this work but it may not be for several years (COS_E2).

This created a collaboration based lag for active municipal planning efforts, with staff from some municipalities commenting that while waiting for FBC strategy to be developed their own municipal-level action on the issues was being forestalled: “[Action on flood management]...it's kind of been slow because they're trying to figure out what FBC and the Joint Program Committee are doing” (SF_EP). By trying to cater to all (with the leading municipalities being ahead, while the smaller least resourced being behind), it was unclear how the historically prominent issue of equity in sp-R funding was going to be addressed. As a senior staff from FBC suggested when asked about what the funding model would look like for the regional strategy given the differential capacity within the region:

... we don't know yet. We're trying to serve all and when we review the current management practices and policies there may be some insights that come out of that about the capacity to manage the issue. If there was a funding program perhaps there would be provisions around equitable access. There might be greater influence in terms of the vulnerability. So if there is a small rural community that had a lot of critical infrastructure going through it I would expect that that still would be a high priority. If there was relatively little regionally significant vulnerability then that might be a lower priority (FBC_1).

Overall, across resourced and least resourced municipalities there was a unanimous recognition that they will not be able to address long-term SLR issues without dedicated and long-term support from the higher levels of government. FBC was seen as a central actor for this advocacy role. However, relying on FBC to lobby the higher levels of government reduced the potential for self-organization and gaining political influence at the municipal scale. This over-reliance on FBC can serve as a barrier for regional gen-R.

In addition to boundary organizations, individual boundary spanners –individuals who link their organization with the external environment (Williams, 2002)—played an increasingly important role. In that sense sp-R planning through FBC was functioning as a distributed system by using lateral protocols based on equality of relationship as opposed to a decentralized system, which would use hierarchical protocols where a higher scale actor would control the lower ones. Yet, when it came to transfer of the knowledge within each municipality it was highly reliant on the capacities of the participating senior engineers to transfer knowledge to the organization. As a key boundary organization FBC was “trying to stay in communication and not duplicate, and complement what the different groups are doing” (FBC_1). While coordinated action has clear benefits, municipalities by relying on FBC to represent their interests at the higher levels of governments were reducing their potential to self-organize and gain political influence at multiple scales, thus compromising their sp-R influence and collective gen-R. The FBC staff were cognizant of this need for asserting political pressure at the higher scales as voiced by this interviewee:

On the local government side of things, [politicians] really influence the kinds of land use decisions that are made and whether or not those decisions increase community vulnerability or don't. Local elected officials have also been quite active in lobbying senior levels of government for financial assistance. Ultimately, it will be those senior level politicians that decide whether or not this issue is part of their budgets (FBC_1).

The discussion above shows that non-governmental networks can play an important role in disseminating knowledge, encouraging learning, and legitimizing and prioritizing climate

change mitigation and adaptation. Learning through shared platforms can lead to convergence in knowledge and perspectives, promoting communication and thus coordination and synergies as similar learned practices are adopted. FBC's JPC served as one of the main regional platforms for information exchange, solutions sharing, and collective sense-making. The choice to embrace SLR in addition to the historic river focus, and the choice to address risk rather than the historic hazard focus showed the agile and responsive nature of this boundary organization. However, FBC lacked implementation authority, relying on slowly-paced consensus driven policy creation and voluntary adoption of the policies and best practices developed which maintained fragmented approaches to sp-R. While coordination and collaboration in regional planning is achievable without the participation of the higher levels of government as an active partner, implementation will require its active role as a partner, especially in the domain of SLR: "Resources and jurisdiction. Because ... as soon as you go out to the water then it's the feds" (SF_EP).

FBC JPC was an unquestionably leading organization for regional sp-R planning with its focus on long term adaptive capacity developed to stressors and changes in flood risk. From an institutional perspective, JPC was striving to address some of the key governance barriers. Its watershed-based planning was aligned with best practices in the literature for addressing the problem of fit between the issue and the system governing it. The organization was funded by members, meaning a literal and figurative buy-in to the importance of institutions such as JPC. The decision-making structures were concerned with regional prioritization but tried to avoid politicizing issues. By developing long term capacity to manage change, including political influence across the scales, this mediating institution served as the main platform for shared collective decision making by developing regional sp-R repertoires that would go beyond the jurisdictional boundary of each individual municipality. Its strengths, such as planning and decision-making through a consensus-based collaborative model and focus on regional prioritization for sp-R, yielded procedural benefits for gen-R with regard to human and social capital, regional learning, and regional collaboration (Table 6-4).

Table 6-4 Summary of key findings for FBC's JPC and Regional Flood Management strategy

Gen-R indicators	
Human capital and social capital	Historically senior municipal engineers, recently some planners; expert regional stakeholders (e.g., critical infrastructure managers); ad-hoc engagement of academic and other partners. Lack of First Nations as part of regular meetings.
Collaboration, self-organization, political influence	Regular face-to-face meetings, a leading collaborative platform, however, overreliance on JPC leads to less lateral self-organization between municipalities, which, while contributes to coordination, constrains their collective political influence.
Learning, experimentation and innovation	Engagement in issue-specific regional studies (ranging from hydraulic models to regional risk studies)
Maintaining options for the future	Explicit focus of the regional flood management strategy development by connecting science to policy (key function of boundary organizations).
Institutional continuity and memory	Established in 1997, history of responsive and agile approaches to changing sp-R needs of the region/Basin. High reliance on key staff (one key person leading the portfolio over the years) which presents a vulnerability to institutional continuity.

However, several concerns were expressed regarding the reliance on the organization by the province to do its job, its piece-meal funding, and the reliance of the municipalities on the FBC to lobby on their behalf at higher levels of governance, all of which presented a potential barrier for gen-R. While it allowed for more coordinated action (a clear benefit) this arrangement also prevented municipalities from actively self-organizing to develop shared political influence for sp-R outside of JPC. Only the larger municipalities (e.g., CoV and CoS) were capable to lobby across multiple scales individually, as well as chose at which pace and what projects they contributed to FBC, given their more advanced planning. The equity concern (e.g., smaller municipalities' access to knowledge, consulting, funding) was something that FBC was trying to address; however, it was rather unclear how it could do so. Equity was also a concern when it came to the ability to maintain options, a key factor of gen-R.

6.6 Maintaining options: from historical path-dependency to future options

Gen-R is rooted in history. To better understand gen-R it is important to incorporate historical knowledge, the use socio-ecological memory, and a long-term perspective (Redman, 2014) into the analysis of current flood management regime. For disaster risk reduction process to be effective, the process of disaster risk creation needs to be understood across temporal, spatial, jurisdictional and other scales: “The unfolding process of risk construction and thus disaster creation starts from contradictions or contrasting or conflicting goals within the structures of the socio- cultural systems, leading to internal functional disorder or dynamic pressures” (Oliver-Smith et al., 2016, p. 20).

Regional capacity to deal with change is a product of complex historic decisions at different scales of governance. Understanding the history of flood management in BC is important because it has direct implications for current and future sp-R and gen-R. Drawing on the path-dependent and incremental organizational and institutional changes analyzed in the previous chapter, in this section I focus on the interplay between the provincial, regional, and municipal scales to answer the following question: How do historic sp-R planning decisions influence (enable or constrain) options for enhancing gen-R? Answering this question allows exploring a key factor for gen-R: the ability to maintain options to adapt in the future.

As illustrated in Chapter 4, historically development in the Lower Mainland was directly dependent on structural protection from floods. In the mere 70 years of intensive diking that began following the devastating 1948 flood the region has become fully accustomed to nearly flood-free living that intensified co-evolution of development and risk, resulting in a low public memory of flood events. Drawing on Chapter 4, I highlight the antecedents of the shortcomings and successes of the modern flood management regime by combining historical evidence with primary interviews and survey data. As the Chair of the Lower Mainland Local Government Association Flood Control committee and a Councillor from a municipality located in a neighbouring regional district stated: “When I look long-term and I look back at some of the decisions that are being made, some of those decisions probably impacted negatively within what we need to do in the future”. In understanding future options, previous and current management decisions need to be placed in a historical context.

I begin this historical analysis with a reminder of the magnitude of the natural assets – the Fraser River and the Burrard Inlet, the two main protagonists around which the flood

management regime (and this dissertation) revolves. As Bruce Hutchinson, Canada's prominent journalist and author wrote in 1950:

No man stands beside the Fraser River without sensing the precarious hold of his species upon the earth. The fact is disclosed, perhaps, by all of the nature's largest spectacles, but here it is thrust upon you with a special clarity. In this grisly trench, bored out of solid rock through unimaginable time by the scour of brown water, the long history of lifeless matter, the pitifully brief record of life, the mere moment of man's existence, are suddenly legible. And here, in this prodigal waste of energy, nature's war on all living creatures is naked, brutal and ceaseless (p.3).

In the 1982 edition of his book, Hutchinson noted that strangers in British Columbia would hardly realize the extent of man-made change along the river, not only physical but psychological change: “A type of people far different from pioneers has come to settle, to farm the benchlands, log the forests, lay down paved speedways and give the wilderness the benefits of modern civilization” (n.p.). Once small and ‘primitive’ Vancouver full of stumps and clearing fires, turned into a soaring metropolis, the river’s unlikely child and one of the world’s greatest ports” (n.p.) and then eastward, the fertile delta, “made of river silt in time unimaginable, has sprouted towns and industries constantly encroaching on the precious croplands” (n.p.).

The Fraser flows into the magnificent Burrard Inlet. The Burrard Inlet is part of the Strait of Georgia, a semi-enclosed waterway located within the broader “Salish Sea”, which encompasses the Strait of Georgia, Puget Sound, and Juan de Fuca Strait. The Strait of Georgia is a unique ecosystem rich in biological diversity which has been threatened over time with pollution due to population growth (nearly 75% of British Columbia’s population lives close to the Strait and the Fraser River), industry (pulp mills, logging, shoreline developments) and spills (such as sewage discharge and oil spills) (Beamish and McFarlane, 2014). As these brief descriptions of the Fraser River and the Burrard Inlet show, economic interests have been driving development at the cost of environmental degradation. The social costs of these developments were particularly concentrated within groups of Indigenous populations.

For thousands of years this region was inhabited by diverse groups of First Nations. In the late 1700’s, when settlers began visiting the Northwest region, they reported vigorous, richly diverse, and strong cultures, with an obviously notable exception of the Strait of Georgia culture (Glavin, 2014). A catastrophic smallpox plague in the late 1700s decimated the local population to small remnants. The journals of the first European explorers present a post-apocalyptic portrait of a radically diminished society with deserted villages surrounded by heaps of bones

"promiscuously scattered about the beach in great numbers" as recorded by Captain Vancouver (Glavin, 2014, p. 273). As one estimate suggests: "In the century or so after the first arrival of European infectious diseases, native populations throughout the Western Hemisphere commonly declined by some 90 percent: that, in all probability was also the magnitude of decline in British Columbia. If so, then the population of the province on the eve of the first epidemics was well over two hundred thousand people, of whom more than fifty thousand lived around the Strait of Georgia and up the Fraser River to the limit of Coast Salish territory. If population decline was on the order of 95 percent, then these figures are doubled" (Harris, 1994). Accounts of oral tradition in the region suggest an unimaginable degree of cultural resilience. Harris (1994) cites Old Pierre, a Katzie, who lived along the Pitt River whose recollection was influenced by the missionaries: "The time came, he said, when the land was "overcrowded." When people "gathered at the Fraser River to fish, the smoke from their morning fires covered the country with a pall of smoke." Then the "Lord Above" sent rain that fell until most of the mountains were covered and most people had drowned. After the flood, the population multiplied again and "the Lord Above ... saw that once more they were too numerous in the land." Then snow began to fall in October and soon every house was buried. Nine months passed "before the snow melted completely from the house-tops" and half of the people died of starvation. A third time as the population grew, came the smallpox epidemic as described by old Pierre:

Then news reached them from the east that a great sickness was travelling over the land, a sickness that no medicine could cure, and no person escape. Terrified, they held council with one another and decided to send their wives, with half the children, to their parents' homes, so that every adult might die in the place where he or she was raised. Then the wind carried the smallpox sickness among them. Some crawled away into the woods to die; many died in their homes. Altogether about three-quarters of the Indians perished (Jennes (1955) as cited in Harris (1994, p. 597).

Through waves of epidemics of complex European infectious diseases that together were far more devastating than any one alone, the land was virtually depopulated over a century at the time that changing technologies of transportation and communication reached the northwestern corner of North America, "an almost empty land, so it seemed, for the taking" for the benefit of the capitalist world economy. In the late nineteenth and early twentieth centuries, as railways multiplied, speculations proliferated, and boosterism filled towns, the Indigenous populations further dwindled, restricted to the reserves as wards of the state, segregated from the mainstream of white society (p.617).

Diking played an important role in this colonization process. A large scale transformation of First Nations territories and ‘the wilderness’ into farms, transportation, energy infrastructure, and communication corridors linking the Lower Mainland with the Interior began by Samuel Brighouse (Smith, 2004), a white settler who in 1864 purchased 697 acres in what is today the downtown core of Richmond where he grazed cattle and initiated the diking of Lulu Island (City of Richmond, 2016). Initially, the colonial, provincial, and federal governments relied on the individual settlers to reclaim floodlands (Collins, 1975). The history of reclamation was full of land speculation, failures, and broken promises. The interplay between opportunistic land investments, rugged individualism, and the government’s willingness to support these initiatives resulted in a patchy network of dikes and flood protection in the region.

Historically, the two pillars of prosperity for the Fraser Valley – agriculture and resource extraction – rested on controlling and harnessing water to power industry and to enable the resource economy (Watt, 2006). For example, in Surrey, in the late 1800’s, farmers in the area began reclaiming the land for agricultural purposes through the installation of dikes and canals. Over time, changes in land-use patterns such as logging and increased development resulted in intensified run off and increased localized flooding which resulted in litigation from farmers against the City (COS_E2). One of Surrey’s three floodplains, the Nicomekl and Serpentine Rivers, historically an intertidal zone, is located close to sea level. In 1910, the Surrey Dyking District was formed under the Drainage, Ditch, and Dike Act with a mandate to construct sea dams on both the Serpentine and Nicomekl Rivers. The sea dams consist of gates which open when tides are low to allow fresh water to flow to Mud Bay. When tides are high, the gates prevent brackish (salt water) from migrating up the river into farm land (CoS, 2016). As an example of a reinforcing feedback loop of increasing flood risk, as time went by the dikes in agriculture-based settlements were built higher and higher and the water inside the dikes became increasingly an issue as the dikes kept the rain water in. In order to deal with that extensive and interdependent drainage systems were created. These drainage systems required an additional form of social organization, moving from actions of individual farmers to more organized collective action on floods, an approach which was institutionalized through Dyking Districts and Drainage committees. As the Director of Engineering in Richmond stated: “Most municipalities typically get established as water districts so that’s really the first level or coordination of interested parties or land owners... They go onto a common water source and

distribution system and that grows into a municipality and into a city and all the other services that we provide". As the human-created flood risk feedback loop got more complex so did the collective action and institutions in response to it.

In the second half of the 19th and early 20th century, "these dyking, drainage, and reclamation projects represented the imposition of the settlers' aspiration for new uses of these lowlands, once very different from those nature intended" (Smith, 2004, p. 21). In 1912, when considering how to 'beautify' Vancouver's beach that ringed English Bay, the city's park commissioners were advised by renowned town planner Thomas Mawson to construct "a seawall of rugged stone work, with a simple severe balustrade, after the manner of those so often seen along the Italian shores, say Como, where the piers which stand along the walk level are of one piece of roughly squared granite with length of simple iron work" (Muir, 2014, p. 290). As a large scale Europeanization of the landscape continued, the industries were growing. By the 1920s Vancouver was engulfed in serious air pollution from cheap low quality locally mined coal, wood smoke and commercial pollution with the stench of the rotting salmon leftovers from canning industries drifting out of the river on the ebb tide, spreading around Point Grey as far as the water around the easternmost Gulf Islands (Muir, 2014).

These reclamations projects that began throughout the Fraser Valley as private enterprises would not have been completed without public subsidies and control and interventions following the 'super freshets' of 1894 and 1948 (Collins, 1975). The 1894 flood was much more than just financial damage; it was a significant challenge to agriculture in an era when successful farming was an indicator of progress (Watt, 2006). The actions by the government following the two largest recorded floods were focused on physical reconstruction but more importantly on rebuilding public confidence and citizens' morale. Until the extensive diking was developed "the major floods of 1876, 1882, and 1894 as well as frequent minor inundations ruined crops, bankrupted farmers, tore up roads and bridges, depressed property values, and reduced the profits of service businesses. Obviously, until the entire area was protected from the spring freshets, profitable farming operation would be restricted to the available high ground" (Smith, 2004, p. 22).

Following the catastrophic flood of 1948 that leveled communities and washed away agricultural land, a renewed support for public morale and especially of farmers whose commitment to the region was shaken by the devastation was needed. Confidence in the

management of flood protection infrastructure needed to be restored urgently to ensure continuous development. The Prime Minister at the time gave a mandate for the Fraser Valley Dyking Board (comprised of three civil engineers) to “give to the people of the Fraser Valley a greater sense of security than they have known hitherto for their homes, their families, and their futures” (Watt, 2006, p. 264).

This work faced numerous challenges (e.g., long stretches of peat islands, sand, and coarse gravel that were ill-fit for the foundation of the dikes) which were overcome “with careful engineering” (Watt, 2006, p. 267). The recovery after the 1948 flood was focused on bringing back public confidence in the region rather than ensuring long-term longevity of the diking system. As illustrated in an excerpt from the 1950 Fraser River Board’s Final report (Figure 6-6), recovery work started immediately without proper studies or assessments and this flying start “was faced with many problems where empirical decisions, based only on judgement and experience had to replace the usual tedious surveys and calculations” (Fraser River Board’s Final report, 1950, p.11). The rapid construction works were finalized in 1950 in time for the freshet season despite lack of time for appropriate design, development of more permanent installations, or the use of better quality materials.

The Engineering Problem

Under normal engineering practice a project such as ours involving expenditures of close to ten million dollars would demand a period of at least a year of economic studies, preliminary investigations, hydrological surveys, soil surveys and structural design.

Construction proper would demand at least another two years and possibly, three, depending on weather.

Conditions, however, in the Fraser Valley after the last flood completely precluded any such orthodox approach. Physical Damage was appalling and the understandable unrest and uncertainty of the residents even more serious.

Immediate and visible action had to be taken, not only to repair the flood damage to the dikes, but start on the reconstruction of all dikes, so that the residents could recover some measure of confidence in themselves and in future living conditions in the Valley.

The Board started both projects simultaneously and within a week of its first meeting had men and equipment visibly at work.

The wisdom of this move has been amply demonstrated during the past six months. Mentally and physically the valley is today almost back to normal.

But in making such a flying start the Board was faced with many problems where empirical decisions, based only on judgement and experience had to replace the usual tedious surveys and calculations.

Figure 6-6 Recovery from 1948 flood: engineering solutions to boost public morale.

Source: Fraser River Board’s Final report (1950, p. 11) in Watt (2006, p. 267).

In addition to structural changes, a key institutional change that defines modern day approach to structural protection in BC, the Dike Maintenance Act, was adopted after the 1948 flood as many dikes failed during that event due to inadequate standards and inadequate maintenance. It was felt at the time that the Provincial government needed to provide oversight over the dike authorities to ensure adequate public safety. The eroding quality of the hastily constructed dikes remained a continuous concern throughout the years, starting as early as 1963 (when the Fraser River Board called attention to the deterioration of the dikes in the fifteen years since they had been built to bring them up to the post-1948 standards).

With regard to non-structural approaches, a key promising institutional change of the era occurred in 1949, when the Province established the Lower Mainland Regional Planning Board (LMRPB) covering an area from Hope to the Georgia Strait. As described in Chapter 3, the region was a leader in the early adoption of regional floodplain *risk* management practices in BC through its 1966 *Official Regional Plan (ORP)*. The plan called for keeping the floodplains free of urban uses except where historical development existed that would be subject to floodproofing. However, the Board was dissolved in 1969 and its planning functions divided amongst four regional districts (APEG BC, 2010) including the Greater Vancouver Regional district created in 1967.

Historically, multi-level governance dynamics and issue-specific politics over conflicting perspectives on appropriate land-use has been a strong influential factor in shaping the direction of regional planning in BC. As discussed in Chapter 4, in the mid-1960s, the predecessor to the GVRD, the LMRPB, a progressive plan that addressed *flood risk* and land use, posed a threat to provincial power by engaging in open criticisms of provincial land use policies (Artibise, Cameron, & Seelig, 2004). The plan was terminated. In the early 1980s, the GVRD planning committee opposed provincial support to remove a particular piece of land from the ALR. The owner of the property was a long-time supporter of the Social Credit, a party in power at the time. The province responded by stripping *all regional districts of their planning powers to allow this specific municipal land-use decision to go ahead*. As a result, all regional plans and official regional plans prepared prior to that time got cancelled: “the province justified its action by saying that regional planning was redundant, in view of advanced level of municipal planning then in place” (Artibise, Cameron, & Seelig, 2004, p. 200). In 1986, the Municipal Act called for municipalities to create Official Community Plans (OCPs) in lieu of larger Official Regional

Plans (Lyle & Mclean, 2008). However, the effectiveness of OCPs as key land use mechanism for regulating flood risk has not met its indicated potential as discussed in Chapter 5, given their municipal rather than regional focus.

Historically, multi-scalar dynamics have been crucial for determining approaches to sp-R of the region. The Federal-provincial *Fraser River Flood Control Program* (1968-1995) worked to provide “cost-effective flood protection to large areas of existing development in the lower Fraser Valley” by bringing dikes to a minimum standard to withstand the 1894 design flood. Out of 44 proposed projects, 19 were completed, 3 partially completed, 22 never started. Dike protection was built or improved along 247 km of dike (half of which aimed at rebuilding the hasty post-1948 construction) and 23 pumping stations were built to protect 55,000 hectares of floodplain. At this time diking was a provincial responsibility, and a more coordinated and funded approach was used (MNFLRO_1).

In addition to enhanced structural protection, the FRFCP had developed a mechanism for institutional memory and continuity by consolidating information about river management in a single place, acting as a lead agency on flooding issues, providing a continuous source of technical expertise, as well as being a source of funding for critical problems which endangered Program works. It claimed to have served as a mechanism to hold and negotiate tensions between the multiple competing issues with river management over three decades: “the FRFCP responded to a changing environmental and social consciousness and worked to balance not only the objectives of public safety and flood damage reduction, but also a host of sometimes conflicting objectives including community development and natural resource extraction” (Environment Canada, archived page). Under this program the capital works were funded by provincial and federal governments on a 50/50 basis while local governments were required to provide right-of-way and maintain the works.

This approach was terminated in 1998 and municipalities were left with the dikes and distributed dike authorities. Diking Authorities were obliged to have a flood response plan, which had to be integrated with the *Local Authority Emergency Response Plan*, and provide emergency response. This decentralized responsibility for dike maintenance resulted in further erosion of the quality of dike protection (below the designated 200-year flood event), and a number of orphan dikes (that do not meet the standard and do not have a responsible care taker assigned to them) (Arlington, 2012).

Toward the completion of *the FRFCP*, the performance of the program was reviewed by a Task Force comprised of municipal, regional, provincial, First Nations representatives, and federal officials. The review concluded that FRFCP has spent the funding allocated “responsibly, and has fulfilled the requirements of the 1968 agreement in an efficient, cost effective fashion” (p. ii) with “only the projects with benefits greater than the costs” being completed (Fraser Basin Management Program, 1994, p. 54). However, the review also raised a number of questions and recommendations. The report highlighted the residual risks such as dike failure due to an earthquake, dike overtopping or breaching during prolonged high water combined with a continued development of a floodplain as a growing unfunded liability. The report also suggested that this liability should be funded by residents of the floodplains, especially those who choose not to floodproof as opposed to relying on higher levels of governance for disaster assistance.

The following paragraph summarizes the overall sentiment of the report:

Given the current philosophy, if the Agreement was being negotiated today, some of the aspects of the Program might be done differently. Environmental and social aspects might have been included in the benefit assessment, affecting project selection. Provision for consideration of the special circumstances of the Indian reserves, and possible special eligibility criteria, might have been included. With the current federal and provincial environmental assessment requirement, all projects would have been subject to a detailed environmental assessment. There could have been more emphasis placed on set-back dikes, consideration of biological methods of bank protection and a stronger emphasis placed on the uses of non-structural control methods (Fraser Basin Management Program, 1994, p. 54).

This statement signals a considerable change in the framing of flood protection and management from a narrow focus on protecting the most valued properties and lands through engineering solutions to taking into the account social and environmental costs and consequences of such actions by exploiting multiple options. In other words, it shows the progress towards situating sp-R within broader sustainability objectives and gen-R aspirations.

These changing values were somewhat institutionalized through subsequent provincial policy changes and regulation. The updated Dike Maintenance Act of 1996 provided for the provincial role in structural flood protection and it gave the Inspector of Dikes and other provincial staff authority to enter on to a dike, inspect a dike, even on private land, and also to issue orders with respect to dike safety, and to fix any critical dike issues. Generally, the Act did not give the authority to upgrade a dike which is a political decision (MFLNRO_1) given the funding arrangements in place. Reflective of changing values at the time, for any new dikes and

other hard protection, an approval had to be obtained from the province under the *Water Act* and the *Dike Maintenance Act* and, where applicable, from the federal government under the *Fisheries Act* and the *Environmental Assessment Act*. These changes showed a more distributed shared responsibility and an increased provincial oversight at the time.

Overall, during this era, the key to defining sp-R was a shared responsibility approach across multiple scales of governance. When examined across the temporal dimension and spatial dimensions, gaps in the multi-scalar governance arrangements of this shared responsibility also resulted in concentrated pockets of flood risk. For example, in the historically settled “Urban Exempt Areas” (UEA)¹⁰, provincial and local governments, as part of flood plain management policies, have exempted high density historical areas from floodproofing requirements. Since the 1970s this policy allowed rapid growth, development, and redevelopment of those areas without any floodproofing measures by relying solely on structural means for flood protection. Over the years, several reports have called for a need to address concentrated vulnerability in these areas (Fraser Basin Management Board, 1996; Lyle & Mclean, 2008; Arlington, 2011; FBC, 2016) especially given the differing strategies that each of the municipalities chose to pursue as they grew and developed. This overreliance on structural protection in certain areas is not unique to BC and was partially enabled by the program at higher levels of governance. Under the federal *Flood Protection Reduction Program* (FDRP), with rare exceptions, development behind a ‘certified’ dike did not have to be floodproofed. For example, in Winnipeg, Manitoba new houses that were protected by the Primary Dyking System required backflow preventers while new houses protected by the Secondary Dyking System were required to be elevated using fill (Shrusbohle et al., 2003).

These communities represent a classic illustration of a ‘levee effect’ (Tobin, 1995) where an area behind a levee develops given the false sense of security and places more assets at risk, as the levees eventually overflow. These areas also present an unfunded liability for the government across the scales of governance. As one of the provincial level interviewees puts it: “...exempt areas, like in west Richmond... we would approve subdivisions in this area and even

¹⁰ These communities include Downtown Chilliwack, Clayburn and Matsqui villages in Abbotsford, Agassiz, Harrison Hot Springs, Ladner, Richmond, downtown Port Coquitlam, downtown Squamish, Brackendale, Queensborough, New Westminster Quay, South Westminster and Crescent Beach in Surrey, and parts of Haney and Port Hammond in Maple Ridge (Arlington, 2011).

Terra Nova... There were some complicated rules for how these areas got established based on different designations and different plans and all that kind of stuff, but it was all formalized for these communities" (MRLNRO_1). Speaking to a hypothetical example of unfunded liability at the municipal scale that would be transferred to the higher scales of government in a mass casualty event subject to liability lawsuits: "If we get a dike failure and downtown Chilliwack floods [UAE], there's likely to be fatalities. There's the one thing what government pays, but then it's the lawsuits. They'll dig out documents and say there's a...seniors home built to grade contrary to the rules. Say 50 people die in one of those homes, the families will then say well why was that structure permitted?...The City's got limited pockets and Province and federal governments have bigger pockets and in a disaster people say "well, it wouldn't have mattered anyway" (MRLNRO_1).

In MVR, this levee effect is of regional scale with impacts that could overwhelm most municipalities given the interconnectivity and interdependence of infrastructure systems and movements of human capital. A regional flood would also pose a significant resource and economic drain on the Province by impacting the most populated and wealth-generating region in BC. With the removal of provincial oversight over the politically-driven economic growth, the Province has been accumulating risk and unfunded liability across multiple scales of governance, a process further enabled by the 2003/04 legislation change based on an issue-specific lobbying: "...prior to 2003 there was a system for providing flexibility and where the province would share the liability. But some politicians at the time notably former mayor of Chilliwack, who became a Provincial cabinet minister took it upon himself to get rid of this program as an impediment to development and a news release accompanying the changes referred to red tape several times and the local governments there wanted the freedom and all these kinds of words, so it was portrayed as a barrier to economic development" (MRLNRO_1).

The historic analysis above shows several important underpinning trends that will explain the path-dependency and imprinting that happened to the provincial approach to sp-R and in turn influenced gen-R. Gen-R is also defined by the ability to address *path-dependency*, or the dependence of the state of a system on its history, through pro-active planning. As Coaffee and Lee (2016) suggest, how localities and communities cope with path-dependency and how successful they are at breaking into new streams of action is a core variable explaining why some regions are more resilient than others. In normative terms, this ability includes positive and

negative resilience. Positive aspects include building on long-term historical knowledge of resilience practices and connecting them to modern-day operations, on maintaining institutional memory through a narrative of resilience or succession planning, and on maintaining institutional reservoirs of options. The negative side of resilience can be exemplified by persistent oppressive regimes that maintain their resilience at the expense of sub-groups (e.g., by systematically excluding certain groups for the benefit of the others). Designing institutions, systems, and structures in a way that maintains future options while learning from and addressing the failures of the past is another core aspect of resilient systems.

In what follows I explore how these path-dependent trends underlie the changing interplay between sp-R and gen-R, set against the backdrop of continued historic analysis of the contemporary era. I examine major policy changes—the 2003/04 change and the emergence of SLR planning—as major influential factors for institutional changes for sp-R and gen-R.

6.6.1 Sea change to sp-R policies: what's province got to do with it?

Barriers: lack of clear provincial guidance (top 4th at 83%);
lack of strong leadership at the provincial level (76%);
poor coordination with provincial levels of government (73%)

In this section I discuss two major policy changes that directly impacted the multi-scalar distribution of shared responsibility for sp-R, and the institutional responses generated which in turn impacted gen-R. Given the nature of the actors involved in sp-R governance it is particularly important to understand hazard mitigation and disaster reduction policies as cross-scale dynamic processes.

As previously described, a fundamental shift in redistributing the authority for sp-R occurred in 2003/04. Prior to this change, from 1975 to 2003, the Ministry of Environment (and its related name changes) administered the Floodplain Development Control Program which was built primarily around two main pieces of legislation: 1) Section 82 of the Land Title Act which said that an Approving Officer cannot approve a subdivision in a floodplain without the consent of the Minister of Environment, which allowed for direct provincial oversight in setting conditions and development of a policy of flood proofing, and 2) Provisions in the Local Government Act indicating that if a local government was going to enact a floodplain bylaw (which wasn't mandatory), that bylaw needed the approval of the Ministry of Environment

(MFLNRO_1). In tandem, both provisions worked “very well” to share responsibility and liability through a negotiation process between the scales of governance:

...taking on the bylaw side of things a local government would say: well, look this historical area, we cannot floodproof practically in there. So the Ministry would say: okay, that's a historic area, it will have a bit of redevelopment, we won't worry about floodproofing that but your new development is going to be focused in this other area, which can be floodproofed because it's not tied to existing grades of roads and things, there would be new roads and fill...So we'll set up the bylaw [to] maximize the amount of floodproofing for the new development and address some of these historical issues and then sign it off. That becomes an approved bylaw with these major exemptions that the community wanted, right? In that sense the Province and the local government shared the liability because the Province signed off on those exemptions. If those areas got flooded then the Province was there because they approved that (MFLNRO_1).

What this means is that prior to 2003, the Province had a direct role in approving subdivisions under the Land Title Act and approving bylaws under the Local Government Act (MFLNRO_1). A MoTI Subdivision Approval Officer was required to refer all subdivision plans for lands subject to flood hazards to MNFLNRO, and MFLNRO was involved in assisting local governments with the preparation of floodplain bylaws (MFLNRO_1; APEG BC, 2011). Under the current regime, this authority has been delegated to local governments, and MoTI no longer refers subdivision applications to MFLNRO:

The key thing before 2003 was the subdivision and major developments usually involved, not always but probably 90% of the really big developments required some kind of legal adjustment of land and that triggered the subdivision approval, by the ministry, except for the exempt areas. That was really the strongest part of that program and I think fairest too because when people subdivide, they have to follow whatever development rules there are. If you have an existing lot that there's a much more sense of entitlement to be able to do whatever else can do, but if you subdivided something, it's something new and, of course you have more potential to make money on the development side but also there's much more freedom for the regulatory agencies to put in different rules (MFLNRO_1).

This removal of oversight resulted in a potential for a regulatory capture with local approving officers becoming close to their councils and “they may not have a good understanding of flood hazard or their staff, depending on the size of the municipality and the sophistication or political pressure by developers or whatever” (MFLNRO_1). These changes significantly weakened any higher-scale oversight over municipal development leading to inconsistent policies and decision making based on political priorities with a potential to prioritize economic growth objectives rather than long-term public safety objectives.

To facilitate the development process, MFLNRO provides land-use guidance in the form of the *Flood Hazard Area Land Use Management Guidelines* (the Guidelines) which were published under the *Environmental Management Act* in 2004, at the time when the Province changed legislation (MFLNRO_1). With this delegated authority, risk was also transferred to municipalities as noted by a municipal engineer in the SF sub-region:

...what's concerned us a lot is the handing down of the risk...to the local governments if they approve something. The concern going forward is that at what point does the provincial government step in with funding to address something that was approved by the municipality? That risk transfer concern is a big one. I think it's better if it's shared with the broader community, but there's different models and we're working under the current model. In some municipalities...[2003/04 change has] been viewed very positively...I didn't think this previous system was broken, per se, but from a developer perspective I can understand that it added delays...and that can be pretty significant costs. The delays may be totally legitimate but they couldn't just deal with the local government to address the concerns and that's what it's done, it's allowed the local government to address the concerns and sometimes that is faster... (SF_E).

This observation was strongly supported in the provincial policy review conducted by Arlington Group in 2008 as illustrated in this representative quote:

Downloading of the responsibility for flood plain management from the province to the local governments has placed greater pressure on local governments to deal with applicants, without additional resources. Local governments now have to be the 'bad guy' to say no, and are under pressure to be innovative in finding ways to approve. We continue to be uncertain about our exposure to liability for such decisions (Arlington, 2008, p. 42).

Within this regime of transferred risk, LGA S. 910 requires local governments to 'consider' the provincial guidelines when adopting a bylaw. However, as pointed out by numerous interviewees at the municipal, regional, and provincial levels, there was lack of clarity within the regulation especially around the meaning of the terms "must consider". Part of the lack of clarity was the wording as expressed by several provincial interviewees:

They don't have to adhere to them; that is their choice (MoE_1)

"Consider" is an interesting one from a legal perspective: it's not a mandatory obligation on the part of local governments either to adopt a bylaw or to actually follow the guidelines word for word but they must consider them, whatever that means" (MFLNRO_1).

"Consider" is a "wiggle word" which "means to turn your mind to it and you make your own decision; doesn't mean you have to follow it but you do have to look at it" (MCSCD_1).

This lack of clarity of meaning expressed by the leading provincial employees transpired into further lack of clarity and inconsistency at the municipal scale, a concern shared by interviewees across the region (lack of clear provincial guidance was the top 4th barrier for sp-R action at 83%).

The reduced oversight led to an overreliance on consultants, as was discussed in Section 6.4. Local government staff were acutely aware of the limitations of this approach and uncertain about the long-term implications for the local government liability and accumulated risks as illustrated in the quotes below from the 2008 *Review of Flood Hazard Area Land Use Management in BC* study commissioned by Fraser Basin Council (Arlington, 2008, p. 42-43):

Consultants can do their best at making such recommendations however in my view there is really no substitute for having a body of flood experts in place that have the expertise, experience and wisdom required to make such determinations.

Local Governments do not have the expertise that the Province had. The flood hazard management tools are too general to apply to specific creeks.

Concern flood management needs to have strong Provincial role and regional approach based on watersheds.

A further complication arises under LGA S. 910 which states that local governments may designate land as a floodplain and set specific requirements related to siting and uses for new developments. However, the Compensation and Disaster Financial Assistance Regulation (BC Reg 124/95), section 15, states that: “If an area is designated under the Municipal Act as floodplain and a structure is built or installed in that area after the area has been so designated, no assistance will be provided to repair, rebuild or replace the structure if it is damaged in a flood unless the structure was determined by the Minister of Environment, Lands and Parks or by the Canada Mortgage and Housing Corporation to have been properly flood protected”. Compliance with regulation determines eligibility for Disaster Financial Assistance in case of flooding. The mechanism for getting this approval from the province is not clear, meaning that structures built subsequent to a local government making a designation under S.910 might not be eligible for assistance (Carlson, 2013). Given this, some municipalities were choosing not to designate areas as floodplains, while others are being proactive in applying the new Guidelines in the areas that are not designated as floodplains, as illustrated in this quote:

...in absence [of clear provincial guidance] local governments have a choice: they can build structures that...do not conform with the guidelines, but there may be

consequences in the future. There is a bit of a hiccup in the legislation in that the guidelines technically only apply if a floodplain is designated, at least that is one reading of [it]...As I understand, some local governments have avoided designating a floodplain so that they feel as though they are not subject to those development restrictions or don't require considering them. Other local governments do rely on those guidelines, even though they may not have a designated floodplain...I think there is a slight lack of clarity about when they apply and when they don't apply (MoE_1).

Numerous municipal interviewees stated that this lack of clarity and legislated uncertainty was making their sp-R planning additionally difficult. While it gave room for context specific solutions and more local control (which is aligned with the principle of subsidiarity), some interviewees suggested that instead of trying to figure out where they belonged in this grey area, they would have preferred a specific policy on sp-R for enacting changes at the municipal level. This discussion presents a complex relationship between the trade-offs of local governance of risk (i.e., decentralized, context-specific, guided by the principle of subsidiarity) and governance of risk at the higher levels (e.g., coordinated and mandated from regional, provincial, and national scales).

In understanding the antecedents of these policy changes, I further explore the politics of scale for sp-R governance and their influence on gen-R as a product of multilevel governance. The 2003 change was enacted as a provincial cost cutting measure (MNFLRO_1, MCSCD_1) under Premier Gordon Campbell. The change had significant implications to the overall flood management regime (sp-R) and for gen-R such as it reduced human capital, social capital, collaboration levels, monitoring capacity, and ability to maintain options across the scales: “When the change in 2003 came along, suddenly there was no ability... they eliminated all the staff in the province working on this or moved them to other jobs. Actually, they weren’t that many. It only took about 10 people provincially to run that whole program, so it was a false economy” (MNFLRO_1). Provincial oversight and technical expertise were both lost as part of the change: “So when Ministry of Environment used to have all of their technical engineers they did the mapping, they could look at individual applications, they could say this is safe. Local governments do not have that level of technical expertise...So when that expertise was lost, I don’t think it was good for anybody” (MCSCD_1). More importantly, from an institutional adaptation perspective, a certain degree of flexibility was lost in terms of the relationship between the province and the municipalities in negotiating approaches and spatial and fiscal trade-offs to sp-R through shared liability:

There were no staff [at the provincial level] so there's just a guideline so there was no way for the province to review bylaws and to make any decisions whether they were acceptable or not or to make judgments on exemptions or anything. They were just basically guidelines and they had to consider the guidelines and so local governments then they're sort of stuck: well, we used to be able to have this flexibility with the ministry's approval now we don't have that flexibility, what do we do?

So some consulted lawyers and some lawyers said well don't adopt the bylaw at all and others said you must adopt the bylaw because the hazard is there... and so they get mixed messages even from their own lawyers and then some go ahead, some don't... It's a very mixed bag and many local governments don't have bylaws at all and the ones that do are probably not very effective and nobody really knows either (MNFLRO_1).

This change led to a significant reduction of incentives and oversight over non-structural approaches for sp-R thus increasing reliance on the dikes which were in sub-optimal state. In 2015, another FBC commissioned study evaluated 74 dikes over 500 km that protect the Lower Mainland based on multiple criteria (such as the adequacy of dike crest levels, geotechnical stability, erosion protection, control of vegetation and animal activity, building encroachments, associated structures, and administrative arrangements such as right-of-way agreements, maintenance procedures, and emergency preparedness). According to this evaluation only 13% of the dikes were classified as being in fair to good condition, while the remainder were poor to unacceptable (NHC, 2015). However, as the discussion below will demonstrate it is not just the physical condition of the diking system that was of concern for sp-R but also the fractured, defunded, and politically-driven institutional system governing it.

In addition to the eroding quality of the physical infrastructure, as Chapter 4 and the historical analysis above demonstrate, continuous cuts and reductions to the provincial capacity to plan for sp-R have also significantly eroded the remaining weak institutional infrastructure including the provincial capacity to deal with change, gen-R. For example, monitoring capacity, a key to maintaining gen-R has been eroded in both physical and institutional terms, as discussed in Section 6.4.4.

These types of staff and funding cuts across various programs that addressed sp-R directly impacted the ability for provincial staff to build gen-R. For example, investment in face-to-face learning opportunities at the municipal level discussed in Chapter 5 presented a high contrast with the cuts at the provincial level. This resulted in significantly reduced opportunities for human capital development and learning (e.g., conferences), and social capital and collaboration (travel and stakeholder relationship building). This limitation had implications for

the effectiveness of provincial-level work given the prominence of relationships for resilience. Uncodified and tacit forms of knowledge that are important in addressing novel planning challenges are better consolidated through face-to-face contact due to the transactional advantages of proximity and their dependence upon a high degree of mutual trust and understanding, often constructed around shared values and cultures (Amin, 1999). As one EMBC interviewee put it:

In times like this, when we know that we don't necessarily have the freedom we have in better financial times – we don't travel. We don't get out into the regions, and we don't have an opportunity to meet face-to-face with our clients: local governments, emergency program coordinators, chief administrative officers, First Nations groups. That does pose a challenge. We do our best through teleconferences, but it's never as good as face-to-face. That's one of the biggest challenges, **because we are so relationship-based, but we can't get out and be face-to face**. We do suffer from that lack of ability to just really connect with people and sit across from them and to get our regional managers to say “well, listen; take a look at your tsunami plan. Let's go drive your evacuation route, and let's just talk about what that looks like.” That's invaluable. So we are feeling that we're suffering from that for sure (EMBC_2).

As illustrated in Chapter 4, starting in 2007, sea level rise (SLR) planning was added to this complex, dynamic, multi-scalar sp-R planning process. One of the provincial interviewees suggested that SLR played a significant role as a catalyst for realizing the need to revise the pre-SLR flood management regime: “My personal opinion, not a Ministry position, is that if we weren't having climate change, everything could, probably, just, perk along quite narrowly... The problem with climate change is being 1 and 2 meters, is that it's changing rules of the game, huge areas that used to be relatively safe are not any longer and now that we have that we have to do something about it and so what we're trying to look at is a retroactive fix” (MCSCD_1).

In this expanded sp-R domain, several key institutional changes impacted gen-R. Enabled by the seed funding from the federal level of government, the province took a proactive approach to understanding the needs, opportunities, and barriers to planning for SLR, including a coordinated approach to identifying whether the current flood management policies were able to accommodate adaptive action.

The initiative was led by the Climate Action Secretariat (CAS), a unique boundary spanning department embedded within the Ministry of Environment (MoE) which has a mandate to operate across provincial sectors and pursue active stakeholder engagement for coordinating climate action. Created in 2008 and building on the previously existing MoE climate committee

as part of the provincial initiative on climate change, CAS was initially focused on mitigation of climate change and served a coordinating role across government sectors. At the time of interviewing it also led a number of key initiatives on SLR. Providing an important distinction between direct action on sp-R vs. an evaluation of the capacity to deal with change under the current regime (gen-R), a CAS staff member who later moved to a different department (MoE) described their involvement as the following:

I wasn't directly involved in flood management. My role was more about how to take into consideration changes in flood hazard in the management regime that we have. So specifically, I focused on climate change impacts like sea level rise and worked with colleagues and other parts of government who are more directly involved in flood hazard management to think through how our policy and management regime would be affected by those things (MoE_1).

This process created dedicated institutional capacity for a better understanding of how the existing flood regime could accommodate SLR. Having this dedicated institutional capacity at the provincial level resulted in a set of studies and guidance materials developed thorough partner ministries and organizations. CAS was tasked with securing funding for this work (including from the federal agency Natural Resources Canada). As one of the provincial employees stated: "We're very lucky in this province to have someone like the Climate Action Secretariat who is able to get a lot of money and allocate some staff" (MCSCD_1). In addition to the formal CAS, an informal staff-level multi-ministry working group played an important role in facilitating shadow cross-departmental learning and collaboration (EMBC 1; EMBC 2; MoE; MSCSD), as discussed in section 6.4.

In order to understand the enabling conditions for this enhanced gen-R capacity that in turn influenced sp-R policies, I analyze the larger structural and political changes that happed during that period provincially. In 2007-2008, the provincial government tabled 10 pieces of legislation to enable *BC Climate Action Plan*, including a legally binding requirement to reduce BC's greenhouse gas emissions by one-third from 2007 levels by 2020, and 80 percent by 2050 (BC MoE, n.d.). In 2008, BC introduced North America's first economy-wide carbon pricing policy: a revenue-neutral tax on carbon pollution, which remained the continent's strongest carbon-pricing initiative and had been recognized globally for the effectiveness of its design. Institutionally, initiatives such as the establishment of CAS (enhancing cross-department and multi-sectoral collaboration for proactive learning and collaboration) and the establishment of

the Pacific Institute for Climate Solutions (a dedicated capacity to learn for solutions based on a formalized partnership between four major BC universities) and other initiatives dedicated to enhancing human capital in BC for addressing climate change directly contributed to investments in gen-R at a previously unprecedeted scale.

An analysis of gray literature shows that the majority of these institutional changes can be tracked down to one person, Gordon Campbell, the BC Premier in power at the time, which speaks to the importance of leadership. However, this is striking since it was Gordon Campbell's government which effectively defunded sp-R capacity at the provincial level by enabling the 2003-04 change as a cost-cutting measure. As noted in a media article:

Political observers still can't explain Gordon Campbell's 2007 transformation from eco-villain to trail-blazing climate activist. While other North American politicians stood slack-jawed on the sidelines, British Columbia's then-premier, an avowed enemy of environmentalists, launched the continent's boldest experiment to fight climate change. Many doubted Campbell's sincerity. Six years earlier, the former Vancouver mayor had terminated his predecessor's climate change program within months of taking power, created a tax loophole for gas-guzzling luxury vehicles and reduced provincial fuel taxes. He joined the premier of oil-producing Alberta in opposing ratification of the Kyoto protocol (Pollon, 2011).

Given this 'eco-villain' reputation, what was at the heart of this change, a critical juncture in BC's approach to climate change, enabled by a complete turn of heart by the political leader at the time? I interviewed Mr. Campbell to find out:

One of the things that struck me was a visit to China at that time and it wasn't so much that I was made aware of the issue with regard to climate emissions because it was something that I started working on when I was mayor of Vancouver. We did a program called Clouds of Change when I was still mayor of Vancouver before it was particularly popular to do it. But when you went to China what became really obvious was that small actions by individuals add cumulatively significant and substantive effect...I thought if we're really going to do these sorts of changes we have to decide that we're going to do it ourselves. Our caucus agreed with that and, we moved on it... in the fall of 2006 and made the major throne speech commitments in February of 2007 (Gordon Campbell).

When asked about the potential for development of political immunity for these policies long-term, Mr. Campbell responded: "There's always the opportunity. I think that this is something that as Governor Schwarzenegger used to say, there isn't democratic air and republican air. There isn't democratic water and republican water...Similarly, it is not only our air shed that we're dealing with but what we do has an impact on, first of all our immediate air shed, but overall on the global situation".

This change was also lauded by Mike Harcourt, the former Premier (1991 to 1996 as the National Democratic Party leader) and the mayor of Vancouver (1980-1986). Speaking to the lack of leadership at the federal level, Mr. Harcourt noted: “Until we get a change federally I think provinces and cities are going to have to do it. BC seems to be well placed because we have... Gordon Campbell, different politics for me, but he had the courage to bring... carbon tax regime, that by and large is being followed and, I mean, [has had] a pretty positive impact”.

Despite these intentions and progress that was celebrated internationally, it was Mr. Campbell’s Liberal party that subsequently dismantled some of this climate leadership legacy by further eroding the provincial capacity to deal with change. As one of the regional actors put it: “... I think there’s still such a wide spectrum of climate change denial... We’re still educating people on the fact that it’s even an issue, and that goes for some of the mayors in the Lower Mainland, it goes for our Premier Christy Clark who is not acting as though climate change is an issue whereas Gordon Campbell did. It’s frustrating because we’re so at the mercy of politics, right? You get a really good leader and then their plan is up and they get replaced with somebody who just doesn’t keep going all this thinking that has been going” (ACT_SFU). Lack of strong leadership at the provincial level one of the significant barriers identified by municipal survey participants (76%).

However, in this promising process of changes, a principal barrier—lack of direct engagement with the municipal level from the province—continued to hinder effective action on sp-R. As one regional interviewee noted, speaking to the reflective sp-R policy evaluation work done at the province:

...there’s some issues around how that policy was being developed, that it was through the Climate Action Secretariat, which has been very valuable as the catalyst for moving forward with even asking the question of whether the existing regulations are sufficient to address this very new challenge of climate change and rising sea levels. But on the other hand, the Climate Action Secretariat doesn’t have any particular area of expertise **with local government or urban planning or development**. I think that sometimes has been evident in the way the work has rolled out and within the government the connection between the ministry that does have that expertise and the Climate Action Secretariat hasn’t always been made. It’s not the fault of anyone but it’s again the way... things are structured (WCEL_1).

These organizational and institutional barriers coupled with the overall lack of engagement with key stakeholder – municipalities—was strongly supported by triangulated evidence. For example, both analysis at the municipal level in Chapter 5 and analysis of the

provincial level thus far in Chapter 6 showed this absence, a qualitative and document analysis finding strongly supported by the survey (poor coordination with provincial levels of government was identified as a barrier by 73% of respondents). As I discussed in Chapter 4, municipalities' involvement in creating or being consulted on proposed provincial guidance has been limited, with a handful of exceptions (e.g., surveys conducted by FBC in 2008 and focus group/workshops conducted for the Arlington (2014) study).

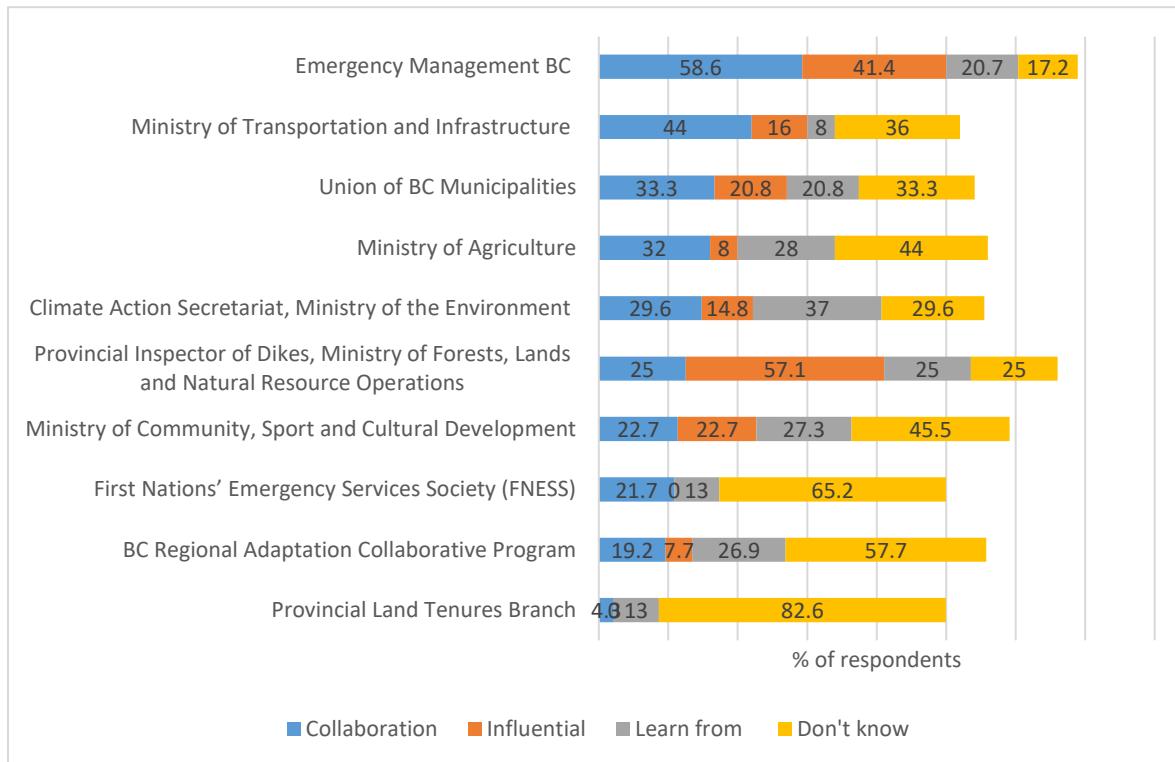


Figure 6-7 Relationship between municipal FMPs and key provincial level organizations

Given this limited interaction, which provincial agencies contributed to advancing sp-R through key gen-R processes such as collaboration, learning, and influence? As Figure 6-7 illustrates, EMBC, one of the main sp-R funders, got the highest score on collaboration (59%), followed by MoTI (44%), and UNBC (33%). The Provincial Inspector of Dikes ranked the highest on influence (57%), followed by EMBC (41%) and MCSCD (22%). CAS, MoE get the highest score for learning (37%), followed by a close, near-tie between MoA (28%), MCSCD (27%), BC RAC (27%), and MFLNRO (25%). EMBC, a key agency for flood mitigation works funding distribution and flood response, despite receiving the highest score for collaboration, got the third lowest score for learning (at 21%). Given the fundamental role that MoTI can play for sp-R, it surprisingly got the lowest score in the 'learn' category at 8%. BC RAC (8%) and MoA

got the lowest scores for influence. While this influence was ranked low by municipal participants, the funding that was provided by BC RAC through NRCan was very influential for developing the core technical and guidance materials for the SLR regime as was illustrated above. As one regional actor put it: “The decision of NRCan to fund this work and the Regional [Adaptation] Collaborative for British Columbia… they were champions that catalyzed a bunch of research and… that wouldn’t have happened otherwise” (WCEL_1). Federal funding through BC RAC was fundamental for carrying out the studies that ended up being the trigger points for action, and scoring the lowest for influence from the perspective of the municipal survey participants, the provincial interviewees were very aware of this influence. Yet, even this funding could not help overcome the barrier of the lack of municipal engagement in shaping the sp-R policy that influences them:

... I think it was 3.3 million dollars from the federal government to do work on adaptation and there were 21 projects (the first round). Were they the best projects? Not necessarily. But they were projects that were ready to go and had some matching funding. If you were given 3.3 million dollars would you have done those projects? Definitely not some of them, but we did the best with what we could at the time... The difficulty is... in a perfect world, local government interest [would have been] involved in most of those projects and in a perfect world there should have been local government people on each one of the projects. It didn't happen. (MSCD_1)

A related, second tier barrier to this, is that lack of engagement led to lack of ownership and buy-in which impacted the usability of the produced tools. As planning literature demonstrates, the benefits of collaborative planning go well beyond the final product by accruing direct benefits from the planning process itself. In this case, by externalizing the tools development process to consultants (given the defunded capacity at the province), the utility of the tools was diminished as they were not reaching the users: “If I had a whole bunch of money I would put more publicity into what we’ve already got... we do have some publications that people don’t even know” (MSCD_1).

Given the defunded capacity at the provincial level, the ability to promote tools was dependent on external forums rather than direct province-to-local government communication channels. This created a bottle neck: “With the implementation guide we did a soft release and tried to do presentations at the Planning Institute at the Land Summit at UBCM. UBCM, for example, we were turned down. So that’s disappointing but it’s their choice who they have and what they have (MSCD_1).”

What can be learned from this discussion of changes in sp-R policies and its influence on gen-R at the provincial level? Over time, there have been politically- and austerity-driven efforts to reduce the overall capacity and role of the province in overseeing flood risk at the local level. This resulted in direct erosion of gen-R: defunded human capital (by laying off or relocating provincial staff in charge of technical support and oversight); defunded social capital and collaboration (provincial employees unable to travel and work face-to-face with their municipal and regional partners which in turn eroded the relationships-based capacity for sp-R planning and defunded monitoring capacity (expressed in physical and institutional forms). The capacity to maintain options, a key determinant of gen-R, had also been defunded over the years, which prioritized structural approaches to sp-R.

It shows that 2003/04 was a major watershed moment that placed more responsibility for sp-R on municipalities in determining their development in the floodplains which also transferred risk to the local level, subsequently partially externalized to the consulting industry, as discussed in the previous sections. Within the new regime, developers could place more pressure at the local level. Without the provincial oversight, the Approving Officers given their close relationship with the councils could be forced to make decisions contrary to provincial guidelines. These guidelines in themselves present a lot of confusion and result in a patchy network of responses across the region to provincial drivers. While municipalities exhibited strong evidence of innovation and leadership, as Chapter 5 demonstrated, few of these have been spread horizontally or applied systematically.

More importantly, gen-R at the provincial level was significantly reduced across all of the key determinants identified in the conceptual framework. Human capital was significantly reduced with numerous staff laid off at the provincial level, resulting in reduced human capital to assist municipalities in making flood-risk informed decisions and providing oversight. Monitoring capacity was significantly reduced for freshet risk for both hard infrastructure and the social and institutional infrastructure supporting it, with the River Forecast Centre remaining as one of the last legacies of previous federal-provincial programs. Institutional reserves, institutional memory repositories, and options were significantly cut and destroyed by terminating programs, laying off specialist personnel, and externalizing research capacity to consultants.

While some promising institutions were established such as Climate Action Secretariat, or Pacific Institute for Climate Solutions, their influence on the practice of flood management remained limited, partially due to organizational barriers (the byzantine system of distributed flood management functions across various agencies which impeded their direct ability to coordinate and collaborate horizontally across the departments at the province due to organizational barriers in place and vertically across scales of governments with municipalities). Partially, this was also due to lack of understanding of the on-the-ground reality of municipal issues which in turn was due to lack of direct engagement (due to budget cuts overtime).

Overall, a general climate of reduced programming and the efforts of the BC Liberal government resulted in a defunded system for sp-R that significantly eroded gen-R. However, as the analysis in the previous chapters demonstrated, the overall system had been responsive and, in the absence of a formal ability to regulate flood risk, a number of boundary and informal institutions emerged to fill some of the sp-R governance gaps.

During my fieldwork, I often wondered whether this defunded provincial capacity was issue-specific (flood management) or sector-specific (public safety) or whether it was a more general provincial government-wide issue. The 2017 *Oversight at Risk* report that surveyed 403 government scientists in 10 provincial ministries (excluding EMBC but including MoTI, MoE, MFLNRO) offers some insights into this. The survey identified that one of the main challenge for provincial scientific integrity in BC was cutbacks to capacity within the public service, which impedes the government's ability to fulfill their responsibility for regulatory oversight. The specific highlights illustrative of this reduced capacity include the following:

- 71% of respondents witnessed a decrease in research capacity in their ministry and/or branch over the course of their tenure in the BC government.
- 68% believe that there are insufficient resources to effectively fill their branch or ministerial mandate
- 71% think that capacity changes negatively impact their ability to produce scientific/expert reports and documents
- 59% think that capacity changes negatively impact environmental research/regulation
- Around half (49%) of government scientists surveyed across Ministries believe that political interference is compromising their ministry's ability to develop laws, policies, and programs based on scientific evidence.

These findings, reflective of eroded general capacity across the provincial level of government are strongly supported by qualitative evidence within the ministries in charge of sp-R domain as described above.

Situated against this backdrop of defunded gen-R, some promising institutional changes driven by the emergent SLR regime were taking place, which in turn is influencing sp-R and gen-R by building back some capacity, subsidized by federal government programs such as BC RAC. However, some fundamental barriers for effective collaboration and coordination remained as a by-product of slower variables such as institutional inertia, historic path dependency, and faster political change across the scale variables. The lack of leadership at both the provincial and federal levels was identified as one of the main barriers to collaboration at the regional level. The majority of municipal respondents (both flood management professionals and elected officials) noted that long-term adaptation challenges require investments and more direct collaboration with the province and the federal government. As one of the regional actors suggested: “what’s really missing is funding and leadership at the federal and provincial levels to drive these [adaptation] processes at the municipal level” (ACT_SFU).

6.6.2 Federal level

Lack of strong leadership at the federal level and poor coordination with the federal levels of government (tied for top 3rd place barrier at 86%)

The majority of the interviewees at the municipal, regional and provincial levels saw lack of federal leadership and lack of federal as major barrier for sp-R action in the region, a finding strongly supported by the survey. Mike Harcourt, a former Mayor of Vancouver and Premier of BC, who was in regional planning described this multi-scalar challenge:

We started 40 years ago or more, to do growth management livable region strategy, basically compressed the urban growth into 30% of land areas, the other 70% left is green either agricultural, watershed, significant ecological areas, park and wilderness. We started thinking in those terms quite a while ago and I think learned from the flood of '48 [about] the devastation it can create if you don't have diking or proper protection. So all the basic elements are in place, but political will to really be aggressive and the resources to do it. And there's been people around Andy Yan of Bing Thom, and David Marshall, of Fraser Basin Council, who are saying we need to take steps to deal with it and the emergency prep people are realizing that climate change and flooding and earthquake are probably the big catastrophes that we face, right? ...So we've got all the basic components, what we're missing is a sense of urgency about climate change at the national level, in particular, and therefore, it's

sort of left to the provinces and municipalities. It's really interesting, we're basically urban citizens now, 95% of us live in cities (Mike Harcourt).

Overall, federal level institutions received some of the lower scores across categories of actors, with the exception of ‘learning’ category (Figure 6-8). The federal level on average received higher scores for learning than for collaboration (a trend reversed for most of other evaluated levels), which speaks to another principle gap to building gen-R across the scales. The participants could learn from the feds but they could not collaborate with them, as one survey participant noted: “I would love to collaborate more with Federal agencies such as DFO, EC, and NRCan but sadly they are not well positioned to collaborate in a staff to staff way” (SC_14). NRCan received the highest collaboration score given their active presence in the region (BC chapter) through stakeholder meetings and the fundamental role in funding BC RAC.

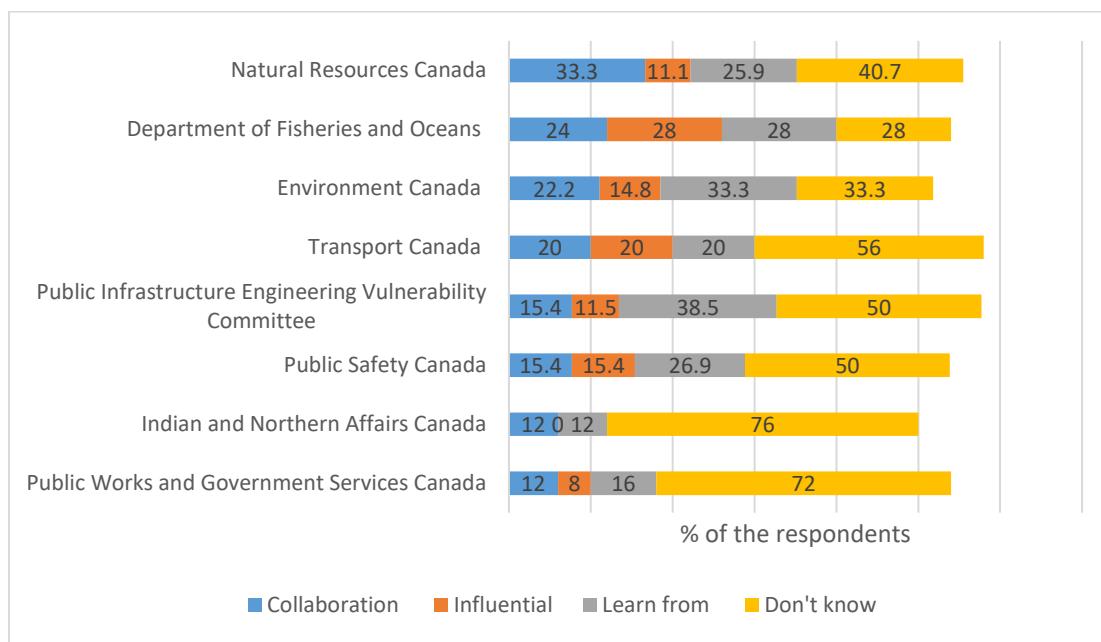


Figure 6-8 Relationships between municipal FMPs and key federal agencies

Overall, with regard to federal actors, similar to trends at other levels, a move from government to governance was present. For example, it was not an individual department but the collaborative multi-stakeholder Public Infrastructure Engineering Vulnerability Committee (PIEVC) that received the highest score for learning (Figure 6-8). Created in 2005, the Committee was initially co-funded by Natural Resources Canada (NRCan) and Engineers Canada as a national initiative that aims to determine and mitigate engineering vulnerability in Canadian public infrastructure to the impacts and risks of current and future climate, and facilitate the development of practices, guidelines, and tools for Professional Engineers and

Geoscientists in their day-to-day practice. Metro Vancouver was actively represented as part of the PIEVC through staff participation and case studies.

Another significant determinant of ability to maintain options at the municipal scale was funding provided by the higher scales of governance. In what follows, I provide an in-depth examination of the mechanisms for sp-R financing across multiple scales of governance.

6.6.3 Sp-R resilience financing: examining the impacts of funding structures and allocation processes on gen-R

Barriers: lack of resources for capital expenditures -100%;
limited municipal resources and capacity - 94%;
competitive nature of funding applications -75 %

In the field of SES resilience, Nelson et al. (2007) suggest that scale is central to the concepts of adaptive capacity and resilience. Scale relates to the length and frequency of perturbations (e.g., a flooding event) and the spatial scale at which perturbations occur (e.g., whether a local, regional, provincial, or national emergency). Understanding these scales in turn helps identify commensurate scales of change and adaptive capacity needed to maintain reserves and options. The organizational scale of focus is also important as it identifies the boundaries of social-ecological systems and the horizontal and vertical linkages and networks that are used to capture and mobilize resources. In the field of disaster resilience, supplementing or subsidizing local systems with inputs from other scales is common when dealing with disasters. However, subsidies can work at cross-purposes with wise hazard mitigation by creating perverse incentives for individuals and communities (Birkmann, 2003). As this quote by a flood mitigation director at the provincial level suggests it would take a bold political step to change this:

We've had municipalities not put forward their most important [mitigation] project to us because they know – during the next freshet, it's going to flood, and we will come in and fix it. So there's sometimes a perverse incentive there. What can we do to change that? What can we do to make...the municipalities to get on time with the knowledge of "this is your only chance."... I think that that's going to have to be a bold political step to be made in terms of how we provide disaster financial assistance. That's going to be the only way to make it happen (EMBC_3).

However, this 'bold political step' would have a significant political cost. Public assistance in the wake of disasters—particularly to local governments—is generous and comes with relatively few restrictions, which can provide disincentives for engaging in more effective hazard mitigation (Birkland, Burby, Conrad, Cortner, & Michener, 2003). Thus, less effective structural flood control and other infrastructure projects are promoted over careful land use and

environmental management. An important research gap emerges on understanding how substituting adaptive capacity at different scales affects the overall resilience of a system *before* the disaster occurs. Given the nature of the actors involved in sp-R it is particularly important to understand disaster reduction policies as cross-scale dynamic process, where typically, an agency or upper-scale government authority develops policy that requires lower-scale government or the public to implement it. From the response stand point, the immediate disaster response rarely involves federal agencies, but the federal government has a role in building sub-national response capabilities and more generic resilience (Handmer & Dovers, 2007). From the mitigation stand point, the federal government is highly motivated to reduce disaster losses because the disasters that are only a ‘statistical probability’ at the local level are ‘a mathematical certainty’ at the national level (Prater & Lindell, 2000).

Despite this dynamic, as discussed in the literature review the resilience of communities is determined primarily at the local level for a number of reasons: 1) the majority of land-use decisions occur at a local scale; 2) a substantial portion of infrastructure is controlled by local government and most buildings are owned by households and private sector organizations; 3) the regulations governing land use and building construction practices are established at the local level; and 4) the local government level is arguably the closest and most accountable to its constituents, among many other reasons. This underlies the importance of cross-scale vertical intergovernmental relationships for successful policy implementation, as federal and provincial hazard mitigation policy can only be carried out at the local level (e.g., May and Williams 1986; Prater and Lindel, 2000). However, the municipal ability to self-finance sp-R is limited, as an engineering consultant suggested: “I feel so sorry for the municipalities because they’ve got all this stuff dumped on them and their only income source is property tax or hotel tax... It’s so limited in terms of what they can do. The impacts of these kind of events are not just Vancouver. It’s going to be national and regional, right? The money has to come from higher up” (EC_1).

At the municipal level, the FMPs were unanimous in that it would be impossible to address current and future flood risk without financial support from higher levels of governance. The survey revealed that the two most significant barriers for addressing sp-R at the regional level were ‘lack of resources for capital expenditures’ (100%) and ‘limited municipal resources and capacity’ (94%). A closer look at municipal financing provides further insights into these two barriers. For example, CoD, CoPM, CoPC and CoS had limited capital funds (lack of capital

funding was identified as a top barrier in the survey at 100%). CoS ran on remarkably low operating funds given its size, with 37% of Vancouver's operating funds (with an approximately 17% population difference). As outlined in the chapters above, the CoS is also known for the lowest municipal taxes, the lowest per capita spending, and one of the highest population growths in the region. In addition to lack of capital funding, the separation between capital and operating funds presented a major challenge for resilience investments in municipalities. While operating funds provides some certainty for daily operations, the competitive nature of capital funding that has to be aligned with funding cycles of the higher scales of governance added an extra level of uncertainty. Addressing the limitations of this separation required creative financing due to the competitive nature of capital funds and inability to know in advance whether the application would be successful, which was particularly problematic for multi-year infrastructure projects. Provincial overview (e.g., the 180-day review cycles for environmental assessment) also extended this timeframe. These timeframes also caused issues with securing contractors during the busiest seasons of the year. To address these issues of misaligned timeframes and uncertain competitive funding cycles, some municipalities began implementing asset management programs (e.g., asset management program in DNV uses a 10-year planning horizon) which ensured that a longer-term planning process was in place before they pursued infrastructure funding opportunities (including flood protection infrastructure).

Competitive nature of funding applications was identified as a barrier for regional sp-R by 75 % of respondents. Under the current regime, senior levels of government (provincial and federal) occasionally (rather than systematically) have programs that provide funding to local governments to undertake flood protection or flood mitigation measures (MoE_1). These funding programs tend to be reactive following large-scale events or threats and near-misses. Historically, structural investments tended to dominate (e.g., construction of dike improvement, building pump stations and other engineering works). Funding programs tend to be cost-shared (e.g., 1/3 paid by each level of government) (MoE_1; EMBC_2). For example, the 2007 freshet served as a catalyst for mitigation funding to the Flood Hazard Protection Fund, a provincial cost-sharing program which was managed by Emergency Management BC (EMBC). The majority of the approved proposals for this program involved structural mitigation measures (EMBC_3). The funding mechanisms were competitive (by application) and cost-shared, which resulted in some smaller municipalities' inability to secure funding for their diking works with a

priority given to densely populated areas, a concern voiced by the smaller municipalities and some regional actors (CoC_C, CoPM_E, CoPM_M, CoPM_P; EC_1).

For example, an engineer in Pitt Meadows, commenting on the allocation of funding under the current Provincial Flood Protection program, suggested: “I saw who got all the grants on that last program and it was dealing mostly with urban areas: dikes that protect urban areas. They’re worried more about people than agricultural land; agricultural land can flood but... [it is] an economic disaster to those farmers” (CoPM_E). Similarly, the Mayor of Pitt Meadows at the time noted: “We just got turned down for another grant for one of our flood stations and it’s extremely frustrating when we see the bigger municipalities that have the resources getting them. And, regionally, we talk about protecting agriculture land but they don’t realize the challenges we have to protect our agricultural land, and the pump stations are critical and we need help. It’s not the type of thing that we can do... [on our own]” (CoPM_M). Equity was also raised as a concern by regional consultants: “It’s the better resourced municipalities who get access to the funding because they’re able to make a case for it and apply for it so the municipalities that have the greater capacity to actually do it themselves are getting the provincial funding” (EC_1).

The competitive nature of funding maintained fragmented and area-specific and hazard-specific approaches rather than moving toward a systematic regional risk-based approach. As the Chair of Lower Mainland Local Government Association Flood Control committee and a Councillor in City of Chilliwack (located within a neighbouring regional district) stated:

The funding model, currently delivered through flood protection is way oversubscribed and we’re forced into a position whereby we have to compete with our neighbours. You’re putting your project application in and you hope that you’re going to be successful and not Abbotsford, you know? But the irony is that if a dike breech happens in Abbotsford, knocks the TransCanada out, our farmers don’t get their stuff transported down TransCanada and vice versa. We’re not immune to that, it will affect us all.

In addition to its competitive nature, the funding would often be allocated on ad hoc, reactionary, and opportunistic bases (e.g., in an emergency state leading up to a potentially catastrophic flood – the near-miss of 2007). This resulted in a diking system that grew in a non-strategic and uncoordinated way: “There’s been closer to 100 million dollars spent or allocated since 2008 basically and while much of the work has been useful, it hasn’t been strategically coordinated with this respect to achieving any specific objectives” (MNFLRO_1). While there is some evidence in the literature that significant crisis and disaster events can offer opportunities

for renewal, reform, and change (Pelling & Dill, 2009), BC had not benefited from this opportunity in the recent history.

Historically, significant flood events (e.g., 1948) brought political attention from the higher levels of government (provincial and federal) which resulted in large scale funding allocations for enhancing structural protection. However, as illustrated in previous chapters, these activities focused on rushed projects to boost public morale rather than building long-lasting flood protection. Several interviewees stressed that the year 2007 could have been a major milestone for action given the updated scientific base (the updated hydraulic model and the profile for the Fraser River) which coincided with a focusing event (a near-miss in the region that resulted in flooding up the Fraser due to high snowpack) which brought political attention to the issue. These factors contributed to a hopeful atmosphere among concerned professionals for a more integrated and strategic approach to flood management. However, the promise did not fulfill its potential:

We got some funding but [it] was so reactive...in a very short-term ...16, 17, 20 million somewhere in that range was spent in 6 weeks in the run up to the flood. There wasn't a lot of big picture thinking because no one had spent time ahead of that event thinking about where that money should go. So it was the municipalities who had the capacity to sort of come up with a dike plan, so the Surreys, the Coquitlams of the world got a lot of the money to raise their dikes really quickly but quite poorly. It wasn't particularly well done, because there was no plan, a 'what if?' plan, a 'what if the big snowpack then these are the priority projects?' I guess there was some of the basis...the profile that we had redrawn and you can see the areas that were going to be most impacted but it seemed that it was very reactive and not particularly well thought through (EC_1).

Referring to the same period, one of the elected officials stated:

..we leveraged that because of a potential emergency threat, so it got our dikes into an excellent position. The kind of funny thing is you just want to make sure your dike is a foot higher than someone else's downriver or up the river. So we did...we got ours up to right where the standard was, they are in good structural strength and now we have to maintain them on our dime. It's not at all bad we were able to leverage that.

While perceived as beneficial for an individual community this approach results in a regionally questionable approach to public safety. A senior provincial official suggested that given the cost-shared nature of the funding program, a lot of the projects were picked based on a shovel-ready basis that only addressed parts of the problem rather than applied a systematic approach to risk:

Most of the dikes do not meet the design levels. You would think a program would be set up so that there was systematic meeting of standards but because it was set up in a way that did not have any provincial direction, it was just basically “Here’s a pot of money you apply and then we pick the best projects...” Well, the best projects depend on how much money the whole local government had. So in many cases they only constructed... maybe if they have a 12km dike... maybe they only had enough for 1km. So you raise 1km of dike, there’s not a lot of benefit, eventually maybe in 50 years there might be if you finish it, but in the short term there’s no benefit other than the jobs. But the public doesn’t know that the other [11]km is still a metre low and ... water will just come around. **It’s like building bridges half way across the river and not being able to drive across, but you don’t see it** (MLFNRO_1).

The lack of strategic coordination and politically driven funding allocations was also coupled with a strong bias towards funding structural approaches over planning and other options of flood management: “Since then [2007 freshet season] ... a total of 10 million dollars a year to do flood works in the Province but it’s all flood works, **it’s not planning, it’s not thinking, it’s building dikes...** That whole funding makes me very mad, the way that that money only goes to structural projects. **It’s only good if a politician can stand on the dike and cut a ribbon, it’s not good for the other many ways you could mitigate damage and risk**” (EC_1).

Similar to findings at the municipal level, it was suggested that long-term flood protection and planning needed to be isolated from political process and had to be based on a coordinated regional approach: “The model can’t be one by which we have to compete. It has to be an identification of prioritization of major infrastructure or major projects and a commitment on a regional level to knock those off one by one a long term, stable manner” (CoC_Councillor). A survey participant indicated that in addition to lack of stable funding, there was a lack in institutional capacity to manage flood risk at the regional level: “Lack of stable funding is a big issue, as is the competitive, unreliable nature of infrastructure grants. Regional flood-related planning is currently done through Fraser Basin Council, but there is no government body that manages this role (SP_29)”.

These funding limitations and the need for a more strategic systematic risk-based approach were recognized by the director of the program at the time:

The last 2 years, I’ve been looking at how we can change it to be more effective to address some more strategic levels. Just the flood mitigation works that we have. Because what we found was that we were just doing spots: spot here; spot here; spot here, and what we really need to do is to look at it from a more strategic, systematic, system of defense. And so for us, from the flip side of that equation, is, “where are we spending all of our money?” Where are we spending all of our time? Are we going in every 2 years to the same community? Pumping a whole bunch of money into

response? Well, maybe we just need to sit back and say, “OK, we need to really build something they care about. We need to look at retreat. We need to look at other factors, because this isn’t going to stop.” It’s more than likely going to get worse and get more extreme in the type of event, and we have to be able to identify where our vulnerabilities are (EMBC_3).

However, working toward this more strategic approach was constrained by the application-based structure of the program: “we have to wait for the local government to contribute, so what we are attempting to do is first identify what specific areas we want to target, and then move towards working with those communities; put something in place that’s going to protect them” (EMBC_3).

Another barrier to effective and equitable sp-R funding allocation was based on the core decision making tool. Cost benefit analysis (CBA) is one of the most common decision-making tools for allocating investments in specific resilience to floods. Used widely at national and sub-national levels in Canada and the US, CBA enables prioritizing projects based on the value of protected entities compared to the investment levels into protective measures. CBA can offer rigour to an evaluation of whether a particular project is “economically justified” by providing a quantifiable metric to inform decision making among a diverse set of potential projects (Ellen, Yager, Hanson, & Bosher, 2016). In an ideal application, it requires a sound assessment of risks, costs of initiatives, and potential damage avoided based on a standardized approach to systematic evaluation of alternatives under a range of scenarios. Despite its commonplace requirement for flood protection and disaster mitigation funding, CBA has a number of drawbacks, especially when reviewed from a gen-R stand point.

The 1997 review of the FDRP illustrates a particularly relevant finding for this relationship between sp-R valuation and gen-R. Specifically, it suggests that an emphasis placed on the economic value of flood protection discounted social, environmental, and cultural values. This reliance on a CBA formula tied tightly to land values, coupled with interjurisdictional and governance challenges, meant that the First Nations Reserves “in some places were left out of the equation – the dikes simply went around them—placing First Nations populations on the river side of structural protection measures” (Watt, 2006, p. 269). In advocating for a different approach in the future, the review panel raised the issues of agency and limited adaptive capacity of residents on reserves:

Economic analysis excludes certain social values that are perhaps unique to Indian Reserves. First, it does not take into account the limited mobility of a resident of a reserve. Most residents of a floodplain are there by choice and have the option of selling and moving elsewhere. Residents of reserves, however, have much less mobility since they can neither sell nor mortgage their property and are, for practical purposes, limited to relocating elsewhere on the reserve. Also, the benefit analysis does not consider the value of assisting Indian bands to become self-sufficient. Neither does it take into account the values which Aboriginal communities place on traditions, customs, heritage or the environment (Fraser Basin Management Program, 1994, p. 26)

In other words, the economic resilience of the overall system was maintained at the expense of concentrated pockets of vulnerability, discounted social and cultural values, and denied opportunities for safety and economic development on the reserves. The issue became a vicious circle: “As a result of this, development of Reserve land has been retarded, with the result that there are seldom sufficient economic benefits to justify dyking, using the conventional analysis. However, flood control for Reserve lands is often necessary to provide safe and adequate living standards on the Reserves (Fraser Basin Management Program, 1994, p. 58)”. This issue was not only a BC issue. Shrubsole (2000) further highlights the limitations of CBA as applied “in aboriginal areas where lands are communally held” compared to ‘non-native communities’. “On this basis, lands that are held in free title, particularly lands zoned for commercial or industrial use, will show higher benefits and therefore greater need relative to native lands (Bronsro et al., 1999 in Shrubsole (2000), p. 9). What seemed as rational from a CBA perspective which prioritized economic values (protecting populous sections with high value property and infrastructure) presented significant opportunity costs from social justice and gen-R perspectives (such as the ability to self-organize, collaborate, and maintain options for the futures). While seemingly obvious today, the recommendations of this review have not been implemented with a large proportion of the First Nation’s land in the region located in the floodplains and unprotected by the dikes. While dikes in themselves are a limited flood protection mechanism, it is the purposeful differential treatment of reserves and their denied equal opportunity in standards of safety that is particularly striking. An important factor to mention is that the Fraser Basin Management Board review committee has been able to put forward such a thoughtful analysis partially due to inclusion of representatives of First Nations as part of the review Board.

Ellen, Yager, Hanson, & Bosher (2016) provide a number of compelling arguments about the limitations of CBA as a decision-making approach in resilience planning. The underlying parameters for CBA can be arbitrary and reflect the mainstream/dominant value system of the time (e.g., colonial), thus discounting certain values (e.g., cultural and environmental values) and other hard-to-quantify costs and benefits, which can result in the exclusion of most meaningful issues for the local population (Messner, Zwirner, & Karkuschke, 2006). As a top-down decision making tool, CBA provides limited accounting for equity or livability concerns (Bedsworth & Hanak, 2010), accounting for project impacts on ecosystems, it lack quantification of the distributional impacts (e.g., who benefits and who pays?) (Shreve & Kelman, 2014), and fails to provide “reliable estimates of things that are valuable but not valued in markets” (UNFCCC, 2011, p. 12) with gen-R being one of them. Given these limitation CBA is poorly positioned to account for gen-R including social and environmental trade-offs and co-benefits, procedural benefits, and the benefits of maintaining options in the future despite the present-day opportunity costs. Despite “a real push” to include social, environmental, and other noneconomic costs and benefits into CBA, in practice, the approach still heavily favours those considerations that are more easily quantifiable (Ellen et al., 2016). Including cultural values of First Nations would present a particular challenge for a standard CBA analysis. As one interviewee put it: “They think of water as a relative, they don’t think of it as a commodity and it really becomes clear that when you listen to them that if we thought the same way they did we wouldn’t be in the mess we’re in because they’re very worried about the concept of pricing water for instance...because for them it’s like putting a price on your aunt. You can’t do that and in a way putting price on it diminishes its value. It’s a hard conversation with them. I think they find it very uncomfortable to think the way we think” (SFU_ACT).

Despite these equity concerns, historically differential treatment of certain groups in terms of regulatory restrictiveness, public spending, and pricing of risk transfer, all of which demonstrate clear limitations of CBA, it remains as one of the main decision-making mechanisms within the modern flood regime. In the case of the First Nations, efforts to reduce vulnerability through established decision-making tools such as CBA and land use planning tools continued to reproduce uneven risk exposure and socio-economic vulnerability. By denying ‘safety’ (with all the limitations of structural protection) to First Nations, they were also denied opportunities for economic development. This is partially because these policies were embedded

in the very institutions and development processes that created that vulnerability over time (colonialism) and continued to reproduce uneven risk exposure and socio-economic vulnerability (Anguelovski I et al., 2016).

This analysis showed a highly path-dependent flood management regime that favoured investments in structural protection. While a significant amount of money was spent in a short period, these investments served a limited function for enhancing regional levels of protection from flood given the fragmented nature of investments. While this approach to sp-R arguably contributed to some locally accrued political gains, it did not systemically reduce risk at the regional level. While there were signals of change within the provincial understanding for a need to manage *flood risk* rather than *flood hazard*, this change in understanding was constrained by the overall funding regime: its cost-shared, competitive, and unstable nature. Overall, despite the intentions, the regime maintained its focus on flood hazard, rather than moving toward a risk-based approach.

This systematic bias towards structural solutions is a strong path-dependent characteristic that was nurtured over the years across multiple scales. Federally, even the *Flood Damage Reduction Program* that historically was considered to be a leading program for a non-structural approach to flood risk management, created specifically in recognition of the limitations of structural measures to flood reduction, dedicated over 50 percent of the expenditures under the Canada Water Act to finance the federal share of structural measures (Shrubsole, 2000).

Another limitation of this funding regime identified by a majority of participants was lack of funding for studies, a major issue that prevented municipalities from thoroughly investigating options available to them. A related bias towards investing in engineering rather than planning was also identified. The consulting industry, which played a significant role in defining options for adaptation, had a limited expertise in planning, with the majority focusing on engineering solutions rather than the planning process, a vital stage for identifying options.

The way current emergency financing is set up, Canadian tax payers pay for the unfunded liabilities of the residents in the floodplain. The recent disaster response and recovery numbers in 2013 alone included \$1B for flood in Toronto and over \$6B for floods in Southern Alberta. Canada was, until very recently, the only G7 Nation that does not offer country-wide overland flood insurance, with individual insurers now offering insurance in certain pockets of the country (e.g., in Calgary following the damaging flood of 2013). The issue of unfunded liabilities has

been recognized in BC for a while. In 1994, the Fraser River Board report recommended a user-pay system where flood protection for new developments would be self-financed, and flood plain residents who benefit from flood protection provided by dikes, including transportation and utility corridors, would contribute to maintenance. Flood plain residents would also fund the unfunded liability of flood damage caused by their residing in the flood plain. It was recommended that the relevant ministry at the time (Ministry of Municipal Affairs (MMA)) amend the provincial legislation to permit diking authorities to levy the costs of flood protection as a development cost charge, provide financial authority to permit diking authorities to levy a diking and channels maintenance charge on all properties in the floodplain and to carry and accumulate funds to provide for unforeseen emergencies and long term replacement facilities. These recommendations for developing mechanisms for self-insurance and other risk management measures to address the residual risks of living on a floodplain did not receive an uptake by the government.

Federally, in 2015, the Government of Canada established a dedicated mitigation program to invest over \$200 million over five years for the National Disaster Mitigation Program (NDMP). The NDMP, led by Public Safety Canada, was established to reduce the impacts of disasters on Canadians by focusing investments on significant, recurring flood risk and costs, and advancing work to facilitate private residential insurance for overland flooding. The program operates on a cost shared basis, merit-based, competitive basis.

As part of the program requirements, the competitive application process looked projects that had co-shared funding and met certain criteria. In other words, similar to the provincial funding allocation mechanism, instead of allocating funding based on a systematic risk assessment or some other strategic approach, an application-based program meant that investments were made for those projects that had the capacity to apply. Overall, the significantly low investments in mitigation pre-disaster compared to post-disaster assistance in Canada are consistent with an international regime where globally investments in prevention, preparedness, and mitigation continue to be low when compared to response and recovery. For example, in 2014 only 0.4% of official development assistance was spent on disaster prevention and preparedness (UN General Assembly, 2016). Post-disaster financing can also provide disincentives for incorporating mitigation measures, when it requires to rebuild to the pre-disaster standard.

Ability to maintain options is central to gen-R. However, under the current regime, several factors contribute to path-dependency that denies an active opportunity for pursuing alternative options. First, there is technological lock-in: once dikes are built it is nearly impossible to imagine a future without them. There was a clearly expressed degree of path-dependency when it came to exploring and maintaining options for adapting in the future within (already diked) municipalities and provincial levels. For example, a provincial interviewee (an engineer) questioned the ‘practicality’ of alternative approaches to structural flood management in the built-up region:

There’s maybe a few spots where retreat would be practical and recreating the salt marsh or just sacrificial agriculture, like in Delta, or Ladner...you maybe put a ring dike right around the urban area and the rest of the area is to a lower standard. If it floods well it’s a big problem but it’s not the catastrophe that it would be if the urban area flooded, right? Sure, there’s lots of ideas like that but I don’t... **fundamentally, we’re locked into our development pattern...** Lower Mainland that’s got potential except for ALR has been developed, right? And there’s a dike protecting it.

(MNFLRO_1).

The current funding regime maintained this path dependency by favouring structural solutions over other approaches. For example, another provincial interviewee when asked about whether soft measures such as wetland restoration could be considered under flood mitigation funding (which at the time supported primarily structural protection) responded that they were planning to include it in their next intake but were also cautious about the effectiveness of such approaches:

The problem is, in terms of us requiring anything, we don’t have enough data yet to fine tune to say what the level of effectiveness is. So what we’re saying is “if you build these in, your application would be viewed more favourably, but it’s not going to be a sure-up”. It’s going to be small, incremental. But again, it’s part of that education and part of that “Hey! We’re going to fund this too!”, which is quite a big deal (EMBC_2).

In moving forward from this path-dependency, an interviewee from the MCSCD reflecting at the *Cost of Adaptation* study (which predominantly focused on structural solutions) highlighted the need to differentiate between the policy and the technical and the planning solutions:

There’s a difference between doing a technical study that says how high should the dike be and looking at a planning solution. I think they can be quite different things. So for example, 1) there are a number of different people I imagine that would assume

that because the province has said it will cost 9.5 billion dollars to assisting dikes that's going to happen. That may well not happen, that may... that may well not be, the solution for any given area, there may have to be very tough choices made about protecting some areas and not others and so the policy choice is completely different than the technical solution (MCSCD_1).

This discussion shows that while the framing and the understanding of sp-R to floods have evolved significantly beyond being framed as a narrow reliance on dikes, as illustrated in the previous chapter in the way FMPs conceptualize and operationalize resilience, funding structures, decision making tools and the overall institutional framework maintain their focus primarily on easier quantifiable structural approaches. Lack of funding for research, studies on alternative options, and the planning process constrains opportunities to engage in gen-R planning. Under the current regime, smaller municipalities (e.g., Pitt Meadows) are struggling to secure funding from higher levels of government given their predominately agricultural base. However, due to their low tax base they also struggle to self-finance the maintenance of dikes in a changing climate. In a move from government to governance of sp-R, financing mechanisms were also seeing a change with boundary organizations filling some of the gaps as discussed in the next section.

6.6.4 Gen-R financing: moving beyond government

Investments in Gen-R, a less tangible aspect of resilience, related to unknown risks and the need to build a culture and ethos within organizations to deal with the unexpected and unanticipated, goes against funding models which aim to boost short-term efficiency through cost-cutting and elimination of reserve capacity. This divestment accumulates long-term costs to the detriment of long-term system performance. Government and regulation can play a central role in discouraging such approaches by requiring long-term planning and incentivizing investments in disaster mitigation and climate adaptation.

An emerging literature on resilience financing suggests that in the developed nations, resilience investments decisions are more about prioritization rather than availability of funds (e.g., Burch, 2011), an observation supported by several regional interviewees: “Capacity is one of the biggest issues that we face. I talked to the World Bank, saying, there’s all these funds for developing countries to do adaptation, is there anything for developed counties? [Their] response was “no, the money is there you just have to prioritize it differently.” But without really visible evidence of climate change it’s very difficult to get municipalities to reprioritize...What’s really

missing is at the federal and provincial levels funding and leadership to drive these processes at the municipal level” (ACT_SFU).

Echoing the idea of prioritization rather than resource availability, Gordon Campbell, the former Mayor of Vancouver and Former Premier of BC suggested: “Cities make choices every day. The fact is if you want to deal with the climate is it’s got to be at the top not at the bottom of your choice list. That has nothing to do with the economy. It has everything to do with the choices that you make. But one of the things in the city is they say “well, we would be doing fine if we just had more money from the [province]...and then provinces might say “well we would be doing fine if we just had more money from the federal government”. You start by understanding that there is only one taxpayer; it’s the same person. You pay city taxes and property taxes, you pay corporate taxes, you pay provincial taxes, you pay federal taxes – it’s always the same tax payer”.

However, despite these suggestions of perceived budget barriers and other research pointing to the lack of prioritization as the root cause of financial constraints, the majority of the interviewees and survey respondents have cited fiscal constraints as the main barriers for sp-R and gen-R (similar to Graham and Mitchell (2016)). In overcoming this barrier, some of the existing effective models of municipal self-financing (e.g., flood-specific utilities in CoR and CoPM), were acknowledged by other municipal FMPs but were not implemented widely across the region.

Resource pooling and sub-regional partnerships were also seen as a solution to financing joint sp-R investments. While the large resourced municipalities were more likely to lobby the higher scale government for funding, smaller municipalities were coming together for developing solutions. A low-key but effective example in the neighbouring regional district was mentioned by several interviewees:

The Fraser Harrison Rivers Committee which includes a number of municipalities and First Nations...the Kent, Agassiz, Seabird Island, Cheam First Nation and Chilliwack. They get together occasionally, a couple times a year to talk about common issues [e.g., river sediment and erosion challenges in that part of the Fraser] (FBC_1).

I really like the District of Kent model, the Kent, Harrison, Agassiz, all very small, they’ve created an MOU, work together with local First Nations on their own little joint program around river issues. It’s not very well talked about...but it’s working. They work together. They get people of different stripes and different organizations in the same room and they can build consensus and they don’t have big press conferences and stuff, they’re quietly sitting at the Tim Hortons working these

problems out. Those are the types of things that... make me hopeful because if it can be done at that level and it can be maybe expanded on, people can work together (CoC_Councillor).

In a move from government to governance, various resilience financing models were being used across the region. Boundary organizations and research institutions were seen as useful partners in their ability to attract funds, especially for planning process. For example, FBC ‘member sourced’ their initial steps on developing a regional flood management approach, with requests for \$5000 to their members to initiate the planning process. In another example, the SLR Collaborative funded by the real estate and insurance industries was able to provide staff time to ensure regular meetings and support for municipal knowledge co-production and informal coordination. Similarly, while numerous municipal FMPs stressed the need to question and groundtruth academic knowledge, they acknowledged the benefits of academic financing and resource pooling opportunities (CoV_P; CoV_E; DNV_PS; DNV_EP) and opportunities to test DRR and resilience solutions in university settings (DNV_PS; DNV_EP). At the provincial level the benefits of academic collaboration were also acknowledged: “researchers tap into a certain pool of funding and are able to bring things to the table that we can’t tap into” (EMBC_3). One interviewee spoke to a specific example of collaboration and resource pooling, especially in response to budget cuts at the provincial level: “We gave him [a PhD student] a small loaning – we gave him about \$66k. He matched it with a SSHRC... So we ended up with...\$250,000 worth of work that we got for tsunami wave modeling in one of our most at-risk areas of the province. It was through those partnerships – and if you’re asking about budget cuts – being able to put in \$66,000 and getting \$250,000 back...[Budget cuts] is one of the biggest challenges, but everyone’s feeling it. We’re doing the best that we can with duct-tape and shoestring!” (EMBC_3). In this process of knowledge co-production, several FMPs stressed that academic timelines that did not meet the urgency of the practical realities as a barrier to an effective collaboration.

It is important to note that these funding models were filling a significant deficit in the current sp-R funding regime. Despite millions spent on structural solutions on flood hazard (not flood risk), there was a lack of funding for planning, design, collaboration, and learning – the procedural dimension of resilience investments that would build on gen-R. Similarly, Graham and Mitchell (2016) suggested that a significant benefit of working with boundary organizations is in their capacity for research and ability to bring funding to cities. Boundary organizations

represent broader groups that fund their work which gives them an ability to leverage funding from across the scales of governance: from federal (through the CAS for BC RAC (NRCan), private and insurance sectors (e.g., SLR Collaborative), University partnerships (e.g., SFU ACT, ICLR, UBC), and member funded (province, municipalities, critical infrastructure sectors – FBC). In leveraging external funding, boundary organizations can innovate and expand their impact through creative funding mechanisms, while minimizing transaction costs (Lemos et al. (2014) in Graham and Mitchell (2016)). Through a key chain approach, a boundary organization can partner with end-users to fund separate projects (e.g., FBC finding funding and solutions across multiple scales for debris floods). In a linked chain approach, a boundary organization can partner with other boundary organizations to customize information for end-users (e.g., sub-regional SLR Collaborative as a partnership between WCEL and SFU-ACT). In a network chain approach, a boundary organization can play a facilitation role in connecting boundary groups and end-users to maximize knowledge translation (a role that was partially fulfilled by provincial CAS).

6.7 Conclusions

In this Chapter I explored the sp-R—gen-R relationship situated in a multi-scale flood governance system.

I first identified key barriers to sp-R action at the regional scale. These barriers can be grouped into four major categories: resources and financial/funding barriers; governance and coordination/regulatory (across the scales); leadership (across the scales of governance); and contextual (varied needs and capacities of municipalities). The majority of the barriers were multi-scalar in nature, and framed analysis in the subsequent sections.

To explore the sp-R—gen-R relationship at the regional scale, I examined key planning processes that influenced this relationship. These included *Regional Growth Strategy* and related planning process and tools. Overall, I found that despite the promising potential and contribution of these planning processes to gen-R (e.g., increased collaboration at the regional scale), the existing regional planning processes did not effectively address sp-R at the regional scale. Key barriers included lack of flood-specific formalized planning process at the regional scale, the future-oriented nature of the planning process that did not address existing risk, as well as “responsibility without the authority” barrier, which meant that while regional planning was well-positioned and institutionally supportive for such core gen-R principles as connectivity,

diversity, and ability to maintain options, very few planning tools at the regional scale addressed sp-R on a systematic basis. While promising examples that contributed positively to both sp-R and gen-R were emerging (such as regionally initiated Integrated Storm Water Management planning process described in Chapter 5), these planning processes were focused on localized flooding rather than larger scale regional floods.

Across the scales of governance, professional, organizational and sectoral silos, social capital served as a glue that enabled a more proactive sp-R action lead by champions (exceptional human capital) in the region. This movement of ideas, solutions and practices was supported by experience (with 63% of the surveyed FMPs reporting over 10 years of experience in the field of flood management) and lateral movement of human resources across the region (53% of surveyed FMPs worked in another municipality in the region) weaving a network of organizationally enabled policy champions that leveraged their practical knowledge and political influence for implementing novel solutions.

For learning across the scales of governance, active polycentric processes of shadow and spotlight learning unfolded fueled by municipal, regional and (to a much lesser degree provincial) champions. Regional planning for sp-R, given its absence in a formal regulatory sense, was enabled by mediating institutions (such as FBC and SLR-C). These institutions played an important role in translating sp-R process in gen-R outcomes such as increased social capital and collaboration, joint learning and investing in the ability to maintain options across temporal and spatial scales. However, an overreliance on these mediating institutions may also serve as a barrier to an active self-organizing at the municipal scale, a pattern that can have long-term gen-R implication by constraining municipal action. Across the levels of government, across the scales of governance, questions of nested capacities to address sp-R under conditions of change were being actively explored, with the lower scales (municipal and regional) of government unable to address this change on their own requiring action from provincial and federal scales.

The analysis shows that the ability to maintain options for sp-R is a dynamic multi-scalar issue. Similar to the municipal scale, this ability was highly reliant on the decision-making processes for resource allocation for sp-R. A major concern for sp-R planning is single parameter decision-making that prioritizes certain values (e.g., fiscal) but discounts others (e.g., social or environmental). As analysis in the previous chapters illustrated, the tightly intertwined

relationships between politics and fiscal policies impacted both sp-R and gen-R. From decision making perspective, the discussion above shows a continuous prioritization of an economic dimension across the history of flood management in BC. Even when an attention was given to social/public morale after the significant floods, it was done so that the economic development could continue. A key decision-making tool over time, the cost-benefit analysis (CBA), was meant to ensure a ‘reasonable’ relationship between the costs of construction, the population, and the ‘real values’ being protected. This approach, while arguably pursuing fiscal equivalence, a base principle for governance in BC (UBCM, 2008), led to a historically inequitable distribution of risk. The historically implemented CBA, reflective of the priorities of the time, was initially focused on protecting more densely populated areas and the most productive agricultural lands, a focus that was subsequently shifted to protecting high value properties. This CBA resulted in increased structural inequities concentrated within the First Nations on the unceded territories of which the region lies.

Across the scales of governance, the erosion of gen-R is especially evident at the provincial level that determines and regulates sp-R at the lower scales. This applies to the loss of human and social capital through cuts to staff and programs, reduced and removed capacity to monitoring and oversight, reduced capacity to collaborate and engage with municipalities directly, reduced capacity for learning which leads to an overreliance on consultants and industry and potentially leading to knowledge capture, all of which leads to reduced institutional capacity for sp-R. To summarize, the analysis in this chapter found that sp-R and gen-R are related through complex feedback loops across spatial, temporal, jurisdictional, and institutional scales.

Chapter 7: Conclusion

7.1 The dissertation journey

Resilience is a popular policy objective. As an approach to managing uncertainty, resilience seeks to explore policy alternatives and develop solutions based on the capacity-building strategies of institutions to deal with uncertainty and change. In this dissertation, I analyzed the formal and informal institutional arrangements across multiple scales that govern planning for resilience to floods (sp-R) and their influence on the capacity to deal with change in general (gen-R). By combining socio-ecological resilience, planning, and disaster resilience studies with a review of hazard-, risk-, and resilience-based approaches to managing uncertainty, I identified key planning activities that can contribute to gen-R. The core question that I was seeking to answer was “What is the relationship between sp-R and gen-R”? In other words, when operationalized, “Can the process of planning for a specific hazard (flood), increase social and human capital, increase capacity to self-organize, collaborate, and learn, all while maintaining options to adapt”? Finding an answer and identifying the mechanisms across multiple scales behind these procedural dimensions of gen-R could offer insights in how to build a generalized capacity to deal with change, irrespective of the hazard faced.

In answering this question, I immersed myself in a mixed-methods, 2.5 year-long field work to explore the flood management regime at the regional scale. I attended over 30 events and meetings, ranging from one-day intense workshops to being a regular participant of a two-year long Collaborative. I interviewed 60 experts who were actively working on sp-R: municipal engineers, emergency managers, planners, fire personnel, mayors and councillors, regional planners and engineers, consultants, critical infrastructure managers, and provincial staff. I also interviewed people who were at the critical junctures of policy change in BC in the past, such as former mayors and premiers. I identified key flood management staff in the region and administered a targeted regional survey based on my literature review, interviews, and participant observation. Every major municipality in the region participated. By adopting a mixed methods approach that drew on historic accounts, policy analysis, interview and survey data, I triangulated various sources of information for creating an institutional narrative behind the search for regional resilience through the process of institutional change and adaptation, learning, and collaboration across multiple scales of governance.

Methodologically, the choice to pursue a mixed method longitudinal study ensured a deeper understanding of decisions behind key policy junctures in the regional story. It allowed me to apply a diagnostic approach to regional resilience as a process by taking into account complexity in a systematic fashion (Pahl-Wostl, 2009) by unpacking key drivers and barriers for institutional change across multiple scales. In what follows, I summarize the key findings of my research.

7.2 Summary of research findings

7.2.1 Understanding sp-R –gen-R across the scales of governance

In this dissertation I explored the formal and informal institutional arrangements across multiple scales that govern planning for resilience to floods (sp-R) and their relationship to the capacity to deal with change in general (gen-R). Figure 7-1 presents a summary of the findings.

What I found across the scales of governance was truly exceptional human capital that served and championed sp-R objectives. Motivated by their knowledge of the rate of change in socio-ecological systems from local to global scales, driven by provincial changes, and supported by their councils, the sp-R champions found creative ways to align long term planning for SLR with existing institutional structures and planning mechanisms to legitimize climate change adaptation in general. Similar to mechanisms described in the literature (Anguelovski & Carmin, 2011), the staff in more resourced municipalities were highly opportunistic in their engagement with actors, attending numerous regional events, and drawing on international/supranational platforms and networks to leverage action, legitimize, and institutionalize climate change planning in their municipalities. Their actions, however, were strongly influenced by structural factors and the political context at the local and higher scales of governance (Baker et al., 2012; Cashmore & Wejs, 2014; Juhola & Westerhoff, 2011). The political process strongly influenced implementation of the outcomes of the planning process across the scales of governance, as reflected in the upper box of the diagram, where I added politics to the original ‘governance and institutions’ heading.

The efforts of the champions were enabled by social capital, a ‘glue’ that held the informal and formal institutions together. Unlike the original conceptual framework where social capital was suggested as a subset of gen-R, I found that social capital was a cross-cutting variable that connected sp-R and gen-R across the spatial scales, across the scales of governance, and across professional silos. To reflect this connective tissue function, I have placed social

capital and networks immediately after the overarching category of Governance, politics, and institutions in the revised conceptual framework below (Figure 7-1).

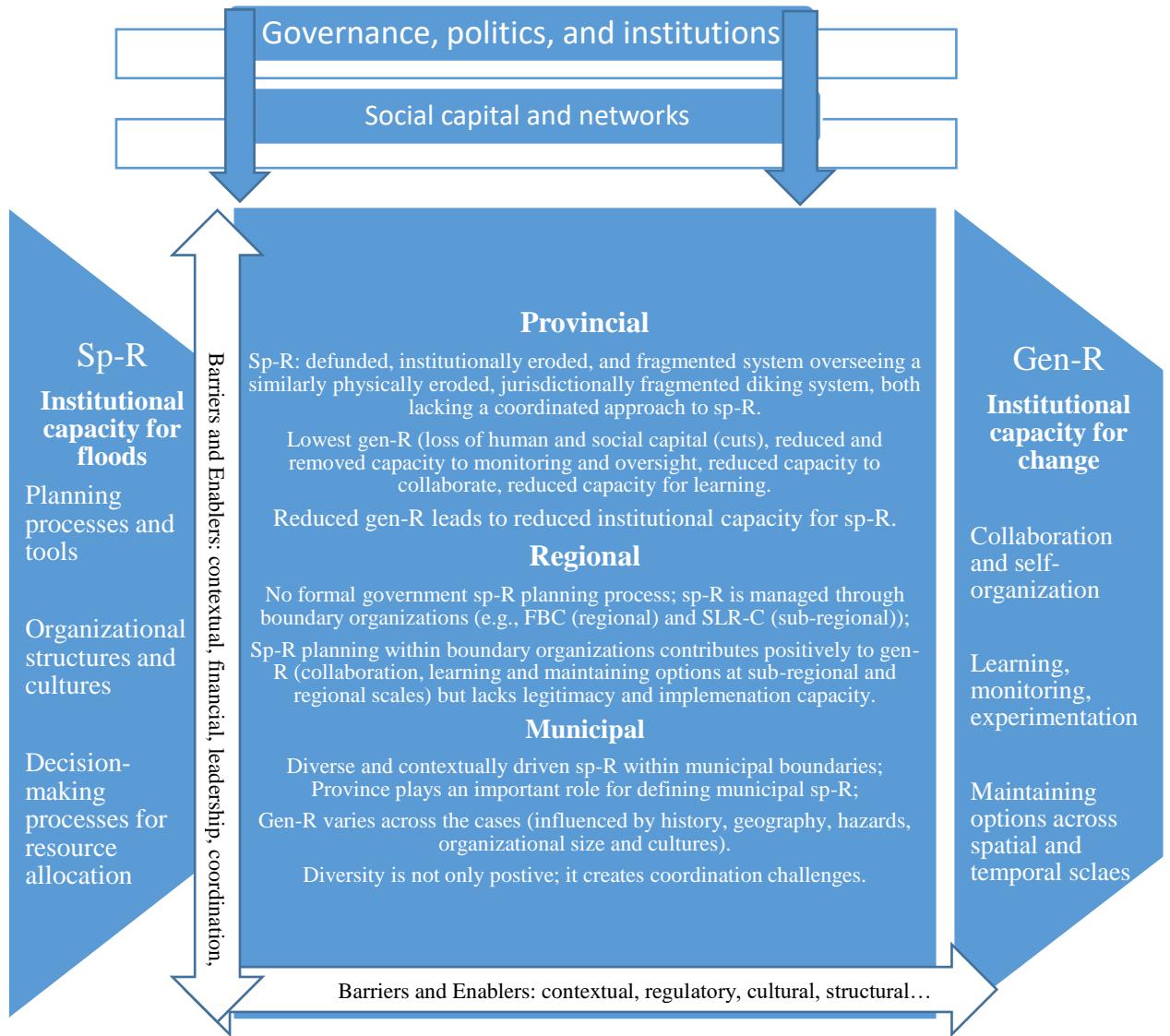


Figure 7-1 Revised conceptual framework with key findings

I also found strong evidence that local decisions regarding sp-R are shaped and constrained by horizontal interaction at the local levels as well as vertical interactions with structures at higher geographical scales that may mandate, encourage, and inform local actions (Baker et al., 2012; Nass et al., 2005; Wilbanks & Kates, 1999). In a move from *government* to *governance*, I documented the importance of cross-scale linkages on multiple levels of institutional and regulatory control, and the influence and impact of these interactions on

individual scales (Basurto, Kingsley, McQueen, Smith, & Weible, 2009; Cash & Moser, 2000; Nelson, Adger, & Brown, 2007; Vignola, McDaniels, & Scholz, 2013). I summarize some of the key findings across the scales below. This is followed by a summary of key findings organized by the initial research questions. I conclude with study implications and limitations and future research directions.

Provincial level

Overall, at the provincial level, I found a defunded, institutionally eroded and fragmented system overseeing a similarly physically eroded, jurisdictionally fragmented diking system on the ground, both of which lacked a coordinated approach to sp-R. Despite recent pro-active developments in supporting the emergent SLR regime through a number of technical and policy evaluation studies, the provincial level analysis indicated trends for reduced gen-R. These included loss of human and social capital (due to budget and staff cuts), reduced and removed capacity to monitoring and oversight, reduced capacity to collaborate (especially directly with the municipal level), and reduced capacity for learning (with learning primarily externalized to consultants). Reduced gen-R led to reduced institutional capacity for sp-R which speaks to a complex interdependent relationship between the two. The defunded capacity created a significant reliance on the consulting industry which influenced the development and the direction of policies at the provincial level. These same consultants were also advising municipalities, thus potentially creating a knowledge capture, especially under conditions of significantly reduced oversight. This reduced capacity had directly implications for sp-R and gen-R at the lower scales of governance.

Regional

There was no formal sp-R planning process at the regional scale. Instead, this governance gap in a regional approach to sp-R was negotiated through an existing long-running boundary organization (Fraser Basin Council (FBC)) and an emergent sub-regional issue-specific boundary organization (Sea Level Rise Collaborative (SLR-C)). As the provincial role in regulating flood risk diminished over time, FBC, funded in part by the province, took on a broader portfolio to regional flood management. While sp-R planning within boundary organizations contributed positively to gen-R (increased social capital, collaboration, joint learning, and maintaining options at sub-regional and regional scales), it lacked implementation capacity.

Municipal

At the municipal scale, I found diverse and contextually sensitive sp-R regimes influenced by history, geography, hazards, and capacity (e.g., size, human capital). The province played an important role in defining municipal sp-R approaches and action.

Gen-R varied across the cases, influenced by history, geography, hazards, organizational size and cultures. Diversity was not only positive but also created challenges for the regional sp-R system leading to coordination challenges for a systematic region-wide reduction of flood risk. Sub-regionally, gen-R dimensions were most prominent in the Burrard Inlet sub-region, and least prominent in the Fraser Freshet sub-region. The degree of novelty of the sp-R planning challenge (the geographically distributed prominence of SLR as a planning and development challenge), existing institutional capacity, and the relationship between the elected officials and staff (trust, enabled leadership) were some of the major determinants of gen-R outcomes, supporting propositions 1B outlined in the beginning of this dissertation.

Ultimately, resilience is about relationships. As examples elsewhere demonstrate, what matters for effective adaptation is not only formal institutional structures (which are necessary to give an organization shape and direction) but the contingent, shared world of informal relationships that champion sp-R across the scales of governance. The previous chapters demonstrated examples of mechanisms in which the sp-R processes, through a complex network of social relationships across the scales, enabled gen-R originating from within and across organizations bounded by the geographic region and beyond. In this process both spotlight and shadow mechanisms were used as vehicles for learning. As analysis in previous chapters demonstrated, jurisdictional scale is just one of the multiple scales in which the sp-R—gen-R relationship unfolded with interactions taking place across multiple levels within a scale (cross-level) and also across different scales (cross-scale) (Cash et al., 2006), indicating a significant complexity of sp-R governance.

In what follows, I return to my four main research sub-questions introduced in Chapter 1 as a synthesis of findings. I then outline the contributions of my research to the interdisciplinary field of urban and regional resilience. I conclude the chapter by assessing the limitations of this study and outline potential future research directions.

Q1: What are the key elements of sp-R at the municipal scale?

I found that municipal sp-R regimes were rooted in local history, responsive to local hazards, and were distinct products of local governance and civic regimes situated within their capacities and limitations. Within this diverse mosaic of sp-R regimes, my analysis showed that the general tools and processes lacked effectiveness in regulating flood risk in the region, placing a higher emphasis on site/area specific tools used within municipalities. While this framework enabled flexibility for adopting locally needed solutions, it reduced opportunities for more strategic region-wide approaches to managing flood risk. As a result, the municipalities did not have sufficient institutional capacity to address sp-R at the regional level through formal municipal tools and processes.

This municipal diversity further translated into sub-regional constellations of sp-R regimes, products of hazards faced, historic and emergent collaboration patterns (driven by geographical features, organizational cultures, and joint planning challenges) and learning mechanisms (that ranged from virtually no mutual learning across the municipal border to a dedicated, multi-year, multi-stakeholder collaborative process focused around a sp-R planning challenge). In the Burrard Inlet sub-region (City of Vancouver, City of North Vancouver, and District of North Vancouver), the issue of sp-R (enabled by new provincial SLR guidance combined with coastal developments in municipalities) generated the most amount of action. It required a negotiation of trade-offs between investments in the sp-R of tomorrow vs. immediate community priorities. The sub-region was in an acute learning stage, actively collaborating, drawing on formal sub-regional mechanisms (such as NSEMO) but also enacting latent social capital, and forming semi-formal working groups (at the staff level) to collectively investigate options. In this sub-region, the sp-R process resulted in significant gen-R outcomes (e.g., ability to self-organize to leverage political influence, collaborate, and learn). Individual champions connected through social capital developed through both the pre-existing and emergent institutional arrangements were key to this process.

In the South Fraser double-exposure sub-region (City of Surrey, City of Delta and City of Richmond), addressing coastal flooding and freshet floods was a more familiar task. However, the provincial *Cost of Adaptation report* (that suggested that billions would be required for dike improvements in the sub-region to meet future flood risk, including seismic upgrades) fueled a scientifically-based resistance from the municipalities. Similar to Burrard Inlet sub-region, this

required a negotiation of trade-offs. Working with the consulting industry, municipalities proved to the Province that investing in sp-R protection from a low probability/high consequence event would come at the expense of meeting their current needs and create opportunity costs for community resilience. Instead, the municipalities were developing a layered approach to safety (a combination of flood protection, emergency management, and recovery planning measures). These approaches signaled a move away from hazard-based approaches to risk management and resilience.

In Fraser Freshet sub-region (City of Pitt Meadows and City of Port Coquitlam), the provincial guidelines did not create a similar splash. These municipalities were the least engaged in the regional forums, given their smaller size, capacity and a lesser degree of perceived urgency of the impact of SLR (despite tidal influences on the Fraser). However, these two municipalities both had sp-R innovations such as a drainage utility and a unique recovery planning process, fueled by champions.

In addition to a somewhat varied interpretation and implementation of provincially legislated tools, municipalities were using diverse and context specific approaches, tools and mechanisms to regulate, fund, and manage sp-R. These approaches were locally informed and tested, knowledge and data generated at higher scales were scrutinized and made locally relevant. These practices, while illustrative of the best practices in the resilience literature, regionally added up to an uncoordinated patchy mosaic of sp-R responses. Seen as desirable from the perspective of socio-ecological resilience literature, this diversity presented a management challenge from a public administration perspective. While direct inter-municipal collaboration was present to a varied degree in sub-regions, coordination, understood as the management of inter-organizational interdependence, was externalized to the boundary organization (FBC) that lacked authority and capacity to mandate implementation as a consensus driven organization.

Overall, the diversity of distinct needs, capacities, and responses of municipalities across the sub-regions to internal drivers (e.g., escalating sp-R costs) and external drivers (e.g., changing hazards; provincial guidelines) that characterized municipal sp-R were both enabled and constrained by multi-scalar governance and were subject to regulatory, contextual, and organizational barriers and enablers.

Q2: What is the relationship between sp-R and gen-R at the municipal scale?

As the analysis in Chapter 5 demonstrated, at the municipal scale, sp-R and gen-R were related through the planning process (as hypothesized at the outset) but also through organizational dimensions and decision-making processes. At the municipal scale, resilience planning unfolded beyond the activity of professional planners as a process that brought together multiple professions to negotiate multiple objectives and trade-offs within the sp-R—gen-R relationship. I summarize key findings for each of the categories below.

To better understand the role of *planning* on gen-R, I examined three formal processes: Official Community planning, sustainability, and climate change adaptation. These three processes and associated tools showed a varied effect on procedural benefits for collaboration and learning across the cases, gen-R. I found that in addition to the importance of the procedural benefits of the *planning process* for gen-R, the actual outcome of the planning process, the high level *plan or strategy* (e.g., CoS Sustainability Charter; CoV's Greenest City Plan) played a critical role as an enabler for action (e.g., climate change adaptation plans and strategies) as it provided a framework of institutional continuity for dealing with changes at staff and political levels by enshrining the collective vision of the municipality and providing long-term clarity. In addition to existing and widely used tools, the chapter showed that adapting to climate change will require re-evaluation, development, and regular updating of planning practices across departmental and organizational silos to reflect the changing needs of municipalities.

In addition to the three planning processes mentioned above, I found numerous examples of unique innovations and planning mechanisms that allowed the maximizing of procedural benefits of gen-R. These mechanisms depended strongly on organizational and cultural/behavioural factors such as leadership and trust. Some exceptional examples of this included the learning process for DNV's risk tolerance criteria (RTC) and CoS's staff-driven, collaborative, polycentric, and distributed planning processes. DNV RTC resulted in exceptional gen-R outcomes such as increased learning (at the organizational, institutional, and public levels), collaboration (inter-municipally (across departments), across the sub-region, across the scales (through numerous federal-municipal partnerships) and internationally, across countries). The RTC also served as a foundation for a fundamental change to how decisions were made locally by adopting criteria as a benchmark for decisions governing multiple risks. However,

these individual innovations remained contained within the individual municipal boundaries and lacked a mechanism for a horizontal regional spread.

Several organizational factors have influenced the sp-R—gen-R relationship. Municipal sp-R practices were constrained by physical barriers (water bodies) that then led to mental barriers (e.g., island mentalities that limited levels of collaboration and learning) thus disrupting connectivity, reinforcing path-dependency barriers (commitment to a certain approach to sp-R, such as dikes) and maintaining organizational barriers (including organizational cultures within municipalities and across the professions). Overall, when it came to barriers and enablers (contextual, regulatory, cultural, structural), these were manifest within the horizontal interactions and processes and across the vertical scales of governance as illustrated in Figure 7-1 and discussed in more detail below.

The analysis of learning at the municipal scale showed several major themes. Political climate strongly influenced capacity to learn at the individual, organizational, and institutional levels. By supporting sp-R learning, the elected officials enabled several procedural gen-R benefits such as human capital development, increased social capital and collaboration, and the ability to openly discuss and pursue sp-R options available to municipalities. While municipal staff were most effective in single and double loop learning (including small events locally such as DNV's landslide that lead to the creation of RTC), they lacked the capacity for transformative triple loop learning to question the very foundation of the governance regime, as it is determined at the higher scales of governance.

As suggested in both the SES and climate governance literatures, resources and reserves played a role in defining the levels of gen-R. Resourceful municipalities (human capital, social, capital, financial resource, and institutional capacity) were able to learn (internally, regionally, and internationally), experiment, and take risks. Financial and political stability and support allowed certain municipalities to actively translate their sp-R planning process into gen-R outcomes (such as increased social capital and collaboration, ability to participate, create and leverage polycentric learning platforms, and ability to invest in exploring and maintaining options).

The detailed analysis of the ability to maintain options showed the importance of decision-making processes that in turn highlighted a nuanced understanding of fiscal, equity, spatial, and temporal trade-offs. While there was a depth and nuance to identifying the types of

trade-offs, examples of transparent and systematic decision-making methodologies for evaluating them were limited. In the City of Pitt Meadows and the City of Richmond, proactive flood-specific fiscal mechanisms were created to ensure that flood investments did not erode the overall capacity of the municipality to deal with change. Overall, the consideration of trade-offs remained within the municipal boundaries with no mechanisms to evaluate sub-regional or regional actions.

Planning, defined as an ability to connect knowledge to action (Friedmann, 1987), is a distinct capacity of human systems. As I hypothesized at the outset of this dissertation, planning did indeed have a role in defining the sp-R—gen R relationship. My findings show that the sp-R – gen-R framing and its operationalization for this dissertation has withstood the criticisms of gen-R theory. For example, Duit (2016) suggested that “If it was indeed possible to design, guide, and control processes of social change to the extent that is assumed in many of the policy prescriptions emanating from the resilience literature, then there probably would not be any environmental problems to begin with... Controlling even just one of these system properties (e.g., ‘trust’ or ‘diversity’) lies beyond the capacity of most real-world managers (even more so in countries with weak institutions), and the true challenge for any public administrator is to address social problems without such capabilities” (p. 373)” .

As the municipal scale analysis has shown, carefully constructed planning processes (such as the process behind the DNV risk tolerance criteria) and nurtured organizational cultures (such as Surrey’s highly collaborative, trust-based and lean culture that influenced their sp-R planning process) can enhance trust within the organization and with the public, can build political and staff leadership, and encourage diversity of planning responses and solutions.

This diversity of planning responses for sp-R was partially enabled by lack of clarity within provincial regulation and a regional scale governance gap (an absence of formal regional-scale planning for flood risk). Similarly, changes in municipal sp-R practices were enabled by provincial regulations (including devolved responsibility for flood management, new technical studies and evaluation of potential costs of adaptation) but action remained constrained due to insufficient funding (inability to address the scale of changing risk on their own) and the constrained ability for transformative change given the dependence of municipalities on the higher levels of government as “creatures of the province”. A number of regional scale barriers were identified.

Q3: What are the barriers for sp-R at the regional scale?

The sp-R barriers that were identified through the interviews and then ranked through the survey can be grouped into four major categories: resources and financial/funding; governance and coordination/regulatory; leadership; and contextual. I discuss each of the categories below.

The two most significant barriers, ‘lack of resources for capital expenditures’ and ‘limited municipal resources and capacity’ were the most expected based on the interviews and literature (e.g., Anguelovski, Chu, & Carmin, 2014; Measham et al., 2011; Moser & Ekstrom, 2010). The interviewed municipal staff were unanimous in that it would be impossible to address current and future flood risk without financial support from higher levels of governance. Lack of resources for studies also limited the ability to explore and maintain options, thus influencing gen-R.

However, it was not only the lack of funding but how this funding was distributed that was identified as a barrier. Competitive funding models (by application) were a major barrier for regional sp-R as they supported ad-hoc flood mitigation improvements rather than systematic reduction of risk. This was an issue at the municipal (e.g., funding 12km of the 45km dike where the water would just go around), regional (funding the more resourced municipalities who had cost-shared matching funding which left the less resourced municipalities out), and provincial (funding those municipalities that had the capacity to apply and had major expensive assets to protect) levels. The historically applied cost-benefit analysis that was used for decision-making for resource allocation by design favoured flood protection of more expensive assets. This has led to an accumulated sp-R deficit in smaller and less resourced communities, especially in Indigenous communities, an equity issue that was further exacerbated by multi-scalar colonial policies that still define the differentiated levels of public safety and development opportunities of today.

My analysis in Chapter 6 also clearly shows the multi-level governance nature of the barriers, a finding consistent with climate resilience literature given the fragmented governance systems that present a major coordination challenge in coastal areas (Tol et al., 2008; Macintosh, 2012). Lack of coordination across the scales of governance was a particularly significant barrier at the federal and provincial levels. Lack of clear provincial guidance was also a major factor that influenced sp-R at the municipal scale. As the qualitative analysis of the interviews and policy documents has demonstrated, lack of direct engagement between the province and the

municipalities was a major barrier for systematic flood risk reduction. While boundary organizations were able to fill some of these inter-scalar gaps, it was not sufficient for addressing the risk of today and of the future.

Lack of leadership across the scales of governance was identified as a major barrier that decreased with the scales of governance (highest at the federal level and lowest at the municipal level). Clearly, municipal respondents had higher expectations for an enabling context for sp-R action from the higher scales of government. The provincial government, while providing guidelines for action, left municipalities on their own to make sense of the impacts of climate change (such as SLR) and articulate their response options. It appears that in the absence of active participation of a higher level of government that employs its regulatory authority, provides effective incentives, and ensures the ability of municipalities to access the necessary resources, coordinated collaborative actions driven by municipalities are unlikely to develop to meet the changing flood risk. Yet, lack of a coordinated and systematic approach to the management of natural hazards risks at the regional level that is due to an inconsistent knowledge base and the absence of regional oversight of municipal actions, can result in a sub-optimal approach to sp-R. The majority of the interviewed participants believed that the province has to play a larger role in this process.

Finally, within the contextual municipal-regional scale, it was the different hazards and needs of municipalities that were identified as the most significant barriers, followed by the related existing diked vs. undiked approaches, and differing organizational cultures. I discussed the diverse sp-R regimes in detail in Appendix D and explored their relationship to gen-R in Chapter 5 (e.g., water bodies in between that lead to ‘island mentalities’ influencing planning regimes and organizational cultures).

The survey also revealed some surprising findings indicating that MVR has moved beyond some of the commonly cited barriers. For example, lack of regional scientific level data/better regional models to create a baseline for further planning and lack of regional learning opportunities were identified as some of the least significant barriers.

Q4: What is the relationship between sp-R and gen-R at the regional scale and across multiple scales of governance?

Regional coordination and collaboration are essential to an effective response to climate change. Yet, as I identified in Chapter 5 and 6, streamlining planning for sp-R in a non-

amalgamated region is a formidable task. Recognizing flood resilience as a cross-scalar issue requires attention, learning and legitimization by a broad range of stakeholders. This study revealed that the level of this attention, the implementation capacity, and the willingness to self-regulate risk through existing legislated mechanisms (e.g., Official Community Plans) and optional mechanisms (e.g., Climate Change Adaptation Strategies) varied greatly across the region. As a result, the fragmented governance system failed to account for interdependent cumulative effects of land-use changes and planning initiatives that spilled over municipal boundaries. This may have led to missed opportunities with regards to exploiting procedural and substantive benefits gen-R for the region as a whole as it moved on with developing the adaptation agenda.

A core concern with sp-R planning is an overreliance on a single tool or a single approach (e.g., structural approach to flood protection) that removes the redundancy of layered approaches that spread risk (e.g., through a combination of land-use measures, building practices, and preparedness measures and economic incentives and insurance). Across the scales of governance, historical path dependencies influenced the approaches to sp-R, with structural approaches dominating. The current sp-R funding structures was a product of multi-scale governance; often political and reactionary. Historically, provincial investments in sp-R to floods was a major factor for the economic growth in the region. Since the inception of this provincial influence, diking had been a dominant approach to framing sp-R over time. Unlike a diverse number of tools and innovations unevenly and inconsistently employed across the region by municipalities, at the provincial level this overreliance was clearly manifest, which in turn impacts the extent to which municipalities can imagine and maintain options.

In a move from government to governance, this study highlights the role that non-governmental networks can play in disseminating knowledge, encouraging learning and legitimizing sp-R options and supporting gen-R across the scales of governance. At a regional scale, I found formal (coordinated, long-running) and informal (self-organizing, polycentric) networks of champions, policy entrepreneurs, key stakeholders, and mediating institutions which enabled collaboration, self-organizing, and learning. These networks partially filled the sp-R governance gap – the absence of formal institutions and policy instruments to address the multi-scalar and cross-sectoral nature of flood risk at the regional scale—through the emergence of several mediating institutions. These ranged in scale, capacity, age and purpose.

The Fraser Basin Council (FBC), a unique non-governmental organization served as one of the main regional platforms for information exchange, collaboration, and developing regional options. Originally formed to address issues connected to flooding on the Fraser, this institution showed responsiveness and awareness of the overall systems to planning gaps (such as SLR), and has maintained its position as a leading regional scale boundary organization for developing a regional flood management strategy. However, the FBC lacked regional implementation authority, relying on consensus-driven policy creation and voluntary adoption of the policies and best practices. This voluntary mechanism cannot fully address the fragmentation of implementation initiatives across the region. While coordination and collaboration in regional planning is theoretically achievable in a non-amalgamated region without participation of the provincial government as an active partner, *implementation* will require its active role as a partner. Additionally, future studies will need to address the role of the federal government in the process of climate change adaptation given the scale and the magnitude of required regulation and financing that municipalities, regions and even provinces are unlikely to be able to meet on their own.

Across the scales of governance, the erosion of gen-R was especially evident at the provincial level. This had direct influence on sp-R at the lower scales. This applied to the loss of human and social capital through cuts to staff and programs, reduced and removed capacity to monitoring and oversight, reduced capacity to collaborate and engage with municipalities directly, reduced capacity for learning which led to a reliance on a narrow set of consulting companies and industry and a potential for knowledge capture, all of which led to reduced institutional capacity for sp-R. In summary, I found that sp-R and gen-R are related through complex feedback loops across spatial, temporal, jurisdictional, and institutional scales.

7.2.2 Gen-R principles revisited

One of the main theoretical contributions of this study is the interdisciplinary theoretical framework tested against the empirical case study, a major gap identified in the literature. By bridging the hazards/disasters, SES, planning, and public administration and governance studies, this dissertation made a contribution by operationalizing and examining the sp-R—gen-R relationship. The study found that across the scales of governance, *human and social capital, leadership, and trust* were central to defining this relationship through such core procedural dimensions as the ability to collaborate and self-organize, learn, monitor and experiment, and

maintain options and reserves across temporal and spatial scales. In addition to these commonly mentioned elements of gen-R, empirical in-depth exploration of gen-R principles such as *diversity*, *modularity*, *openness*, and *feedbacks*, combined with insights from resilience principles in the fields of climate governance, public management, and planning could make an important contribution. I summarize them briefly below.

Diversity and modularity. This study found that *diversity* is not only positive, as widely described in the SES literature, but from management and governance perspective it presents a coordination challenge, especially when projected to an event of regional large-scale disaster. In the case of MVR, governance failure (such as an absence of regional-scale planning for flood risk) and lack of clarity from the province enhanced the diversity of planning responses for sp-R. The municipal planning regimes, diverse, contextual, responsive and governed at the lowest scale (aligning with the principle of subsidiarity) were also largely modular, meaning that what happened in one municipality did not translate into another, thus eliminating the risk that tightly connected systems have for cascading a managerial mistake.

However, this system has its clear drawbacks when analyzed from a regional governance perspective. From gen-R perspective, my research questions some of the very foundational tenets of resilience theory. Put simply, diversity is not always a good thing, a finding that is consistent with public administration studies suggesting that there is little evidence that increased diversity in public administration will create a more resilient governance system (e.g., Comfort, 1994; Duit, 2016), especially in an event of large-scale regional disaster that requires mobilization of available resources and knowledge across jurisdictional boundaries for timely action at the local level. Lack of coordination of structural and non-structural flood protection measures, collaboration patterns based on geography that led to island mentalities, unequally distributed patterns and mechanisms of learning, have all contributed to unequal distribution and accumulation of risk across the region.

The degree of *openness* varied across the scales with municipalities being the most common early adopters, yet their ability to fundamentally transform the governance system was constrained by the higher scales of governance. At the regional scale, given the absence of the formal, government-based sp-R planning, the degree of openness was determined by the boundary organizations that were driving planning for sp-R. The key regional institution FBC's JPC which historically was dominated by senior engineers with a focus on structural solutions

was slowly being changed by the increasing number of planners and emergency managers. This change, however, was relatively marginal and did not reflect the scope of influence of those professions on the overall sp-R regime, especially at the municipal scale. Another boundary organization, the SLR-C, was comprised and driven from the very beginning of planners, emergency managers, and engineers, as the challenge that brought them together (SLR and raised FCL in particular) was ultimately a planning and urban design challenge first. The degree of openness at the provincial level was strongly influenced by the political climate and fluctuated over time, with low openness at the time of the interviews (Oversight at Risk, 2017). With regard to openness in *learning*, trends indicating a potential knowledge capture were present with consultants playing a disproportionately large role in defining flood management regime. While this can be seen as a positive trend (e.g., systems' openness to new knowledge) in reality it was a handful of consulting companies that were most influential and most commonly contracted.

Tightness of feedbacks. This dissertation made a contribution by providing insights into political dimension of feedbacks: the feedbacks between elected officials (a fast variable) and bureaucracy (slow variable) that have direct implications on sp-R and gen-R.

As suggested by Walker, Abel, Anderies, & Ryan (2009), there is often a trend of lengthening times for responses to signals, due to increasing levels of governance, and increased steps in procedural requirements. However, the excessively tight relationship can be problematic. For example, one of the potential issues mentioned by the interviewees was the increasingly close relationship between approving officers and councils that could lead to regulatory capture. As the analysis at the municipal and regional scales has shown, the most effective mechanisms for maintaining a tight feedback between the degree of change and the responses required to manage it was done through trusted and supportive relationships between the staff and the political leadership.

The higher the scale of governance and the larger the size municipality (in terms of number of staff rather than geographical size), the further the distance and the feedback between the politicians and staff. Yet, as the municipal scale analysis has shown, carefully constructed planning processes (such as the process behind the District of North Vancouver's Risk Tolerance Criteria, or the City of Port Coquitlam's multi-year multi-stakeholder recovery planning process) and nurtured organizational cultures (such as the City of Surrey's highly collaborative and lean culture that influenced their collaborative planning process) can tighten the feedback by

enhancing trust within the organization and the public, enabling political and staff leadership, and encouraging diversity of planning responses and solutions.

At the regional level, no political body oversaw the regional approach to floods. At the provincial level, given the organizational distance between the staff across the departments, the tightness of feedback was maintained through policy evaluation. However, direct evidence on policy learning and implementation following this evaluation was limited.

Reserves and resources. Decision making for reserve and resources allocation (such as funding and staff time) has been a major focus of this dissertation. The resourced and resourceful municipalities were able to learn, experiment, and take risks. Financial and political stability and support allowed certain municipalities to actively translate their sp-R planning process into gen-R outcomes (such as increased social capital and collaboration, ability to participate, create and leverage polycentric learning platforms, and an ability to invest in exploring and maintaining options). This was especially demonstrated in the Burrard Inlet sub-region and driven by the novelty of SLR planning challenge, supporting the original proposition.

Overall, the human resources dedicated to sp-R varied significantly across the region. In smaller municipalities, the staff wore multiple hats with flood management being just a small portion of their daily duties. In larger municipalities, the staff had an opportunity to deeply specialize in certain aspects of flood management and then drive this area as champions. When it came to financial reserves, 100% of the municipal survey respondents identified it as a barrier to both municipal and regional action on sp-R. Only two municipalities have created dedicated sp-R funding mechanisms. By adopting an adaptive approach to SLR planning and implementation, adjusting their practices as new information and science comes in, and investing into local scale monitoring, the City of North Vancouver, the City of Vancouver, and the City of Surrey were leading the best practices identified in the literature of adopting an iterative process that can be responsive to changing knowledge, preferences, and based on learning from previous successes and failures. While this approach seems to be a luxury that bigger municipalities could afford, creating opportunities and support for smaller municipalities to learn from the failures and successes of the bigger ones would be important for enhancing gen-R at the regional level.

At the regional scale, FBC, the core boundary organization was financed by the province and also ran a member fundraising campaign for initiating a planning process for a regional flood management strategy. While this can be seen as a positive development that indicated buy-in

from the members, the historical analysis shows that the funding allocated by the province effectively served as a downloading measure rather than a measure to enable systematic action on flood risk. When situated against multiscale analysis of the ability to maintain options, I found that it was not the lack of funding but rather how it had been administered (ad hoc, competitive, by application basis) that served as a major barrier to a risk-based systematic approach. At the regional scale a rapid loss of ecosystems was happening, monitored by Metro Vancouver but unnoticed by the public. Future studies would benefit from an explicit focus on ecosystem loss and management in the context of regional resilience planning and its relationship to sp-R.

7.3 Study implications and significance

Recommendations for planning metropolitan resilience through effective inter-regional learning

The Metro Vancouver region's unique history, planning culture, and the overall institutional capacity to plan for floods and to deal with change in general offers valuable insights for other metropolitan regions. As the regional identity, boundaries, and planning institutions evolve in response to demographic, political, and environmental changes (SLR, habitat loss, salinization of agricultural lands, etc.), the region could also learn more effectively from other regions that face similar challenges and/or have implemented effective planning solutions. I summarize key recommendations on what the region could offer and learn from other regions.

Learn from the past to understand the interplay between disaster risk creation and disaster risk reduction

A search for regional resilience must be rooted in the history, the place, and the geography. To create adaptive resilience planning strategies, cities and regions must develop a shared narrative that can embrace and understand the past. For disaster risk reduction to be effective key drivers behind risk creation over time as well as previous failures and maladaptive responses must be understood.

The region holds rich examples of best practices for risk-based regional resilience planning. As I demonstrated in the historical analysis in Chapter 6, it was the 1948 catastrophic Fraser River flood that made regional planning politically feasible among the Lower Mainland's diverse municipalities after dozens of lives were lost and millions of dollars in infrastructure damage convinced many officials of the need for flood plans that transcended municipal

boundaries. An example of regional risk-based solution to this issue was the short-lived (for political reasons) 1966 *Official Regional Plan* that called for keeping the floodplains free of urban uses. An example of ground-breaking collaborative, multi-stakeholder regional resilience planning initiative was the globally acclaimed, award-winning 100-year, urban sustainability plan for Greater Vancouver *cityPLUS*. While these processes informed the developmental trajectory of regional planning, today they are largely forgotten within formal planning. Similarly, at the provincial level, numerous reflective policy evaluation reports over the past few decades offer insights into path-dependent failures of flood risk management and solutions moving forward. For example, the benefits of establishing watershed-scale institutions or river authority to oversee long-term large-scale planning for the region, as opposed to fragmented dike maintenance, have been articulated by multiple actors over time. Yet, few of these suggestions have been adopted over time, the identified issues have persisted under conditions of a further fragmented, defunded, deregulated, and institutionally eroded provincial system, all while the flood risk has been changing due to intensified development behind substandard dikes (known as a levee effect (Tobin, 1995)) and climate change. Similarly, at the federal level, a number of programs have come and gone over time, leaving a few institutional traces such as outdated maps.

As I discussed in Chapter 6, part of the difficulty in learning from the past stems from short-term institutional memories as departments and ministries get reformed under newly elected governments. Given the weak institutional basis politically the memory lies with a few key staff within the government's bureaucracy. Staff cuts and lack of succession planning further erode this memory. Creating politically insulated democratically elected institutions that can levy their own taxes for water management, such as the Dutch waterschappen, regional government bodies in charge of flood management could offer useful insights in alternative governance systems for regulating flood risk. Regional understanding of risk is key to this process.

Invest in regional risk assessment, better understanding of interdependencies, and cumulative effects of sp-R action on gen-R of the region

The fragmented tightly jurisdictionally bound and politically driven flood management regime leaves little room for pursuing a strategic watershed-based regional approach to sp-R. With the exception of immediate land bordering neighbours, direct inter-municipal collaboration and self-organizing was limited. Addressing island mentalities through planning would require a

solid understanding of interdependencies based on a regional scale risk assessment. As I discussed in Chapter 5, there was a low level of awareness about how the entities in the region depend on each other. What are the key regional assets (infrastructure, agricultural land, places of cultural significance)? How can investments be prioritized and distributed across the region taking into account procedural fairness and distributed justice?

While some of this work was being done through the FBC, the majority of the work is focused on infrastructure interdependencies and technical protection, with a limited emphasis on understanding planning interdependences and the cumulative effects of municipal-level sp-R action on regional levels of risk and resilience.

The flood management regime has been heavily focused on the *hazards* themselves rather than *risk*, while investments have been focused on infrastructure and asset protection. A regional risk management approach needs to be formulated and residual risk needs to be dealt with through *resilience* building strategies.

Foster better coordination across scales of government and governance by revisiting hazard-, risk-, and resilience-based approaches and funding mechanisms

My research identified lack of coordination across the scales of governance as one of key barriers to sp-R. This coordination was lacking from both inter-scalar management and conceptual perspectives. Moving forward, the foundational approaches that underpin flood management across the scales of governance will need to be explicitly acknowledged: are they hazard-, risk-, or resilience-based? This has direct implications for sp-R—gen-R relationship. Although BC historically was a leader in risk-based regional planning for floods in the mid-60s as Chapter 4 and 6 have illustrated, in recent history the Province maintained its hazard-based approach to inform policy development and investments. However, as I discussed in Chapter 5, at the municipal level an increased number of *Flood Risk and Consequences* studies among resourced municipalities were signaling an active exploration of alternative policy approaches. This approach emphasizes the consequences of hazards and draws on a range of instruments with a broader objective than just protection; they include land use measures (including emerging conversations on retreat measures), and layered systems of protection (that combine hazard mitigation, response, and recovery strategies). To move from hazard-based to risk-based decision-making, a systemic and systematic review of the decision-making processes and tools

will be needed. The Province, by maintaining a hazard-focused funding approach, was providing strong disincentives for capturing the full benefits of sp-R processes.

At the provincial level, the eroded organizational and institutional dimensions described in Chapter 6 need to be addressed at the same time as the conditions defining sp-R (such as the current state of the dikes, the associated programming, and the funding structure) are also revisited to ensure a more integrated, equitable, and risk-based approach to flood management and public safety. This primary remaining provincial function of supporting structural protection (a sub-set of sp-R) is subject to organizational barriers that prevent systematic risk-based investments instead of ad-hoc, competitive, opportunistic, and politically driven basis. Currently implemented competitive cost-shared funding programs at the provincial and federal levels that favour ‘shovel-ready’ projects with financial backing from the more resourced proponents will not achieve a systematic region-wide risk reduction. A cost-benefit formula that is tied to the value of protected assets by default prioritizes more expensive properties further maintaining the sp-R deficit and widening gen-R gap for less resourced communities. An emphasis on funding structural protection meant that less expensive non-structural approaches were largely underfunded. Expanding the regional menu of sp-R options is key.

Expand sp-R options: from controlling floods to working with nature

I found that across the scales of governance, the dominant sp-R approaches were based on *protection strategy* by keeping water out rather than changing public expectations to living with water (accommodate) or beginning to seriously consider retreat as an option in some areas. In Handmer and Dovers (1996) terms, these strategies are still resistance-based (solutions designed for change at the margins) rather than transformative.

In expanding sp-R options, the region could learn from some international examples that offer alternative solutions. For example, the adaptive urban environment of HafenCity in the old harbour of Hamburg, along the river Elbe which was transformed from the formerly inner-city port fringes by allowing flooding that stays resilient to high water, with waterproof parking garages, a network of emergency pedestrian walkways, and no residential units at the ground level. This reciprocal interaction means that HafenCity will not be surrounded by dikes, nor cut off from the water. One of the fundamentals of the project is understanding urban development as an adaptive learning process, thus directly contributing to gen-R through sp-R measures.

Given the unique geographic context of the region and distinct sub-regional needs, building clusters of sub-regional sp-R and climate resilience innovation systems could be a solution for the currently absent regional spread of municipal resilience innovations. These sub-regional solutions could be shared regularly to ensure a region-wide conversation and learning. While FBC could serve a role in that for professional communities, expanding beyond the regular suspects of sp-R action is key.

Build multi-disciplinary teams to create a risk-informed culture of preparedness

The region has unique examples of boundary organizations such as the FBC and the SLR-C that other regions could learn from for encouraging an outside-of-the-government platform for negotiating sub-regional and basin-wide issues and for creating a champion-led network for collective trouble-shooting. However, both of these institutions were largely comprised of the usual suspects of sp-R action: engineers, planners, and emergency managers. Moving forward, an effective engagement with the political dimension through elected officials and chief administrative officers will be necessary. Engaging legal professionals early on as part of the regional conversations would be important, especially in the context of First Nations Land Title and rights.

Develop monitoring strategy with measurable metrics

Monitoring and continuous evaluation are key to progress on disaster risk reduction and climate resilience. Yet, as I discussed in Chapters 5 and 6, this was a weakly developed practice across the scales of governance but especially at the regional scale. For example, the Metro Vancouver’s Regional Growth Strategy 3.4. “Encourage land use and transportation infrastructure that improve the ability to withstand climate change impacts and natural hazard risks” was the only one that had no performance measures.

In developing monitoring strategy and indicators, examples in Europe (Harvey et al., 2009) and Australia (e.g., Melbourne’s Climate Change Alliances) could offer guidance for MVR. These examples call for including both process-based indicators (that contribute to gen-R, such as a number of sub-regional sp-R plans developed collaboratively by municipalities) and outcome-based indicators (e.g., sp-R outcomes such as the percentage of flood protection or green infrastructure completed) as well as effectiveness (e.g., number of people and assets protected or environmental or economic damage mitigated). While this information was

available in some municipalities, no regional level repository was available. This prevents from tracking both adaptation progress and monitoring regional-level maladaptation.

In addition to the more technical details, a stronger emphasis on procedural benefits and understanding of how sp-R planning process impacts regional gen-R would be beneficial. This would require asking, as part of the planning process, are we becoming more collaborative, more effective learners, and is this process helping us to maintain our future options? This would require a stronger emphasis on planning.

Place a stronger emphasis on planning

In a region that has not seen a major disaster in recent history, resilience is an aspiration and an exercise in planning. What is the regional story, the shared narrative of Metro Vancouver region's ability to deal with and plan for change? Planning as a dedicated professional practice for connecting the past, present, and future is ideally positioned for creating such a narrative. Regional resilience planning strategies need to deal with the complexity of prior decisions on current and future outcomes within interoperable regional planning systems over space and time. Addressing path-dependencies through planning will become one of the core factors for gen-R. The ability to plan for the future, while learning from and addressing the mistakes of the past, and designing planning processes, institutions, and systems and structures in a way that allows maintaining options in the future will be key features of resilient systems. This means a shifting emphasis on the value of the planning *process* in developing a risk-based culture of preparedness across organizations and sectors. Yet, as I discussed in previous chapters, a lack of planning, a lack of planning knowledge, a lack of funding for planning, and limited design and planning capacity was a recurring theme across the scales of governance.

Moving forward in creating a regional resilience narrative in the context of increasing risk and extremes, it would be easy and efficient to frame and implement adaptation as a narrowly defensive task – enhancing specific resilience to protect core assets or functions from the risks of climate change (Pelling, 2011). A more profound engagement, which sees climate change risks as a product and a driver of social as well as natural systems, and their interaction, would require addressing the historically unequal distribution of risk in the region. The current prosperity of the region was built on settlers' narratives of progress and development. Diking played a significant role in taming the variability of nature to allow development to grow

unchecked, deepening inequity. This deepening inequity is one of the profound growing urban challenges that will require a careful examination across temporal and spatial scales.

Promote equity and inclusion as part of resilience agenda

As regions around the world move forward with a resilience agenda, a stronger focus on metropolitan equity and social justice issues is needed. As previous chapters demonstrated, this is a weakly developed area in the region. Other regions offer some promising examples. For example, in the US, it is the institutionally unique Mayor's Office of Resilience and Racial Equity in Boston that leads planning efforts for dealing with catastrophes and slow-moving disasters such as persistent racial and economic inequality. In San Francisco, an initial focus on planning for earthquakes has led to a proactive approach to sea-level rise, which in turn led to a more coordinated effort to connect hazard planning and management with the city's broader strategies on the housing inequality crisis. In Australia, the Resilient Melbourne strategy connects economic development, unemployment, globalization, and population growth to planning for resilience to shocks and stressors at the organizational, community, and government levels. These planning processes are reflective of some of the 'new regionalism' approaches that call for pursuing policies that reduce racial segregation, the concentration of poverty, the disproportionate exposure of marginalized groups to environmental risk, and interjurisdictional inequality because these conditions undermine the economic competitiveness and overall well-being of a region (Bollens, 2002). As a conduit of gen-R outcomes, planning has a role to play in these domains, in addition to addressing specific hazards and risks.

To truly embrace this approach, the recognition of the historic and the ongoing deep-rooted socio-economic and political drivers of vulnerability, and the developmental patterns that resulted in the inequitable social and spatial distribution of risk and resilience across the region will be required. Studies around the world demonstrate that urban planning can facilitate efficient adaptation within market- and state-led initiatives, and in this process measures to address coastal climate hazards need to be integrated into planning processes as soon as possible (Tol et al. 2008; Macintosh, 2012). Yet, if these planning responses are not appropriately designed and implemented, they can produce inequitable outcomes and maladaptations, where actions taken to prepare for or respond to global environmental change increase the social costs of climate change on the ground (Macintosh, 2012) concentrating these costs within populations that have already faced historically inequitable distribution of risk further deepening socio-spatial disparities

(Pelling, O'Brien & Matyas 2015). Planning is central to this process, as these outcomes can be deliberate 'acts of commission', when interventions negatively affect or displace marginalized communities, and 'acts of omission', when they protect and prioritize elite groups at the expense of the marginalized communities (Anguelovski et al., 2016).

In addressing the role of planning for equity, both distributive and procedural justice will need to be considered (Anguelovski et al., 2016). Distributive justice would work toward allocating adequate resources to provide a similar standard of flood protection and development opportunities for most flood-prone and socially vulnerable groups. Procedural justice would ensure meaningful participation of communities in decisions that affect them, going beyond flood hazard and considering the interaction of multi-hazard risk, for example SLR combined with an increasing oil spill risk and loss of food sovereignty.

7.4 Study limitations and future research directions

Pulling together: First Nations voices for disaster risk reduction and adaptability

A major limitation of this research was the lack of First Nations voices as part of the regional resilience narrative. The physical region is built on the bones and dispossessed lands of First Nations people. The region as a social construction continues to be built on the near-eradicated cultures and ways of life of the First Nations people by maintaining institutional racism through the multi-scalar governance system. Indigenous Knowledge, absent in the formal sp-R planning regimes at the time of this inquiry, will need to be incorporated. As the region moves forward in negotiating its future adaptability, either ignoring First Nations Peoples' perspectives or attempting to use their knowledge without their full consent and participation would be unethical (Turner & Clifton, 2009). Full participation in a format and location that works for the First Nations people will be required that would need to go beyond event openings and talks in university environments. Ensuring that communities themselves participate fully in planning regional future, in negotiating the governance interface that can accommodate the unique needs and strengths of First Nations people, while addressing issues of intergenerational injustice, and the deep-rooted impacts of cultural genocide and land dispossession on self-governance and social wellbeing will be required. As the ocean moves forward, First Nations will be on the frontlines of disappearing land. How can the region redraw its lines in a way that considers traditional territories and future adaptability? Can we conceptualize the region as a living organism where, if one part suffers, the other areas suffer as well?

Future research will need to address equity as part of the gen-R framework that can support multiple objectives and explicitly acknowledge trade-offs between the economic, procedural fairness, and growth distribution, with a careful consideration of ecosystem depletion. If the resilient city is primarily framed as the economically growing city, at the expense of social and environmental justice, how is this different from other planning approaches that failed to take inequitable power distribution into account? Without a careful consideration of equity across spatial and temporal scales, the ‘resilience’ approach implemented by the dominant society can contribute to deepening vulnerability of historically marginalized groups.

Engaging the public

One of the major limitations of this research was its focus on professional communities rather than public responses. As the sp-R regime to SLR matures, in a shift from government to governance, regional collaborative planning processes will need to engage and mobilize the public. This study showed that till now sp-R policies and planning have been seen primarily as an intra-organizational and inter-organizational objective. This is in striking contrast to the development of climate change mitigation policies in the region. These were developed through a series of public consultations and engagement mechanisms (though their intensities varied greatly across the region). As municipalities come to realize the risks that they face, it will be important to engage in public consultation as part of the design and evaluation of climate change adaptation options. This process can draw on the cultural diversity of the region which includes a small, culturally diverse population of Indigenous peoples and an immigrant population which comprises 40% of the total regional population. Utilizing this strength could become an advantage for adaptation options which seek to mobilize the general population. The ability to draw on Indigenous Knowledge combined with adaptation practices around the world could become Metro Vancouver’s core planning competency in its search for regional resilience.

Redefining ‘competitiveness’ through sp-R—gen-R

Another major limitation of this research was its tight geographic context bounded by Metro Vancouver and BC. Yet, regions and their ability to manage risk and resilience are increasingly dependent on international ebbs and flows. Resilience of coastal regions to floods (sp-R) and the overall ability to deal with change (gen-R) will be a key determinant factor in the global competitiveness of regions, their attractiveness for investments, and their long-term development. Examples of regions around the world suggest that adaptability can serve as an

economic opportunity (e.g., Rotterdam Climate Proof, the Dutch export of adaptive strategies or HafenCity in Germany, an adaptive, learning environment). By adopting the adaptive approach to SLR planning and implementation adjusting their practices as new information and science comes in, investing into local scale monitoring, the City of North Vancouver, the City of Vancouver, and the City of Surrey were leading the best practices identified in the literature of adopting an iterative process that can be responsive to changing knowledge, preferences, and based on learning from previous successes and failures (Klein et al., 2001; Tol et al., 2008). Creating opportunities and support for smaller municipalities to learn from the failures and successes of the bigger ones would be important to maintain the overall competitiveness of the region.

However, competitiveness, traditionally defined as an ‘economically reductionist conception of development’ that ignores the broader ecological and material limits and capacities of a region, has a long-term cost and will need to be redefined under conditions of climate change (Bristow, 2010). This industrial definition creates a ‘short-termist, growth-first’ approach to development where competitiveness of today depends on the capacity to deplete and denude a region’s physical environment, while also drawing effectively on resources from elsewhere, thereby limiting its competitiveness for tomorrow (Bristow, 2010). Gen-R framing offers a new insight on regional competitiveness. Can we reimagine a competitive resilient region as a learning region that sustains itself without an overreliance on the disrupted external supply chains and deliberately maintains its options to adapt in the future? A region that can effectively plan for long-term stressors and can quickly recover from shock events? As sea level rises throughout the world economic competitiveness will be redrawn with some of the key economic hubs around the world facing acute environmental pressures. This merging of economic compatibility with political and social stability with the broader ecological and material limits and capacities of a region (weather, stable environment, ability to manage shocks, and stable provision of services) will ensure the mainstreaming of regional resilience planning (Bristow, 2010). Effective planning will be central to this task.

7.5 Final words: region as a changing story

A ‘region’ is a spatially and temporally defined social construction. Beyond the bio-physical reality, competing visions of a ‘region’ as a concept can be determined by the political, ideological, and economic interests of the time. The balance of power between such competing

visions determines the priorities and actions of political actors and organizations affecting the body of institutions that govern a ‘region’.

Today, as a visitor to this region, I found a place that has been, through regional planning, seeking to find a balance between its present and the future needs, between social, environmental, and economic pressures and opportunities; a region that has been seeking to inspire others. A region in a reflective search of its resilience story as it faces population growth, reconciliation with its past, and changing flood risk.

Overall, this dissertation showed promising signs for regional gen-R. These included a general move from sp-R government to governance, strong human and social capital, high collaboration levels, a presence of responsive mediating institutions, signals of moving from hazard to risk- and resilience-based approaches, and a presence of polycentric learning networks. However, in this process of finding a shared narrative for regional resilience, the really tough conversations about regional priorities addressed through long term planning and investment are still waiting to happen: How can First Nations’ vulnerability be addressed equitably given their long-term historic trauma combined with the acute pressures of today and their disproportionate risk of changing hazards, all under a governance system where a federal government oversees the activities on reserves with limited involvement from neighbouring municipalities? Is the region collectively willing to spend millions to protect agricultural land to ensure food security? How can municipalities pay for increasing risk on a limited budget when they are stretched to meet the risk of today? How can they effectively manage hazards when their main revenue source is connected to property taxes which requires growth to accommodate more growth, including in hazardous areas given limited vacant land in the region? Given assets of significant national value, how can the multi-scalar governance system be adapted to effectively address risk that it has outgrown? How to ensure that federal level agencies (e.g., Port, Rail) do not increase their resilience at the expense of local resilience?

In answering these questions, finding gen-R benefits and synergies in sp-R processes could ensure that a *planning process* becomes one of the main benefits in itself. Since the outcomes of adaptation planning are inherently uncertain, prioritizing the procedural benefits such as building human and social capital, increasing learning and collaboration, and maintaining options would ensure a lower-regret approach to the future upon us.

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Appendices

Appendix A Learning loops and adaptability

Elements	Contributions to Sp-R and gen-R		
Adaptability/ Transformability	Resistance - Maintaining status quo	Change at the margins	Transformation
Learning loop	Single-loop- ad hoc or routine learning, responding to errors by making smaller adjustments. Commonly used for sp-R learning following events.	Double-loop -active attempts to change values and policies in response to detected errors (Argyris & Schön, 1978; Armitage, Marschke, & Plummer, 2008) often in response to crisis (Voss & Wagner, 2010) that indicated failure of existing practices.	Triple-loop - fundamental change in the design of governance norms, protocols and processes (Argyris & Schön 1978; Armitage, Marschke, & Plummer, 2008; Lof, 2010)
External conditions– degree of change	This form of adaptive learning which is part of routine behaviour in organizations relates to stable situational and environmental conditions and requires few behavioural modifications (Voss & Wagner, 2010).	In response to dynamic contextual changes, in the long term, this double-loop approach which is geared towards change will provide an organization with greater effect than single-loop-learning (Voss & Wagner, 2010).	This type of learning enhances the response capacity of the organization or a network of organizations with regards to unpredictable societal and environmental change.
Internal response - Degree of change	“first-order-change”: Existing problem-solving procedures are maintained, optimized or ‘modernized (Voss & Wagner, 2010).	Second-order change - New knowledge overcomes prevailing behaviour patterns and allows new problem-solving techniques and scale comprehensive cognitive interpretation system or “usage theories” to emerge.	In designing and/or revisiting these norms and protocols learning provides a reflective mechanism to foster changes to the underlying governance system (Armitage, Marschke, & Plummer, 2008).
Knowledge generation and outcome	‘Adaptive learning’ - knowledge is generated about which programs and behaviours lead to certain results in <i>specific</i> situations. This type of incremental learning in the long term, remain on the same development and observation level (Voss & Wagner, 2010) and maintain the status quo of the system as long as possible without the fundamental questioning.	“Learning for improvement”, beyond simple error correction, it questions underlying causes and it triggers additional learning. It leads to examination and re-development of problem and error-causing structures of organizations, processes and operating procedures. (Schreyoeg 2002). Additionally, it may lead to “unlearning” where previous behaviour rules and obsolete patterns are discarded.	Learning to learn, to understand questions the existing learning processes, learning behaviour and learning successes and failures (Voss & Wagner, 2010): what are barriers and enablers of learning that secure capacities for self-organized adaptive development? Knowledge of past failures in practice and learning is gathered, its communication encouraged and consequently a process of (self-) reflection of the adequacy of organizational knowledge, structures and rules of behaviour is institutionalized (Voss & Wagner, 2010).

Institutional characteristics	<p>'Defensive routines' (Argyris & Schön, 1996) that can inhibit learning</p>	<p>Characterized by trust-building efforts, a willingness to take risks in order to extend learning opportunities, the transparency required to test and challenge embedded values, active engagement with civil society, and a high degree of citizen participation (Armitage, Marschke, & Plummer, 2008).</p>	<p>Leadership (Voss & Wagner, 2010) and shared visions for the collective implementation of individual and team learning; structures that enable informal networking and socialization; and understandings of underlying mental models (Lof, 2010); collaborative processes which are interactive and participatory, the process of social learning, and their products (e.g., social capital), which may facilitate further collaboration (Armitage, Marschke, & Plummer, 2008). In other words, this type of learning strongly contributes to gen-R.</p>
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Appendix B Additional details of methodology

B.1 Interview guide for elected officials

Could you please briefly talk about the history of your municipality in relation to natural hazards?

Where does natural hazards management fit given other competing objectives within your municipality?

Could you please tell me about your role as Mayor in shaping the direction within your municipality on flood management issues?

Could you please tell me some of the common challenges that municipalities face with regards to flood management? [Emergency management? Planning? Engineering? Public engagement?]

Are there any ways in which flood management has contributed synergistically to other municipal objectives in unexpected ways?

How do disasters elsewhere impact on how you think about floods in your municipality? Region?

How do past events in the region influence how you think about the future floods?

As Mayor you would be expected to talk to public and media in an event of emergency or a prominent threat. What was that like? Could you please give some specific examples? How is that different for gradual issues such as climate change (e.g., sea-level rise)?

What are some of the challenges for political leadership in a changing climate?

Are there any forums or networks that you found particularly useful in developing deeper understanding on natural hazards and climate change issues?

Is there any mayor support network where you can share some of your concerns with regards to planning for disasters, or leadership in emergency situations?

Under your leadership how does your municipality view climate change?

- Fundamentally new problem
- Exacerbation of existing problems

How would you assess levels of collaboration with other municipalities in Metro Vancouver on flood management issues?

Do you think there is a sufficient existing institutional capacity to address flood management at the regional scale?

With regards to political leadership, who do you think are some of the leaders in the Metro Vancouver region with regards to natural hazards?

What can be some effective mechanisms for maintaining the prominence of the natural hazard as a regional issue [in the absence of recent regional emergencies in Metro Vancouver region]?

B.2 Interview guide for Flood Management Professionals:

Planning for natural hazards at the municipal and regional levels is a notable challenge for effective management of issues like flooding that occur without regard for jurisdictional boundaries. This study investigates flood management strategies that are designed and implemented within and across different municipalities, between different levels of government, and how this may influence regional outcomes. I am particularly interested in the process of flood management: how are your policies formulated? How do you see flood management changing in the future? How do you build your organizations ability to deal with the unexpected?

Do you have any questions before we start? Please feel free to ask me questions at any time, and if you'd like to stop the interview at any time, you are free to do so.

Could you please briefly introduce yourself and tell me about your background.

Please briefly describe general flood management process in your organization. What aspects of flood management are you responsible for?

In the past 3- 5 years in which ways has flood management process contributed to changes in understanding hazards and risks within your organization?

In the past 3- 5 years in which ways has flood management process contributed to planning for other hazards and/or planning process in general within your organization?

What are some key flood management documents/policies? How were they created (drivers, process, actors involved)?

Are there ways in which changes in flood hazards are challenging some of the fundamental professional assumptions? How do you see these changing in the future?

When faced professionally with a novel challenge who do you go to for an advice? When your Department/organization is faced with a novel challenge what process is in place for addressing the challenge?

In the past 3- 5 years in which ways has flood management process contributed to extending your networks within your organization? Regionally? Provincially? Federally? Internationally?

In the past 3- 5 years in which ways has flood management process contributed to accessing new knowledge or joining new platforms for shared learning with other professionals and stakeholders (public, First Nations)?

How would you assess your current levels of collaboration within your municipality for flood management purposes? Who would you like to be included in the future?

How would you assess your current levels of collaboration within neighboring municipalities for flood management purposes? Who would you like to be included in the future?

How would you assess your current levels of collaboration regionally for flood management purposes? Who would you like to be included in the future?

Can you give some examples, if applicable, for the ways in which flood management contributed to broader, more general goals and objectives of your organization? municipality?

In which ways has SLR/freshet process contributed to your engagement regionally? What are the implications of the municipal planning process for regional outcomes? (interdependencies)

In your opinion, is there sufficient institutional capacity in the current governance structure to deal with flood management effectively at a regional level? If not, what opportunities for creative collaborations exist or what institutional changes may be necessary to enable this?

B.3 Interview Consent Form

PhD Dissertation Research Project Planning for natural hazards in the Metro Vancouver region

Principal Investigator:

Dr. Stephanie Chang, *Professor*

School of Community & Regional Planning
University of British Columbia

Email: [Email address]

Co-Investigator:

Lilia Yumagulova, *PhD candidate*

School of Community & Regional Planning
University of British Columbia

Phone: [phone number]

Email: [Email address]

Purpose:

The purpose of this study is to investigate planning strategies that contribute to the ability of municipalities and regions in BC to withstand a variety of threats ranging from freshet flood to sea-level rise. The research methodology is a qualitative case study. It will include the collection of three sources of data: written documents, interviews and an on-line survey. You have been invited to participate in this study because of your knowledge and leadership in planning initiatives. This study is being completed in partial fulfillment of the co-investigator's PhD dissertation. The dissertation is a public document that will be available online through the University of British Columbia library upon its completion.

Study Procedures:

If you choose to participate in this study, the Co-Investigator will ask for approximately 45-60 minutes of your time in order to interview you about your part in and your perspective on municipal and regional resilience planning initiatives within in your organization. If you are interested, your participation will consist of 1) an anonymous online survey (25 minutes) and 2) a one-hour interview.

- 1) The anonymous survey is designed for collecting systematic data on specific planning strategies, general organizational characteristics and to determine the structure of regional organizational networks. The survey can be filled it out electronically at your convenience after the interview. While the online option is preferred, a paper version will also be provided at the interview to be filled out before the interview.
- 2) The interview will comprise a conversation led by the Co-Investigator. The interview guide is designed for eliciting more detailed and in-depth information about regional resilience planning.

The Co-investigator will be taking notes during the conversation. With your permission the interview will be recorded as a digital audio file to accurately record the responses you give. This data will be used for analysis. Please contact the Co-Investigator if you wish to review your interview before the dissertation is completed.

Confidentiality:

The data collected for this research will be published as a doctoral dissertation and may be used in future publications related to the research as well as presentations at regional, national

or international conferences. As a study participant you may choose not to be identified by name in any publication or presentation. Your interview responses will be coded with an identification number such that only the researcher can identify the responses belonging to you. If you choose to allow your name to be used in the dissertation, and any future publications and presentations derived from this data, you will have an opportunity to review any quotes attributed to you before publication.

Your survey responses will be kept confidential. The survey is hosted using Canadian FluidSurveys service. All survey data from FluidSurveys is hosted in Canada and the company abides by a very strict privacy policy and terms of use statement to ensure maximum protection. As an anonymous survey study participant you will not to be identified by name in any publication or presentation.

Potential Inconvenience:

Participation in this study may cause some inconvenience to you in taking the time to speak with the Co-Investigator.

Potential Risks:

No harm is expected to come to you as a result of your participation in this study. If you do not wish to answer a particular question, please inform the interviewer as you do not have to answer. Every effort will be made to protect the identity of interview subjects who do not wish to be identified by name. In these instances, when quotes are used in the dissertation or future publications, they will be ascribed to “Mayor, Metro Vancouver municipality”, “Metro Vancouver Planning Staff” or “BC Hydro staff”, etc.

Potential Benefits:

The benefit of participating in this study is that the research findings may help to illuminate how planning for certain risks such contributes to building resilience to other potential threats that are distinct in their nature (e.g., sea-level rise). The research also may help to inform decisions related to implementation of future municipal and regional resilience building strategies. The research will provide you with an opportunity to share the initiatives and approaches that are being implemented within your organization.

Remuneration/Compensation:

There will be no payment or remuneration for helping with this study.

Contact for information about this study:

If you have any questions or would like further information about this study, please contact Lilia Yumagulova at [phone number], or by email at: [Email address]

Contact for information about the rights of research subjects:

If you have any concerns or questions about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at 604-822-8598.

Consent:

Your participation in this study is entirely voluntary and you may refuse to participate or withdraw from the study at any time.

Your signature below indicates that you have received a copy of this consent form for your own records and indicates your consent to participate in this study.

Subject Signature

Date

Print Name

Appendix C History of flood management in BC

C.1 Key programs and timelines

Time period and level of government	Impetus	Program Focus	Brief description of the program
1948-1950 Federal-provincial	The 1948 flood on the Fraser River	Flood hazard; Structural; emergency rebuilding	The federal-provincial Fraser Valley Diking Board that coordinated an emergency dike rebuilding program
1948-1963 Provincial	1948 Fraser River flood	Flood hazard; Flood control and hydroelectric power generation on the Fraser River.	the Dominion-Provincial River Board (changed to the Fraser River Board in 1955)
1950s – present Provincial	1948 Fraser River flood	Flood hazard; Provincial oversight of structural protection	The provincial Dike Safety Program; the adoption of the Dike Maintenance Act. The office of the Inspector of Dikes, through administration of the Dike Maintenance Act oversees maintenance of dikes by local diking authorities, sets diking standards, and approves changes to existing dikes and new dikes.
1966-1969 Regional	1948 Fraser River flood led to the establishment the Lower Mainland Regional Planning Board (LMRPB) 1949	Flood risk; Lower Mainland Regional Planning Board's Official Regional Plan (LMRPBOP)	Floodplains were to be kept free of urban uses (except where already present). Further urban development to include floodproofing measures. Future development on floodplains to be limited to uses that would not be highly susceptible to flood damage minimizing the public and private expenditure for flood protection and minimizing losses resulting from periodic flooding (LMRPBOP, 1966).
1968-1995 Federal-provincial	A new Canada/BC agreement	Flood hazard; government cost-sharing programs	The Fraser River Flood Control Program, established under a new Canada/BC agreement.
1975- Federal	Extensive flood damages across Canada in the early 1970s across Canada	Flood risk; Non-structural approach that “tackles the root of the problem by discouraging flood vulnerable development and promoting living in harmony with the river's natural	Flood Damage Reduction Program (FDRP) under the Canada Water Act: from an ad hoc structural response to flooding to a more comprehensive approach focusing on prevention and

Time period and level of government	Impetus	Program Focus	Brief description of the program
		regime". (Environment Canada, archived)	non-structural measures. (Environment Canada, archived)
1975-2003 Provincial fulfillment of the Federal program	The large Fraser River flood of 1972	Flood risk; Non-structural: controlling development on the floodplain and reducing potential damages	The province managed development in designated floodplain areas under the Floodplain Development Control Program which fulfilled a key term of the Fraser River Flood Control Program Agreement between BC and Canada: “to a program of land use zoning and flood proofing to diminish potential losses in the area covered by [the] Agreement.” Under the program provincial oversight included an MTI Subdivision Approval Officer and MFLNRO assistance to local governments in floodplain bylaws preparation.
1973-present Provincial	Loss of farmland to rapid housing and industrial expansion	Not specific to flood; Protection of arable land where agricultural work is promoted and prioritized, while non-farming uses are restricted	After becoming one the main provincial election issues in 1972 (ALR, 2008) an Agricultural Land Commission (a separate appoint provincial commission)
1987 to 1998, 1975-1994 Federal-provincial		Flood risk mapping: to provide information to help minimize flood damage in the areas susceptible to flooding, which were designated as floodplains by the federal and provincial Environment Ministers and restricted development.	The Floodplain Mapping Program was a joint initiative by the federal and British Columbia governments
1999-2005			Flood Protection Assistance Program
2003-present	Cost savings for provincial government (MNFLRO, CSCD)	The Flood Hazard Statutes Amendment Act made critical changes to key legislation: Dike Maintenance Act; Drainage, Ditch and Dike Act; Land Title Act, Section 82, Section 86(1) and 219 (adds new sections) and Local Government Act,	The province allocated \$1 million for the development of integrated flood hazard management tools for floodplain planning, dike operations and maintenance, and emergency preparedness and response to be led by

Time period and level of government	Impetus	Program Focus	Brief description of the program
		Section 910. These changes transferred flood hazard management responsibility from the province to municipalities.	Fraser Basin Council, in collaboration with local and regional partners.
2007	2007 Fraser Freshet	Structural: 30 M was spent on preparation to 2007 freshet	Urgent Mitigation Works (completed in 2007)
2007-2017 Provincial-Federal	2007 Fraser River freshet (Loski, 2011)	Structural protection works to reduce flood risks: dike upgrading, erosion protection and sediment/gravel removal. Three-way cost sharing program between the federal, provincial and local governments (if population is above 15, 000)	Emergency Management BC (EMBC), Ministry of Justice and the Federal Building Canada Plan (BCP) Disaster Mitigation Category of Infrastructure Canada offer a Flood Protection Program which provides funding for infrastructure projects that will provide flood protection to communities across BC. Provincial Flood Protection Program (FPP) of Emergency Management BC (MoTI, 2015).
2015-2020	Widespread flooding in the spring of 2011 across Canada	Non-structural, flood risk: Focusing investments on significant, recurring flood risk and costs; and Advancing work to facilitate private residential insurance for overland flooding.	National Disaster Mitigation Program was established to fill ‘a critical gap in Canada’s ability to effectively mitigate, prepare for, respond to, and recover from, flood-related events by building a body of knowledge on flood risks in Canada, and investing in foundational flood mitigation activities’.

C.2 Summary of key studies, technical guidance and evaluation reports (2007-2015)

Date, guidance material, consultants	Description
Flood Hazard Area Land Use Management: Review of Flood Hazard Area Land Use Management in BC, December 2008 Fraser Basin Council Arlington Group Planning + Architecture Inc.	Commissioned by FBC this report provides a review of how 2003 and 2004 legislative changes with respect to floodplain management have been implemented (legislative changes to the Land Title Act and the Local Government Act as well as three other provincial statutes, in 2003 and 2004, granted local governments the authority to manage land use in flood hazard areas without MoE approval for subdivisions and floodplain bylaws within flood hazard areas, with the proviso that provincial guidelines must be considered). Based on a detailed survey circulated in 2008 to all local governments, Ministry of Transportation Approving Officers, Crown Lands Management Officers (responsible for Crown land disposition in the Integrated Land Management Bureau), flood safety staff in the Ministry of Environment, and applicable private consulting engineers and geoscientists.
Flood Protection Strategies in British Columbia November 2010 the Arlington Group planning + architecture; EBA, a Tetra Tech Company Client: BC Real Estate Association	Commissioned by the BC Real Estate Association (which “has a vital interest in ensuring the protection of life and property affected by flood hazards”) the report provides analysis with respect to flood protection strategies: current legislative provisions for flood protection (Local Government Act; Community Charter; Land Title Act; Dike Maintenance Act; Emergency Management Act). Provincial policies and information resources from Federal and Provincial sources and funding sources at the Federal and Provincial levels are also reviewed and analysed.
APEGBC Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC, June 2012 Funding: NRCan and MFLNRO Administered by: FBC BC RAC (FBC, MNFLRO with NRCan funding) Committee: UBC, KWL, BGC Engineering, APEGBC	Guidance for professional practice for flood assessments with a focus on a risk-based approach to flood management and an emphasis on the need to consider climate change and land use changes in risk assessments. If applied, these guidelines enable “a consistent and comprehensive flood assessment report being submitted to government authorities” (p.1). Differentiates between flood hazard vs flood risk management and provide guidelines and information about methodologies to address flood risk for professionals involved (engineers and geoscientists) that should undertake flood assessments consistently and transparently; provide for appropriate consultation with approving authorities; use a level of effort and approach appropriate for the nature of the elements at risk; standardize the flood assessments to make them directly comparable within BC; consider existing regulations and the level of protection provided by structural mitigation works; increasingly consider “risk management” and “adaptation” as opposed to solely “protection” and “defense”; consider a broader range of issues and broader range of analytical techniques to help achieve improved social and environmental outcomes as part of development; include predicted changes in the hydroclimate as well as natural and anthropogenic changes to channel morphology and watersheds in

Date, guidance material, consultants	Description
	<p>the flood assessment; and identify situations that require expert input</p> <p>Commissioned by the BC Ministry of Forests, Lands and Natural Resource Operations, Water Management Branch, Flood Safety Section, facilitated by FBC. Formally adopted by the Council of the APEGBC.</p>
<p>Climate Change Adaptation Guidelines for Sea Dikes & Coastal Flood Hazard Land Use</p> <p>Ausenco Sandwell, 2011</p> <p>BC Regional Adaptation Collaborative (BC RAC)</p> <p>MNFLRO</p>	<p>Technical studies to inform and encourage engineers, planners and others to address sea level rise (carried out as part of the BC Regional Adaptation Collaborative, funded in part by the Province and NRCan). Provides an estimated SLR over the next two centuries (deterministic numbers of 1m by 2100 and 2m by 2200).</p> <p>The studies do not represent official provincial policy and are for “information only”. They were first released without stakeholder consultation which created an active discussion in the region. The final version of the guidelines to be developed with further stakeholder and public engagement.</p> <p>The Sea Dike Guidelines document has an updated sea dike design methodology for coastal flood protection measures. The new design criteria include sea level rise, subsidence, storm surge, and wave effects, and provide a higher level of protection than previous guidelines.</p>
<p>Coastal Floodplain Mapping Guidelines and Coastal Flood Hazard Areas</p> <p>Kerr Wood Leidal, 2011</p> <p>Client: MNFLRO</p>	<p>The purpose of coastal floodplain maps is to identify the coastal flood hazard(s) and to provide the technical basis for land use planning and developing floodplain bylaws. Floodplain mapping is an important first step in developing a flood hazard management plan, as floodplain maps identify the flood hazard(s) and provide information on the spatial distribution of Flood Construction Levels (FCLs).</p> <p>This report provides a methodology to develop floodplain maps for coastal communities for coastal flood hazards, including sea level rise. A web-based coastal flood hazard screening tool has been developed for coastal areas in British Columbia displaying the potential year 2100 floodplain areas based on approximate Flood Construction Levels, incorporating sea level rise (floodplain areas have not been ground proofed, verified, or studied to confirm their exact location).</p>
<p>Cost of Adaptation - Sea Dike and Alternative Strategies</p> <p>MNFLRO</p> <p>Delcan, 2012</p>	<p>Provides estimate of the cost to construct flood protection to meet the rise in sea level predicted by 2100 for Metro Vancouver coastal shorelines and Fraser River shorelines (36 reaches totalling 250 km which includes shorelines of West Vancouver, the District of North Vancouver, the City of North Vancouver, Port Moody, Vancouver, Burnaby, New Westminster, Richmond, Burnaby, Vancouver International Airport, Delta, Surrey and White Rock). The estimate</p>

Date, guidance material, consultants	Description
	(\$9.5 Billion) “is a first step in developing a regional flood protection adaptation strategy”. It includes costs for structural improvements, property acquisition, seismic and geotechnical improvements, environmental compensation, and engineering and project management but is primarily focused on structural protection.
<p>The Sea Level Rise Adaptation Primer: a toolkit to build adaptive capacity on Canada’s south coasts, 2013</p> <p>The Arlington Group Planning + Architecture Inc.; EBA Tetra Tech, De Jardine Consulting; SSG</p> <p>Client: Ministry of Environment</p> <p>Funding: NRCAN, the Province BC, the Atlantic Climate Adaptation Solutions Association and ACT, SFU.</p>	A resource for local governments and land management authorities to help them identify and evaluate options for adapting to the impacts of sea level rise and associated hazards. Provides information on a range of tools that can be used as part of a sea level rise adaptation strategy. Provides an introduction to past and future sea levels, an overview of four adaptation strategies (protect, accommodate, retreat, avoid), a recommended framework for decision making and 21 adaptation tools to support local adaptation action:
<p>Fraser River Hydraulic Modeling Reports MoE (2008)</p> <p>MNFLRO (2014)</p> <p>Northwest Hydraulic Consultants Ltd.</p>	<p>A number of studies were conducted to address changes to Fraser river flood scenarios. A summary of the most relevant ones to this study is provided below.</p> <p>Review of Fraser River Flood Flows at Hope (2008)</p> <p>Since the 1950s, the design of flood protection for the Lower Fraser Valley has been based on the large floods of 1894 and 1948. In 2008 NHC reviewed the magnitude of these two floods at the Hope gauging station and established an updated flood frequency analysis. It provides flood probability information for quantitative risk analyses, and recommends additional work to improve understanding of Fraser River flood hydrology.</p> <p>Fraser River Design Flood Level Update Hope to Mission, Final Report (2014)</p> <p>This report, prepared by the Flood Safety Section of the Ministry of Forests, Lands and Natural Resource Operations, describes the development of a new hydraulic model for the Hope to Mission reach of the Fraser River based on 2008 LiDAR and bathymetry data. An updated design flood level profile is provided for the Hope to Mission Reach. The report also compares design flood levels with recent dike crest elevation surveys.</p> <p>Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios (2014)</p> <p>The ministry’s Fraser River Hydraulic model (a) has been used to develop a series of flood profiles to show changes in flood levels that would result from sea level rise and possible changes in peak flood flows, for the 170 km reach from Hope to the Fraser river</p>

Date, guidance material, consultants	Description
	mouth. This project was a joint effort of the Flood Safety Section of the Ministry of Forests, Lands and Natural Resource Operations and Northwest Hydraulic Consultants (NHC). NHC completed the hydrological component of the project.
Evaluation of BC Flood policy for Coastal Areas in a Changing Climate, 2014 BC MoE The Arlington Group Planning + Architecture (Arlington Group), assisted by Kerr Wood Leidal, Sustainability Solutions Group and Greenomics.	The BC Ministry of Environment, Climate Action Secretariat commissioned to analyze BC provincial policies related to flood hazard management from a climate change adaptation perspective with an objective to examine whether existing policies and programs support or hinder adaptation to sea level rise and related climate change impacts in coastal areas, and to recommend appropriate measures to facilitate adaptive action. The policies analysed represent the legislative enactments, regulations, plans and programs available in BC to reduce the risks of flood hazards and respond to and recover from flood events.

Appendix D Municipal case studies

Introduction

This Appendix provides detailed descriptions of each of the municipal case studies based on the document review, interviews, and survey data. These data serve as a foundation for exploring the relationship between specific and general resilience at the municipal level in Chapter 5. This Appendix is organized into three sub-regions:

The Fraser River freshet (FRF) sub-region (City of Port Coquitlam (CoPC) and City of Pitt Meadows (CoPM)).

The Burrard Inlet (BI) sub-region (City of Vancouver (CoV), District of North Vancouver (DNV), and City of North Vancouver (CNV)).

The South Fraser (Corporation of Delta (CoD) and City of Surrey (CoS)).

The profile of each municipality includes the following information: General community characteristics (geography; history, demographics, urban development patterns and drivers of change; organizational profile; regional role); flood hazards and risk; flood management and regulation (including structural and non-structural measures); and emergency management approaches. Maps are only presented in cases where an official map was available during the fieldwork. A number of municipalities have since updated their mapping; these maps are not included. Additionally, information of organization arrangements and structures and regional-level involvement is presented. All images were taken by me, unless otherwise indicated.

D.1 The Fraser River Freshet Region

For the purpose of this study the Fraser River Freshet Region (FRF) region includes two municipalities: the medium sized Port Coquitlam and the territorially large but sparsely populated municipality of Pitt Meadows. The two municipalities are separated by the Pitt River and bounded by the Fraser River to the South. Both are dependent on standard and non-standard dikes¹¹ for flood protection.

¹¹ A non-standard dike, or agricultural dike, is one that does not meet Provincial design standards, where: a) to be constructed to the elevation of the flood of record (1894) plus two additional feet (0.6 meters) of freeboard; b) to be constructed with appropriate side slopes (i.e., 2:1 river-side slopes and 2.5:1 land-side slopes, depending on dike height) for stability during high water; c) to be maintained free of large trees and woody vegetation that could cause a breach in the dike during high water (CoPM, 2016).



City of Port Coquitlam

The City of Rivers and Mountains



Port Coquitlam: “The City of Rivers and Mountains”

Community Profile

Port Coquitlam is a medium-sized municipality with moderate growth that originally developed as a railroad servicing centre. It is home to 58,000 residents (Port Coquitlam, 2013), a 7% increase from the 2006 census (Census, 2011). The city is known in Canada and in the world as the birthplace of Terry Fox, a renowned humanitarian and cancer research activist. The city is located in the northeast of MVR at the confluence of the Fraser River and the Pitt River. It is adjacent to the larger municipality, the City of Coquitlam, on its land border. The Fraser River borders it to the south, the Pitt River flows slowly with the tides to the east and the fast waters of Coquitlam River move to the west (PC_M). Port Coquitlam and the neighbouring municipalities of Coquitlam and Port Moody and the Villages of Anmore and Belcarra are often referred to as the Tri-City area and share a regional Tri-City Chamber of Commerce. Kwikwetlem First Nation (“Red Fish Up the River” or “small red salmon” in Halq’emeylem language) has two reserves that are nestled against the Coquitlam River; one close to the mouth of Coquitlam River and another one in Port Coquitlam, further up the Coquitlam River. The nearby Colony Farm Regional Park lowland marsh provides sanctuary to birds and wildlife. The PoCo trail is a regionally popular 24-kilometre trail that meanders along river dikes and forested slopes before entering the city. Regionally significant facilities such as North Fraser Pretrial Centre (600 prisoners) and the secure, 190-bed Forensic Psychiatric Hospital (in neighbouring Coquitlam) are also located in the floodplains.

The city encompasses 29.17 km² with a population density of 1931.3 per sq. km (Census, 2011), an increase of 0.2 per sq. km from 2006. Between 2001 and 2011 the population growth rate slowed down to 9%, lower than the regional average of 14%. Metro Vancouver’s Regional Growth Strategy projects that Port Coquitlam’s population will grow by 17% by 2021 (Port Coquitlam, 2014).

The mayor and six Councillors with an executive team and staff manage the city. The current Mayor Greg Moore is also the Chair of the Metro Vancouver Board. The City runs at a surplus and had \$80.3 million in operating expenses in 2013, with Parks and Recreation at the highest expense at \$16.7 million (20.8%), followed closely by Engineering and Operations at \$15.9 million (19.9%). Fire and Emergency Services accounted for 11.2% of the operating expenses.

Rail played an important role in the development of the city; presently, the city is home to the largest rail yard in BC (CoPC, 2015). The farmland surrounding the railroad yards turned into car-dependent suburban developments over time. In 2011, Port Coquitlam had a total of 20,655 occupied dwelling units (single detached homes at 42%, apartments at 24%, ground oriented multiple family 34%). The 2012 Housing Price Index in Port Coquitlam was considerably below regional levels and housing costs across housing types remained lower than in the other Tri-City municipalities, making Port Coquitlam one of the more affordable places to live in Metro Vancouver region. Originally developed around railroad service, the town centre of Port Coquitlam has a welcoming and a somewhat pedestrian-oriented feeling. The City’s current mission includes “decision-making that integrates the social, economic and environmental interests of the community” and includes a vision for a community where “the environment is nurtured for present and future generations.” (EnviroPlan, 2011, p. i) Among new developments are the promotion of Smart Growth policies and land use designations within OCP, and a revised zoning bylaw providing incentives (through density bonusing in some zones) for green buildings and growth concentration areas (i.e., downtown).

Flood hazard, risk and experience

Unlike the majority of other case studies, Port Coquitlam has experienced major flooding events and burned down to the ground twice. The 1894 Fraser River flood of record inundated the entire Fraser Valley, including Port Coquitlam. Many farms and homes were underwater and many families saw their livelihoods literally washed away, and never returned (PoCo Heritage, 2015). In 1920, a major fire devastated the downtown area. In October 1921, a major log jam on the Coquitlam River took out the Canadian Pacific Railroad and traffic bridges over the Coquitlam River. Many downtown businesses,

including the Myrtle Hotel were washed away and the flood damaged much of what was left from the fire (PoCo Heritage, 2015). In May of 1948, a freshet flood became the greatest flood disaster in modern British Columbian history when a 200 foot section of the Matsqui dike broke away, inundating low lying areas along the Fraser and Pitt Rivers. Residents of the two Indian Reserves at Colony Farm had to be evacuated by rowboats (PoCo Heritage, 2015). The last major and damaging flooding event in the area was an upsurge in the Coquitlam River in January, 1961, that left logs and debris piled up on the Red Bridge. This unanticipated dam inundated homes and businesses upstream and significantly changed the course of the river. This flood did more damage to Port Coquitlam itself than the historic 1948 flood (PoCo Heritage, 2015). In the late 1960's, significant diking work was done which has continued into the present with the most recent dike raising in 2007 (CPC_M; CPC_EM).

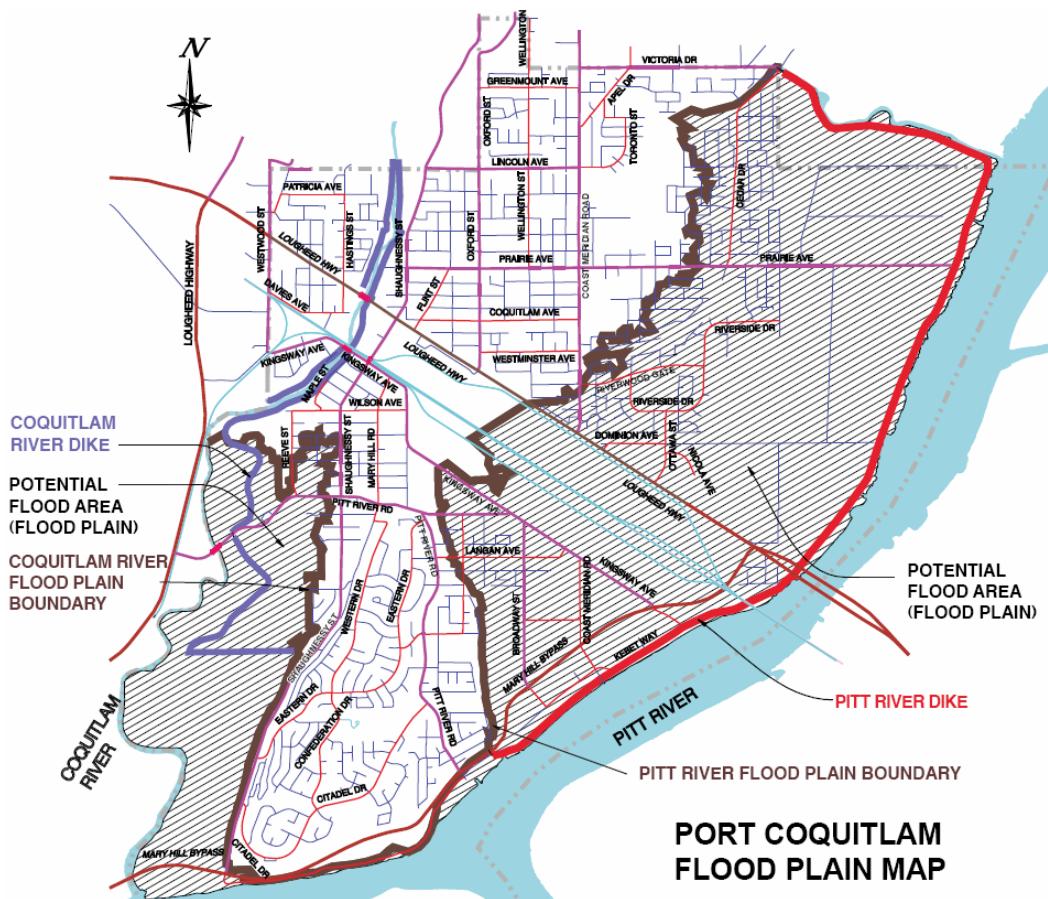


Figure D.1 City of Port Coquitlam Flood plain map (used with permission)

Approximately 45% of Port Coquitlam is located within the floodplain of the Pitt, Fraser, and Coquitlam Rivers. The City is protected from flooding by a system of 200-year (design return) standard dikes and pump stations.

The city of Port Coquitlam has two main floodplains - the Fraser/Pitt River zone and Coquitlam River zone (Figure D.1). According to Port Coquitlam's Enviroplan (2011) the city's most apparent vulnerability is flooding due to rising peak river flows combined with SLR, given that it is surrounded on three sides by water and a significant portion of the community is in a floodplain. SLR was not mentioned by interviewees.

The City's Hazard Risk and Vulnerability Assessment identifies flooding as a second priority risk, with rail accidents being number one. However, internally and for planning purposes, flooding is a

number one priority “because CP kind of takes care of themselves essentially” (PC_EPO). Survey responses (N=3) also identified the Fraser freshet as a high priority, followed by rain-related flooding and creek/river floods from rain or snow events sharing second place. One of the respondents did not rank flood hazards, stating that “Council has not established its priorities for hazards. 2/3 of our community is located in the flood plain and it is a priority to us to maintain the dikes which protect the community” (SPC_2).

Mayor Greg Moore identified flood management as a ‘quite high’ year-round priority for the municipality:

It’s something that is talked about throughout the year: whether we are talking about emergency preparedness, services, or our committee, it usually comes up in our budgeting discussions because usually there is a need to look at our diking. For us in Port Coquitlam in the last few years it was very prominent for us because we had to...we were negotiating with BC Hydro on the Coquitlam dam. And because that is a huge flood mitigation tool and the way that they manage that dam affects us down river. It also affects us... to make sure that its seismically upgraded because if it ever burst we’d be in big trouble, but from a year to year basis on how they release water, when they release water, uh, has major impacts down river on the size of our dikes, the dredging if we had to do any... that sort of thing.

Flood Management: the regulatory landscape

The city employs a traditional approach to flood management. Several city staff within engineering and planning have declined participation in the interview component of the study citing the relatively limited resources at the time to address planning policy and regulations related to flooding concerns. Some of these staff provided written comments and participated in the survey.

The City’s OCP states that “Floodplain management has changed as the provincial government has reduced services and support. Local government is now responsible for establishing its own regulations, under a framework of the Province for development in the floodplain. Approval of the Province is no longer required for subdivision in the floodplain and the City is responsible for dike maintenance” (CoPC, 2013, p. 60). The same page of the OCP also includes the following quote from a resident: “I would like to see less “hard” infrastructure (ditches, pumps, etc.) and more “soft” infrastructure (erosion preventing trees, less building in steep, wet land).” (PocoPlan Participant, CoPC, 2013, p. 60).

From a zoning and building perspective, the City’s Zoning Bylaw (Schedule B, Bylaw 3630) establishes a minimum flood construction level for a 200-year flood and requires habitable accommodation to be above this level. The policy states that “no habitable room shall be located below the habitable floor elevation” (p. 72) and defines a habitable room as “all rooms whose ordinary use involved the presence of people other than a bathroom, garage, utility or mechanical room, and entry foyer” (p.4). There is a historical clause that states that habitable rooms may be constructed below the flood construction level (FCL) as additions to a dwelling unit existing on March 23, 1987, provided that the floor area of the addition below the FCL does not exceed the existing floor area by more than the lesser of 25% or 110m² (CoPC, 2015).

The building permit procedures require a geotechnical engineer’s report to indicate that any building within the identified floodplain is safe for the use intended. Under Section 56 of the Community Charter, a building permit cannot be issued unless the registered owner of the land first enters into a covenant with the City registrable under s. 219 of the Land Title Act (CoPC, not dated b).

Information on the FCLs is available on the publicly available interactive mapping GIS system, PoCo Map. The map provides information by lot, on the required FCLs, floodplain boundary, and floodplain area under review. In addition, it shows the dikes and emergency operations centre. The

Official Community Plan is scheduled for an update in 2015 and, as part of this work, a review of current policies and approaches related to addressing potential flooding is anticipated (PC_P).

The City's drainage system depends on watercourses for carrying runoff, which raises concerns over how the quality and quantity of the runoff impacts watercourses and adjacent riparian areas (CPC, 2013). The City has Development Permit Area (DPA) guidelines for streamside protection "to conserve and restore riparian and associated areas while recognizing that these areas provide public and private amenities such as trails and private yards" (CoPC (n.d) c). The Official Community Plan (OCP) designates lands within 50 metres of watercourses as Development Permit Areas (DPAs) which include ponds, lakes, rivers, creeks, brooks, ditches, springs, wetlands, and surface drainage (whether containing water or not). Development within a Watercourse Protection DPA and alteration of land is subject to municipal review with some provincial oversight. For most sites within 30 metres of a watercourse, an engagement of a qualified professional is required (CoPC (n.d) c).

Among the more recent initiatives, the city recently participated in a flood policy review workshop as part of the provincial review initiative (commissioned by the Ministry of The Environment). The City was also participating in an initiative led by Metro Vancouver, and was planning on attending a meeting of the Regional Engineers' Advisory Committee - Climate Protection Subcommittee focused on local government climate adaptation planning, projects, and initiatives. From a policy perspective, there were plans to integrate flood management into an Official Community Plan review; from a regulatory perspective, an update to regulations applicable to properties in the floodplain was being planned (future work program) (SCPC_2). Table D.2 presents the key legislation that addresses flood management.

Table D.1 Key flood management legislation

Bylaw	Map	Other
Emergency Program Bylaw 3701	Floodplain	Official Community Plan (2005, updated 2013; review pending 2014-onwards)
Subdivision Servicing Bylaw 2241	Flood Constriction Levels	Public EnviroPlan (2011) and internal Implementation plan
Zoning Bylaw 3630	Elevations Dikes	Corporate and Community Climate Action Plan Flood and Evacuation Response Plan (internal, eyes only) The City Response Plan (internal, eyes only)

A notable document is the city's Environmental Strategic Plan, the EnviroPlan (2011), which provides "a platform to let dreams for our future take flight" (p.iii). The plan states that "municipalities are key players in helping society develop a more responsible relationship with the environment" (p.1). The plan has several goals and initiatives related to flood management and planning. Under "Pillar 1: LIVE: Develop a compact, complete community and neighbourhoods," a strategic direction of increasing the natural and built environment's resilience to the impacts of climate change through smart land use management practices is outlined: "Threats from flooding and severe storms are just some of the impacts connected to climate change. Consider slope and proximity to floodplain, among other factors, when siting a proposed project" (p.29).

In addition to this flood-specific guidance, the plan has a number of general environmental policies that could contribute beneficially to flood management objectives. For example, goals oriented towards preserving biodiversity and ecosystem health (which help maintain a quality-of-life that citizens "demand") and integrating and protecting riparian areas and green spaces at a variety of scales - backyards, boulevards, regional parks and the floodplain.

The plan refers to the city's green spaces (such as Colony Farm, the Pitt and Coquitlam River corridors, parks, nature reserves and agricultural lands) as a critical component of Port Coquitlam's ecological and community health. Described as the city's "green infrastructure" (which, like roads and water systems, are an essential part of a healthy community) these spaces provide valuable habitat and

connections for wildlife, and provide ecosystem services such as rainwater infiltration and transpiration, water purification, capturing carbon and recreation opportunities. This publicly available document is supported by an internal Implementation Plan that identifies the detailed steps necessary to achieve the broadly stated environmental goals of the EnviroPlan.

Emergency Management

The emergency operations planning and emergency management function, described as the preservation of life, property and the environment, is embedded within Port Coquitlam Fire and Emergency Services. Originally focused on response to fires, the services have expanded over the years to meet the growing needs of the community, such as medical emergencies and environmental disasters. One of the survey respondents stated that the “Council has not established its priorities for other hazards [beyond floods]. However, the City has established an Emergency Operations function to address the identified hazards” (SPC_2).

The Emergency Program is one of five divisions in addition to Administration, Protective Services and Public Education, Fire Suppression, and Training. The Emergency Program department develops and implements the City’s Operational Emergency Response Plan, delivers public emergency preparedness courses, awareness sessions, and volunteer activities. The department updated the Flood and Evacuation Response Plan in 2014 (which included updated of maps and communication protocols) and the City Response Plan (CPC_EM). The Plan includes action items on preparing and disseminating flooding information to the public, liaising with other government organizations and utilities, developing contingency plans, patrolling and maintaining the City’s dikes and pump stations, monitoring weather forecasts and river levels daily, and updating the evacuation plan as necessary (CoPC, 2013). The 65 member contingent serves the City population of approximately 60,000 (CoPC, 2015).

The Emergency Planning Officer (EPO) is the lead coordinator of the Emergency program. The EPO has been actively working on connecting various city departments for emergency management training and communication. An innovative, two-year pre-disaster recovery planning process was also being developed at the time of the interview. In addition to internal work, the City’s EPO has heavily invested in fostering regional connections as part of IPREM’s steering committee for the regional concept of operations, and the Regional Emergency Planning Committee for the training and exercise sub-committee and the professional development sub-committee, on the Emergency Social Services Directors committee for reports. In addition, the EPO is actively involved with research initiatives at the Justice Institute of British Columbia, a certification and training institution in the field of emergency management.



Pitt Meadows: "The Natural Place"

Pitt Meadows is a low-lying agricultural area with a relatively small population base of 18,000 people. It is heavily reliant on diking and drainage infrastructure to protect its agricultural lands from the surrounding rivers and for pumping the rain water out from behind the dikes. Over 86% of the municipality is a floodplain with urban development being concentrated in the highland area (PM_P). Pitt Meadows is a good citizen of Metro Vancouver with regards to flood management: they concentrated most of their development in the highlands area, established a Floodplain Designation Bylaw, established a drainage utility to help with the growing costs of drainage and maintain their dikes to the best standard possible (despite several refusals of their requests to access provincial funding for dike upgrades, due to their small population base and primarily agricultural lands) (PM_M;PM_P;PM_E).

Community profile

Pitt Meadows is located in the Lower Fraser Valley, east of Vancouver in the northeastern part of Metro Vancouver region. It is hemmed in by the Fraser River as the southern boundary, the Pitt River and Pitt Lake (the largest tidal lake in North America) at the northern boundary (Pitt Meadows OCP, 2009), and the confluence of the Fraser and Pitt Rivers on the western water boundary. Two arms of the Alouette

River run through the municipality, along with a number of other waterways. The only land border is shared with the municipality of Maple Ridge and the Katzie First Nation (which are on the other side of the dike). The Katzie and Whonnock First Nations lived on this land prior to the beginning of farming by European settlers in the late 1800s.

Incorporated in 1914, Pitt Meadows became a member of Metro Vancouver in 1995. It officially changed its original designation from “District” to the “City” of Pitt Meadows on January 1, 2007 (OCP, 2009). Primarily a low-lying agricultural area, it has a total land area of 85.38 km² (2006 Census) and a population of 18,000. The city is run by 62 staff, including the work yard and fire department (PM_M; PM_P; PM_E). Pitt Meadows’ first land-based transportation route came in 1885 with the construction of the Canadian Pacific Railway through to Port Moody. The highway bridge over the Pitt River was opened in 1957 (upgraded in 2009). Since 2009 the Golden Ears Bridge provides a direct connection over the Fraser River.

Pitt Meadows prides itself as being “the Natural Place” and is home to Codd and Pitt-Addington Wetlands as well as bogs and marshes that provide sanctuary for birds and wildlife. Over 95% of the Pitt Meadows land base lays within the floodplain for the Fraser and to a smaller degree the Pitt River (Pitt Meadows, River Watch, 2014). As Deb Walters, the Mayor at the time of interviewing¹² states:

One of the things about Pitt Meadows is we are in a floodplain, the majority of our land base is in a floodplain. We have about 8,826 hectares of land and water, we’re surrounded by 3 rivers we have the Alouette, the Fraser, and the Pitt River. So, when climate changes, spring freshet, those types of things, impact us quite drastically. We depend on our dikes to keep us dry and we control it by flood gates and flood boxes and we really do control our environment here, we have to or... or we flood out. We did get flooded out in 1948 we had a devastating flood that destroyed a lot of our land so, we’ve learned to appreciate the environment around us and respect it and by doing that it has allowed us to keep our citizens safe. I think it’s one of those ongoing things that we learn from, you know? (PM_M).

The nourishing floodplain soil is used for farming which plays an important role for the municipality with eighty-six percent of Pitt Meadows protected as farmland within the BC Agricultural Land Reserve. The farming industry is one of the motivations behind the municipality’s active flood monitoring and management “it’s very important to us that for the survival of our farmers that we maintain the land” (PM_M). Most residents live in the urban town centre, which is located on a highland area. The rest of Pitt Meadows presents several challenges to development, including deep peat and bog soil conditions that require considerable fill or pre-loading prior to development, adding to the cost of building (Pitt Meadows OCP, 2009). However, there have been developments approved in the floodplain (one commercial, which complies with different standards, and two residential). Pitt Meadows has not experienced any major river flooding events since the catastrophic freshet flood of May/June 1948 which devastated and destroyed a lot of land (PM_M).

The municipality is surrounded by rapidly developing communities and regional transportation improvements, such as the Golden Ears Bridge and the new Pitt River Bridge. As expressed in the OCP (2008): “It is a major challenge of this Plan to recognize and support the rural and farm uses of Pitt Meadows in the face of demands for housing, commercial and industrial development” (p.10).

Flood Management Policies and Practices

The Municipality of Pitt Meadows’ main flood management policies and documents are presented in Table D.2. The following sections outline some of main policies that are most relevant for this study. The sections are organized as land use and non-structural flood mitigation measures, structural

¹²The interview was held on May 6th 2014. Deb Walters did not seek re-election in November 2014.

flood protection, and emergency management. The final section describes flood management funding mechanisms and challenges.

Table D.2 Key flood management tools for Pitt Meadows

Bylaw	Maps	Other
Drainage System Protection Bylaw 2266 Waterworks Bylaw 2343 Floodplain Designation Bylaw 2384 Zoning Bylaw 2505 Subdivision &Development 2586 Sanitary Sewer & Storm Drain Bylaw 2601	Dike & Bike Route Drainage Catchment Areas Environmental Sensitive Areas Floodplain dikes	2014 Operations and Development Services Business Plan Drainage Utility Operational Flood Response Plan

Land-use and non-structural flood mitigation measures

Land use and non-structural flood mitigation measures in Pitt Meadows generally try to restrict development in the floodplain and include zoning; development permits and guidelines; an Urban Containment Boundary; and flood construction levels (PM_P). Much of Pitt Meadows' residential population is concentrated in areas outside of the floodplain in highland areas which are not supposed to flood. Any areas that are outside of the highland area must be built up to flood protection level, or abide by the flood protection bylaw (PM_P). Recent changes in legislation now also require the registration of a flood protection covenant on title (Pitt Meadows, 2014).

The most recent OCP (2009) suggests that it will establish development permit guidelines and bylaws to ensure that appropriate measures are taken for development in potentially hazardous areas (slopes or flood prone areas). These will require that mitigation techniques for erosion and sedimentation be identified as part of the development review process, and implemented and monitored during the construction process.

In the 2009 OCP the City also introduced the concept of an Urban Containment Boundary, building on years of management of development growth through commitment to farmland and the Agricultural Land Reserve and by way of its natural features (i.e., floodplain). These lands naturally curtail development in most of the City. It is envisioned that an Urban Containment Boundary will more clearly identify those areas to be preserved as rural and those areas to be developed. The Urban Containment Boundary is a conceptual line that generally coincides with the Agricultural Land Reserve and with Metro Vancouver's Green Zone. Possible development of each area requires separate review and consideration from the City, as well as an approval from Metro Vancouver and the Agricultural Land Commission, ensuring the regional and provincial level overview of proposed municipal developments.

Structural flood protection

Pitt Meadows heavily relies on structural flood protection measures. The dikes, which are heavily used for recreation, are in good condition and well maintained, but are below the standard according to recent studies. The dyking system comprises 31.5 kilometres of agricultural dikes (earthen dikes built in the 1950's to no particular standard) and 32.6 km of standard dikes. The City serves as the local dyking authority for Pitt Meadows with responsibilities extending into Maple Ridge (City of Pitt Meadows, River Watch, 2014). According to the information provided in the Flood Response plan (p.4) the standard dikes were rebuilt between 1977 and 1989 under the Fraser River Flood Control Program and were constructed to the 1969 design elevations. Based on the 2006 hydrology study, the current dike levels are now .5m to 1m low. The Plan also states that: "These dikes are in good condition and maintained to the current design standards" (p.4).

The earthen non-standard agricultural dikes were rebuilt between 1949 and 1950 following the devastating flood of 1948. The design crest is 5.15m with the average elevation at 4.7m. Based on the

2006 hydrology study, they are 0.8m too low. In the spring of 2007 during the freshet season, some areas were topped up with a grant from the Emergency Flood Relief Fund (Flood Response plan, 2007/2013).

Between 1976 and 1986 the dikes protecting Pitt Meadows were upgraded to protect against Fraser River water levels reached during the 1894 flood (River Watch, City of Pitt Meadows, 2014): “...most of the work that was done in Pitt Meadows on flood management concerns our dikes and pump stations and they were all rebuilt in the late ‘70s early ‘80s under a federal, provincial agreement, I think it’s the Fraser River Flood Control Program. At this time we are just manage or maintain that infrastructure as is” (PM_E).

The interviews with the staff and the Mayor suggested that the dikes and the structural protection works are a high priority for the municipality as they provide protection from floods: “as council, we’re responsible to make sure that we have the proper funding and the business plan in place that those dikes are maintained on an annual basis that the funding is there to be able to do that work... we do dike inspections and have to make sure as a council that that whole program is carried on and it is a high priority for us” (PM_M).

In recent years, the City has completed a number of dyking system upgrades to prepare for Fraser River freshets. In addition to large capital projects, the City also completes numerous maintenance activities throughout the year to ensure the dyking system is properly maintained.

Drainage utility

The dikes, while keeping the river water out, keep the rain water in. Drainage in the low-lying floodplain areas in Pitt Meadows relies on a complex and interdependent system of ditches, culverts, sloughs, flood boxes, and pumpstations that collect, convey and discharge storm water through and over the dike system that is impacted by many factors. The drainage system consists of four separate, independent drainage areas. Six pump stations (with a total of 13 pumps) and six sets of flood boxes provide drainage protection for the majority of the land (6,700 ha) located on a floodplain. There are approximately 350 homes and businesses within the floodplain that rely on the dikes and pump stations for flood protection (Flood Response plan, 2007/2013).

In 2006 a review of the City’s lowland drainage system identified that flooding and periods of extended ground saturation were becoming more frequent in the low-lying areas of the community which were attributed to the increasing urbanization and global climatic/weather changes resulting in more frequent high intensity, short duration winter storms events. It was also specifically noted that the drainage and irrigation operating, maintenance and capital costs have been escalating at a rate greater than other municipal services, at 12%/year between 2002 and 2007. This was recognized to be unsustainable over the long-term.

In response, the City adopted an “aggressive 40 year drainage capital improvement program in 2008 that includes major culvert replacements, new floodboxes and pump stations, as well as, the upgrade and replacement of the 6 existing pump stations” (Pitt Meadows, 2011 p.47).

In 2008, the City established a drainage utility for funding drainage infrastructure that would capture the full cost of operating the system as a way to generate sustainable long-term funding for drainage infrastructure, in a manner similar to the water and sewer utilities.

The staff suggested that this utility was explained well to the public and generally well received (PM_E). In the public communication materials it was specifically emphasized that the increasing spending on drainage costs could impact other general civic priorities, such as maintaining roads and buildings, funding special events and constructing recreation facilities.

Emergency Management

Pitt Meadows employs a traditional approach to emergency management and planning in conjunction with fire services. The guiding emergency response document is the Pitt Meadows Operational Flood Response Plan (prepared on May 15, 2007 and updated May 2013 prior to freshet season). This plan describes the methodology the City will utilize for coordinating activities to manage a flood event. It also coordinates the plans developed by the individual EOC sections and deals with the

operational criteria during specific phases of a freshet. The Mayor and Engineering and Planning staff suggested that there was regular interaction between the EOC sections for training purposes (PM_M; PM_P; PM_E).

Pitt Meadows collaborates closely with the neighbouring municipality of Maple Ridge on joint emergency operations and parks and leisure (PM_M; PM_E; PM_P). In 2011 the collaboration between the two municipalities was recognized at the annual Canadian Association of Fire Chiefs' Conference in Calgary for the development of a unique joint emergency program featuring a comprehensive evacuation plan. Maple Ridge and Pitt Meadows police, fire and emergency operations teams share a GIS database containing property addresses and a corresponding map that has been divided into 'Canvassing Assignments'. The emergency evacuation manual contains 14 sections detailing every aspect of evacuation planning, from policy to operational details and assignments and allows for updating of key information as part of regular joint training and planning sessions. "With this system in place, we can quickly identify addresses that may be impacted by a disaster and generate address lists for our evacuation teams so that we can move into the field and direct citizens to safety quickly and efficiently," said Barb Morgan (at the time Emergency Services Program, Maple Ridge) (as quoted in Maple Ridge News, October 2011).

The Mayor emphasized the multi-hazard interface and the effort invested in continuous learning from events that happen outside of the jurisdiction: "We really do watch out for earthquake warnings and those types of things because we don't want our dikes compromised and so we do take note on things that are going on around us in the world and we learn from them here in Pitt Meadows (PM_M)."

The discussion above shows that the FRF municipalities are 1) reliant on structural protection which are reflected in their municipal priorities at the staff and political levels; 2) At the time of the interviews Port Coquitlam was at the initial stages of rethinking their flood management regime which at the time was oriented to meeting the minimum standards required by the province; 3) Pitt Meadows showed some unique policies that were implemented in response to changing pressures. The drainage utility in particular is a tool that was implemented to ensure that flood management does not erode the municipal budget and ability to meet other competing community needs. It was implemented to ensure that the general needs of community were not compromised by escalating costs of one specific domain of flood management.

D.2 Burrard Inlet region

The three selected municipalities, City of Vancouver (CoV), District of North Vancouver (DNV) and City of North Vancouver (CNV) are located around Burrard Inlet (Figure D.2). While very different with respect to their size and development patterns, all three are subject to SLR and, compared to the other case studies, are not reliant on existing dikes for flood protection (with some small exceptions). DNV and CNV are also subject to numerous other hazards (including creek floods) given their terrain and proximity to the mountains.



Figure D.2. Burrard Inlet, City of Vancouver and North Shore (to the right). Copyright Evan Leeson. Used with permission.

The CNV is located on the northern shore of Burrard Inlet, surrounded by the DNV. The Tsleil-Waututh Nation and the Squamish Nation had been living on the North Shore land for thousands of years prior to the European arrival around 200 years ago. The DNV was the first municipality formed on the North Shore on August 10, 1891. Successful growth in the Lower Lonsdale area led to the establishment of the separate CNV in 1907, called "The Ambitious City" as it set out to rival CoV. In 1912, West Vancouver separated from the DNV. The Lions Gate Bridge (opened in 1938) and Iron Workers Memorial Second Narrows Bridge (opened in 1960) connect the North Shore to the rest of the Metro

Vancouver region through the CoV. The bridges played an important role for development of the area. A SeaBus passenger ferry also services this sub-region.

The CNV, DNV, Squamish Nation, and Port Metro Vancouver share four main creeks and rivers that include the Seymour River, Lynn Creek, Mosquito Creek, and Mackay Creek. Two key intermunicipal creeks, Lynn Creek and Mackay Creek, are situated at the east and west municipal interfaces respectively, while all four watercourses begin in municipal jurisdictions and pass through either Squamish Nation and/or Port Metro Vancouver lands before reaching Burrard Inlet. Given the shared natural hazards risks and shared institutions that manage them, this section will mention both CNV and DNV in places.

City of North Vancouver

“...a truly livable city with a distinct sense of place and visible links to the community's natural and cultural past, a city that is safe, welcoming, inspiring and inviting to all people” (Draft OCP, 2015).

Community profile

CNV is home to 48 196 people (Statistics Canada, 2011) and has the smallest land base and the highest population density of the North Shore municipalities. At 11.85 square kilometres, it is the smallest municipality for land size within the selected sub-cases and has a limited potential for sprawl. According to the 2011 census the City grew at a faster rate than its North Shore neighbours (DNV and West Vancouver) and the City of Vancouver. Due to its central location on the North Shore, relatively high density, transit accessibility, and proximity to Vancouver's central business district (SeaBus connection), the City is recognized as a Regional Town Centre within the Metro Vancouver region.

The City prides itself on having a diversified business community such as major port terminals, shipbuilding facilities, shopping centres, a vibrant industrial area, a waterfront business park, and a mix of commercial and professional services, as well as infrastructure to support specialty manufacturing and advanced technology (Think CNV, 2012).

Densification and an embrace of sustainability goals lie at the heart of CNV development. Since the early 2000s the CNV has been adopting a progressive approach to GHG mitigation, has incorporated sustainability goals into its Official Community Plan and has received numerous awards as one of the first Canadian municipalities to adopt a district energy service (the Lonsdale Energy Corporation). The City's Sustainable Development Guidelines led to building the first LEED residential tower in Canada. The City is the recipient of a LiveSmart BC Green Cities Award for implementing its official community plan, based on smart growth principles. Its collaboration with other North Shore municipalities on social issues, recycling, and innovative bylaw dispute mechanisms were also highlighted as part of this award (LiveSmart BC, 2007). The city is run by a Mayor and 6 councillors, an executive team, and a municipal staff of 675 (including City Hall, Operations, Fire, Police, Library, Arts Office, and John Braithwaite Community Centre). Mayor Darrel Mussatto has served the city from 1993 to 2005 as Councillor and 2005 to present as Mayor. The City has no debt and has an established reserve. Public Safety is one of the largest expenditures in the City's Operating Budget, followed by Parks and Recreation (CNV, 2015).

Flood hazards, risks and experience

Framed by steep mountain creeks and the ocean, CNV faces distinct flood hazards. It takes a proactive approach to flood hazard management and undertakes regular creek flood protection and maintenance projects to remove sediment and debris, and improve bridge crossings (CNV, 2014).

Creek floods typically occur in the fall due to a high rainfall and/or snowmelt and are categorized as “unpredictable, dynamic and can quickly change during flood situations” (CNV, 2014). The increasing rainfall intensity (currently, the average rainfall of 1,117 millimetres) and the increasing impervious area are considered to be the biggest contributing factors for increasing creek flood risk.

The steep mountain water systems are typified by flood prone areas on large fan landforms at the transition between the confined upstream reaches and Burrard Inlet. These fan features are low-lying and overlap neighbouring fans, leading to a complex floodplain area with predominating flow paths that are

further complicated by urban development and linear corridors. Fans are inherently hazardous landforms, given that fans are formed by deposition during overland flow in flood events, which is still a possibility in many areas. Significant floods have been experienced on all four watercourses in the last 30 years, with the largest floods occurring between 1980 and 1984. Another large flood was experienced on the Seymour River in 1990, and modest floods have occurred on Mackay Creek since 1995. More recently, on November 3rd and 4th, 2014, a heavy rainfall (up to 86 millimetres of rain in 24 hours) overflowed the creeks and flooded some streets and houses overnight, resulting in localized evacuation.

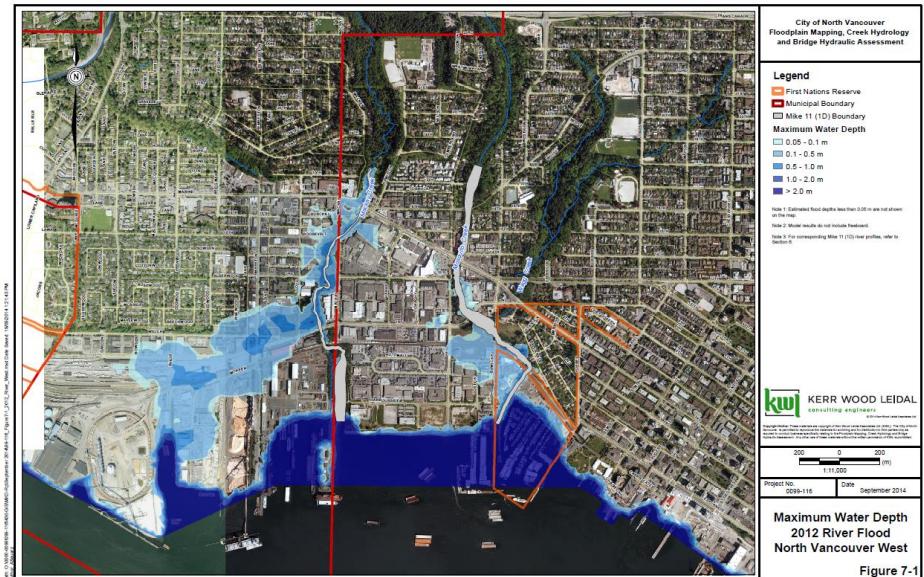


Figure D.3. Sample flood scenarios for the City of North Vancouver (year 2012). Used with permission.

Although the average elevation of the city is 80 meters above sea level, certain parts of the city are subject to SLR and coastal flooding in the present day (Figure). Burrard Inlet presents high tides or "King Tides" combined with storm surges and waves that can increase coastal water levels well above normal levels, causing flooding in low-lying areas of the city. In these areas, a new understanding of

storm surge and waves combined with the long term impact of SLR present another significant concern. A number of extreme water events such as Mackay Creek flooding in November 2006, and the English Bay and False Creek storm surge events in December 2012 have all contributed to an increased awareness of flood hazards.

The following quote by Mayor Mussatto summarizes the city's approach to flood management. It speaks to the diversity of hazards faced, interdependence of hazards and development, and a range of required solutions:

On the adaptation side, we don't have a lot of land right at sea level but we've got a new sea level rise mark so that anything being built at sea level has to have...it's up on a metre than what we had previously planned. As well as designing the foreshores so that the wave action is dissipated by design, as opposed to it just coming up right up and over...We're making sure that if people build houses in ravines and creeks that they have enough setback from the top of the banks; the ones that are within the setback that they're built properly, that they've got a proper foundations for their houses, cause we are expecting challenges with what we call debris flows, you know, when you get those massive slides, or, debris flows we have on Squamish highway, for example. Massive amounts of water that can be tamed on a temporary dam, a log dam, and releases – you get these massive torrents of debris and water. We have to make sure that we've done that. Everything we do now is put though that lens of climate change. And, when we get these peak rain events, we want to try to reduce the amount of massive water flows into our creeks and streams so if we have such hard surfaces everywhere with catch basins, massive flows of water into creeks...they just completely wipe out the fish bearing area, wipes out the local ecology, so we have to make sure that we're not doing that. So we need more green space, a more absorptive environment, so that the water does come down and it strikes the land and then it slowly over a period of hours is absorbed into the creeks and so you don't get those massive surges. We'd look at all of that now. (Mayor Mussatto).

The interviewed staff emphasized that having a supportive council makes a big difference in their work. The staff were encouraged to lead by example, to show innovation and inform the council of any emerging issues (CNV_P; CNV_E; CNV_CAP).

Land-use and non-structural measures

CNV has also been investing in better understanding and monitoring of flood risk. In 2012 the City, in cooperation with DNV, undertook a study of major creek and coastal flood hazards. The *Creek Hydrology, Floodplain Mapping and Bridge Hydraulic Assessment (KWL, 2014)* worked to assess current flood hazards, the effect of climate change on flood hazards and infrastructure, and to develop floodplain mapping and development guidance for current and future development. The study suggests that given the rates of development and redevelopment pressures in the flood prone areas, there is almost 'no opportunity' to avoid development in hazardous floodplain areas. Reduction of the flood hazards itself has a very 'limited feasibility' given the types of watercourses, hazards, possible approaches and costs. The study recommended reduction of community vulnerability as part of integrated floodplain management, including the following measures:

- Limit development in various hazardous areas by establishing hazard corridors and development restrictions with either appropriate setbacks or other measures.
- Prepare plans for Flood Control Levels (FCLs) for all new developments, and require that all new development meets FCLs for a foreseeable flood hazard (i.e., incorporate climate change).
- Establish corridors, through some planned retreat, to connect parcels and expand parks for future structural flood protection (i.e., dikes).

- Utilize FCLs and local measures to limit the vulnerability of new developments in communities, while structural measures can be implemented over longer time scales. (KWL, 2014).

Based on this study, the City has moved forward with a number of initiatives, including the following:

- Updating the Sewerage and Drainage Utility Bylaw (No. 6746) to include a coastal flood construction level of 4.5 m in elevation (Canadian Geodetic Vertical Datum - an integrated reference level for surveying), and a revised flood hazard map.
- Planning for long term structural flood protection works (i.e., dikes) along Mackay Creek and in the Harbourside area.
- Planning for the upgrade of bridges requiring additional capacity or opening area for floodwaters.
- Continuing maintenance programs for creek channels and bridge crossings.
- In collaboration with the District of North Vancouver, conducting a review of the Integrated Storm Water Management Plan (ISMP) to assess local storm drain infrastructure.

Currently, floodplain management in the city consists of a combination of land use measures such as the preservation of river corridors and floodplains for the Mackay Creek Ravine and the Mosquito Creek Ravine. There are also area specific policies that regulate development and provide guidance for site specific measures. For example, the Streamside Protection and Enhancement Development Permit Guidelines provide guidance for development in the riparian areas (within 15 metres of the top of a watercourse bank /10 metres from the top of a ravine bank), constructing structures or buildings, constructing impervious or semi-impervious surfaces, and undertaking landscaping changes, including tree removal.

The main flood management policies, tools, and studies are present in Table D.3. Several of the studies are joint studies between the CNV and DNV.

Table D.3 CNV flood management policies and tools

Bylaw	Map	Others
Sewerage and Drainage Utility Bylaw 6746	Green Zones	Climate Change Adaptation Plan (2013)
North Shore Disaster Bylaw 7809	Environmental Sensitive Area Designations	Climate Changes and Impacts Study
Emergency Plan Bylaw 7418	Streamside Protection & Enhancement Development Permit Areas	Creek Hydrology and Floodplain Mapping (Seymour, Lynn, MacKay)
North Shore Emergency Management Office Agreement Bylaw 7417		KWL 2014
Subdivision & Development Control Bylaw 8014		Creek Hazards Overview Report, 2010
Zoning Bylaw 6700		

Development of the Harbourside Waterfront which coincided with the release of the provincial guidelines (2011), put coastal flooding in the spotlight within the city and requires some dedicated discussion.

Establishing the interim flood construction levels

As discussed in Chapter 4, in 2011 the BC Ministry of Environment released the Guidelines for Management of Coastal Flood Hazard Land Use, a recommended methodology for determining flood protection measures such as Flood Construction Levels. Following the release of the guidelines, CNV and DNV undertook a joint floodplain mapping study in 2012 to better understand the flooding conditions each municipality could expect during given storm events. The results of the flood mapping study for the City's ocean shoreline, recommend that a minimum FCL of 4.4 m geodetic should be established to ensure limited risk to property and life under 2012 conditions (not accounting for SLR).

Since 2013, the City has been reviewing development options for the Harbourside Waterfront, an area located south of Harbourside Drive that has been vacant for decades. Facing Burrard Inlet and located between Merry Creek and Mosquito creek, the area is subject to floods. The City's draft OCP outlines a vision: that the development of these lands to mixed commercial and residential uses will create a dynamic waterfront destination that will provide space for businesses and help meet day-to-day shopping needs and support, reaching a critical mass of employment, shopping, and dining opportunities to animate the waterfront (draft OCP, Land use, p. 5.9). The Harbourside development was one of the main impetuses for addressing the provincial guidelines (CNV_CAP; CNV_E; CNV_P).

Prior to the review process, the city's FCL level was set at 3.35 metres geodetic (i.e., 3.35 metres above mean sea level). The FCLs were specified in the 1995 Sewerage and Drainage Utility Bylaw 6746. It is important to note that this FCL was not established through modelling for coastal flooding, but reflected the regional design standard, because this is the level at which the Metro Vancouver (MV) sanitary trunk sewer will begin to surcharge and flood properties and land with sewage (CNV_E; Pitts, 2013).

In October 2013, The City proposed that "Sewerage and Drainage Utility Bylaw No. 6746, 1995," be amended to raise the Flood Construction Level to a minimum of 4.5 metres geodetic, plus site specific allowances for creek hydrology "to the satisfaction of the City Engineer" (Minutes of the regular meeting of council, October 28, 2013, p. 7). The amendment was carried unanimously and the City raised the FCL in July 2014. Several city staff emphasized that the issue was communicated to the elected officials in an accessible format, which visually represented some of the landmark community features with the adjusted FCLs (Figure D.4) (CNV_P; CNV_EP). The higher FCL is seen as an adaptive measure that "greatly reduces barriers to implementing future SLR management strategies and increases the City's resilience to extreme weather today and in the future" (CNV, 2015).

These levels were set as interim construction levels that meet current 2012 flood risk but do not include an allowance for future SLR¹³.



Figure D.4. What does 4.5m look like? Examples in City of North Vancouver (CNV, 2013). Used with permission

Climate change adaptation plan

¹³ Provincial guidelines recommend planning for a one metre increase in sea level by the year 2100 and an additional metre by the year 2200.

While renowned for mitigation measures, adaptation was not addressed directly within the City policies prior to 2012. The effects of climate change are clearly communicated on the City's website: "...temperatures are higher, winters are wetter, summers are drier, and extreme weather events are becoming more and more common. Extreme and damaging events – like the floods caused by heavy rainfall in Fall 2014 and the heat wave, drought, forest fires, and poor air quality of Summer 2015 – will become regular events in the coming decades" (CNV, 2015).

CNV is a member of ICLEI Canada's Building Adaptive and Resilient Communities (BARC) program. The program's five-milestone framework leads cities through the process of developing, implementing, and monitoring a climate adaptation strategy, with a focus on reducing risk throughout the community. The city's Climate Change Adaptation Plan (2013) lays out the vision that "the City of North Vancouver will remain a vibrant, diverse, and highly resilient community by planning for the climate of the future rather than today, and improving the natural, physical, human, social, cultural, and local economic capacity of the community to respond to the impacts of climate change" (p.11). The overarching goal of the plan is to increase the City's resilience to the physical, social, economic, and environmental impacts of climate change.

Overall, flooding due to intense rainfall was highlighted as one of the greatest climate change risks for the city: "as large storms become more frequent and powerful, traditional storm water management that relies on storm sewers and engineered waterways will lead to skyrocketing costs, environmental damage, and will still leave us at risk" (CNV, 2015). At the time of the interview, the City was embarking on a review of the Integrated Storm Management Plan (ISMP), and as one staff pointed out: "Harbourside is sort of a big first piece for addressing the coastal risk but that's really a smaller concern for us and the bigger one is storm water management. Going through that ISMP process is a big part of looking at that again and starting from scratch pretty much and seeing what we can get to do, you know, in terms of storm water" (CNV_CAP).

At the time of the interviews, the City planned to integrate adaptation throughout all City operations, including the 2014 Official Community Plan (OCP) update. As part of these updates, the Hazard Lands Development Permit Area identifies lands within the 200-year floodplain and areas near steep slopes (areas at the most risk to increasingly extreme weather), and requires that landowners obtain a Development Permit before proceeding with any development or alteration (CNV, 2015).

Regionally, the city is part of the Fraser Basin's Regional Flood Adaptation Strategy initiative. The city staff also participate in the Sea Level Rise (SLR) Collaborative, an informal network of planners, engineers, and emergency managers working in the area of climate change adaptation with a specific focus on SLR. The city has an active informal climate change working group between the three North Shore municipalities. Additionally, through the North Shore Emergency Management Office (NSEMO), the city participates in a number of regional emergency management related activities outlined in the next section.

Emergency management

The emergency management aspect of public safety is delivered through NSEMO, a unique tri-municipal entity that provides emergency management services for the CNV, DNV, and District of West Vancouver. NSEMO coordinates preparedness, planning, response, and recovery activities supporting both a municipal and sub-regional North Shore perspective. Public Safety is one of the largest expenditures in the City's Operating Budget.

NSEMO serves as a facilitator for various North Shore working groups such as the North Shore Information Officer Committee, Interface Wildfire Committee, North Shore Hazmat Working Group, and North Shore Responder Working Group. NSEMO is also very involved in the informal tri-municipal climate change adaptation group (NSEMO_1).

Outside of the North Shore, NSEMO supports the "Hand across the water initiative", informal meetings between the NSEMO and CoV Emergency management office that support collaboration between the two agencies. NSEMO participates actively in regional committees and working groups such as the Integrated Partnership for Regional Emergency Management (Steering Committee; Regional

Concept of Operations committee; Hazard, Risk and Vulnerability Committee), Regional Emergency Planning Committee Transportation Community Awareness and Emergency Response program, and Regional Group Lodging volunteers, a consortium of Richmond, Vancouver and North Shore Emergency Support Services volunteers. NSEMO also builds connections with non-governmental organizations to be available for evacuees during a time of need (e.g., Salvation Army, Red Cross, Tzu Chi Buddhist Relief, Canadian Baptist Global Relief, etc.).

District of North Vancouver: “Inspired by nature, enriched by people”

Community profile

The District of North Vancouver (DNV) is home to 86,396 people (CSCD, 2013). It is located on the North Shore of the Metro Vancouver Region and covers a large area with diverse terrain, from mountains down to sea level. It covers a large area of 17,000 hectares, twenty percent of which is built up. DNV descends from the Coast Mountains to the north, to CNV and Burrard Inlet to the south, and is bound by the Capilano River to the west and Indian Arm to the east. It is low density, with detached homes making up 70% of the housing stock. DNV is an award winning and regionally and nationally renowned model municipality with regards to natural hazards management.

With the annual budget is around \$120 million, DNV has one of the lowest projected growth rates in the region at less than 1% per year (DNV, 2011). However, it is experiencing significant re-development (DNV_EM) with 60% of its residential housing stock being over 35 years old, while at the same time experiencing unprecedented growth within its town centres. The low population growth (about 50 people per year) limits the ability of the District to leverage funding through development cost charges and community amenity contributions, which creates a reliance on property taxes to fund infrastructure, facilities, and improvements. The District recognizes that the financial implications of continuing on the current path of minimal growth and a spread out land use pattern may be costly in the future (DNV, 2011). According to the Annual Budget report (2013), 14% of taxation revenue (\$12.6 million) is now going directly towards keeping the capital assets in a good state through timely maintenance and renewal (2015-2019 Draft Financial Plan, p.4).

The district has an ageing population with one in four residents aged 55. Approximately 22% of the population identify themselves as a visible minority, with English continuing to be the language most commonly spoken at home (90% of residents). There are approximately 30,000 residences in the District with the majority, approximately 70%, being single detached homes. Home ownership is higher in the District relative to Metro Vancouver, with 82% home ownership and 18% rental, compared to Metro figures of 65% and 35% respectively. The District is heavily reliant on individual car ownership for transportation: of the 38,660 District residents who commuted to work in 2011, 73% drove a vehicle, while 5% got to work as a passenger, 15% used public transit and 5% walked or cycled to work (all numbers from DNV, 2015).

The district is currently managed by a long-serving mayor, six councillors, an executive team, and approximately 530 regular fulltime municipal staff including engineering and planning departments and a GIS group. The interviewed DNV staff were actively involved in collaborating at a regional scale, including with the geotechnical community and the Association of Professional Engineers and Geoscientists of BC (APEG BC) on the development of the Risk-based Land-Use Planning guide, a collaborative initiative between the Centre for Natural Hazard Research at SFU, NRCan, the Justice Institute of British Columbia (JIBC), Public Safety Canada and the Integrated Partnership for Regional Emergency Management (IPREM). The District has also frequently hosted SLR Collaborative meetings.

Flood hazard, risk and experience

Many natural hazards lurk in the beautiful slopes and ravines of the District that put historically developed and modern day properties at risk. Mountain streams run through the District with elevations ranging from 1,450 meters to sea level. During rapid residential development of the area in the 1950s through the 1970s, building sites were often levelled by pushing or end-dumping loose materials over the

escarpment crests, thus placing residential lots on marginally stable colluvium and loose fill soils (DNV, 2011; Tappenden, 2014).

The District receives, on average, 2,400 mm of annual rainfall, with most precipitation occurring during the period of November to February, when the region is subject to “pineapple express” storms (DNV, 2011). These storms often trigger landslides and debris flows throughout southwest British Columbia, with the colluvium and loose fill soils along the DNV escarpments especially vulnerable to landslides when saturated. The DNV respondents to the regional survey ranked extreme weather events as a top priority (N=3) followed by the earthquakes (N=2, Top Priority, N=1, High) and debris floods/debris flows in creeks/rivers. Coastal flooding with future SLR and Creek/river floods from rain or snow events were both ranked unanimously as high priorities (N=3, High).

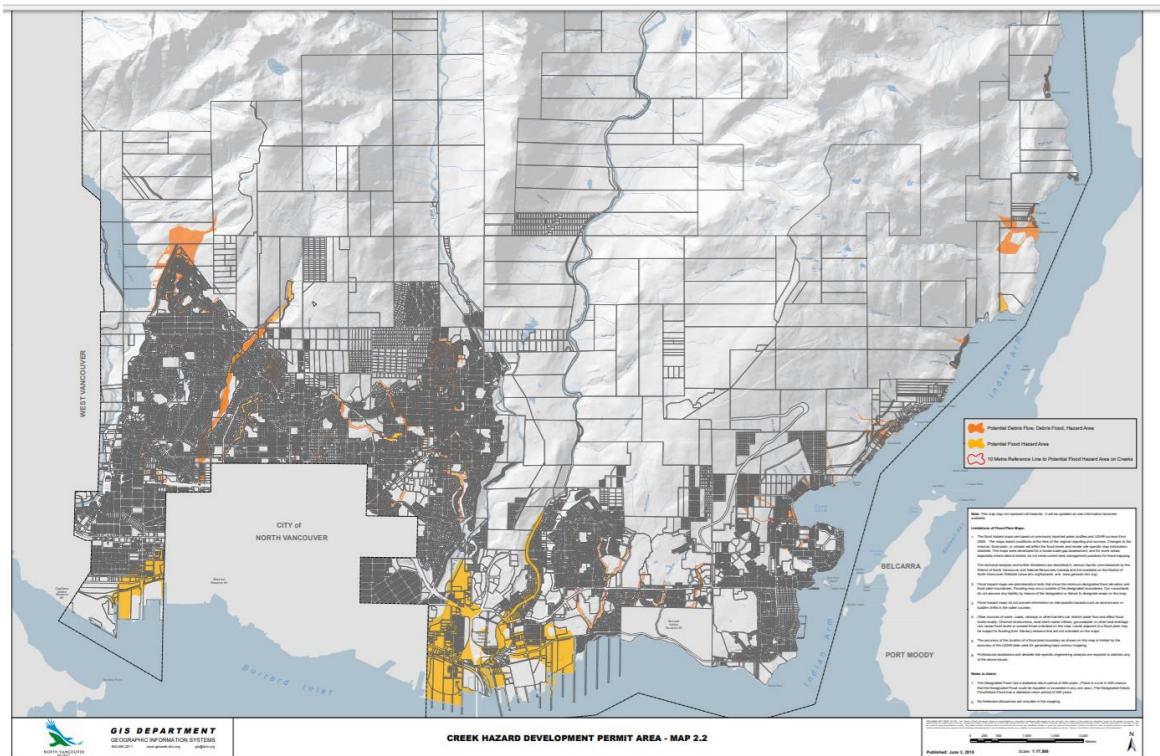


Figure D.5. DNV’s creek hazard Development Permit Area (Orange - Potential Debris Flow, Debris Flood, Hazard Area; Yellow - Potential Flood Hazard Area). Used with permission.

According to a recent study (KWL, 2013) the District has substantial development in flood prone areas that is a mix of industrial, commercial and residential land-use. The study suggests that given the rates of development and redevelopment pressures in the flood prone areas, there is almost no opportunity to avoid development in hazardous floodplain areas. Similarly, there is very limited feasibility of any reduction of the flood hazard itself, given the types of watercourses, hazards, possible approaches, and costs (KWL, 2013). Given these constraints, the new developments are being placed in the floodplains subject to hazard-specific Development Permit area (Figure D5).

The following quote by Mayor Walter summarizes the District’s approach to natural hazards. It provides a glimpse of the District’s journey from a focus on *hazard* and response, to a focus on understanding disaster *risk* through a process of proactive learning:

...The landslide that we had about 8 or 9 years ago where there was a loss of life alerted us to the fact that there were natural hazard risks in our community that we just weren’t aware of. We did respond in a systematic way, sought out best practices in other jurisdictions and did whatever we could to raise the level of awareness within

our community, working with our citizens and residents, and trying to become a world leader in making sure we were able to identify risks and respond to them quickly. I think what we have done in the past is that we certainly have a disaster response recovery network that all three North Shore municipalities contributed to. We were able to call out a volunteer base very quickly and tap into all the emergency services, probably as well as anyone in North America. What we haven't done, many other communities haven't done probably, was to focus on seeking out what those risks were, and through our working with geotechnical engineers, their more mathematical approach was to actually quantify levels of risk. We actually learned from that that we needed to identify, if possible, risks in more of a mathematical way and focus our resources in areas where it was demonstrated that there was greater potential risk to human life, which is what we did. And I think that it was probably that work that led us, our community, to receive the Sasakawa award, the UN award, because we had taken it beyond, I think, what any other community had. And we give a lot of credit, certainly to Hong Kong, which reached out to us, and helped us learn, from them because they had a terrible loss of human life in the 1980s and 1990s, with typhoons and land slippages, and we were able to not take their technology, but take their approach and take the wisdom that they learned and apply it. And we did and I think we actually even extended it further (Mayor Richard Walton).

The Berkley landslide, the tragic event that Mayor Walton refers to, happened on January 19th, 2006, killing a resident in their house and seriously injuring another. This event served as a trigger for the establishment of a Natural Hazards Management Program to conduct risk assessment, evaluate mitigation options, and to provide public access to hazard and risk information. As a result of this process in 2009, the District adopted a new regionally and nationally ground-breaking policy for risk tolerance that approached the management of natural hazards by considering both the consequence and the likelihood of natural hazard. According to DNV, they were the first municipality in Canada at that time to assemble a natural hazards task force comprised of community members for the determination of tolerable risk due to natural hazards (DNV, 2011). The task force used social, legal, and scientific information for informed decision-making, which led to the adoption of the recommended risk-tolerance criteria. As a legacy of that process, DNV takes a proactive approach to ongoing public involvement and education efforts with respect to natural hazards and risks as well as considering the accessibility and usefulness of open access information for increasing residents' and the community's ability to address natural hazard risk. The program gained worldwide recognition and was awarded the UN Sasakawa Award.

Although most of this work was initiated by a specific hazard (landslide), the strategy aimed to take a multi-hazard approach and deal with events such as debris flows, wildland-urban interface fires, earthquakes, and flooding.

Land-use and non-structural measures

The key flood management legislation and studies for the District are provided in Table D.4. As the table shows, DNV has invested heavily in understanding natural hazards risks, with more studies on the way. At the time of the interviews, a significant body of work had already been completed with regard to debris flows, and with broad scale assessment of riparian flood hazards on the way.

DNV does not have designated flood plains other than the old Seymour floodplain. Given its diverse topography, DNV does not have a mandated district-wide flood construction level; instead they rely on site-specific assessments to produce appropriate flood construction levels based on qualified professional advice for larger lots, and the requirements for single family residential are provided through publicly available information and maps with flood elevation points. The Creek hazard permit development area and the streamsides protection development area are the two complementing policies that guide development in the municipality. In early 2015 the municipality was in the process of updating

the language in the creek hazard DPA in light of the KWL (2014) study and the flooding event that happened in November 2014.

Table D.4 Key legislation for DNV

Bylaw	Map	Others
Emergency Plan Bylaw 7304	Development Permit Areas Natural Environment Development Permit Area	Creek Hydrology and Floodplain Mapping (Seymour, Lynn, MacKay) KWL 2014)
Waterworks Regulation Bylaw 8022	Slope Hazard Development Permit Area	Seymour River Management Plan 2003 (draft)
Zoning Bylaw 3210	Streamside Protection Development Permit Area	Creek Hazards Overview Report, 2011 Flood Hazard Assessment and Gap Analysis (NRCan and NHC) Lynnmour Inter River Flood Protection Works Flood Hazard Assessment (Lynnmour & Inter River) 2006

Emergency management

As mentioned in the CNV case above, the emergency management office is operated jointly with neighbouring municipalities through NSEMO. DNV has a Public Safety Manager position responsible for hazards and risk planning and emergency management planning based within the Engineering Department. This organizational structure is unique for the region as it allows to connect normally separated functions of Engineering and Public Safety while maintaining very close connection to the Emergency Management office through regular staff interactions and joint planning (e.g., as part of the climate change adaptation group).

The District has a strong collaborative relationship with NSEMO and has jointly participated in a number of research projects with academic institutions in the region. For example, the DNV has been involved in many innovative initiatives such as developing community-based risk tolerance criteria for accepting land-use proposals; the debris flow warning system; training and education with the real estate sector; community-based geohazards mapping via their web site; and the Natural Hazards Task Force. The DNV has partnered with Natural Resources Canada to be used as a pilot community for the NRCan-initiated research project (Quantitative Natural Hazard Risk Assessment in Canada - a Project to Increase Disaster Resilience) and this partnership has been further leveraged by the DNV's engagement with the University of British Columbia's Earthquake Engineering Department.

City of Vancouver: “By Sea, Land & Air, We Prosper¹⁴”

The City of Vancouver (CoV) is British Columbia’s largest city with a population of 603,500 (Census, 2011). The city has continuously ranked as one of the world’s most liveable cities according to several international polls and rankings (Fraxy, 2009; Economist, 2015). It enjoys a mild climate and scenic views, surrounded by water on three sides. Since 2007, the City has been working towards becoming the ‘greenest city’ in the world as part of a political, environmental, and branding initiative. The city has enjoyed a relatively uneventful history with regards to natural hazards. In 2011, it developed one of the first municipal climate change adaptation plans in Canada. The City has a stand-alone emergency management office that employs a number of permanent staff and project-specific contractors.

¹⁴ A motto on the coat of arms of Vancouver

Four staff and a councillor were interviewed and five staff participated in the regional survey. The survey results showed that coastal flooding with future SLR was ranked as the priority hazard with regards to flood management (22%), followed by rain-related flooding events (17%), and coastal floods in the present day (14%). The direct risk of freshet flooding is considered low to negligible.

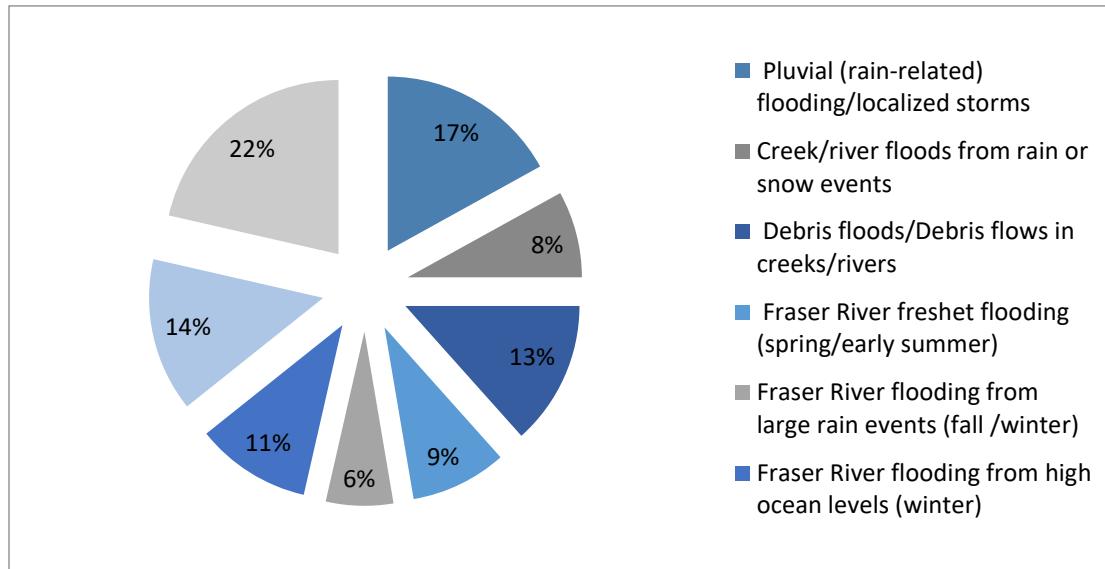


Figure D.6. Priority hazards for Vancouver (N=5)

Community profile

CoV is located in the southeastern corner of British Columbia and bounded by water on three sides: to the west and north by Burrard Inlet and to the south by the Fraser River. The City of Burnaby borders the city to the east and Electoral Area A borders on the western tip of the Burrard peninsula. CoV is home to a major shipping industry and is the population and business centre of the MVR, with 27% of the regional population residing on CoV's 4% of the regional land share. A land area of 114 square kilometres is home to a population density of 5,249 people per square kilometre (Census, 2011). It is ethnically diverse, with 52% of residents having a first language other than English, of which Cantonese and Mandarin are the predominant languages.

In 2014, CoV formally acknowledged that it sits on the unceded traditional territory of the Musqueam, Squamish, and Tsleil-Waututh First Nations as part of the reconciliation process to emphasize the ambiguity created by modern institutions that were established without respect for the people or their traditions (COV, 2014).

Since the 1970s, Vancouver's economy has been decoupling from the provincial resource-based economy and moving towards a service economy. In addition to housing Canada's largest port (Port Metro Vancouver, 2015), Vancouver's economy is increasingly animated by an economy of entrepreneurs, traders, and technological, scientific and creative workers (Barnes, Hutton, Ley and Moos, 2011). Vancouver continues to rise in its international profile as a desirable place to invest for real estate, allowing wealthy immigrants to enjoy relatively low pollution and other benefits of Canadian society. The mild climate is also becoming an increasingly sought after commodity.

Vancouver has 21 neighbourhoods that differ in their history, cultural identity, geographic characteristics, socio-economic profiles as well as the hazards that they face. The city is responsive with regards to community-specific local service delivery, amenities, projects, and initiatives. The complexity of intra-city neighbourhood relations is beyond the scope of this study and CoV for the purposes of this study is understood as a single organizational entity.

From “Clouds of Change” to the “Greenest City” action plan

CoV has been thinking about its emissions since 1990 when a program called “Clouds of Change” was developed “before [the climate change issue] was particularly popular” (Gordon Campbell, Mayor of Vancouver at the time). The city’s Task Force on Atmospheric Change led the effort and included 35 policy recommendations aimed at taking responsibility for, and dealing with, atmospheric emissions (setting targets, putting a price on emissions, encouraging active transportation and cycling). The plan also envisioned CoV as a regional leader and influencer of the federal and provincial government on setting emission reduction targets. Few recommendations were implemented.

In 2008, climate change intent turned into a climate change action plan: Mayor Robertson of the Vision Vancouver Party got re-elected with a promise to make Vancouver the “Greenest City” in the world by 2020, a tremendously ambitious endeavour given the (then) 3 year municipal electoral cycles. The Mayor has been subsequently re-elected in 2011 and 2014. The Greenest City initiative began with the creation of an external “Blue Ribbon” panel which provided an internal review of the most urgent areas for action for the City with regards to climate and environment, as well as an external review of the globally leading benchmark cities which would allow setting targets for progress commensurate with global leadership (Holden 2013). While the City’s Sustainability Office has been taking the lead, the organizational structure of the initiative distributes climate action among leading departments. The CoV reports that over 60 City staff, 35,000 citizens and 120 organizations participated in drafting the plan. Connecting to the public with regards to long-term thinking and planning in the face of climate change was achieved through a "Talk Green to Us" public outreach campaign. While initially focused primarily on mitigation, the public outreach campaign also helped to tap into citizen emotions and aspirations for the environment (e.g., biodiversity and access to nature, recreation, and water conservation) to enable appropriate connections to adaptation actions to preserve those assets (ICLEI, 2013).

The first annual progress report, released in 2012, suggested that 125 projects related to Greenest City goals were underway but “there continue to be challenges in achieving what is one of the world’s most comprehensive and ambitious plans” (City of Vancouver, 2012, 3). The report sought to be transparent about both successes and challenges faced by the initiative. It featured some of the procedural benefits of the planning process, expressed in numerous networking, relationship, and capacity building forums. The latest 2013-2014 implementation report suggests a 6% decrease in community GHG emissions (since 2007); 19% decrease in total water consumption (since 2006); 12% decrease in solid waste sent to landfill or incinerator (since 2008); and 265 kilometres of bike network.

Hazards, risk and experience

I think it was probably in the ‘60s when there were a few big [earthquakes] down in California. That sort of woke people up to the idea that we need to be more prepared. Having said that it wasn’t really until the very modern era so, sort of 2008 onward that we’ve really intensively looked at how we can be best prepared for earthquakes and then subsequently looking at climate change and the risk of storm surges, flooding as a result of extreme weather events, extreme heat events, and how we deal with that so the list of issues we’re dealing with seems to keep growing (CoV Councillor).

Vancouver has been blessed with a relatively uneventful history from the natural hazards perspective. Some notable events and the city’s response are described in this section to illustrate how the city handles emergency events and subsequent learning. In summer 2015, during a record breaking drought, the city was covered for weeks in smoke and ash from surrounding forest fires. The city is also subject to localized rain storms and continuously deals site-specific flooding and sewer backups on residential properties (CoV_E).

The Fraser freshet risk is considered low for Vancouver, given the tidal nature of the river along Vancouver borders. In 2007, during a regional high alert for a potentially catastrophic freshet event, the City, in response to public concerns, surveyed the water levels in the river. The measurements showed

that despite high freshet measurements further upstream, and combined with the high tide, there was very little impact (within centimetres) in comparison with the predictions based on tide (CoV_E). This non-discernable difference due to high freshet flow was consistent with the Northwest Hydraulics model, giving the city confidence to keep this as a low priority risk. However, given the tidal nature of the Fraser stretch and the coastal low lying areas of Vancouver, SLR has been taken very seriously by the city despite the perceived temporal distance of impacts. Vancouver heavily relies on its coastline, which is a major asset with 17 hectares of natural shoreline habitat, almost 18 kilometres of beaches and 25,000 people living within 300 meters of the shoreline (CoV Adaptation Strategy, 2012). SLR risk has led to a number of significant changes to the way the city addresses flood risk.

Flood management: regulatory landscape

Unlike other municipalities in BC who function under the *Community Charter*, CoV is uniquely governed by the *Vancouver Charter*. Unlike other municipalities, CoV does not have a city-wide OCP. Instead, there are a number of land use and transportation plans and policies (e.g., Greenest City 2020 Action Plan (2011), Healthy City Strategy 2012 - 2020 (Ongoing); Housing and Homelessness Strategy (2012); Transportation 2040 (2012); EcoDensity (2008); and CityPlan (1995), among others) that form a planning framework (COV, 2015). CoV has a city-wide zoning and development by-law. Similar to other municipalities, the Charter requires the preparation and adoption of a Regional Context Statement (RCS) in support of the Regional Growth Strategy (RGS). The RCS, adopted by City Council as an Official Development Plan (ODP), shows how Vancouver's polices and plans align with the goals and strategies set out in the RGS (CoV, 2013).

Key legislation and documents that guide the current approach to flood management are presented in Table D.5. Like other municipalities, CoV has the jurisdiction to designate floodplain areas, and to establish flood construction levels and other requirements to mitigate flood hazards (*Vancouver Charter*, SBC 1953, c. 55, s. 306 (cc).).

Table D.5 Key flood management legislation

Key legislation/Bylaws	OCP and RGS	Others
Vancouver Charter Emergency Response Bylaw 5654 Sewer and Watercourse 8093 Subdivision Bylaw 5208 Zoning Bylaw 3575 Waterworks 4848 Vancouver Building By-law (FCL update 2014)	Planning Framework (No OCP) Regional Context Statement (2013) Official Development Plans	Greenest City Action Plan Climate Change Adaptation Strategy (2012) Flood-proofing Vancouver: Policies for a Resilient City Coastal Flood Risk Assessment Corporate Business Plan

The CoV's Flood Proofing Policies (1988, 1995, 2007) were intended to reduce or prevent injury, human trauma, and loss of life, and to minimize property damage during a flood event. The policy mandates flood construction levels (FCLs), which are the minimum floor elevations for living spaces and areas used for storage of goods that could be damaged by flood waters (CoV, 2013). As a Charter city, CoV can regulate its building design and has the ability to adopt its own Building Bylaw, which is unique in BC: "this ability allows City Council the opportunity to quickly respond to issues that have an impact on building safety within the City. This ability has provided the City of Vancouver the opportunity to be a leader with respect to building regulations, in the areas of: Accessibility; Alteration to existing buildings; Artist Live/Work Studios; Energy utilization; Rain screen cladding systems; Sprinklered buildings" (CoV, 2015).

In 2014, the Vancouver Building By-law was updated to require an FCL of 4.6 m, a one meter increase from the previous FCL of 3.5 metres that had been in place since 1972. Prior to that, an interim FCL of 4.5m was adopted by council in 2012 in response to provincial SLR projections outlined in the

Delcan (2012) report. CoV was the first municipality in the region to adopt a prompt response to provincial guidelines. The new FCL is based on a detailed modeling analysis of 1.0m of SLR by year 2100, 1:500 year storm surge and the likely extreme wind and wave conditions; and 0.6m freeboard (Barlett, 2014). In the remainder of this section I describe the processes behind the adoption of these progressive SLR policies in CoV that began with a general climate change adaptation strategy and resulted in a specific focus on SLR.

Climate change adaptation strategy

Vancouver is the first municipality in BC to have a Climate Change Adaptation Strategy, passed in 2011 and adopted in 2012 to ensure that ‘Vancouver remains a liveable and resilient city in the face of climate change’ (CoV Climate Change Adaptation strategy, 2012: 2). The Strategy was developed in less than two years, having built an adaptation team across municipal departments, conducted vulnerability and risk assessments, identified adaptation actions to undertake, and developed an implementation plan for carrying them out (ICLEI, 2013).

Adaptation planning was a natural leap for CoV after having gone through the Greenest City Plan:

We have the Greenest City Action Plan so it made sense from our perspective that if we agree that climate change is happening and we need to try and mitigate it then we should also understand that it’s happening and there’s a certain level no matter how we do at mitigating we’re already to the point where we will have to respond to extreme weather events. We had a situation in 2009 where we had a heat wave in Vancouver and we had an individual die in that heat wave, a direct result of the weather, and realized that although we’ve had extreme colds, we call it the extreme weather measure but really it was only geared towards cold weather, and that we had no plan in place at all for extreme hot weather. So now we have that protocol in place. (Councillor, CoV).

The strategy recommended nine primary actions and over 50 supporting actions to incorporate climate change adaptation measures into new projects as well as existing daily operations such as streets, sewers, building infrastructure, parks and greenspaces. The strategy, often mistakenly named as the first climate change adaptation strategy in Canada (there were preceding initiatives in the Eastern Atlantic provinces), was the first of its kind in British Columbia. At the time of the interview, a dedicated climate change adaptation planner was part of the Sustainability Office at the CoV. Led by a Sustainability Group staff member, the development process loosely follows the (ICLEI) “Changing Climate, Changing Communities” guide. For years, CoV had a close connection to ICLEI, during which time Vancouver City Councillor David Cadman served as a President (2002-2011).

Working with the Pacific Climate Impacts Consortium (PCIC) to downscale regional climate change data and create more local-level projections, the City identified impacts through interviews with general managers and working group meetings. Subsequently, these impacts were prioritized through a risk and vulnerability assessment, and adaptation actions were devised and evaluated through staff workshops. The impacts spanned physical (vulnerabilities in the sewer infrastructure and the existing building stock), environmental (the urban forest) and social (vulnerable populations). The Adaptation Steering Committee provided a final review and comment on the Strategy prior to taking it to the Council. The council adopted the strategy within two months. The implementation of the Strategy is seen as the responsibility of the lead department’s staff with coordination and support from the Sustainability Group. The strategy attempts to analyze in advance, how planning and implementation of adaptation actions for specific risks connects to addressing other risks and opportunities in the city by focusing on the co-benefits and synergies with other programs such as earthquake risk management, emergency response planning, and the City’s overarching sustainability plan. Proposed actions were evaluated based on their effectiveness; overlap with sustainability and mitigation goals; cost-benefit ratio; and time horizon for

anticipated impacts. The mitigation, sustainability and adaptation co-benefits were analyzed using Environment Canada's Canadian Communities Guidebook for Adaptation to Climate approaches (Bzikova, Neale, Burton, 2008). The actions were prioritized into the categories of 'must do', 'monitor' and 'investigate further', with capital planning cycle integration for 'must do' items. Regional collaboration and leadership were also some of the objectives, in recognition that impacts do not stop at municipal boundaries.

Planning for sea level rise: creating a flood management adaptation strategy

As a result of the Adaptation Strategy development process, preparation for SLR, including amending flood construction levels, undertaking a *Coastal Flood Risk Assessment* and developing a flood-specific long-term adaptation strategy were identified as priority actions. The first step in creating a strategy was flood mapping and understanding the consequences of floods. Led by an internal advisory committee and working with a range of consulting firms and academic institutions, the City used the provincial projection of 1 metre of SLR by 2100 for modeling and assessing the impacts of coastal flooding. A combined probability of high tide, wind and wave effects for 1:500 year and 1:10,000 year storm surge events were assessed. In addition to evaluating the hazards, the risk and consequences were also assessed. These included impacts on infrastructure, economy, and the environment. Community hot spot mapping was also undertaken. The next phase of coastal flood planning is to identify and prioritize location-based protection options (e.g., Stanley park and seawall pictured below in Figure D.7), including a mix of structural (grey infrastructure) and non-structural (land use changes, green infrastructure, and preparedness measures) approaches.



Figure D.7.Vancouver's seawall and skyline

Emergency Management

The City of Vancouver has a dedicated Office of Emergency Management Office (EMO) with the same mandate as the rest of the local governments in BC but with a well-resourced capacity to address it. The office is responsible for preparing emergency plans; leading the initial response to emergencies and disasters; coordinating and managing emergency planning with first responders; running emergency training and exercises with City staff and other first responders; training volunteers to help deliver essential services and housing during a disaster; providing basic services to those impacted by a disaster;

and maintaining police, fire, and specialized teams (such as a hazardous materials team) to mobilize quickly in an emergency situation (CoV, 2015).

The EMO collaborates with other departments for infrastructure protection on a variety of issues and programs such as flood hazard mapping, extreme weather response, bridge upgrades, dedicated Fire Protection System (DFPS) and stormwater management (CoV, 2015). The office invests in protecting its community by providing Emergency Social Services, public education, specialized response (for events such as oil spills), and developing a volunteer corps. The office strives to provide coordinated planning and response and regional collaboration. The new Earthquake Preparedness Strategy and state-of-the-art Emergency Operations Centre are some of the key features of the office.

The EMO has been actively experimenting with citizen engagement in emergency management through their ‘covert’ and ‘overt’ emergency management strategies through their recent work on “Disaster support hubs”, designated locations where citizens can initially gather to coordinate joint efforts and offer assistance to members of their community as well as serve as the post-disaster recovery centres that would connect bottom-up community-driven and City-led initiatives. Within this work, the ‘covert’ strategies are strategies that aim at building overall community resiliency irrespective of the incidents or disaster events by facilitating closer community connections. While ‘overt’ efforts aim at developing emergency-specific capacities.

D.3 South Fraser Region

The South Fraser region contains a lot of low-lying agricultural land, and is home to unique ecosystems and growing commercial and residential developments. It is vulnerable to both freshet and coastal risks. The City of Surrey and the Corporation of Delta have both developed regional, national and international reputations with regards to climate change mitigation and adaptation planning.

The City of Surrey: “the future lives here”

Surrey is the second most populated municipality in BC with 317 sq.km of urban, suburban, and rural land base (with approximately 30% in ALR and 27% in the floodplains) and is home to 48 % of the region's industrial land (Surrey City Centre, 2016)). Formerly known as a crime-ridden suburb of Vancouver, it has transformed itself into an award winning, rapidly growing city known for its sustainability initiatives. CoS relies on structural flood protection but has also developed proactive land use regulations and climate adaptation strategies to address diverse and changing flood risks. The municipality prides itself on “running lean” with 3400 staff servicing the growing city, which results in high collaboration levels within the municipality (CoS_E1; CoS_E2) and regionally (SF_1; ACT).

Community profile

For thousands of years, the Semiahmoo and Kwantlen First Nations people had been living along the mouth of what is now known as the Fraser River, at Crescent Beach, at the mouth of the Campbell River and in the north along the sheltered bends of the Fraser River (CoS, 2015a).

When new settlers arrived, forests were logged and cleared, settlement took place and Surrey started to take shape. Surrey was incorporated in 1879 (CoS, 2015a). In September of 1993, Surrey officially became a city. Today the city consists of six distinct town centres (North Surrey, Newton, Fleetwood, Guildford, Cloverdale and South Surrey) (CoS, 2015a). Surrey hosts 48 % of the region's industrial land (Surrey City Centre, 2016). At 18.6% growth (Census Canada, 2011), and 507,000 people in total (Barron, 2014), it is the second fastest growing municipality (after Port Moody) in MVR, adding 800-1000 residents per month (Surrey City Centre, 2016). It has a young, diverse, multi-cultural population with a 52.6% ‘visible minority’ population. It is expected to become the largest city in BC, surpassing the City of Vancouver's population within 10 years. It prides itself for having a diversified economy and has been named the best place in BC to invest by the Real Estate Investment Network for

four consecutive years (Surrey City Centre, 2016). Surrey's transportation network includes six major highways, access to Vancouver International Airport, two border crossings into the U.S.A., rail, and a deep sea port, which places it in a strategic position within Metro Vancouver.

Surrey has been transforming itself from a sprawling bedroom community with high crime rates to becoming one of the sustainability hotspots in Canada and a 'global city'. A poster for a regional event focusing on CoS transformation stated: "A new city is emerging unnoticed within the shell of the old. As the centre city [Vancouver] chokes on its own wealth, the surrounding city assumes roles shed by the center – for jobs, for homes, for immigration, for real community, and for citizenship" (Spacing.ca, 2016).

Flood hazards and risk

Surrey's geography is characterized by major rivers and an ocean boundary, a number of uplands, along with low-lying lands and 54 km of shoreline. It is hemmed in by the Fraser River to the North (for 22 kilometres) and by Boundary Bay the South (for 32 kilometres). The interior of Surrey was sculpted and is drained by the Serpentine and Nicomekl Rivers. The city has 4 different floodplain areas (Figure D 8):

- 1) a floodplain along the Fraser River is divided into an undiked area and a dike protected area (subject to freshet floods and behind dike floods).
- 2) The Serpentine and Nickomekl River lowlands (2 large rivers, one originates and flows through the city and the other one originates in the neighbouring Township of Langley) make up the agricultural heartland or centre of the city. The lower sections are subject to storm surge events or longer duration high tides, the upper reaches are susceptible during strong rainfall events, and the middle reaches are influenced by both factors. Tides have a significant impact because a large portion of the area is at or below sea level.
- 3) Crescent Beach in the south-west portion of the city, is a small residential commercial area that is at risk due to tidal influence or due to the ocean (diked area, subject to storm surge and groundwater intrusion).
- 4) A small floodplain along the Campbell River in the southern portion of the city, has very limited residential or any development along that floodplain (undiked, subject to storm surge and rainfall events). (COS_E1)

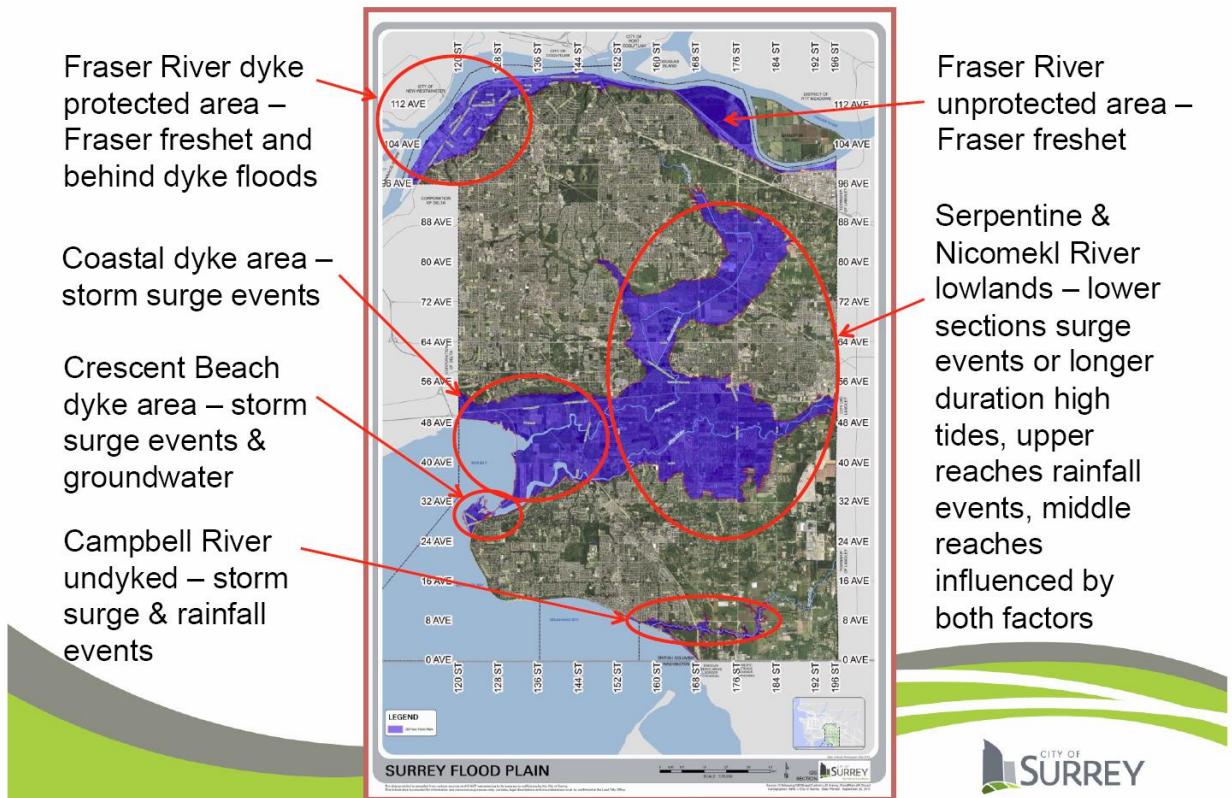


Figure D.8 Floodplains of Surrey (Source: Baron, 2014, used with permission)

Surrey has the lowest average annual rainfall in the Lower Mainland, at 1050mm or 41in. Modelling carried out by the city suggested that the floodplain area, currently at 8855 ha, would reach 9392 ha (estimated) by 2100 and 9854 ha by 2200 (estimated) (CoS, 2016). The city identified the following flood risks as high (Baynham, 2013): overtopping of sea dikes; reduced gravity drainage; and reduced subsurface drainage. Freshet flooding is considered to be medium risk.

Interviews and documentary research show a very proactive approach to monitoring natural hazard risks with a number of studies completed and more underway addressing rainfall intensity, river floodplains, and wave and coastal conditions (subsidence issues) (SE, SDEM). For example, an analysis of rainfall trends showed statistically relevant increases in precipitation at the 3 Surrey gauges, while an update of IDF curves showed that the new curves changed by up to 44% for some rainfall periods (Barron, 2014).

The top five flood hazards, as rated by 3 municipal staff as part of the regional survey, are freshet floods, rain related events, creek flooding, and coastal flooding with future SLR (all at 16%) and coastal flooding in the present day (13%). This distribution shows the complex flood profile that the City faces.

Flood management policies

The main flood management policies and tools are presented in Table D.6. One of the main land use policies is the 2008 Surrey Council Policy (O-55) that restricts development in the Serpentine-Nicomekl 200-year floodplain. Additionally, Draft OCP (PlanSurrey 2014) has new Hazard Lands Development Permit Area (DPA) for flood prone areas and steep slopes. The plan currently defers to Provincial FCLs and will likely be the tool to regulate Surrey-specific FCLs when engineering studies are complete.

Table D.6 Key flood management policies

Policies and Bylaws	Maps	Other key documents
Erosion and Sediment Control 16138	Disaster	Hazard Lands Development Permit
Zoning Bylaw 12000	Response	Area (DPA), Draft OCP (PlanSurrey, 2014)
Policy No. O-55 “Policy to Regulate Development Within the Serpentine and Nicomekl River Floodplains”	Network	Climate Change Adaptation Strategy (2013)
Subdivision and Development 8830	Flood Protection	Community Climate Action Strategy
	Floodplain	Agriculture Protection and Crescent Beach Climate Adaptation Strategy Enhancement Strategy Addressing Drainage Concerns

Structural protection

Surrey has an extensive interdependent network of flood protection. There are approximately 100 km of dikes, 30 drainage pump stations, 2 sea dam structures, over 170 flood boxes and 10 spillways.

The City is acting on the need to re-think the current flood protection infrastructure with regards to potential climate impacts. The calculated impacts to flood protection by 2100 include 200-year return events becoming less than 2-year events for lower reaches. All of the coastal dikes are too low with some requiring over 3 metre extensions. River dikes will need to be reassessed for each flood cell and spillway design and it is expected that the majority of them will be too low. Finally, of the 13 bridges on the rivers, scenarios suggest that 3 will be completely submerged and 7 will be partially submerged, as they have not been designed for future scenarios (Barron, 2014).

At the time of the interviews, the City was actively reviewing the level of river risk to be able to properly address it through structural protection. For example, the Serpentine, Nicomekl and Little Campbell Rivers are being reviewed for changes to the floodplains as a result of climate change. The new Maple Drainage Pump Station located in Blackie Spit Park on the north-easterly end of the Dunsmuir Channel and at the eastern boundary of the Crescent Beach dike system has been completed. The Dunsmuir Channel is the only stormwater outlet for the community of Crescent Beach. The new pump station was constructed to address the high groundwater levels in Crescent Beach; to mitigate the impacts of future SLR; and to mitigate increases in precipitation events (City of Surrey, 2014). Additionally, two major structural designs are underway: a preliminary design for sea dam replacements and a design concept for Nicowynd Dike.

Sustainability and Resilience through climate action

“Strategic action on climate change will strengthen the resilience of our community in the face of what appears to be inevitable change.” Corporate report to Council, R233

In 1998, Surrey joined the Partners for Climate Protection Program (PCP) of the Federation of Canadian Municipalities (FCM), a national program that brings Canadian municipal governments together to act on climate change and reduce the local production of greenhouse gas (GHG) emissions. The City Council unanimously adopted a Sustainability Charter in 2008, and won awards for its sustainability initiatives.

Organizationally, the Charter also resulted in the establishment of a Sustainability Office that leads initiatives, evaluates progress and reports directly to Council and Mayor.

Surrey's Climate Adaptation Strategy

In 2011, the City became part of the new International Council for Local Environmental Initiatives (ICLEI-Canada – Local Governments for Sustainability) Climate Adaptation Planning Initiative. With the assistance of ICLEI, Surrey created an adaptation strategy that was adopted in November, 2013.

Overall, the Strategy outlines 91 actions to increase resilience in six sectors: Infrastructure, Flood Management and Drainage, Ecosystems, Urban Trees, Human Health and Safety, and Agriculture and Food Security. The actions then were prioritized and included the following priority areas for action: supporting the development of a Regional Flood Management Strategy, enhancing data collection and monitoring specific to Surrey, continuing to improve and protect the quality and quantity of habitat, planting tree species for conditions of a future climate, ensuring adequate tree canopy and root space, and continuing to build community capacity to reduce vulnerability and increase resilience.

Building on these initiatives, in 2016 the staff presented a report to seek Council's approval for the development of a Coastal Flood Protection Strategy that would address current flood hazards and incorporate long-term flood protection needs resulting from projected climate change. In the opening of this report, the City acknowledges the previously freshet-oriented regime and calls for leveraging regional work to meet the local needs: "While most of the past regional and provincial discussion has focused on the Fraser River, it is important that a Surrey managed strategy addressing Surrey's Boundary Bay Coastline commences to fully leverage the regional work and ensure the unique needs of Surrey are addressed" (CoS, 2016b). The city has been effective in developing space for the SLR regime to develop and be integrated across departments and sectors (from infrastructure to planning to agriculture).

Emergency management

Surrey's Emergency By-law provides for the establishment, administration, and operation of an Emergency Plan and Program for the City. The Surrey Emergency Program is administered by the Surrey Fire Service and consists of volunteer members from Search and Rescue, Emergency Social Services, and Surrey Emergency Program Amateur Radio. The Fire Service has been responsible for the Emergency Program since January 1994 (Surrey Emergency Program, 2015).

The City also offers a relatively new Neighbourhood Emergency Preparedness Program, which consists of presentations by trained instructors to any neighbourhood, school, or interested group in Surrey on preparing for 72 hours of neighbourhood self-sufficiency. The 3-day program is expanding to cover recovery and business continuity issues (SFC).

Surrey has a detailed, internally-exercised freshet flood response plan. The four main phases of the plan are publicly communicated. The phases are based on the information provided by the Ministry of Environment Forecast and the Mission gauge. The plan provides a sequence of action depending on the water levels and local conditions from precautionary measures to declaring a local state of emergency. The plan specifies that the State of Local Emergency Declaration will commence at the 7.3 metre water level in non-diked areas and at the 7.6 metre water level in the diked area. The plan progresses from inter-organizational activation to public interface and evacuation and concludes with Recovery Plan Implementation. The plan outlines roles and responsibilities for the engaged stakeholder that include internal departments and regional and provincial partners.

Corporation of Delta

"Delta is an agricultural and industrial hub. We are vibrant cityscape paired with rural countryside. We are a waterfront town and a wildlife sanctuary. We are all of this and more, but we are not a City" (Corporation of Delta, 2014).

Delta is a low-lying municipality with an agriculture-based economy and slow population growth. It is home to regionally significant ecosystems (Burns Bog, the largest undeveloped urban landmass in North America and an internationally renowned Pacific Flyway, a major north-south flyway for migratory

birds) and assets (the ferry terminal). Delta's elevation varies between zero and two meters above mean sea-level, which makes it heavily reliant on 61 km of dikes. Freshet floods, storm surges, rising sea levels, a subsiding land base, and salt water intrusion are some of the factors that make this municipality particularly vulnerable to flood risk. Delta is known regionally and internationally with regards to its use of visualization and participatory approaches to flood management and SLR in particular.

Community profile

Delta has seen some remarkable changes over the past century. In 1921 Delta was home to 2,800 people (CoD, 2013). Now Delta is home to 104,000 people (Census, 2011) serviced by 1700 municipal employees (CD_M). Delta encompasses primarily a low-lying area of 180 square kilometres bordered by the Fraser River to the north, the United States border and Boundary Bay to the south, the City of Surrey to the east and the Strait of Georgia to the west. Delta's flatlands and coastal shores were inhabited by the Tsawwassen (meaning "land facing the sea") people of the Coast Salish First Nations. Archaeological evidence shows seasonal settlements in the area near the present-day Alex Fraser Bridge that date to over 8,000 years ago (Corporation of Delta, 2014a). In 2007, following 14 years of negotiations, the Nation signed a treaty with Canada and BC which was the first treaty reached under the BC Treaty Commission process and the first urban treaty. The Nation's modern day territory is located adjacent to the South Arm of the Fraser River and the Tsawwassen Ferry Terminal. To the south of the Tsawwassen First Nation land lays Point Roberts, a U.S. enclave at the tip of the Tsawwassen Peninsula. In 2007, after 14 years of negotiations, the Tsawwassen First nation was the first in BC to achieve a treaty under the BC Treaty Process and the only First Nation member of the Metro Vancouver regional district. The Musqueam First Nation also has a land reserve in Delta.

According to the municipal website (Corporation of Delta, 2014b), Europeans first sighted this land in 1791 when the Spanish explorer Lieutenant Francisco Eliza mistook the area for an island and named it Isla Capeda. The Gold Rush of 1858 and the creation of the Colony of British Columbia attracted settlers to the land. The fertile soils of the Fraser River delta gave rise to farming and agriculture. Fishing and canning also became important industries. Together, farming and fishing were the economic foundations of Delta. As the population grew, incorporation was granted to The Corporation of Delta in 1879 (Corporation of Delta, 2014b).

Modern Delta consists of three distinct, geographically separated communities: Tsawwassen, Ladner (located in the lowlands), and North Delta (located on the higher lands). Delta has one of the fastest growing industrial areas in the region (Corporation of Delta, 2014b). Delta has a hospital, an airport, numerous community facilities and bike and walking trails in a varied network of parks including waterfront parks on the Fraser River, Boundary Bay and Strait of Georgia. A significant part of Delta is part of the MVR "Green Zone" and includes the Fraser River foreshore, channels, islands and wetlands; Georgia Strait dikes, foreshore, inter-tidal areas and accreted lands; and banks, marshes, sloughs and drainage ditches throughout the municipality (CALP, 2013). The main land uses in Delta are agriculture at 46%, Burns Bog at 17%, single family residential at 11%, parks at 10%, and industrial use at 7% (CALP, 2013). Delta's neighbourhoods are primarily composed of single family residential housing stock (single family /duplex housing at 81.5%, low rise apartments (less than 5 storeys) at 14%, and the rest is in higher-rise apartment and mixed-use buildings). Delta is an ethnically diverse community with approximately 27% foreign-born residents (compared to its neighbouring municipalities of Richmond at 54% and Surrey at 33%) (Delta OCP). Delta's population is projected to grow to 121,000 residents by 2041 (based on Metro Vancouver projections), adding approximately 8,300 dwelling units, with the majority of the growth occurring in North Delta (higher elevation) (CoD, 2013).

Delta is home to a large proportion of regionally significant ecosystems and farmlands. Almost half of Delta's land is included in the ALR, which accounts for 26.1% of the gross farm receipts in Metro Vancouver (CALP, 2013). An astounding high percentage of certain crops is located in Delta: about 50% of the province's potato acres, 50% of the greenhouse vegetable area and 25% of the field vegetable acres (Crawford et al., 2013). Delta is home to the Burns Bog Ecological Conservancy Area, which occupies approximately one-fifth of the municipal lands. It is the largest green belt in MVR, the largest raised bog

ecosystem on the west coast of the Americas and the largest undeveloped urban landmass in North America covering about 4,000 hectares (Corporation of Delta, 2014c). The Bog has been called “mother’s nature’s own solar powered coastal defence” (Bellamy, 2005). The Pacific Fly-way, an internationally renowned north-south path for migratory birds, is also nestled in Delta and the nearby tidal flats, which are an important habitat for birds and fish.

Delta is connected to the rest of the region via the George Massey Tunnel (opened in 1959) that links Ladner to Richmond and Vancouver. With the opening of the Tsawwassen Ferry Terminal in 1960, Highway 99 was rerouted from the King George Highway in Surrey to a new route through Delta in 1962. This highway brought 400% growth to Delta over a period of 20 years (Ref). In 1986 the Alex Fraser Bridge was completed, connecting North Delta to New Westminster and Vancouver.

Two important regional transportation hubs are located in Delta at sea level: the Vancouver Port Authority’s causeway, leading to the Delta Port shipping terminal, and BC Ferries Corporation’s Tsawwassen Terminal, also reached by causeway. Deltaport, the Vancouver Port Authority’s (VPA) container cargo terminal and coalport facility is the largest shipping terminal and coal exporter in the Lower Mainland (CALP, 2013).

Flood hazards and risk

Delta is primarily a low-lying area with dependence on dikes for protection from floods. Land elevation across the municipality varies from zero to two meters above mean sea level (Burch, 2011), while high tides can reach two metres (CALP, n.d.). The municipality relies on 61 km of dikes for flood protection. Historically, the largest floods due to spring freshet on the Fraser River in Delta occurred in 1882, 1948, and 1972. The 1948 flood occurred due to dike failure, which resulted in ten deaths, loss of property, and the evacuation of 16,000 people. It is estimated that the same event today could cause an estimated \$1.8 billion dollars in damage (Corporation of Delta, 2009). More recently, Delta experienced a number of storm-surge flooding from a high tide coinciding with a storm surge that resulted in the declaration of a state of emergency.

Risk of freshet floods, storm surges and long term SLR with a subsiding land base create major planning challenges for Delta. Given Delta’s location and proximity to the Strait of Georgia, winter coastal water levels typically exceed the spring freshet levels. Coastal high water levels typically result from prolonged storms in the winter months in conjunction with high tide levels and storm surges (Delcan, 2012). Some estimates suggest that in Roberts Bank, which houses some major marine transportation facilities, a 0.58 m SLR with a 2 m high tide and a 0.9 m storm surge (3.48 m total) would overtop the 3.5 m dike (CALP, n.d.). In Westham Island, an agricultural area and popular tourist location for farm visits and birdwatching, a 2 m high tide and 0.9 m storm surge (2.9 m total) would breach the 2.9 m dikes even without SLR (CALP, n.d.). The island is subject to salinization over time, which would eventually affect crops and change the ecosystem and species composition of the George C Reifel Migratory Bird Sanctuary.

Structural protection

Delta’s dike system consists of more than 61 kilometres of riverbank dikes and sea dikes. The dikes surround the entire lowland area, protecting the community from high water levels along the Fraser River, the Strait of Georgia and Boundary Bay, totalling almost 50 kilometres. The agricultural community of Westham Island is protected by an additional 12 kilometres of dikes. The river dikes protect areas adjacent to the Fraser River from flooding that may occur from high tides, storm surge or flood flows. Sea dikes and seawalls provide protection from high tides, storm surge, waves and debris.

There are partial secondary dikes on the Tsawwassen First Nation lands, and the Cuthbert Dike in the Brunswick Point area. Elevated roads and highways, such as Deltaport Way, Highway 17 and Highway 99, would also provide some secondary flood protection if the primary dike was breached.

This dike system originated in the late 1800s, prior to the historic 1894 flood of record and was rebuilt following the widespread 1948 flood and upgraded in the 1970s and 1980s. The most significant

dike upgrading activities were under the federal-provincial Fraser River Flood Control Program (FRFCP) which existed from 1968 to 1995. Flood risk is related to the historical confinement of the Fraser River to its present channels, which began in the early part of the 20th century (before then, distributary channel switching occurred regularly) (CALP, n.d.). Stabilization of the main channel of the delta through dikes and channels led to decreased sediment transfer to Roberts Bank and made it susceptible to erosion.

Delta invests significant funds into regular inspection, maintenance and upgrades of the dikes (COD_M; SF_1; SF_2). Today, Delta's dike system is considered to be constructed to the 200-year flood level, which means the risk of flooding is estimated to be 0.5% in a given year with "a 99.5% chance that flooding from high water will not occur" (Corporation of Delta, 2014 d). However, some dikes and seawalls are currently below this standard (CALP, n.d.). Additionally, storm surge events continue to erode the protective infrastructure (for example, in December 2014, a flooding event resulted in a 21-metre section of Delta's sea wall collapsing (Li, 2014)). Ditches, over 30 pump stations and flood boxes regulate water drainage in the floodplains by conveying storm flows to the Fraser River or the sea. In the summer, the drainage system is also used as an irrigation storage system for farming (CoD, 2015). Since 2008 Delta has been working on creating a Flood Management Strategy Work Plan (Council report, 2008) that would identify Delta's long-term flood management planning. The Flood Management plan includes a seawall/dike improvement strategy to cope with SLR, a flood box and pump upgrade program to reduce the impacts of flood events, and a floodplain bylaw to shape future development. The plan notes that Delta will undertake seawall/dike improvements, and seek senior government funding to address these long term projections.

Flood management policy

Delta's flood management policies have a mix of measures focused on maintaining the appropriate level of flood protection and land use mechanisms (Table D.7). The key flood management policies include the Official Community Plan, Local Area Plans, and Development Permit Areas.

Table D.7 Key flood management legislation

Bylaw	Map	Others
Emergency Program Plan 6050	Agriculture Land Reserve	Agricultural Climate Change Adaptation Plan
Streamside Protection and Enhancement 6349	Disaster Response Network	Climate Change Initiative
Storm Sewers 5786	Emergency Route Map	Flood Management Study (Kerr Wood Leidal, 2007)
Waterways Protection 1615	Environmental Sensitive Area Designations	Delta Flood Risk and Consequence Study prepared by (Delcan DHV, 2010)
Zoning 2750	Watershed Trail	Technical Memo on Sea Level Rise Dike Breach Analysis (Delcan (2011))
Subdivision and Development Standard 5100		

Delta's first Official Community Plan (OCP) was adopted in 1986. In 2010, the Delta OCP was amended to include a section on Climate Change, which provides an overview of the impacts expected under climate change and a summary of the Climate Change Initiative that guides action and subsequent policies concerned with flood adaptation. Delta was also a pilot participant in the International Council for Local Environmental Initiatives (ICLEI) Building Adaptive Resilience Communities (BARC) program. The municipality recently completed three major studies that provided input for flood management approaches in Delta: the Flood Management Study (Kerr Wood Leidal, 2007); the Delta Flood Risk and Consequence Study prepared by (Delcan DHV, 2010); and the Technical Memo on Sea Level Rise Dike Breach Analysis (Delcan DHV, 2011, as part of the BC RAC program). The studies focus on guiding future improvements to Delta's flood protection system. The municipality is currently working on creating a more strategic flood management approach and some staff also expressed the need for a formal Climate Change Adaptation Strategy to tie together all of the individual initiatives and site specific measures (SF_2).

A particularly noteworthy and regionally ground-breaking document is Delta's Agricultural Climate Change Adaptation Plan. Led by the British Columbia Agriculture and Food Climate Action Initiative and Corporation of Delta, this planning process brought together staff from the Corporation of Delta and the BC Ministry of Agriculture, and volunteer representatives of Delta committees and the agriculture sector as part of the Advisory Committee. It was a part of a larger pilot project that also included the Peace region and the Cowichan Valley region.

The OCP contains numerous policies with regards to natural hazards, flood management and climate change mitigation and adaption. Key policies include the maintenance of dikes and flood-proofing strategies of the plan and development permit areas.¹⁵

In addition to outlining land use and structural measures, the OCP promotes proactive engagement of emergency management in the planning process, for example section 2.4.29 states "Ensure Delta Fire and Emergency Services participate in the planning of natural and environmental areas and also in the planning and development process for projects that may impose a wildland interface threat."

Delta is unique in Metro Vancouver because they have invested heavily in a multi-year partnership with academic institutions and federal and regional partners to develop climate impacts visualization material and to consider adaptation options. Delta developed a high profile in the region, in Canada and internationally with regards to their climate change visualization work. This can be attributed to Mayor Jackson's leadership on this issue and the openness of the municipality to collaborate with other partners, including federal government and academic institutions such as CALP, UBC and NRCan, among other partners. The municipality participated in a multi-year multi-stakeholder project that involved a number of key staff working closely with researchers from government and academia. The work produced a number of visualized scenarios of the impacts of SLR on the community, as well as adaptation options. The results were presented several times to the council (at the Mayor's invitation) and to the public on a number of occasions, including via television. The study impacted the region in terms of "mental preparation" (CoD_M) and general awareness raising (SF_2).

Emergency management

Unlike the other case study municipalities, Delta has experienced a number of recent emergencies that led to the declaration of a state of emergency. Mayor Jackson, who has been the Mayor of Delta since 1999, has declared 4 states of emergency (CD_M). These included two fires (a toxic landfill fire on River Road in 2000 and the 2005 Burn's bog fire) and two flooding events (2006 and 2014). In February 2006 a significant storm event caused extensive flooding in the Beach Grove and Boundary Bay Village areas, along with damage and debris deposition along the remainder of the Boundary Bay dike through the agricultural areas. In 2014, a brief state of emergency was declared due to the storm surges in the Boundary Bay and Beach Grove areas. One home in Tsawwassen had to be evacuated when the sea wall protecting it was washed away (CBC, 2014).

Emergency management is embedded within the Delta Fire and Emergency Services Department by aligning "Delta's emergency response capabilities with the community's needs" (CoD, 2015). Supported by 3 deputy chiefs and 160 firefighters, the Chief at the time had been serving Delta's Fire services for over 30 years. One of the Deputy Chiefs is responsible for Fire Prevention and Emergency Management. The Corporation of Delta's Emergency Management Office works closely with Delta Fire and Emergency Services, Delta Police, Delta's Engineering Department, and Parks,

¹⁵ policies directing settlement patterns that will minimize risks associated with natural hazards and climate change (policies 2.4.27, 2.4.28, 2.4.29 and 2.4.30).

policies regarding protecting the community from flooding (policies 2.10.9 through 2.10.13) that address dikes and flood proofing.

Development Permit Areas established to minimize risks from hazardous conditions including flooding and geotechnical hazards such as landslides, erosion, and debris flows (Schedule E).

Policies related to utility planning, climate change, and natural hazards (policies 2.10.4, 2.10.5, 2.10.10, 2.10.12 and 2.10.13).

Recreation and Culture departments and various other internal and external agencies to ensure the safety of residents and their properties. The Department places a primary focus on education and the emergency response required to mitigate any potential incidents within the municipality (OCP, 2005). Acquisition of Burns Bog, the increased use of parklands, the increase in trucked hazardous materials and the planned expansion of Delta Port are all placing new demands on Emergency Services (OCP, 2005).

Summary and conclusions

This supplementary chapter demonstrates the diverse and highly contextualized regimes of each of the sub-regions and municipal case studies within them. Only a limited number of tools were used consistently by the majority of municipalities. These included flood plain maps, registration of covenants, an OCP and an increasing use of Flood Risk and Consequences studies and other geoscientist's reports to guide planning. Three municipalities have completed their climate change adaptation strategies/plans by using ICLEI-Canada planning framework (CoV, CNV, and COS) and DNV was in the process of completing the process.

The hypothesized variation of priority hazards within the sub-regions was confirmed. The primarily freshet oriented regimes of CoPMs and CoPM were somewhat removed from the recent regional discussions and forums; currently primarily relying on business as usual approaches. CoPM has been turned down for funding due to low population base despite their 90% flood plain base. To address funding shortages and escalating flood management costs, the City introduced the unique drainage utility that creates dedicated funding for flood management purposes. CoPC initiated an innovative recovery planning process that was unique to the region. Overall, at the time of the interviews SLR was not mentioned by the interviewees as an issue that is being addressed at the planning level, despite the tidal nature of the river and the largest freshwater tidal lake in North America (Pitt Lake).

In the South Fraser region for the City of Surrey and Corporation of Delta, coastal and river floods are both familiar hazards. The long historic interdependence between farming and diking shows the unique institutional capacity within the agriculturally strong municipalities of Surrey and Delta (and Pitt Meadows) through an active role of the Districts and Dikes and Drainage Advisory Committee. The City of Delta ran a multi-year project on SLR visualization with federal and academic partners with an active engagement from the Mayor's office and staff. It has also approved some of the most regionally controversial developments in a floodplain subject to SLR. The City of Surrey showed a remarkable transformation from the reputation of a crime-ridden suburb to becoming a sustainability leader in Canada and internationally, while being one of Canada's most rapidly growing multicultural cities. All of this along with a very robust flood management regime that proactively addresses coastal and freshet risk. At the time of interviewing the city was in the state of active knowledge seeking. The City heavily invested in studies to ensure evidence-based decision making prior to acting on provincial guidance.

Within the Burrard Inlet, the interviews revealed an active exploratory and solution seeking stage process for SLR implications. This process unfolded at the municipal level and intra-municipal level through a number of mechanisms and forums which will be analyzed in the subsequent chapters. The discussion also identified that this sub-region is home to some of the regional leaders in the field of natural hazards risk management and adaptation. The DNV was the first municipality in Canada to establish a UN award-winning community-defined risk tolerance criteria for natural hazards. The CoV is home for the ambitious "Greenest City Action Plan" as part of which it produced the first climate change adaptation plan in BC. The CNV is known as a regional leader on smart growth and one of the first Canadian municipalities to adopt a district energy service. The CoV and the CNV were the first two municipalities in the region to raise their flood construction levels in response to the provincial guidelines. Vancouver, as a Charter city, was able to amend their building by-law, zoning by-law and rescind the "Flood-Proofing Policies" and replace them with the "Designated Flood Plain Standards and Requirements". The CNV amended the 1995 Sewerage and Drainage Utility Bylaw to introduce new Flood Construction Levels. All of the three municipalities either completed their climate change adaptation strategy (CoV and CNV) or were in the process of developing one (DNV). Development of these strategies were supported using a five-milestone planning framework from ICLEI Canada.