Patching the Leaks: Reforming British Columbia’s Policy Approach to Property-level Flood Resilience

by

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B.A. (Hons., Political Science), University of British Columbia, 2011

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Abstract

British Columbia’s existing flood risk will be intensified due to climate change. One approach to adapt to this increased risk is to encourage the floodproofing of properties in flood prone areas.

This study examines the gaps in BC’s current flood policy framework that are inhibiting the uptake of floodproofing. A literature review and interviews identify the institutional context, a lack of resources and information, and low public awareness as key barriers. A jurisdictional scan examines different options to overcome these barriers, which include the private sector response of creating an overland flood insurance market.

This study recommends a provincial floodplain-mapping scheme as a necessary precondition for further actions. In addition, a program offering floodproofing grants to vulnerable households should be piloted.

Keywords: Climate change adaptation; flood proofing; flood hazard management
For my family and friends.
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<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>DEFRA</td>
<td>Department for Environment, Food &amp; Rural Affairs (UK)</td>
</tr>
<tr>
<td>DPA</td>
<td>Development Permit Area</td>
</tr>
<tr>
<td>FBC</td>
<td>Fraser Basin Council</td>
</tr>
<tr>
<td>FCL</td>
<td>Flood Construction Level</td>
</tr>
<tr>
<td>FEMA</td>
<td>Federal Emergency Management Agency (US)</td>
</tr>
<tr>
<td>FSR</td>
<td>Floor Space Ration</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
</tr>
<tr>
<td>IPCC</td>
<td>International Panel on Climate Change</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Government Act</td>
</tr>
<tr>
<td>MFLNRO</td>
<td>Ministry of Forest, Lands, and Natural Resource</td>
</tr>
<tr>
<td>OCP</td>
<td>Official Community Plan</td>
</tr>
<tr>
<td>SLR</td>
<td>Sea Level Rise</td>
</tr>
<tr>
<td><strong>Glossary</strong></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td><strong>Adaptation</strong></td>
<td>In human systems, adaptation is the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities (IPCC, 2011).</td>
</tr>
<tr>
<td><strong>Climate Change</strong></td>
<td>A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time period” (UNFCCC, 2001)</td>
</tr>
<tr>
<td><strong>Dike</strong></td>
<td>An embankment, berm, wall piling or fill constructed to control the flooding of land. The term levee is used in the USA.</td>
</tr>
<tr>
<td><strong>Freeboard</strong></td>
<td>A vertical distance added to the actual calculated flood level to accommodate uncertainties (hydraulic and hydrologic variables), potential for waves, surges, and other natural phenomena</td>
</tr>
<tr>
<td><strong>Flood resilience</strong></td>
<td>Constructing a building in such a way that although flood water may enter the building its impact is reduced (i.e. no permanent damage is caused, structural integrity is maintained and drying and cleaning are facilitated)</td>
</tr>
<tr>
<td><strong>Floodplain</strong></td>
<td>A floodplain is a lowland area susceptible to flooding from an adjoining watercourse, ocean, lake or other body of water</td>
</tr>
<tr>
<td><strong>Floodproofing</strong></td>
<td>The alteration of land or structures either physically or in use to reduce or eliminate flood damage and includes the use of elevation and /or building setbacks from water bodies to maintain a floodway and to allow for potential erosion.</td>
</tr>
<tr>
<td><strong>Resilience</strong></td>
<td>The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (IPCC, 2014)</td>
</tr>
<tr>
<td><strong>Riverine Flooding</strong></td>
<td>Flooding associated with a river watercourse overtopping its banks</td>
</tr>
<tr>
<td><strong>Urban Flooding</strong></td>
<td>Flooding associated with municipal infrastructure (sewer and street) exceeding their capacity to convey runoff</td>
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Executive Summary

Climate change will increase flood risk in British Columbia. Floodproofing, which is any action that reduces flood damage to individual properties, is an effective tool to address this risk. Policies to encourage floodproofing in BC have had been little applied, and therefore floodproofing practices have had limited application.

This study examines the factors hindering the implementation of property-level floodproofing, and how these barriers can be addressed to ensure communities are adapting to climate change. The methodology involves qualitative semi-structured interviews with key government participants and local experts and a cross-jurisdictional analysis of potential best practices. Cases examined are the District of Squamish, the District of North Vancouver, New York City, and the United Kingdom.

Four barriers to floodproofing in BC’s current policy framework are identified. First, the current legal context in BC provides little incentive for local governments to adopt floodproofing policies. This is problematic because floodproofing policies, while having potential long-term economic and social benefits, are difficult, costly, and often unpopular in the shorter term. Second, information and resources surrounding floodproofing are lacking for both local governments and property owners. This point is related to a third issue, which is low public awareness of risk. Finally, considerations around the distribution of costs and their implications for equity can slow policy change.

This study proposes several policy interventions, which are evaluated for their ability to increase floodproofing in BC. These policies are: a provincial mapping scheme, overland flood insurance, flood bylaws, updated building codes, updated Disaster Financial Assistance, subsidies for floodproofing, and a public education program. Policies are evaluated based on their suitability to be implemented by the BC provincial government.

This study finds that a staged implementation approach to begin the process of raising public awareness and increasing resources would be desirable. First, a provincial floodplain-mapping scheme should be implemented as a precondition for further actions.
To eliminate equity concerns and stakeholder conflict, these maps should initially not be tied to legislation. In addition, a program offering floodproofing grants to vulnerable households should be piloted. Once a pilot program has been implemented and evaluated, a wider subsidy program should begin in tandem with changes to Disaster Financial Assistance. The choice of assistance paired with the removal of post-disaster aid will give individuals the ability to make an informed decision about the level of risk they are willing to accept. Regulatory change is recommended as a final step to improve BC’s flood resilience.

A move toward floodproofing represents a paradigm shift in flood management. It shifts toward reducing flood vulnerability while accommodating more water, as opposed to reducing flood hazards by protecting against water intrusions.
Chapter 1. Introduction

1.1. Policy Problem

In October 2012, the major winds of Superstorm Sandy in New York resulted in a 14-foot wave. The following summer, June 2013, Southern Alberta was hit with a flood that was labeled “the costliest natural disaster in Canadian history” at over $5 billion in damages (IBC, 2014). Not long after that event, Toronto broke a 60-year record when it received 126 millimeters of rain in a single day.

Climate change is now irrefutable, with scientific consensus that coastal and overland flooding will continue to worsen as a result of global increases in temperature. British Columbia, and especially the Lower Mainland area, is already at risk of flooding. As the risk of flooding increases, so does the likelihood of damages to property and communities. In light of changing circumstances and increased risk, a key question becomes: how can communities better mitigate damages from flooding?

Flood management is a combination of actions and policies that address flood risk. This incorporates a range of actions from structural defenses such as reinforcing dikes to property-level floodproofing and emergency response actions. Traditionally, flood management in BC has focused on protection through structural defenses. In recent years the majority of control over flood management has been downloaded to local governments, leaving gaps in management and responsibility. The added flood risk from climate change has increased the need for action without resolving any of the current inconsistencies in responsibility, control and liability.

Property-level floodproofing is any action that reduces flood damage to individual properties; it has become an established pillar of flood management. However, despite the growing costs of flooding, BC remains behind the times in the implementation of
property-level flood mitigation measures, even in flood-prone areas. This study examines the factors hindering the implementation of property-level measures, and how these barriers can be addressed to ensure communities are adapting to climate change.

1.2. Study Roadmap

The following chapter situates this research by outlining the context for flooding in the Lower Mainland, including the causes of flooding, the implications of climate change, and the present institutional context for flood hazard management in BC. Chapter 3 describes the method of data collection for this study, which includes a literature review, participant interviews and a jurisdictional scan of best practices. Chapter 4 explains floodproofing and the role of government involvement in more detail and discusses current uptake in BC. Chapter 5 analyzes the literature and interview findings to highlight what is inhibiting the implementation of floodproofing policy. Chapter 6 analyzes two local case studies, the District of Squamish and the District of North Vancouver, as well as two international case studies, New York City and the UK. These case studies are used to assess best practices in policy to encourage the uptake of floodproofing. The 7th chapter details the framework for analysis that was used to evaluate the policy options, which are explained in detail in Chapter 8. These options, all directed at the province, include a floodplain mapping program, regulation through the building code and flood bylaws, subsidies/grants for floodproofing and increased education. Chapter 9 evaluates each option and examines the viability of relying on market measures through insurance. Chapter 10 presents the recommendations, which include a provincial mapping scheme, changes to disaster financial assistance and a pilot floodproofing grant program.
Chapter 2.  Background

2.1. Climate Change and Flood Risk in British Columbia

Flooding is any circumstance where water rises into an area that is normally dry land. While flooding is a natural event that replenishes groundwater, it can cause adverse social, economic and environmental impacts when it occurs in areas where communities have settled (Fraser Basin Council, 2010). A community’s flood risk is the combination of its hazard and vulnerability. A flood hazard is the probability of flood events as well as their main physical characteristics. Flood vulnerability is the potential damage and local recovery capacity. Therefore flood risk is a function of the natural sources and likelihood of a flood as well as the potential damages incurred (FBC, 2010).

\[
\text{Flood Risk} = \text{Flood Hazard} \times \text{Flood Vulnerability}
\]

Much of BC is at risk of flooding, which can be a result of heavy rainfall, snowmelt, ice jams, log jams, debris flows, sediment deposits and tsunamis (FBC, 2010). The adverse impacts and costs of flood events are increasing for two reasons. First, more people and property are concentrated in flood-prone and coastal areas. Second, a changing climate exacerbates the frequency and intensity of flood events.

Over the 20th century the average temperatures in British Columbia increased by 1.1°C (Rodenhuis et al., 2009). By 2100, earth’s temperatures are expected to rise by an additional 1.7 to 4.8°C (IPCC, 2013). These rising temperatures are associated with multiple water-related impacts. Some of the anticipated impacts in Canada are more frequent heavy precipitation events with an associated increased risk of flooding, and a twofold increase in frequency of rare extreme precipitation events (NRCan, 2014).
Estimates of the magnitude of future changes in global sea level by the year 2100 range from a few tens of centimeters to more than a meter (NRCan, 2014).

2.1.1. Geographical Focus

The increased risk of flooding caused by climate change arises throughout BC, but this study will focus on the geographic area known as the Lower Mainland. The area is defined as extending west to east from Richmond to Hope, and north to south from Squamish to the US border. Appendix A contains a map of the region and demographic characteristics. This area of study coincides with the FBC’s “Lower Mainland Flood Management Strategy.” This geographic scope has been chosen to focus the research on an area of BC that will experience similar flood impacts from climate change. While the focus of this research is regional, the BC government is addressed as the primary policy actor.

2.1.2. Causes of Flooding in the Lower Mainland

Flooding throughout the Lower Mainland has three primary causes, all of which are intensified by a changing climate. These are heavy rain events, higher water levels in the Fraser River and coastal flooding.

Overland flooding can occur when rainfall or snowmelt exceeds the capacity of overland flow routes (Mills, 2013). A 2008 study predicted that precipitation will increase by 10% to 25% in much of BC by 2050 (Thomson et al. 2008), and warming has already caused precipitation to increase by 2% to 4% per decade in southern BC (Rodenhuis et al., 2009). When the impacts of extreme rainfall are exacerbated by high concentrations of impervious surfaces, that is, infrastructure and buildings, urban flooding can result (Sandink, 2009). Urban flooding can have serious implications for property, infrastructure, and people, as extreme flows of water during heavy rainfall events can cause severe damage.

BC rivers, including the Fraser, have experienced earlier snowmelt and higher water volumes in the spring due to climate change (Shrestha, Schnorbus, Werner, & Berland, 2012). A 2014 report found that by the end of this century, a Fraser River flood
of the size that used to occur only once every 200 to 500 years will be more likely to take place once every 50 years (BC MFLNRO, 2014). This has serious implications for the 146 kilometres of diking built in the 1970s and 80s according to historical standards (BC MFLNRO, 2014).

Coastal flooding is connected to climate change through sea level rise (SLR), and it is a significant threat for coastal BC. Rising sea levels are due partly to an increase in the volume of water as it warms and expands and partly to the increased flow of freshwater from land where melting ice adds to the total volume of water in the oceans (Miller & Douglas, 2004). Flooding arises when water levels are higher than normal, which can be a combination of high tides, storm surge\(^1\), storm set-up, wave set-up and waves. Sea level rise increases the flood risk because higher water levels mean that areas of higher elevation will be impacted. The possibility of increased storm intensity and duration associated with global warming could also lead to higher wind, waves and swell in winter which would lead to greater land erosion and flooding during periods of high tide (Thomson et al., 2008).

The provincial government recommends planning for a sea level rise of 0.5 meters for the year 2050, 1.0 meter for the year 2100 and 2.0 meters for the year 2200\(^2\). These targets are consistent with sea level rise projections that are used in Europe and the U.S.A, and Atlantic Canada has adopted the same standards (Ausenco & Sandwell, 2011).

While different types of floods have different causes and consequences, they are not independent of each other. For example, an extreme storm can cause urban flooding from heavy rains as well as a storm surge from high wind.

\(^1\) A storm surge is a temporary increase in the height of the sea, caused by extreme weather conditions

\(^2\) The BC government has specifically addressed SLR through technical studies and subsequent SLR projections, guidelines, and legislation only in the last few years. In 2008, the BC MOE released their first official report “Projected Sea Level Changes for British Columbia in the 21st Century.”
2.2. Measuring Flood Impacts

A clear way of quantifying flood risk is by calculating the potential damages of a flood in monetary terms. This can be calculated by examining both the direct and indirect impacts of flooding. Direct impacts are the harm that results from the immediate physical contact of water to people, infrastructure and the environment. Indirect impacts are caused by economic and social disruptions and the costs associated with emergency response to a flood (Lyle & Mills, 2014).

Depending on the methodology used to calculate costs, both direct and indirect impacts can have very different values (Burrel, Davar, & Hughes, 2007). For example, direct impacts could be estimated by examining post-flood insurance payments or government disaster financial assistance payouts. However, both of these measures fall short of calculating total impact, as they include only damages that are eligible for post-disaster compensation. Indirect impacts of flooding can be even more difficult to quantify.

One study that attempts to quantify the costs of flood risk is the 2010 Economic Impact report by the National Roundtable for the Environment and the Economy (NRTEE). Their methodology applied 2006 census data to estimate the average dwelling value in areas susceptible to flooding. The report predicts that annual flood damage to dwellings in BC could range from $2.2 billion to $7.6 billion in 2050 (NRTEE, 2012).

Finally, the difficulties in quantifying damages from flooding do not interfere with a consensus that these costs are mounting. In the past 30 years, the cost of insurance claim payouts due to extreme weather events has increased 15-fold (IBC, 2014). In addition, 2013 was the fifth year in a row that insured losses from extreme weather events was near or above $1.5 billion in Canada. Insured losses in 2013 alone were over $3 billion (IBC, 2014).

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3 This calculation does not include the costs of overland flooding to private residences, as it is not currently insured in Canada.
2.3. **Key Principles of Climate Adaptation**

The policy decisions needed to confront climate change are usually framed as two different but complementary strategies: mitigation and adaptation. Mitigation is the reduction of the magnitude of climate change itself, principally through the reduction of greenhouse gas (GHG) emissions. Adaptation, in contrast, is preparing for and responding to the impacts of climate change, while not necessarily dealing with the underlying cause of those impacts.

The concept of adaptation was first recognized as a potential response to climate change in the 1990s and was initially seen as a secondary strategy to mitigation. Recently attitudes towards adaptation have shifted and it is now viewed as an essential complement to the reduction of GHG emissions (NRCan, 2014). Adaptation has gained prominence in the climate change literature, and the process of adaptation has been evaluated from social, environmental, economic and psychological perspectives (e.g. Burch and Robinson, 2007; Burch, 2010).

Strategies that address both mitigation and adaptation, are called “climate-resilient pathways”, and they are the latest research and policy trend. Climate-resilient pathways are defined as “sustainable-development trajectories that combine adaptation and mitigation to reduce climate change and its impacts” (IPCC, 2014, np.)

British Columbia is already experiencing the impacts of a changing climate and will continue to do so. While it is crucial to attempt to mitigate future greenhouse gas (GHG) emissions, warming and associated changes will continue globally for at least the next 50 years regardless of whether mitigation occurs, due to the GHGs that are already in the atmosphere (IPCC, 2007). Adaptation is now a necessary short-term and long-term undertaking.
2.4. Adaptation and Flood Management: Where Do Properties Fit In?

Flood management is any action that prevents floods, reduces the probability of a flood, or lessens the damages from unavoidable floods (Burrel, Davar, & Hughes, 2007). Flood management and adaptation literature classifies human response to flood risk into two categories—structural and non-structural (Lyle 2001; Erich, 2002; Kundzewicz, 2002; Burrel et al, 2007). Structural approaches are technical and engineered solutions used to prevent floodwater from entering human settlements. Non-structural measures are adjustment of human activities to accommodate flood threat, which encompasses planning, regulation and land use change (Jardin, 2013).

The common interpretation of “structural” refers to large-scale defenses (Kundzewicz, 2002), meaning that distributed small-scale approaches such as flood proofing are categorized as “non-structural” (Kundzewicz, 2002; Erich, 2002). There is some disagreement in the literature over this classification, and aspects of small-scale approaches can be placed in the “structural” category, such as raising building elevations and using water-resilient materials (Jardin, 2013). However, for the purpose of this research, the common classification will be used and all property-level measures will be considered non-structural approaches to flood management.

The following table provides a summary of structural and non-structural approaches to flood management as classified in the dominant literature.

Table 2-1: Structural and non-structural approaches to flood management

<table>
<thead>
<tr>
<th>Structural Approaches</th>
<th>Non-structural Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Dikes, dams and levees,</td>
<td>• Flood forecasting, flood warning and emergency planning;</td>
</tr>
<tr>
<td>• flood control reservoirs,</td>
<td>• flood risk assessment (such as floodplain maps)</td>
</tr>
<tr>
<td>• river diversions,</td>
<td>• land use planning controls</td>
</tr>
<tr>
<td>• channel improvements (widening, deepening, bank</td>
<td>• laws and regulations, zoning,</td>
</tr>
<tr>
<td>protection),</td>
<td>• floodproofing of vulnerable properties</td>
</tr>
<tr>
<td>• floodwalls and seawalls,</td>
<td></td>
</tr>
<tr>
<td>• pump stations,</td>
<td></td>
</tr>
<tr>
<td>• floodboxes</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Burrel, Davar, & Hughes, 2007; Kundzewicz, 2002; Erich, 2002; Lyle, 2001
2.4.1. **Dependence on Structural Measures**

The primary response to flood risk in BC has been a structural approach, with 600 km of dikes, 400 flood boxes and 100 pump stations protecting residents of the Lower Mainland (Lyle, 2001). The emphasis on this one approach has been attributed to a few factors, including:

1. The economic costs and benefits of hard engineered approaches are easier to quantify;
2. Government cost-sharing agreements have tended to favour large-scale projects (Longland, 2004; Lyle 2001); and
3. Historically negative attitudes toward land-use restrictions (AG, 2010; FBC, 2009).

While structural works provide valuable and necessary protection, they have led to a heavy reliance on publicly supported diking for flood protection. This reliance has had problematic consequences, such as creating a perverse incentive to develop in flood-prone areas (Longland, 2004; Merrits, 2000; Lyle, 2001). This has been labeled “the flood protection-development spiral” (Merrits, 2000), which is the tendency for people to increase settlement in floodplains protected by structural works. In addition to perpetuating this cycle, structural works are costly to build, maintain and upgrade. Current dikes have been built to withstand the flood of record and do not incorporate climate change projections (Ausenco, Sandwell, 2011). A 2012 report estimated that upgrading and building structural protections along 250km of Lower Mainland shoreline would cost upwards of $9.5 billion (Delcan, 2012).

A reliance on structural works can have additional negative consequences on the uptake and understanding of property-level measures, as it moves the focus away from individual action. First, by externalizing all costs related to flood protection, property owners within flood hazard areas are given a false sense of security. Second, the reliance on one type of protection creates a lack of information regarding other measures (FBC, 2009). Finally, an over-reliance on one aspect of flood management limits flexibility in the face of changing conditions (Kundzewicz, 2002). Given the changing context of flood risk in BC, it will be necessary to shift the focus away from structural protections and better incorporate property-level measures in flood management schemes.
2.4.2. **Property-level floodproofing**

Property-level flood mitigation measures are actions taken at the individual property level that reduce flood vulnerabilities. These distributed, small-scale measures can be done either by floodproofing a property or by reducing input into storm water systems. While the focus of this research is on floodproofing, some of the findings are applicable to encourage the uptake of runoff-reduction measures.

Floodproofing measures are one aspect of a wider flood-management strategy and should not be used in isolation. Unlike structural protections, they do not alter the likelihood of a flood occurring at a property (May, Chatterton, 2012). However, floodproofing should be used in situations where large-scale flood defenses are inappropriate or challenging to implement (White et al., 2013; Sandink, 2009). In addition, structural defenses “cannot provide adequate prevention against flood disasters if they do not perform to their design levels due to poor maintenance or if the actual flood exceeds the expected flood level” (WMO, 2014), giving further reason to invest in alternate measures. Chapter 4 provides an overview of different types of floodproofing and more detail on their application.

Floodproofing can be applied to private residences or commercial properties. This research focuses on policies that are directed at private residences.

2.5. **Property-level Measures in Practice**

2.5.1. **British Columbia**

The current tools most commonly used to mitigate flooding at the site and building level in the lower mainland are flood construction levels (FCLs) and setbacks (Mills, 2013), which are both designated in municipal bylaws. These regulatory restrictions are primarily the responsibility of local governments, which has led to a considerable variety in approaches to flood protection including a lack of implementation
measures (AG, 2010). A 2013 study by the Fraser Basin Council (FBC) highlighted that a current deficiency in the BC flood management framework is inadequate floodproofing (FBC, 2013, p. 11), and it has been noted that few examples of flood resilient construction measures exist in the Lower Mainland (Mills, 2013). A 2010 report “Flood Protection Strategies in BC” states, “… there is an ongoing need for education about flood hazards and flood protection. The natural tendency for property owners is to rely on off-site structural means for flood protection. There is little incentive for homeowners to undertake floodproofing unless required …” (AG, 2010, p.434). Thus, while awareness of the importance of property-level measures is growing in BC, it is not yet an established component of flood management.

2.5.2. Canada

Elsewhere in Canada, property-level adaptation measures are starting to gain traction. In Ontario, the insurance industry-established Institute for Catastrophic Loss Reduction (ICLR) has released reports around the concept that individual homeowners have a role in reducing risk through protecting their homes and reducing their contribution of stormwater to municipal sewers/storm-water management systems (Sandink, 2009; 2011). The recent flooding of the Bow and Elbow rivers has precipitated a new Disaster Financial Assistance (DFA) policy in Alberta. To receive compensation, properties must meet minimum flood mitigation measures by performing “wet-proofing” (Mills, 2013).

As costs related to water damages are mounting, interest in property-level measures is also increasing. A recent survey of flood policy stakeholders by Feltmate and Thislewaite (2014) found property-level risk mitigation to be a policy priority. Property-level measures to reduce basement flooding are being encouraged in some Canadian municipalities through incentive programs (Sandink, 2009) but are never referred to as climate adaptation actions. Little Canadian research has assessed the effectiveness or viability of property-level measures.
2.5.3. The US and the UK

The US and the UK are both starting to make significant strides in property-level measures. In the US, the primary source of flood hazard planning and mitigation is the Federal Emergency Management Agency (FEMA). FEMA establishes floodproofing criteria that must be met to be eligible for its nation-wide flood insurance program, NFIP\(^5\). In the United Kingdom, “property-level-protection” is considered to be an “effective and accepted new approach for managing flood risk in the hierarchy of management options” (DEFRA, 2012, p. 2). Further details on policies in these jurisdictions can be found in Chapter 6 of this report.

2.6. The institutional context of flood management

Flood risk is managed through a multi-level governance structure in BC, which involves the provincial government and multiple local governments. The provincial government has a three-part Integrated Flood Hazard Management program, which consists of:

1. **Emergency Management**, which is operated through the Ministry of Public Safety and the Solicitor General’s Provincial Emergency Program
2. **Dike Safety**, which is the responsibility of the Ministry of Forests, Lands and Natural Resource Operations

Up until 2003\(^6\), the provincial government was directly responsible for reviewing and regulating municipal flood management. However, full responsibility shifted to the municipalities due to major legislative change in 2003 and 2004. Instead of direct

\(^5\) Canada is the only G8 country in which neither public nor private agents offer overland flood insurance. For a full discussion of insurance, please refer to section 8.2.

\(^6\) From 1975-2003, the provincially run Floodplain Development Control Program managed development in designated floodplain areas.
provincial involvement, the *Flood Hazard Area Land Use Management Guidelines* serve to assist municipalities in developing their own flood bylaws by giving provincial recommendations, such as ideal flood construction levels (FCL).

Municipalities are not legally required to incorporate standards from the Guidelines into their bylaws (Stevens & Hanschka, 2014). Instead, the relevant provincial legislation requires only that municipalities consider the Guidelines when adopting a flood bylaw. This regulatory environment has resulted in a situation where neighbouring municipalities have very different standards and regulations in place.

The BC flood management context has room for increased coordination, and the Fraser Basin Council is currently working to facilitate a 2014 initiative developing a Lower Mainland Flood Management Strategy to better protect communities in the Lower Mainland (FBC, 2014). Partners in this initiative include the federal and provincial government, and other entities in the region, including those focused on transportation systems, agriculture and business. In phase 1 of the strategy (2014-2015), one of the three projects is to review the condition of flood protection works and effectiveness of current floodproofing measures and bylaws.

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7 As of November 2014, these guidelines are in a state of transition. The Province released draft amendments to the existing guidelines dealing with coastal flood risk, which confirmed that local governments should be planning for one meter of sea level rise by 2100, but which did not specify FCLs.

8 Local Government Act, S.910.
Chapter 3. Research Methods

The methodology for this study involves qualitative research methods using three components:

1. A literature review of the context of floodproofing and the barriers in BC;
2. Qualitative semi-structured interviews with key government participants and local experts;
3. A cross-jurisdictional analysis of the state of floodproofing and potential best practices

3.1. Literature Review

My literature review draws on sources found online, in local libraries, and sources sent to me through preliminary requests for information from flood policy experts. I use academic sources, government reports, legislation, and Official Community Plans (OCPs). The literature review is used to assess current barriers, inform my evaluative framework and assess policy options.

3.2. Interviews

To identify the barriers to implementing floodproofing policies, I interviewed professional stakeholders whose interests are connected to flood hazard management. My sample included planners, provincial policy makers, developers and academics working in the field of flood policy and/or climate change adaptation. I used a snowball sampling method to identify and recruit participants for the interviews, which is a recruitment of participants through a referral process. I was able to secure a total of nine interviews.
Along with an invitation to participate in the interview, I sent potential participants a consent statement and a description of my research, giving participants the option to discontinue participation at any point of the research process. I used a semi-structured format to conduct the interviews to promote flexibility in responses and encourage dialogue with the participants. A weakness of using interview methodology is potential bias in questions and response, as well as inaccuracies due to poor recall (Yin, 2009).

3.3. Jurisdictional Scan

To identify best practices for addressing the policy problem, I conducted a jurisdictional scan. Two local case studies from the Lower Mainland as well as two international case studies were selected. This variety of cases was used both to better understand the local context and to incorporate best practices from other jurisdictions. International case studies were selected if they implemented floodproofing policies that could be transferable to the BC context. Given that a key consideration of the policy analysis is increasing resources and information on floodproofing, preference was given to jurisdictions that have released educational materials on property-level measures.
Chapter 4. Floodproofing: A Deeper Look

Flood management is a type of disaster management. The goal of Canada’s National Disaster Mitigation Strategy is “To protect lives and maintain resilient, sustainable communities by fostering disaster risk reduction as a way of life” (PSC, 2014, np). Thus that the primary societal objective of flood management is public safety—reducing personal injury and the loss of life.

From a public safety standpoint, floodproofing should be considered in the suite of flood management options. Floodproofing can reduce the threat of injury or death from drowning, as well as electrocution, unsanitary conditions, and water-borne debris, all of which are public safety concerns (Longland, 2004). In addition, floodproofing can reduce the stress and disturbance of flood events by reducing clean-up and recovery time after a flood event, as well as by averting the damage to “… homes and the valuable or irreplaceable items they contain” (Longland, 2004, pg.74).
4.1. Floodproofing Methods and Considerations

Floodproofing is any site- or building-level measure that reduces flood damages. The aim of all measures is to minimize risk to inhabitants and to property, and to allow residences and businesses to be habitable/usable as quickly as possible after a flood event. As previously stated, floodproofing is not a direct substitute for engineered structures because it does not change or alter the likelihood of a flood that properties are exposed to. Residents with property-level measures in place must therefore “be prepared for flooding and must recognize that flood damage can still occur, but to lower levels than would be experienced if there was no protection whatsoever” (May, Chatterton, 2012, pg. 3). Property-level floodproofing methods can be divided into four categories:

1. Relocation
2. Elevation
3. Wet floodproofing
4. Dry floodproofing

Relocation has been included as a category of property level measures because it can offer the greatest security from flooding and is therefore an important option in the portfolio of property-level alternatives. However, given the unique policy considerations around relocation it has not been included in the scope of this report. The table below describes the remaining three methods and their purpose.

9 The terms used in this report are the same as those used in 2014 New York Guide, “Retrofitting buildings for flood risk,” and therefore the same as those used in the US regulatory framework. However these terms are not universally accepted and can be interpreted differently. In the UK context, the common term for floodproofing is property-level flood protection. In addition, elevation and relocation are labeled flood avoidance techniques in DEFRA reports. Wet floodproofing is referred to as flood resilience and dry proofing is labeled flood resistance (DEFRA, 2007; 2011). In the limited Canadian documents, elevating structures through raised Flood Construction Levels (FCLs) is often referred to as dry floodproofing and using resilient construction materials in referred to as wet floodproofing. In many Canadian policies the term floodproofing refers only to elevating structures. Finally, in the BC context, a 2001 report for the Fraser Basin Council defines floodproofing as “… the elevation of habitable space to the specified Flood Construction Level and may include the use of flood damage resistant building materials” (Arlington Group 2001, pg. 1). This definition includes only elevation or wet floodproofing as floodproofing methods.
<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Purpose</th>
<th>Example and cost ($USD, 2001)</th>
</tr>
</thead>
</table>
| Elevate         | Elevate entire structure, through constructing a new foundation (structural elevation) | To reduce risk to structure and contents of a building by providing complete protection against water damages | 2-foot raise: Wood frame building with basement or crawlspace – $18 per square foot  
Wood frame building with slab-on-grade foundation – $50 per square foot  
Masonry building with basement or crawlspace – $37 per square foot  
Masonry building with slab-on-grade foundation – $50 per square foot |
|                 | Fill basement or cellar (non structural elevation)                          | To achieve the same protection as constructing a new foundation without impacting neighbourhood character | Same as above |
|                 | Abandon lowest occupied floor and wet floodproof                           | Same as above                                                                                      | Masonry building with basement or crawlspace – $37 per square foot |
|                 | Elevate critical systems, such as mechanical and plumbing systems and electrical utilities | Increase a household’s overall resiliency by reducing the amount of time before key systems are operational after a flood | Masonry building with slab-on-grade foundation – $50 per square foot |
| Dry-floodproof  | Use building materials to make a structure impermeable to the passage of water | To prevent floodwater entry into a building while maintaining the current building structure  
Sprayed-on cement (above grade) – $3.50 per square foot  
Waterproof membrane (above grade) – $1.17 per square foot | |
|                 | Use deployable flood barriers                                               |                                                                                                        | |
| Wet floodproof  | Use building materials that are resistant/resilient to flood water and relocating/modifying a buildings equipment and contents | To allow water to enter and exit the building to reduce dangers of hydrostatic pressure  
Sump pump (with backup battery) – $1,060 lump sum | |

Sources: NYC Planning; 2014, DEFRA, 2013, FEMA, 2001

All methods can be done retroactively by retrofitting an existing property or proactively by incorporating into building considerations.

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10 For most flood events, total prevention of water entry is very difficult to achieve. Under NFIP standards, only non-residential buildings can use dry floodproofing (New York 2014)

11 Buildings are at significant risk of structural damage from excessive water pressure if the water level difference between the outside and the inside exceeds 0.6m (DEFRA, 2007)
4.2. When to Floodproof?

Generally, floodproofing is most effective when the flood duration is short, the floodwater speed is slow, and the flood depth is shallow (White et al., 2013). As described in section 2.1, flood risk is a function of hazard (natural sources and probability of a flood) and a community’s vulnerability. Viewed differently, a community’s flood risk is a function of the likelihood of a flood occurring and the severity of the consequences of the flood. Therefore, floodproofing is well suited as a protection measure against higher likelihood, lower consequence events, known as nuisance flooding. Climate change will further increase the likelihood of nuisance flooding (Sweet & Park, 2014), escalating the importance of finding ways to address flood risk.

![Diagram](image)

**Figure 4-1:** Likelihood vs. consequence of a flood event
Diagram adapted from Lyle & Mills, 2014.

4.3. Floodproofing: An Economic Analysis

Economic analysis is frequently used to make resource allocation decisions in flood management. It is able to “…provide a set of fairly reliable tools for an objective evaluation of the benefits and costs of specific flood management projects in monetary...
terms so as to enable their comparison and judge the economic viability of the proposed projects” (WMO, 2007, pg.7).

Evaluating the costs and benefits of implementing floodproofing measures can be done in two alternative ways. One is the impact on the province as a whole (public), or the economic model. The other is the impact on individual households (private), or the financial model. This distinction has been made as floodproofing can be evaluated as part of a scheme to enhance the recovery time of a whole region, or as a way an individual owner can lessen his or her own damages. The evaluation of public impacts determines the best value for government intervention, from an economic perspective. The evaluation of private impacts determines the best value for an individual considering implementing measures, from a financial perspective.

Taking both public and private considerations into account, it is possible to construct general economic objectives related to floodproofing. First, minimizing the estimated monetary damages from flooding and associated liabilities to both public and private interests. These are estimated damage costs incurred after a flood event and are directly related to the costs of repairing flood damage to structures and their contents. Second is a desire to minimize the costs of implementing the floodproofing strategy for both public and private interests. These are potential costs incurred before a flood event and are directly related to the expenses required to floodproof buildings.

There is little information on the potential cost-savings of floodproofing “... because property-level protection as a flood risk management tool is in its infancy, there is little evidence, either statistical or anecdotal on the actual level of damages that could be saved by their introduction...” (May & Chatterton, 2012, pg. 12). A 2014 cost-benefit analysis done for the UK’s Department for Environment, Food & Rural Affairs (DEFRA) is one attempt to study the cost-effectiveness of different floodproofing options. The study found that temporary resistance measures reduce the costs of damage by around 50% if they are properly installed prior to a flood. Additional investment in permanent floodproofing increases the proportion of prevented damage to between 65% and 84%, but these measures are not as cost-beneficial due to the higher investment costs (DEFRA, 2012).
While a full cost-benefit analysis for floodproofing is beyond the scope of this research, it is possible to estimate the potential cost-savings of proactive action. The following table summarizes some measures of the financial costs of a flood event compared to the costs of implementing a measure.

**Table 4-2: Variables used to measure damages from flooding and costs of floodproofing**

<table>
<thead>
<tr>
<th>Damages from flooding</th>
<th>Costs of Implementing Floodproofing strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct building damage</td>
<td>Cost to survey property</td>
</tr>
<tr>
<td>Property damage</td>
<td>Cost of measure</td>
</tr>
<tr>
<td>Clean-up costs</td>
<td>Maintenance costs</td>
</tr>
<tr>
<td>Temporary accommodation</td>
<td></td>
</tr>
<tr>
<td>Absence from work</td>
<td></td>
</tr>
<tr>
<td>Stress and Mental Health</td>
<td></td>
</tr>
</tbody>
</table>

Source: Defra, 2009

This table describes private financial costs, but there are public economic costs as well. An easily quantifiable public cost is Disaster Financial Assistance, which is post-disaster compensation paid by the federal and provincial government. Financial assistance is provided for each accepted claim at 80 percent of the amount of total eligible damage that exceeds $1,000, to a maximum claim of $300,000. (BC Emergency Management, 2006). Additional public costs include lower economic productivity due to absences from work and public health costs.

Floodproofing is not an appropriate action in all situations. In a high consequence, high likelihood area, it may be necessary to eventually relocate a property, and therefore would not be cost-effective to invest in housing retrofits. In areas with a very low likelihood of a flood event, the benefits of averted potential damages will not exceed the costs of implementing measures. Personal risk tolerance is another factor that can impact the appropriateness of implementing floodproofing measures. Different individuals would be willing to accept different levels of flood risk, which is elaborated further in section 5.4.

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12 An example of a public health costs would be medical attention due to mold inhalation.
4.4. Floodproofing – Why Should Government Intervene?

This distinction between private and public interests in floodproofing relates to Stern’s (2008) evaluation of the economics of adaptation, which distinguishes between two levels of adaptation: planned (public, joint actions) and autonomous (private, individual actions). Planned adaptation applies to managing a public good, such as safety, implying that an adaptation decision impacts the utility of other individuals. In contrast, “…autonomous adaptation is a behavioural change in response to a certain climate change impact, which benefits a particular actor only” (Filatova, 2014, np.).

Floodproofing itself is autonomous adaptation, whereas policies to encourage the uptake of floodproofing are planned adaptations. Therefore the counter-argument to government intervention in floodproofing is that as private adaptation is driven by direct personal gain, it will thrive on its own without any public support (Mendelsohn, 2000).

Floodproofing falls within the realm of government intervention because multiple market failures are preventing individuals from undertaking efficient adaptation through floodproofing. First, as explained in section 2.4, a reliance on structural measures externalizes all costs related to flood protection, giving property owners within flood hazard areas a false sense of security. This can create a moral hazard where property owners have little incentive to incur upfront costs for protection they see as being provided by others. The fact that post-disaster relief comes from the federal and provincial governments does little to remedy the problem. Second, the reliance on one type of protection creates a lack of information regarding other measures. Third, overland flood insurance is not currently available in Canada\textsuperscript{13}.

There is consensus in the literature that to achieve efficient autonomous adaptation individuals need to have knowledge, resources and incentives (Faukauser et al, 1999; Stern, 2008; Filatova, 2014). A lack of knowledge, combined with no insurance

\textsuperscript{13} Insurance is the standard mechanism to reduce the uncertainty of financial loss for disaster risk, by spreading risk across a large number of insured parties. When structured correctly, insurance gives a price for risk, which allows the public to understand their risk and can incentivize measures to reduce that risk. Further information on the potential viability of flood insurance in Canada can be found in sections 5.4 and 9.2.
to set a price on level of risk, and often no maps to delineate risk, creates a situation of imperfect information where property-owners do not know how to protect themselves.

There are many areas in the Lower Mainland that already have a high likelihood of low consequence flooding. As the planet continues to warm, this likelihood will grow, due to increased, more intense events and pressure on infrastructure that was designed to withstand past climates. As flood likelihood grows, it will be increasingly inefficient to depend solely on structural measures for protection. In BC, alternative flood hazard management strategies have focused on providing disaster financial assistance in the aftermath of a flood and using regulations to require elevated floodproofing in the floodplain. Although in place since 1973, the effectiveness of floodproofing policy has been considerably hindered. First, many areas are historically exempt from the policy. Second, it is not mandatory for local governments to adopt bylaws.

In 1966, the Official Regional Plan (ORP) for the Lower Mainland established floodplain boundaries in the Fraser Valley and designated that no new urban developments should occur in the floodplain. However, areas that had been historically settled, "Urban Exempt Areas" (UEA) could continue to be developed (Lyle & Maclean, 2008). Consequently UEAs have continued to experience rapid growth and development. In addition, development in these ‘exempt’ communities was not required to provide floodproofing. Therefore numerous historic communities have relied for many years solely on structural means for flood protection. As a result, a significant proportion of existing homes and businesses located in historic settlement areas are unprotected in the event of a dike failure, or if flood waters overtop the dikes (AG, 2010).

It addition, it is currently not mandatory for local governments in BC to adopt flood bylaws with floodproofing provisions (this legal framework is expanded on in the subsequent chapter). Due to the voluntary nature of floodproofing policy, the resulting

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14 The current exemptions account for 1/3 of the floodplain area of the Greater Vancouver Regional District (Smith, 1991). This includes: 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 Squamish in Surrey, and parts of Haney and Port Hammond in Maple Ridge (BCREA, 2011).
uptake is low. A 2014 study by Stevens and Hanscka found that the adoption of a flood bylaw is not a common practice across municipalities in BC, as 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\textsuperscript{15}. Therefore the state of policies toward elevated floodproofing is inconsistent across the province: completely lacking in some places and out-of-touch with climate projections in others.

Finally, wet and dry floodproofing are rarely used in BC (AG, 2010). Some municipal bylaws include provisions for the use of “Flood Resistant Materials” below an FCL. However, there is no provincial guidance specifying what flood resistant materials should be. In addition, the BC building code does not include the use of flood resistant or resilient materials. This leaves floodproofing initiatives to fall to local governments, developers, and homeowners themselves.

Floodproofing can be a cost-effective way to increase public safety and lower potential damages from smaller-scale flood events, yet uptake of policies to encourage it is very low in BC. The following chapter explores barriers to the implementation of floodproofing policies.

\textsuperscript{15} This study does not include the use of Development Permit Areas (DPA) to regulate development in a flood zone
Chapter 5. Barriers to Floodproofing

Interviews were used to uncover which drivers and barriers impact the implementation of floodproofing policies, thus providing information and insight that is not readily available in existing literature. Interview findings were organized using thematic analysis, which is a method for identifying, analyzing, and reporting patterns within data and is a foundational method for qualitative analysis (Braun & Clarke, 2006). In order to conduct this analysis, interviews were transcribed and the participants’ statements were categorized into key themes. These themes were analyzed and supplemented with information from a literature review where needed. In total, nine interviews were conducted. The interview guide can be found in appendix D.

The interviews found multiple key themes to be considered for this issue. First, the current legal context in BC provides little incentive for local governments to adopt floodproofing policies. This is problematic because floodproofing policies, while having potential long-term economic and social benefits, are difficult, costly, and often unpopular in the short term. Second, information and resources surrounding floodproofing are lacking, both for local governments and property owners. This ties into another issue, which is lack of public awareness of risk and cognitive barriers preventing individual action. Finally, considerations around distributions of cost and their implications for equity play an important role in maintaining the status quo.

5.1. The Institutional Context of Flood Management

A common theme in the interviews was the institutional context of flood management in BC. Many participants noted that the structure of responsibility in British Columbia is problematic. This is because the full responsibility for the implementation of flood management falls to local governments, but this responsibility is neither tied to obligation nor afforded comprehensive support.
In BC, the authority over site-level standards in flood-prone areas falls to local governments through the Local Government Act (LGA). However, the Act does not obligate local governments in any way to designate floodplains or to zone the land appropriately. Since the 2003 and 2004 legislative changes, the primary provincial guidance toward flood hazard management has come from The Flood Hazard Area Land Use Management Guidelines (herein called the Guidelines). This document was originally drafted in 2004 and encompasses most of the policies and practices from the now obsolete “Floodplain Development Control Program”. The Guidelines are “… intended to help municipalities develop their own flood bylaws in such a way that flood risk management provisions recommended by the province are incorporated into bylaws and enforced at a local level” (Stevens, Hanschka, 2014, p.75). The Guidelines are currently the only provincial document that includes provisions for site-level measures, such as a 15 m recommended development setback, and flood construction levels (FCLs) that are no lower than 3 m above the natural water boundary.\footnote{As of November 2014, these guidelines are in a state of transition. The Province released draft amendments to the existing guidelines dealing with coastal flood risk, which confirmed that local governments should be planning for one meter of sea level rise by 2100, but which did not specify FCLs.}

While the Guidelines contain useful content for local governments to include in their bylaws, they face no legal requirement to incorporate the standards from the Guidelines into bylaws. Instead of being legally binding, the recommendations from the Guidelines are linked to two pieces of Provincial legislation, the LGA and Compensation and Disaster Financial Assistance Regulation.\footnote{More detail on these pieces of legislation is provided in Appendix C}

In LGA section 910 (1), “Provincial Guidelines” are defined as “policies, strategies, objectives, standards, guidelines and environmental management plans, in relation to flood control, flood hazard management and development of land that is subject to flooding, prepared and published by the minister under section 5 of the Environmental Management Act”. LGA section 910 (3)(a) states that a local government “must consider the Provincial Guidelines” in making bylaws that designate land as a floodplain. Section 15 of Compensation and Disaster Financial Assistance Regulation
states that structures built in an area designated as a floodplain under LGA section 910 will not be eligible for assistance to repair damage resulting from a flood unless “properly flood protected.”

The result of this legislative framework is that flood risk management through the implementation of site-level standards such as FCLs and setbacks will occur only through voluntary municipal adoption. However, as identified by a majority of participants, it is not always in a municipality’s best interest to adopt bylaws that identify flood prone areas and specify development standards that reduce flood risk in those areas. As one participant noted, “… without mandatory requirements in law, there is little incentive for local governments to work on [floodproofing] because: they are difficult, they cost money, and people don’t like them.”

5.2. “They are difficult, they are costly, and people don’t like them”

The themes of difficulty, cost, and dislike are elaborated in more detail below and form the framework for understanding why floodproofing uptake is so low in British Columbia. While many of the implementation challenges apply to the three types of floodproofing discussed in chapter 4, there are a few distinctions. The table below summarizes the key similarities and differences in these obstacles to implementation.

Table 5-1: Floodproofing challenges

<table>
<thead>
<tr>
<th>Category</th>
<th>Specific challenges</th>
<th>Common challenges</th>
</tr>
</thead>
</table>
| Elevate            | • Loss of floor-space ratio for developers  
|                    | • Loss of usable space  
|                    | • Potentially encourages illegal basement suites  
|                    | • Lowers handicapped accessibility  
|                    | • Impact on street character  
|                    | • Impact on neighbours’ view corridor and drainage  
|                    | • Not feasible for all types of buildings  | • Added costs  
|                    |                                                                                     | • Potential adverse visual impact on streetscape (aesthetic concerns)  
| Wet Floodproof     | • Lack of information  
|                    | • Lack of tested materials  
| Dry Floodproof     | • Liability concerns if materials do not work  | • Lack of innovative designs  

“They are Difficult”

Floodproofing requirements can have significant clashes with existing regulation and zoning bylaws. Many participants mentioned difficulties encountered in implementation, as current floodproofing practices tend to go against traditional tenets of urban design, such as usability and aesthetics. One planner observed, “... the big question is, how do we change our urban design while still meeting those tenets of liveability?” An example of a challenge arising with elevation is the difficulty maintaining a consistent streetscape form. New homes that are located above existing neighbourhood homes can adversely impact neighbourhood character. This impact is not just speculative: some participants were currently working in areas with recently raised FCLs and trying to find ways to limit this effect.

Another zoning conflict is accessibility. Section 3.8 of the BC Building code generally requires new buildings to be accessible to people with disabilities, and there is considerable merit to making buildings as accessible as possible. In its current form, elevated buildings have more stairs, making them less accessible. Accessibility was not just noted as a concern for people with disabilities and building code restrictions, but also for the usability of areas. In addition, a difficulty in maintaining commercial uses at grade along sidewalks in neighbourhood commercial areas was noted by one respondent, as “…our planners are wary, concerned about aesthetics and usability of business areas…people don’t want to walk up steps.”

Another common concern among participants was the additional increased potential for unauthorized conversion of non-habitable spaces below flood elevations into habitable space after a building inspection. This could be especially problematic in high cost, high-density areas. As one participant from the province commented, “… once you create a space with a minimum ceiling height, you will see people living in it. Once you enclose a space it becomes rentable space.” This was a noted problem – while prioritizing public safety through flood prevention, it is possible to open up a perverse incentive to live in a riskier place (such as an unauthorized basement).
“They are Costly”

Another major barrier to implementation for all floodproofing techniques is additional costs. These up-front costs will need to be borne by someone, whether it is a municipal government, a developer, or a homeowner. Added costs bring difficult questions of who should pay. One participant noted the case of wealthy homeowners living in large homes in high-risk coastal zones, who instead of taking precautionary flood prevention measures continued to pay a fine for violating the municipal FCL bylaw. This anecdote touches on a fundamental theme of the responsibility of both the private and public sector to take precautions based on risk assessments, as well as the differences in individuals’ tolerance of risk.

“People don’t like them”

In this case, “people” emerged as two main groups: developers and homeowners. As municipalities’ principal source of revenue is property taxation and development fees, both groups are significant stakeholders. Another trend that emerged from interviews was the implicit conflict between implementing flood risk management policies versus approving development and economic growth in flood-prone areas.

A specific issue for development and floodproofing is the loss of habitable space that comes with both elevation and potentially other floodproofing techniques. It is difficult to achieve full floor space ratio (FSR) when space is lost to elevation, especially if there are building height restrictions in place. Municipalities can relax height restrictions but this can then impact the streetscape and the view corridor of neighbouring homes (and conflict with existing zoning). Moving electrical systems out of basements or parking garages can also impact FSR. A participant working in the development industry spoke of their current struggle to find a new place for noisy electrical equipment that is no longer allowed to be stored in underground garages.

In sum, floodproofing does not fit easily with other municipal goals. It differs from energy efficiency, which can be aesthetically pleasing and create cost-savings for those using the space. However, one of the reasons floodproofing is seen to be at odds with conventional planning and development objectives is because there is very little
innovation in floodproofing in Canada, and therefore little attempt to build with co-benefits. Floodproofing is being done the way it always has been, by adding concrete and stairs.

5.3. Lack of Information and Resources

Contributing to the difficulties, costs, and dislike over implementation is an overall lack of information regarding floodproofing. For example, participants noted that there is very little, if any, local information on wet floodproofing. This can be related to two larger, systemic issues:

1. Local governments generally lack the resources and expertise to assume full responsibility for climate change related to flood risk management;
2. The private sector in BC takes its lead on floodproofing from the public sector, meaning that the innovation and availability in the field of floodproofing is low.

The first issue is that many local governments believe they have been given great responsibility to manage flood hazards but inadequate resources to effectively undertake this responsibility. A common theme among municipal participants was the lack of resources for every step of the process, from maps to technical studies of different options to the implementation of regulations. A 2010 study examining flood management in BC concluded with a call for more support from higher levels of government both through expertise and funds (AG, 2010). While flood management provides long-run cost savings, an interview participant stated, “All of these things are costly to implement – how can we demonstrate the savings?”

The second issue is that the private sector has been slow to supply innovative floodproofing products and information. This could be due in part to the lack of overland flood insurance in Canada – there is no real market for floodproofing. As one participant working in development noted “this stuff is really driven by local governments. For FCLs, we are building to local requirements and if we did any higher than that we would just add costs and lose competitiveness.”
In sum, the situation in BC is complex with overlapping factors creating a situation with low uptake of floodproofing policies. Perhaps more important than the local government context is the public’s awareness of the issue. Some participants raised the question of what drives change – public interest in the issue, or government overtly raising awareness? Many participants were concerned that real action would not be taken until the Lower Mainland experienced another major flood event.

5.4. Public Awareness

The general consensus among interviewees was that public awareness of flooding is low. Public awareness and engagement is key, both to gain political buy-in for these initiatives and for property-level implementation. As one participant from the province noted, “all of these things will cost quite a lot of money, so we need public engagement and support on a consistent, ongoing basis.”

Participants commented that even in areas that have experienced flooding, there are mental blocks that prevent an understanding of flood risk. An anecdotal story told by one participant captured this feeling, which was that “… people ask me if this house is in a flood risk zone, and I tell them the honest answer [yes]. And then they buy it anyway.” Drawing from literature on cognitive biases, risk perception, and climate change adaptation (Spence et al, 2011; Dessau & Sims, 2010), it is possible to draw some conclusions about the public’s understanding of flood risk. First, there is a general desire to avoid anxiety and the potentially destructive effects of anxiety (Harris, 2008). Second, psychologists make the argument that actors use mental short-cuts to simplify decision-making. One of these shortcuts that has implications for an understanding of risk is the assumption that recent patterns of events are representative and can be used to predict the future (Nisbett, Ross, 1980). This shortcut will impact flood-related decisions because people who have never been flooded tend to assume they never will be (DEFRA, 2008). Different research indicates that people are aware of flooding at an abstract and theoretical level, but do not accept that it could apply to them.

The rising prominence of climate change in public discourse was discussed as impacting awareness of flood risk, though participants were unsure if this impact is
positive or negative. As this is a relatively new field there is little and mixed evidence on whether living in a place physically vulnerable to climate change influences support for adaption policies (Dessau & Sims, 2010; Zahran et al, 2006).

Finally, as mentioned in Chapter 4, homeowner insurance for overland flood damage is not available in Canada, which removes any index for risk (Sandink et al, 2010). Damages caused by water are only partially covered in the standard homeowners policy through sewer backups and burst pipes. Damage caused by overland water flow is universally excluded for homeowners, but commercial operations can purchase coverage against overland flood (Sandink et al, 2010). Water-related insurance policies can be confusing in Canada, and it has been noted in the literature “… these dichotomies often create much ambiguity and consternation” (Sandink et al, 2010, pg. 54). A 2004 survey of 2,100 homeowners across Canada revealed that close to 70% of homeowners believed that they were insured for flood damages (Sandink et al, 2010). If homeowners use insurance pricing to make judgements about risk and believe their existing policies cover overland flows this could lead to an even bigger awareness gap.

A 2013 study based on interviews with CEOs at insurance companies accounting for over half of the property insurance business in Canada found that the lack of insurance in Canada is due to multiple factors (Feltmate & Thislethwaite, 2013). First, many Canadian insurers argue that flooding is not an insurable peril due to adverse selection (Feltmate & Thislethwaite, 2013). Data gaps, both on flood risk exposure and government and consumer preferences, are another obstacle. In the past, a market for insurance has been hindered by low widespread demand for flood coverage. Finally there is a scepticism regarding government cooperation to implement policies necessary to mitigate exposure in high-risk areas, and low investment in flood risk mitigation and protection was identified as a weakness in the current system (Feltmate & Thislethwaite, 2013).

18 “For the purposes of the study, flood insurance was considered viable if: (1) associated risks and losses can be predicted; (2) premiums are affordable; (3) premiums are sufficient to cover losses; and, (4) premiums are sufficient to incentivize investment in risk mitigation by policyholders” (Feltmate & Thislethwaite, 2013, pg. 1).
With low public awareness of the issue, local governments face little pressure to implement floodproofing policies. In addition to the concerns listed above, a change from the status quo could negatively impact the most vulnerable, that is those who are socioeconomically vulnerable and already living in flood-prone areas.

5.5. Equity

A 2014 analysis of BC’s flood management framework’s ability to cope with climate change concludes, “…climate change impacts raise questions that have to be dealt with in many realms (moral hazard, equity, legal, financial, logistical, technical, social, political, environmental) simultaneously. This reflects the inevitable “messiness” of change in a complex system, which B.C. flood policy does not address” (AG, 2014, 37).

Throughout the interview process, many questions and comments related to equity were raised, but rarely labeled as “equity”. For example, one participant mentioned that those who are already socioeconomically more vulnerable will be the worst off during a flood event. Another question was raised regarding how to allocate costs equitably between those who chose to live in flood plains where risk is increasing and those who do not. Drawing from these comments three key principles emerge, which are maximizing utility, fairness, and prioritizing the most vulnerable.

The principle of maximum utility is that “projects chosen should be those that will secure the greatest risk reduction per unit of resource input” (Newborne, 2009, p. 3). This principle forms the basis of cost-benefit analysis, a commonly used tool for guiding decisions on the distribution of public funds for flood projects (Newborne, 2009). Using maximum utility as an ethical paradigm, choices need to be made regarding the disproportionate costs of supporting groups living in high-risk areas, both through preventative investments and post-disaster assistance. This sense of disproportionate investment is linked to the idea of fairness, or procedural justice. This is the principle that all citizens should be treated equally, and have equal opportunity to have their flood risk managed (Johnson et al, 2007). The case for prioritization of the least advantaged is
based on Rawls’ ‘maximin’ rule - decisions should be adopted to maximise the wellbeing of the worst off, limiting social and economic inequality (Campbell, 1988).

The table below summarizes the principles and the implications for flood management and floodproofing.

Table 5-2: Principles of equity in flood management

<table>
<thead>
<tr>
<th>Principle</th>
<th>Criteria</th>
<th>Implication for flood management policy</th>
<th>Implications for floodproofing policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximise utility</td>
<td>Options chosen to secure the greatest risk reduction per unit of resource input</td>
<td>Assistance provided to those members of society to which the benefits offer the greatest gain to society</td>
<td>Resources should be directed to support floodproofing in areas where it is cost-effective (potential costs to society as a whole which can be averted by floodproofing are higher then costs of investment)</td>
</tr>
<tr>
<td>Fairness</td>
<td>All citizens to be treated equally</td>
<td>Every citizen should have an equal opportunity to have their flood risk managed</td>
<td>Support for floodproofing for citizens who are not currently benefiting from large-scale capital expenditure to manage their flood risk</td>
</tr>
<tr>
<td>Maximin rule</td>
<td>Options chosen to favour the worst-off best</td>
<td>Resources should be targeted at the most vulnerable</td>
<td>Need to identify, and target assistance at, the most vulnerable members of society. Changes in current regulation and assistance structures should not disproportionately burden those who are already living in high risk areas who do not have the resources</td>
</tr>
</tbody>
</table>

Adopted from Johnson et al, 2007, pg. 37

Disaster financial assistance (DFA) is monetary policy whose distribution is visible to tax payers at large and those living with flood risk. As such, considerations around maximizing utility, fairness, and prioritizing the most vulnerable were touched on in interviews in relation to disaster financial assistance. DFA is distributed through a cost sharing agreement between the federal and provincial government, and as recovery costs increase, the federal government will absorb a proportionately larger share of the costs (PSC, 2014). An example of a BC event that required a large amount of assistance was the Squamish River Flood in 1980, which was caused by a combination of heavy
rain and melting snow. An estimated 3000 people had to be evacuated and 200 homes were damaged and total DFA costs exceeded $10 million\(^\text{19}\) (PSC, 2010).

Because DFA is structured as post-disaster assistance, some participants noted that there is a utility-maximizing argument to invest in floodproofing to reduce public payments down the line. In contrast, other participants noted that it was not necessarily fair that properties living in flood prone areas could receive public relief funds multiple times. Sandink et al argue “… public relief reduces the direct costs associated with risky behaviour, where costs are shifted to taxpayers” (2010, p. 54). Another opinion of interview participants was concern that changes in the current structure of DFA could negatively impact the most vulnerable.

Finally, it was mentioned that while aggregate amounts of disaster financial assistance can be high, they actually cover very little for individual homeowners. A participant emphasized that DFA “is for basic emergency use, so you can slap down a floor and live your life. It is not insurance.” Therefore while the way DFA is distributed can help bring clarity to arguments about equity in flood policy choices, it should not be forgotten that there is very little correlation between the amounts of DFA paid and total flood damages. Not all properties damaged and not all losses are eligible for compensation.

5.6. Policy Considerations from Interviews

Policies aiming to increase the uptake of floodproofing will need to address current barriers and gaps. As previously stated, the legal context in BC provides little incentives for local governments to adopt floodproofing policies, which is problematic given the unpopularity of these policies. Information, resources, and innovation with regard to floodproofing are in short supply. Finally, there is a natural tendency for property owners to rely on off-site structural means for flood protection.

\(^{19}\) Federal DFA: $4,328,769, Provincial DFA: $5,814,231 (PSC, 2010)
While barriers to implementation should be lifted, this is not synonymous with imposing floodproofing. Floodproofing is not the best option for many areas. A prominent theme in interviews was the importance of a flexible policy approach when planning for risk. For some areas, the best response could be to continue to invest in diking, especially if all homes are older and retrofitting is cost-prohibitive. For areas at risk of a high-probability, high-consequence flood, it would be impractical to add costly investments that create a false sense of security when the best option is to eventually retreat from the area.
Chapter 6.  Jurisdictional Scan: BC and Beyond

This chapter serves two purposes. First, it examines two local case studies to gain an understanding of what is being done on the ground and how progress is being made in the face of the barriers described above. In addition, through a comparison of two municipalities facing different kinds of pressures, it sheds light on what barriers are the most substantial and how to overcome them. The second major task of this chapter is to find best practices from other jurisdictions. The results of this chapter form the basis of the policy options that are considered for BC.

6.1. Local Case Studies

Two local case studies have been used to gain a better understanding of the local government context in the face of the barriers described above. The case studies were selected based on their level of flood risk. In addition, the two municipalities provide contrast on the urban/suburban dimension to provide a range of detail.

Initially a portion of the case study research was intended to focus on total value of property in the floodplain and total amount of properties floodproofed, to provide benchmarks for performance. However this information is currently not available.

The following table provides a summary of the key demographic characteristics of both municipalities.
### Table 6-1: Demographic characteristics of the District of Squamish and the District of North Vancouver

<table>
<thead>
<tr>
<th>Demographic Characteristics</th>
<th>District of Squamish</th>
<th>District of North Vancouver</th>
</tr>
</thead>
</table>
| Population size and rate of growth | Population in 2011: 17,479  
Population in 2006: 15,256  
14.6% population change from 2006 to 2011\(^{20}\) | Population in 2011: 84,412  
Population in 2006: 82,562  
Population in 2001: 82,310  
2.2% population change from 2006 to 2011 |
| Land Area | Land area, sq. km: 105.59  
Population density per sq. km: 165.5 | Land area, sq. km: 160.7  
Population density per sq. km: 525.1 |

### 6.1.1. The District of Squamish

The District Municipality of Squamish is a partially mountainous community that extends along the Squamish and Cheakamus valleys, with a downtown commercial area that runs along the waterfront. The combination of geological setting, environmental conditions and historical patterns of settlement in fertile agricultural lands along the valley floor have led to significantly high levels of flood risk (Journeay, 2011). Squamish is vulnerable to emerging threats associated with climate change, such as storm surge hazards in the downtown waterfront area, and extreme weather events that exceed the capacities of existing infrastructure. As currently mapped, the floodplain area includes a significant portion of downtown Squamish and some surrounding residential neighbourhoods. The area of potential inundation encompasses nearly 60% of the total building stock. In a 2011 study it was found that an additional 941 parcels currently zoned for residential development are exposed to potential flood hazards (Journeay, 2011).

Squamish has a history of flood events, and “… many people living in Squamish today have either directly experienced the impacts and consequences of a flood, or live

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\(^{20}\) For context there is 7% population growth in the rest of BC and 4.4% for Vancouver
with the memory of previous flood events that have been passed along through stories from generation to generation” (Journeay, 2011, pg. 32). In October 2003, rains of 369 mm in 4 days caused the largest flood since the 1950s on the Squamish River and Cheakamus River. The flood caused District evacuations and damage to flood protection structures.

Floodproofing Policies

In 1994 the District of Squamish completed a Flood Hazard Management Plan, but the Flood Construction Levels (FCLs) established in this plan are now out of date. After the 2004 responsibility shift a floodplain bylaw in accordance with S. 910 of the Local Government Act has not been adopted. Squamish is in the process of creating an Integrated Flood Hazard Management Plan to incorporate “growing population, legislative and regulatory changes, new professional standards, provincial guidance, flood hazard assessment best practices, and environmental change, including on-going sea level rise and associated storm surge effects” (Squamish, 2014). This plan is scheduled for completion in 2016.

6.1.2. District of North Vancouver

The District of North Vancouver (DNV) is situated on sloping terrain, between the Coast Mountains and the Pacific Ocean. The municipality is interspersed with creeks and rivers, and prone to severe weather conditions, exposing it to a variety of natural hazard threats (DNV, 2011). In 2005, a landslide resulted in a death and a serious injury, as well as forced 100 people to flee their homes after the event. The landslide was found to be both “predictable and preventable” and a lawsuit against the District was settled in 2009 (Carlson, 2012).

Floodproofing Policies

Following the 2005 landslide, the DNV adopted a new approach to natural hazard risk management, which includes allocating funding for risk assessment and mitigation, and providing greater public access to hazard and risk information. Part of this program is a GeoWeb Hazards application that visually indicates areas of the
District that are prone to natural hazards (DNV, 2010). In addition, the District funds a ‘Geotech-on-Demand’ service, offering property owners a brief free geotechnical assessment of their property and general guidance on next steps in reducing (DNV, 2010).

The DNV has designated Natural Hazard Development Permit Areas under their new Official Community Plan (DNV 2012). Creek Hazard Development Permit Area guidelines include that development needs to comply with flood construction requirements of a qualified professional from an assessment, floodproofing should be implemented in already developed areas and proposed flood construction levels need to be clearly defined by a qualified professional (DNV, 2011).

6.2. Local Case Study Conclusions

While policies evaluated in this research are directed at the province, much can be learned from experiences of the municipalities, as they are the ones implementing these actions. The case studies examined had important similarities that are driving an interest in flood hazard management. In addition to being at risk of increased hazards from climate change, both cases have had recent events that feature prominently in council’s memory. However, despite these recent events, representatives from both municipalities said there was still relatively low homeowner reaction to this risk. Finally, both municipalities have local champions: people working in this area who are both passionate and knowledgeable about key flood management issues.

A major difference between the two municipalities examined is the pressure each experiences from development. Squamish is in a high development phase, whereas the DNV is rather unique in BC with lower development and a council that is very supportive of hazard-reduction policies. The lower development pressure in the DNV gives it the ability to have more freedom to put hazard management first. Conversely, Squamish has recently made flood management decisions in reaction to development in certain areas.

A final commonality is that both municipalities emphasized the human impact of flooding. Based on first-hand experience with people after flood events, participants
spoke of the importance of policies that were sensitive to individuals’ attachments to their properties and that ensured the liveability of an area. Both municipalities framed flood management in terms of reducing damages to people, as opposed to finding economically efficient policy changes.

6.3. Best Practices from Other Jurisdictions

This section examines best practices employed in other jurisdictions. The jurisdictional scan pinpointed potential policy options that could be utilized to encourage the uptake of floodproofing. As mentioned in Section 3.4, the selection criteria for the cases was that policies have been implemented in that jurisdiction that could be used to encourage floodproofing in BC. The following sections elaborate upon the policies used in New York City and the United Kingdom to extrapolate applications that could be utilized in developing Canadian policy responses to increased flooding.

6.3.1. New York City

New York City has nearly 71,500 buildings, 532 million square feet of interior space, and 400,000 residents located within the city’s 1-in-100 year risk floodplain (NYC DoP, 2014). Due to its size, density, and 520 miles of shoreline, the city faces significant increased coastal flood risk due to storm surges heightened by climate change.

New York City is no stranger to major coastal flooding. In October 2012, the City was hit by Hurricane Sandy, the storm that damaged hundreds of thousands of homes, forced tens of thousands of survivors into shelters and caused billions of dollars in damage to vital infrastructure (FEMA, 2014). The damage and disruption caused by Hurricane Sandy, as well as the ongoing process of storm recovery, have highlighted “the importance of adapting New York City’s coastal neighbourhoods to withstand and recover quickly from future storms and other climate events” (NYC DoP, 2014, np.).

Many other case studies could have been examined but were left out for scoping purposes. For example, some participants suggested that Calgary, Alberta be examined due to their major flooding in 2013 and policies responses, and Germany and the Netherlands have also made large advances in this area.
Following Hurricane Sandy, policies were changed to increase the resiliency of the building stock in the floodplain. These changes are as follows:

1. **Updated Federal flood maps.** New and updated maps will add approximately 36,000 buildings to New York City’s 1% annual chance floodplain, a 101% increase over the previous maps (NYC DoP, 2014).

2. **Congressional changes to the National Flood Insurance Program (NFIP).** Changes enacted in 2012 and 2014 require owners to pay higher flood insurance premiums for buildings that predate the flood maps, putting financial stress on many homeowners who cannot easily retrofit their buildings to meet NFIP standards.22

3. **Changes to the City Building Code.** The building code has strengthened requirements for new and substantially improved buildings in the floodplain. Changes to Appendix G of the NYC Building standards require that flood-resistant materials be used for parts of buildings that are susceptible to water damage, that certain buildings and uses be elevated above anticipated flood levels, and that buildings are designed to withstand the pressure of waves, when necessary (NYC, 2014).

In addition to these policy changes, The Department of City Planning of New York City published Coastal Climate Resilience – Designing for Flood Risk and Urban Waterfront Adaptive Strategies as part of their coastal climate resilience initiative (NYC, 2014).

### 6.3.2. The United Kingdom

There are currently over 5 million properties at risk of flooding in the UK, which is nearly 16% of the total housing stock (UK Gov, 2014). The Department for Food, Environment and Rural Affairs (DEFRA) is responsible for national emergency planning for flooding.

22 The federal government provides flood insurance through NFIP in the United States. NFIP insures a value of about $8 billion USD in New York City (Aerts & Botzen 2011). The insurance program is administered by FEMA, which sets the flood insurance premiums and sets minimum building standards on the basis of flood hazard areas. NFIP plays an important role in floodproofing through imposing a minimum requirement for local government’s flood zoning and flood building codes and providing incentives for homeowners to invest in risk reduction minimum standards. **Insurance as a tool to encourage floodproofing is discussed in more detail in section 9.2.**
The Pitt Review was carried out following devastating flooding in 2007. It resulted in a series of recommendations for improving the way flood risk is managed in England. One of the key recommendations was that the government do more to promote flood protection and resilience, both for new buildings and for existing buildings in flood risk areas (Pitt, 2008). Another recommendation was to revise building regulations ensuring that all new or refurbished buildings in high flood-risk areas are flood resistant or resilient (Pitt, 2008). The Government accepted all 92 recommendations and the *Flood and Water Management Act 2010* implemented those that required legislation, including the provision of clearer oversight of flood risk management at national and local levels, and allowing the changing of building regulations to improve the flood resilience of properties (Parliament UK, 2010). A property-level flood protection grant scheme was launched totalling £5.6million to help properties in areas with a high risk of flooding that do not benefit from community-level defenses.

The UK Land Registry, Risk Management Services, offers a Flood Risk Indicator service, which allows the public to purchase reports on a property’s risk of flooding from rivers and seas. The National Flood Forum provides cost estimates of protecting a property as well as information on what to do before and in the event of a flood. The Environment Agency has published a Guide to the rights and responsibilities of those who own riverside property.

**6.4. Conclusions: Jurisdictional Best Practices**

From the case studies, a progression of steps emerges on how to deal with this issue.

1. **Knowledge of risk.** The necessary first step is to have an understanding of what areas are at risk. All jurisdictions studied have up-to-date floodplain maps.

2. **Incorporate risk into policy to impact public behaviour.** These policies varied, from changes in zoning regulation to policies around insurance.

3. **Support the public with initial uptake.** This also varied, from public engagement to actual subsidies for measures.
The following table summarizes which case study is implementing which policy tool.

**Table 6-2: Summary of case study results**

<table>
<thead>
<tr>
<th>Policy Tools</th>
<th>District of Squamish</th>
<th>District of North Vancouver</th>
<th>UK</th>
<th>New York City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to date flood maps</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special bylaws for flood risk areas</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Updated building codes</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Overland flood insurance</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial incentive for homeowners</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Education Program</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

From the results of the analysis of best practices, it becomes clear that maps are a necessary precursor to any kind of effective individual action. The next important policy driver is the role of insurance. If overland flood insurance exists, the role of government can potentially shift to a more supportive role, making sure that the market is working effectively and implementing measures to protect the most vulnerable. Without insurance, the role of government is larger, as it needs to both inform about risk and incentivize or regulate action.

Drawing on best practices from the case studies examined as well as information from interviews, a list of potential policy interventions emerge that could improve the uptake of floodproofing in BC. These are: a provincial mapping scheme, overland flood insurance, flood bylaws, updated building codes, updated Disaster Financial Assistance, subsidies for floodproofing and public education. Now that all potential interventions have been identified, the task that remains is to comparatively evaluate policies to find what is best suited for the BC context.
Chapter 7.  Key Considerations for Policy Options

The overall goal of policies that increase the uptake of floodproofing is to improve the safety and security of a community during and after a flood by reducing the loss of life and damage to property. To achieve increased uptake, current barriers need to be removed. With that in mind, policy options should satisfy the following criteria:

1. Resolve the responsibility gap of local governments being in charge of implementing difficult policies without the incentive to do so.
2. Increase available resources on floodproofing.
3. Increase public response to flood risk.

In addition to removing current barriers, policy changes should not create new perverse incentives for households to assume a higher level of risk. Policies should account for principles of equity in flood management, as well as the institutional constraints of the policy environment. Finally, all policies examined in this analysis are provincial; therefore, the evaluative criteria are shaped to this level of government. The table below provides a summary of the societal and government management evaluation criteria.
Table 7-1: Summary of evaluation criteria

<table>
<thead>
<tr>
<th>Societal Objectives</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Definition</td>
<td>Evaluation Criteria</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>The degree that policies increase the uptake of property-level floodproofing</td>
<td>Does it address the responsibility gap? Does it increase available resources? Does it increase public response? Does it create perverse incentives to assume higher risk?</td>
</tr>
<tr>
<td>Equity</td>
<td>The impact that policies have on vulnerable groups living in areas with high flood risk</td>
<td>Are the most vulnerable groups unfairly burdened?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Government Management Objectives</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Definition</td>
<td>Evaluation Criteria</td>
</tr>
<tr>
<td>Administrative Complexity</td>
<td>The level of administration complexity required to implement policies</td>
<td>What is the degree of administrative complexity required to implement the policy?</td>
</tr>
<tr>
<td>Stakeholder acceptability</td>
<td>How acceptable a policy will be to identified stakeholders</td>
<td>To what degree will the policy be acceptable for local governments? To what degree will the policy be acceptable for homeowners?</td>
</tr>
</tbody>
</table>

7.1. Effectiveness

Effectiveness explores the ability of a proposed policy approach to increase the uptake of floodproofing policies. This assessment is based on whether the proposed policy approach fulfills the three criteria listed above. As the criteria are based on barriers to uptake, a policy that meets all criteria will have overcome the barriers in BC and increase floodproofing.

In addition to overcoming key barriers, a new policy should not create perverse incentives to assume higher risk, such as encouraging the creation of basement suits below flood construction level. Policies that satisfy the three criteria and do not encourage risky behaviour are deemed to be the most effective.
7.2. Equity

Drawing on information from interviews, policies should account for Rawls’ maximin rule, which is that the worst off should be treated best. In the context of this policy problem, the worst-off are those living in high-risk areas that are not well equipped to deal with the risk. Therefore this criterion ensures that distributional impact of policy on the worst-off is taken into account.

7.3. Administrative Complexity

Administrative complexity has been chosen as an evaluative criterion based on the current policy environment in BC, where administratively complex programs are generally unpopular. One participant noted that a principal reason for disbandment of the Floodplain Development Control Program was the view that it entailed too much “red tape.” Administrative complexity will be evaluated based on qualitative assessments of the resources required to implement a policy choice. Through this assessment, administrative complexity serves as a stand-in for costs born by the provincial government, as policies that require more administrative resources will be both more complex and more costly.

7.4. Stakeholder Acceptability

Stakeholder acceptability assesses whether the proposed policy option will be well received by the identified stakeholders. The two stakeholder groups identified by this analysis are local governments and homeowners. While the development industry has also been identified as having influence, they have been left out due to risk of double counting with the local government stakeholder. The acceptance of the development industry is encapsulated by local government acceptance due to municipal taxation powers in BC – the primary source of municipal revenue is property taxation and development fees. Therefore local governments are unlikely to accept a policy that has a negative impact on the development industry. This criterion serves as a stand-in
for costs born by the private sector, as policies that impose high costs on homeowners or local governments will have a lower acceptability.

7.5. Weights and Measures

The evaluative criteria are measured through qualitative assessments, based on information from the literature, interviews, and jurisdictions that have experience with the policies. Effectiveness is given the most weight (a score out of 4) as the primary goal of any policy intervention is to increase the uptake of floodproofing. Stakeholder acceptability is also given a higher weight (a score of 2) to reflect the high impact policy will have on both homeowners and local governments.

Policies are scored based on a system of high (2), medium (1), or low (0). The scoring system is not meant to serve as set assessment of each policy option, but is instead used to illustrate where the key trade-offs among policies lie and to create a comparative metric.
### Table 7-2: Evaluation scoring

<table>
<thead>
<tr>
<th>Objective</th>
<th>Evaluation Criteria</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>Does it address the responsibility gap?</td>
<td>2 – Removes full responsibility from local government or fully enforces responsibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 – Shifts some responsibility away from local government</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 – Does not address gap</td>
</tr>
<tr>
<td>Does it increase available resources?</td>
<td>2 – Proactively increases resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 – Retroactively increases resources (after a flood event)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – Does not increase resources</td>
<td></td>
</tr>
<tr>
<td>Does it increase public response?</td>
<td>2 – Compulsory behavior change</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 – Incentivizes behavior change</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – Increases awareness without incentives</td>
<td></td>
</tr>
<tr>
<td>Does it create perverse incentives to assume higher risk?</td>
<td>2 – Creates no perverse incentives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 – Has potential to create perverse incentives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – Proven to create perverse incentives</td>
<td></td>
</tr>
<tr>
<td>Equity</td>
<td>Are the most vulnerable groups unfairly burdened?</td>
<td>2 – Most vulnerable do not bear additional costs</td>
</tr>
<tr>
<td></td>
<td>1 – Most vulnerable bear some additional costs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – Must vulnerable groups will bear full burden of costs</td>
<td></td>
</tr>
<tr>
<td>Administrative Complexity</td>
<td>What is the degree of administrative complexity required to implement the policy?</td>
<td>2 – Policy is easy to implement</td>
</tr>
<tr>
<td></td>
<td>1 – Policy requires some new resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – Policy is resource intensive (staff time, funds)</td>
<td></td>
</tr>
<tr>
<td>Stakeholder acceptability</td>
<td>To what degree will the policy be acceptable for local governments?</td>
<td>2 – Highly acceptable</td>
</tr>
<tr>
<td></td>
<td>1 – Somewhat acceptable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – Will experience pushback</td>
<td></td>
</tr>
<tr>
<td>To what degree will the policy be acceptable for homeowners?</td>
<td>2 – Highly acceptable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 – Somewhat acceptable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – Will experience pushback</td>
<td></td>
</tr>
<tr>
<td>Total score (maximum)</td>
<td></td>
<td>/ 24</td>
</tr>
</tbody>
</table>
7.6. Accounting for Cost

Cost is not included in government management criteria for two reasons. First, there is a risk of double counting with administrative complexity, as policies that have a high administrative burden are more resource-intensive to implement. Second, as many of the policies have not been implemented in Canada at a provincial scale it is difficult to accurately estimate implementation costs, and scoring cost alongside the other criteria runs the risk of presenting unknown information as fact.

However, despite its absence from the evaluative framework, cost is still a very important consideration when comparing different policy options. First, it is important that policies have a degree of cost-effectiveness, meaning that the outcomes (in this case, increased safety from flood events) justify the resources spent. In the broader portfolio of flood management options, policies that improve the uptake of floodproofing will be evaluated based on their comparative cost-effectiveness.

It is also important to consider the question of costs to whom - government or private sector – and how to justify these trade-offs. This dynamic will be captured in discussions of administrative complexity and stakeholder acceptability.

7.7. Adaptability

An additional criterion considered for all the policy options was adaptability. Adaptability refers to the ability of a policy to shift to fit changing circumstances. This criterion stems from the concept of adaptive management, which was developed to accommodate the complexity and uncertainty associated with natural systems (WCEL, 2012, pg. 22). Adaptive management involves intentionally learning from implementation pitfalls to improve subsequent policies and actions over time; it is based on the notion that policies are developed with inherent uncertainties (Tompkins & Adger, 2004). This is an important concept for climate adaptation planning and management due to the uncertainty of climate impacts (Peterson et al., 1997; AG, 2014). While climate change is undeniable, there is still uncertainty regarding how rapidly the change is happening and its exact impacts. Therefore “it is important to view adaptation as a process; as new
information becomes available or certain physical changes become apparent, actions can be re-evaluated and updated” (West Coast Environmental Law, 2012, pg. 19). In the context of this policy assessment, adaptability has been used as an overarching framework to consider the long-term viability of a policy choice. One of the advantages of policies that encourage floodproofing in preference to investments in structural measures is adaptability.
Chapter 8. Policy Options

With the context for analysis now established through the development of objectives and criteria, this chapter discusses the identified policy approaches.

8.1. Provincial Floodplain Mapping Scheme

This policy option involves reinstating a provincial floodplain-mapping program. A floodplain map is a technical tool that provides visual information on where floodwater is expected to go. The information contained within floodplain maps can be used to inform building bylaws, regulation and community planning, as well as emergency response and public education. Of countries that belong to the Organization for Economic Cooperation and Development (OECD), Canada is in the minority in not having a national program that undertakes or funds floodplain mapping (Herbert et al, 2014). In its current status, Canadian floodplain mapping is neither complete nor up-to-date. As 50 percent of existing mapping was created prior to 1996, half of existing maps are between 18 and 40 years old.

British Columbia\textsuperscript{23} is no exception. BC’s provincial floodplain mapping program began in 1974 and received joint funding from the federal government between 1998 and 2003 (APEG, 2012). The program was responsible for identifying designated floodplains, so that development in those areas could be under the appropriate controls. One of the provisions of the program was to ensure that any new development in a designated floodplain was flood proofed in accordance with provincial standards (APEG, 2012). However, the program was terminated in 2004 and responsibility for developing and applying floodplain maps was transferred to local governments.

\textsuperscript{23} Appendix D provides a review of the status of floodplain maps in other provinces.
8.2. Overland Flood Insurance

The policy option of overland flood insurance differs from other options, as it is not a provincial initiative. Instead, it is explored to examine the potential role of the private sector. As elaborated in section 5.4 Canada is the only G8 country in which overland flood insurance is not available in any form to homeowners.

8.3. Provincially Legislative Flood Bylaws

This policy option involves enforcing the creation of flood bylaws. As explained in section 5.1, the enactment of flood bylaws is currently the responsibility of municipal governments. This change could be pursued in two alternative ways, either through reinstating a provincial program or through changing the Local Government Act to make flood bylaw adoption compulsory. Once flood risk areas are identified, bylaws will require that the lowest-floor elevation of a building be raised above the flood elevation, plus an acceptable safety factor (for example, a freeboard\textsuperscript{24}). Bylaws could include additional provisions that limit the use of basements as living spaces.

Mandatory FCL provisions can be legislated either through Development Permits Areas (DPAs), such as the Creekside Hazard DPA in DNV, or through floodplain bylaws stemming from S.920 of the Local Government Act (LGA).

\textsuperscript{24} A vertical distance added to the actual calculated flood level to accommodate uncertainties (hydraulic and hydrologic variables), potential for waves, surges, and other natural phenomena (MFLNRO, 2014)
8.4. Reform the BC Building Code

This policy option involves reforming the provincial building code. While municipal bylaws affect land use, the Federal and Provincial Building codes dictate the standards for buildings themselves. Codes are an important component in disaster resilience as they affect the construction and design of buildings, and specify "... not only structural design but also construction methods and materials" (Tobin & Montz, 1997, pg. 212). Illustrating the role of codes in disaster risk reduction, Theckethil (2006) identified several functions of building codes, including reduction of death, property damage and reduction in the need for aid following disaster events.

The BC Building Code does not have a specific section that addresses floodproofing requirements, leaving room for reform to increase property-level flood resilience. First, sections 6.2.1.4 & 5 of the Plumbing Code should be changed to increase clarity of the requirement of backflow valves (Sandink, 2013). 25 Second, there should be a section of building requirements in a floodplain that includes using mold-resistant wetproofing measures. There is precedent for this kind of change. For example, the American 2012 International Building Code has provisions regarding flood damage-resistant materials, which are defined as “Any construction material capable of withstanding direct and prolonged contact with floodwaters without sustaining any damage that requires more than cosmetic repair” (IBC, 2012).

8.5. Reform Disaster Financial Assistance

Disaster financial assistance (DFA) in BC could be revised with the following changes:

1. Require floodproofing to current standards for future DFA eligibility if structure is destroyed or requires major repairs after the 1st claim
2. Allow DFA funds to be used to rebuild to include flood mitigation measures

25 The section on backwater valves in the BC code is commonly interpreted as requiring valves only in rare circumstances.
3. Deny DFA for property damage due to flooding when the property owner has indemnified the local government from any flood loss. This means that if a local government has warned a property that it is in a high-risk zone and the property has accepted the risk, they are no longer eligible for assistance.

4. Link DFA to land title. This will involve a notice placed on Land Titles stating if the property was eligible for past DFA funding.

Alberta has undertaken a similar policy change after the major flooding in 2013. Flood compensation requirements were altered so that applicants must meet minimum flood mitigation measures in order to receive funding to perform repairs or rebuild on their property (Mills, 2013). The measures are referred to as “wet flood-protection” and are intended only to minimize damage, and to speed restoration in the event of a flood, not to prevent damage (Alberta Government, 2013). Changes were also made regarding land title, but once property owners in the flood fringeFootnote 26 submit proof of mitigation their title will be cleared of the notice (Alberta Government, 2013).

8.6. Grants/Subsidies For Floodproofing Measures

A different policy approach would be to offer grants or subsidies to property owners for floodproofing measures. Some municipalities in Canada have developed subsidy and grant programs with the goal of increasing homeowner uptake of measures including downspout and foundation drain disconnection, backwater valve installation, and repairing sewer laterals (Sandink, 2009). Funding for these programs range from $1,500 to $4,000 per property (Sandink, 2009). Manitoba offers a cost-sharing subsidy program with municipalities, where the province allocated $2 million in 2013, with contributions matched by local governments. The maximum subsidy offered covers 60% of the equipment and installation costs for homeowners (Winnepeg Sun, 2013).

Different decisions would need to be made regarding the structure of a subsidy program. For example, subsidies could cover survey work or be part of the cost of a measure. An example of survey work would be the RAIN program in Hamilton. This

Footnote 26 Alberta flood maps characterize areas as a floodway or a flood fringe.
home visit program is designed to identify specific water problems unique to each property and inform homeowners on best practices for how to deal with such problems (RAIN, 2014).

There is also a choice regarding whom to offer the financial assistance, and “… programs may be available to everyone in a municipality, such as in Toronto, to individuals who have experienced basement flooding, such as in St. Catharine’s, or to homeowners who are in an area that may be vulnerable to basement flooding, such as in London and Ottawa” (Sandink, 2009, pg. 6). The majority of existing subsidy programs in Canada are directed at properties that have experienced flooding from sewer backup caused by the City sewer system, rather than flooding associated with infiltration or overland flows27. If a subsidy approach were chosen, it would be necessary to do further research into the effectiveness of the different styles of program.

### 8.7. Education Program

An education program on floodproofing could be developed to disseminate best practices for the mitigation of risks at the property and community levels. Other aspects of property-level risk mitigation could be included in education programs, such as informing property owners what is, and what is not, covered by insurance and public disaster relief programs.

An example of an education tool already in use is FLORETO (Flood Resilience Tool) an online platform developed by the Hamburg University of Technology, which allows households to assess their flood risk and to select the most appropriate floodproofing method or action (WMO, 2012)
Chapter 9. Analysis

The policy options will be evaluated based on the steps established in the jurisdictional scan, which were:

1. **Knowledge of risk.** The necessary first step for floodproofing is to have an understanding of what areas are at risk. The policy option for this stage is floodplain maps.

2. **Incorporate risk into policy to impact public behaviour.** The policies evaluated for this stage are insurance, flood bylaws, building codes, and reforming disaster financial assistance.

3. **Support the public with initial uptake.** These policies are grants for floodproofing measures and an education program.

Based on the analysis of different jurisdictions, step one is a necessary precursor to the next two steps; therefore, floodplain maps will be evaluated separately. Step two and step three do not necessarily need to be sequential. For example, it is possible to support the public with uptake through subsidies without imposing flood bylaws. These choices involve trade-offs, which form the bulk of the analysis below. The policy options will be evaluated based on the criteria laid out in Chapter 7.

9.1. Floodplain Maps

The literature finds a consensus about the critical role of updating floodplain maps in Canada (AG, 2014; Herbert et al., 2014; BCREA, 2014; Feltmate & Thislethwaite, 2014; Sandink et al, 2010), as well as an international consensus that updated floodplain maps are the most logical first step in flood management. “The first and most important step in identifying appropriate measures to protect properties in areas exposed to flooding is to accurately define flood risk areas. Once these areas have been appropriately defined, property level flood proofing measures can be considered” (Kovacs & Sandink, 2013, pg. 9). While floodplain maps can be undertaken in various forms, they all serve to gain a better understanding of flood hazard. Maps
enable a better understanding of disaster risk, strategies for risk reduction and for recovery practices.

Most of the other policy options hinge on up-to-date floodplain maps. From a private sector standpoint, maps have been noted as a necessary precursor to establish flood insurance. A 2013 report on the viability of overland flood insurance for Canada found that existing flood maps are “… inaccurate, out-dated and inadequate for insurance purposes” (Feltmate & Thislethwaite, 2013, p.9). It is also difficult to make accurate and effective floodproofing regulation without knowledge of flood extent or depth. “Floodplain maps can serve as regulatory tools providing basic flood extent or depth maps that depict minimum elevations for flood-proofing. Minimum flood-proofing requirements can then be incorporated into building bylaws, subdivision approvals, and local government planning and regulations” (Herbert et al, 2014, pg. 6). Maps enable the identification and support for areas with the greatest risks of being adversely impacted by floods, and can therefore reduce vulnerability. A better understanding of areas at risk can help target grant programs and improve their efficiency, as well as improve the information presented through education. The only policy option that is not necessarily improved or dependent on up-to-date maps is reforming Disaster Financial Assistance, as this change delineates risk based on properties that have already experienced flooding, not based on future projections of risk.

Research by the BCREA has identified concerns over local government’s liability and access to DFA as political barriers to mapping, as well as worry over

28 The current situation around municipal liability for flooding is murky. The common form of litigation against municipalities is a nuisance claim, which comes from unreasonable interference with a property owner’s use and enjoyment of land (for example, from stormwater infrastructure being overwhelmed causing flooding). In BC municipalities have statutory immunity against these claims unless the failure is due to inadequate design. Inadequate design is not accounting for a known risk. The current unanswered question in the area of municipal flood liability and climate change is, if infrastructure is overwhelmed due to projected climate change impacts, is this inadequate design? (Information from conversations with legal professionals in BC).
impact on property values\textsuperscript{29} (BCREA, 2014b). With these barriers in mind, mapping should not be tied to legislation under s.910 of the Local Government Act but instead serve as an information tool for local governments to use in tandem with other policy choices. This decision has been made to aid in implementation, and will be explained further in the recommendations of chapter 10.

A mapping program would shift some responsibility away from local governments back to the province, as the first policy step would be completed. Mapping itself does not directly impact the demand for floodproofing materials or the supply of information about floodproofing. It is unlikely that maps would impact behaviour unless tied to other policy changes. Delineating risk on its own should not create perverse incentives to assume more risk.

Provincial mapping could be introduced in BC without regulatory change. The \textit{Environmental Management Act} provides the Minister of FNLRO broad powers to establish environmental management plans with respect to “flood control, flood hazard management and development of land that is subject to flooding” (\textit{Environmental Management Act, SBC 2003 S.1.5(f)(i)}). Stakeholder acceptability of maps will be dependent on the policy actions connected to maps. For example, adding climate projections to maps has often been met with local resistance in the US because maps are tied to insurance premiums.

Mapping can be expensive if starting from nothing or a poor baseline. Costs can range from $100,000 for a small community if topographic and hydrometric data exists, to $250,000 for a similarly sized community with no base information; to many more times this for large areas with limited data (Herbert et al, 2014). While there have been no studies comparing the costs of flood maps with their ability to enable floodproofing, multiple studies have shown the general cost-savings that result from up-to-date

\textsuperscript{29} The results of studies comparing the effects of floods and flood hazard disclosures on property values are unclear, ranging from negative to positive effects on property values, with significant variation in the magnitude of the effect, the spatial extent and duration of any effects (Yeo, 2003). For equity concerns, the potential for flood maps to increase costs for those living in high risk depends on the policy actions taken in tandem with the mapping.

Finally, climate change intensifies the need for consistently updated floodplain maps. A 2014 survey and roundtable discussion of flood stakeholders in Canada found the number one priority to de-risk flood potential in Canada was to “… develop new flood plain maps with projections that anticipate changes in the intensity and duration of future precipitation (Feltmate, Thislethwaite, 2014, pg. 2). Maps enable government, businesses and private individuals to avoid developing social, cultural or economic assets in locations that can be adversely affected by floods, which reduces long-term exposure to risk (Herbert et al, 2014; IPCC, 2012).

9.2. The Private Sector Approach: Overland Flood Insurance

Insurance has been included as a policy option due to its potential to influence the behaviour of those at risk. In theory, insurance can attach a price tag to risk and send a signal to policyholders, incentivizing them to address that risk (Surminski, 2014). As previously stated, overland flood insurance is currently unavailable in Canada. However, there is reason to expect this will change soon, as overland flood insurance was an item on the 2014 federal budget and the subject of a recent Public Safety Canada press release (PSC, 2015).

The ability of insurance to positively influence the behaviour of those living in a flood risk areas depends on the design and implementation of the insurance scheme. For the sake of creating a counter-factual scenario, I will assume that if an overland flood insurance market develops in Canada, it will be a risk-based pricing system that correctly estimates risk. Risk-based pricing can help to ensure that insured individuals understand their risk, as those with higher flood risk will experience higher flood insurance rates. I will also assume that the scheme would offer premium discounts for the adoption of risk-reducing measures, incentivizing positive behaviour. The final simplifying assumption for this scenario is that insurance would be mandatory and
potentially enforced through mortgage lender-requirements. In Canada, general home insurance is required to take out a mortgage. As a mortgage is a financial instrument, the lender (a bank) often has a greater financial stake in the property than the borrower. If a home is damaged and the borrower (homeowner) abandons the home and stops making mortgage payments, the lender is caught in a losing position. This policy option does not involve provincial intervention; therefore it will not be evaluated like the other policies. Instead, the potential of insurance to meet criteria of effectiveness and equity are considered.

Relying on the private market to motivate private behaviour is a way of addressing the responsibility gap by taking some responsibility away from local government. Insurance alone could be a lever that influences the uptake of floodproofing and positively influences land use decisions. The introduction of insurance has the potential to increase information on floodproofing over time through increased demand for products. Finally, insurance has the potential to impact public behaviour through pricing risk, as described above.

Depending on the structure, insurance could very likely be cost prohibitive for many who really need it, giving it a low score on the equity criterion. If not lender-required, those who can’t afford it would opt out. However, as disaster assistance does not cover insurable damages, this would leave vulnerable households with the entire bill for damages. The US is currently grappling with the trade-off between effective insurance adequately priced for risk and equity. The federally provided National Flood Insurance Program (NFIP) is criticized because the premiums do not accurately reflect risk. While this makes insurance more affordable for all, it can distort incentives to implement risk-reduction measures as well as threaten the economic vitality of the program. Changes enacted in 2012 and 2014 now require owners to pay higher flood insurance premiums for buildings that predate flood maps, but this puts financial stress on many homeowners who cannot easily retrofit their buildings to meet NFIP standards (Aerts & Botzen, 2011).

In theory, a functioning insurance market is a strong policy option to increase the uptake of property-level floodproofing if provisions are made for equity. Some issues that
would need to be resolved for insurance to increase risk reduction would be: the mismatch between required prevention investment by policy holders and premium savings, the short-term nature of insurance contracts (Brauninger et al, 2011; Filatova, 2014), the uncertainty about the benefits of risk reduction measures due to lack of standardized assessment methods and the need for active involvement of policyholders to put in place and operate mitigation measures (Brauninger et al., 2011).

Finally, a market-based risk-sensitive insurance regime for flood can bring its own moral hazard. “By shifting the costs of risks onto individual householders, it removes incentives for collective action to address flood hazards, be this at the community or government level” (O’Neil & O’Neil, 2012, pg. 13). There is potential for a collective moral hazard that “individualistic risk-sensitive” regimes will shift the burden of adaptation onto those most at risk of flooding, as opposed to maintaining public provision of adequate flood defences.

9.3. The Regulatory Approach: Codes and Bylaws

Table 9-1: Summary evaluation of flood bylaws and building codes

<table>
<thead>
<tr>
<th>Objective</th>
<th>Evaluation Criteria</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>Does it address the responsibility gap?</td>
<td>2 – Removes full responsibility from local government or fully enforces responsibility</td>
</tr>
<tr>
<td></td>
<td>Does it increase available resources?</td>
<td>2 – Proactively increases resources</td>
</tr>
<tr>
<td></td>
<td>Does it increase public response?</td>
<td>2 – Compulsory behavior change</td>
</tr>
<tr>
<td></td>
<td>Does it create perverse incentives to assume higher risk?</td>
<td>1 – Has potential to create perverse incentives</td>
</tr>
<tr>
<td>Equity</td>
<td>Are the most vulnerable groups unfairly burdened?</td>
<td>0 – Must vulnerable groups will bear full burden of costs</td>
</tr>
<tr>
<td>Administrative Complexity</td>
<td>What is the degree of administrative complexity required to implement the policy?</td>
<td>0 – Policy is resource intensive (staff time, funds)</td>
</tr>
<tr>
<td>Stakeholder acceptability</td>
<td>To what degree will the policy be acceptable for local governments?</td>
<td>0 – Will experience pushback</td>
</tr>
<tr>
<td></td>
<td>To what degree will the policy be acceptable for homeowners?</td>
<td>0 – Will experience pushback</td>
</tr>
<tr>
<td>Total /16</td>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>
Changing building code regulations and making flood bylaws mandatory—both regulatory policy approaches—will be evaluated together. Building codes are better for wet and dry floodproofing, because they impact the materials used at the building level. Flood bylaws are a way of imposing elevation, because they dictate setbacks and flood construction levels (FCLs). The impact of the regulatory approach on flood risk reduction is affected by the fact that they apply only to new or proposed construction, and they affect only existing buildings if major renovations are conducted.\(^{30}\) However, while building codes may apply only to new construction, the expected lifespan for housing ranges from 60 to 100 years with major alterations occurring every 10 to 20 years, meaning the incorporation of disaster risk reduction in new buildings can reduce vulnerability over several decades (Sandink, 2013).

Mandatory regulation addresses the responsibility gap through a legislated obligation (municipalities are forced to incorporate changes). If elevation and wet/dry floodproofing were part of regulation, it would potentially increase available floodproofing resources, as demand for products would be forced to increase, which would then slowly increase supply of products. For example, both New York City and the UK have far more resources on floodproofing than areas that don’t incorporate floodproofing materials in the building code. A consideration for this criterion would be that regulation is structured so as to encourage innovation instead of limiting it.

Regulations will increase public response because they will be mandatory. Overall compulsory regulatory change is an effective way to increase the uptake of floodproofing. There is potential for regulatory change to have self-defeating results, depending on the structure of the policy. For example, both changes to the building code and local flood bylaws would be activated by renovation that exceeds 25% of the building footprint (LGA S.20), which could discourage any kind of renovation or safety improvement for fear of activating a full property upgrade to meet new standards. In addition, many participants noted problems of raised FCLs and increased illegal basement suits.

\(^{30}\) LGA S.920: In the case of building renovations, new measures are required if the renovation exceeds 25% of the building footprint
There is a trade-off between effectiveness and equity, as regulation can be a blanket approach that adversely impacts those who live in high-risk areas. The financial costs that would fall to individual households could outweigh the benefits, especially if costs are added at a time when they are already financially stretched, such as rebuilding after a flood event.

The cost of changing the building code itself is not high, but code enforcement would be more costly. Research on the effectiveness of building codes in reducing disaster risk emphasizes the need for good enforcement. For example, “…$4 billion in damages [from hurricane Andrew] were attributed to code enforcement failures of Dade County, Florida” (Sandink, 2013, p.4). The cost of imposing flood bylaws is higher due to administration and oversight of the new regulation, especially if the province established a new body to administer and monitor the changes. This policy change will be complex to implement, as other zoning and building restrictions would need to be reviewed and modified to eliminate conflicts. Effective flood bylaws require monitoring and enforcement as well.

A change in regulation will likely not be acceptable to local governments unless it comes with added resources and in a phased approach. According to a 2010 survey of local governments in the lower mainland, opinion was divided as to whether the province should have a greater regulatory role. Given the consensus from local governments that “…more provincial study, coordination and funding is needed,” regulatory change will be especially unpopular if it is not paired with additional resources to aid local governments in implementation (AG, 2010). Given preliminary experience raising FCLs and other jurisdictions’ experience with changes in the building code (Pottle, 2014), it will likely be disliked by homeowners as well. Some of the reactions in New York were that “the decision to become compliant shouldn't be enforced by government -- it is a choice to be made by homeowners” (Pottle, 2014, np.).
Reforming Disaster Financial Assistance (DFA) would partially address the responsibility gap as it shifts responsibility for disclosure away from local governments to property owners themselves. Changes would not necessarily increase information on floodproofing, as this policy change is reactive – it is activated only after the first incidence of flooding. Changes in DFA would potentially change behaviour of those it impacts by adding a monetary incentive to adopt floodproofing measures. In addition, new homebuyers who were not previously aware of their risk would have a new signal for it. This policy change does not create perverse incentives to assume more risk, but it does potentially have a negative impact on the most vulnerable, giving it a low score for equity. Similar to regulatory change, a change in DFA has the potential to add costs to the most vulnerable when they are already financially burdened from a recent flood event. In interviews, some participants were concerned about the impact changes in DFA could have on vulnerable groups.
The degree of administrative complexity required to implement this change is low because it will be a small change in an existing program, therefore new resources will not be necessary. While a communication strategy will be needed to accompany the changes, these costs could potentially be cancelled out by the cost-savings of dispensing less DFA. This policy will likely have low acceptability to homeowners as it adds direct costs to them. Municipalities will feel less of a negative impact, but may have to bear the displeasure of homeowners who are adversely impacted in a flood with no insurance or government financial support. However, Alberta made a similar policy change and argued it would have little pushback (Calgary Sun, 2013). In general, this policy puts more responsibility and cost on private actors than public.

This policy option is not dependent on updated floodplain maps, as it is a reactive approach to risk-management. Flood risk is delineated by what areas have already been impacted, not by predictions of where floods will occur. The benefit of this approach is that it can be undertaken immediately without flood maps, but the drawback is that it does nothing to account for added risk of climate change.

9.5. The Carrot: Subsidies for Floodproofing Measures

Table 9-3: Summary evaluation of subsidies/grants

<table>
<thead>
<tr>
<th>Objective</th>
<th>Evaluation Criteria</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>Does it address the responsibility gap?</td>
<td>0 – Does not address gap</td>
</tr>
<tr>
<td></td>
<td>Does it increase available resources?</td>
<td>2 – Proactively increases resources</td>
</tr>
<tr>
<td></td>
<td>Does it raise increase public response?</td>
<td>1 – Incentivizes behavior change</td>
</tr>
<tr>
<td></td>
<td>Does it create perverse incentives to assume higher risk?</td>
<td>2 – Creates no perverse incentives</td>
</tr>
<tr>
<td>Equity</td>
<td>Are the most vulnerable groups unfairly burdened?</td>
<td>2 – Most vulnerable do not bear additional costs</td>
</tr>
<tr>
<td>Administrative Complexity</td>
<td>What is the degree of administrative complexity required to implement the policy?</td>
<td>0 – Policy is resource intensive (staff time, funds)</td>
</tr>
</tbody>
</table>

31 Alternatively, cost-savings could be used for the subsidy/grant program as outlined in Chapter 10.
To what degree will the policy be acceptable for local governments?

2 – Highly acceptable

To what degree will the policy be acceptable for homeowners?

2 – Highly acceptable

Total / 16

11

Offering homeowners subsidies does not address the distribution of responsibility as it neither removes responsibility from local governments nor puts more pressure on them to act. A subsidy program would increase resources through a government-led floodproofing initiative. Effectiveness in public response will depend in part on the structure of the subsidy. For example, an assessment of the UK’s pilot grant scheme found that it was important to incentivize the actual implementation of the resilience and protection measures. This finding was due to general unwillingness of property owners to bear costs of flood protection exceeding the level of the grant they had received (DEFRA, 2008).

A subsidy or grant program will not negatively impact the most vulnerable as it is an optional program. Depending on its structure, a granting program could match funds to financial need to ensure the criterion of Rawlsian equity is met.

The costs of administrating this policy will depend on how much the subsidy will cover and on how widely the subsidy is distributed. In addition, it will be resource-intensive to design the program to administer the subsidies and monitor the success of the program. Additional complexity may come from jurisdictional overlap. There is currently no provincial body for flood management, so local governments with provincial funding and instruction would be in charge of implementation.

Depending on its structure, a subsidy program is likely to be acceptable to local governments. If the program is set up through a cost-sharing agreement such as the one in Manitoba, this might prove less acceptable to local governments with many properties in the floodplain. As a voluntary compensation program, it should be highly acceptable to homeowners.
### 9.6. Public Education

#### Table 9-4: Summary evaluation of public education

<table>
<thead>
<tr>
<th>Objective</th>
<th>Evaluation Criteria</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effectiveness</strong></td>
<td>Does it address the responsibility gap?</td>
<td>0 – Does not address gap</td>
</tr>
<tr>
<td></td>
<td>Does it increase available resources?</td>
<td>2 – Proactively increases resources</td>
</tr>
<tr>
<td></td>
<td>Does it increase public response?</td>
<td>0 – Increases awareness without incentives</td>
</tr>
<tr>
<td></td>
<td>Does it create perverse incentives to assume higher risk?</td>
<td>2 – Creates no perverse incentives</td>
</tr>
<tr>
<td><strong>Equity</strong></td>
<td>Are the most vulnerable groups unfairly burdened?</td>
<td>2 – Most vulnerable do not bear additional costs</td>
</tr>
<tr>
<td><strong>Administrative Complexity</strong></td>
<td>What is the degree of administrative complexity required to implement the policy?</td>
<td>1- Policy requires some new resources</td>
</tr>
<tr>
<td><strong>Stakeholder acceptability</strong></td>
<td>To what degree will the policy be acceptable for local governments?</td>
<td>2 – Highly acceptable</td>
</tr>
<tr>
<td></td>
<td>To what degree will the policy be acceptable for homeowners?</td>
<td>2 – Highly acceptable</td>
</tr>
<tr>
<td><strong>Total / 8</strong></td>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>

A public education program has a similar evaluation to a subsidy program. The key difference between the two is a trade-off between effectiveness and administrative complexity. As an education program does not involve allocating public funds to private homeowners, it requires fewer resources to implement. However, without incentives to motivate behaviour, education alone does little to increase public response. A UK 2008 survey on flood risk response concluded that about 20% of households who believe their homes to be at risk take steps to mitigate that risk (DEFRA 2008; Harries, 2008). Empirical evidence reinforces the conclusion that increasing awareness about flood risk does not by itself have a strong impact on behaviour, as “…empirical studies that have investigated the relation between flood risk perceptions and the adoption of private flood mitigation measures and do not find a statistically significant relation at all, or report only a weak relation” (Bubeck et al, 2012).
9.7. Major Trade-Offs and Concerns

The matrix below represents the trade-offs policy makers should consider when comparing different options.

Table 9-5: Summary of policy analysis

<table>
<thead>
<tr>
<th>Objective</th>
<th>Regulations</th>
<th>Reform DFA</th>
<th>Subsidies</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness /8</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Equity /2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Administrative Complexity /2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Stakeholder acceptability /4</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total /16</td>
<td>7</td>
<td>8</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

As discussed in chapter 7, the policy option scoring the highest in effectiveness will best address barriers preventing the uptake of floodproofing. However, effectiveness and equity come into conflict, as the policy that is the most effective at increasing floodproofing (the regulatory approach) has the potential to add high costs on those who are already living in flood prone areas. In addition, both the regulatory approach and reforming DFA have low stakeholder acceptability, as they shift a large burden of responsibility onto homeowners themselves. This contrast brings up a larger ethical question in flood management and climate change adaptation, which is, who should bear the burden of the costs of flood risk? These ethical dilemmas will continue to bear on discussions of flood management, as climate change will make it increasingly difficult to support those living in high-risk areas.

Another key conclusion is that equity and stakeholder acceptability align. This reinforces the idea that policies that shift costs and responsibility to individuals are politically unpopular. This can be attributed in part to low public awareness – until there is major concerns about flooding in BC, there will be little willingness to accept costs or land-use restrictions for a higher level of protection.

Education currently receives a high score because it has been evaluated as having little administrative complexity, and therefore lower costs. Therefore for education
to rank highly there needs be a cap on the amount of resources invested in it. If administrative costs are too high, then education does not comparatively rank as well because it will not be a cost-effective allocation of resources. Education should not be a stand-alone policy choice because it is not proven to be effective.

Finally, based on this assessment no policies should be disregarded as they all score relatively well. Instead, policies with lower stakeholder acceptability should be integrated as part of a phased implementation approach, which is explained in the following chapter.
Chapter 10. Recommendations

The first recommendation is that a provincial floodplain mapping program be set up under the authority of the Minister of FNLRO, which already has broad powers to establish environmental management plans with respect to “flood control, flood hazard management and development of land that is subject to flooding” (Environmental Management Act, SBC 2003 S.1.5(f)(i)). Given the proposed changes to the federal disaster mitigation program\(^{32}\), the province potentially could secure more funding from the federal government to undertake this project. Further research should be undertaken into what type of maps would be most useful, but a necessary precondition is that they incorporate the latest climate change data. These maps would be made publicly available, but will initially not be legislated under S. 920 of the LGA to avoid conflict with DFA in historically exempt areas.

The floodplain-mapping program should be rolled out simultaneously with a public education campaign. Homeowners and local governments should be made aware of different flood zones, levels of risk, and measures they could undertake, as well as what is currently covered by insurance.

Second, a pilot program should be set up that offers funding for floodproofing measures. More consideration would need to be given to the design and administration

\(^{32}\) On January 16, 2014, Public Safety Canada issued a news release regarding the National Disaster Mitigation Program (NDMP) and Disaster Financial Assistance Arrangements, both of which were referenced in the 2014 federal budget (Economic Action Plan 2014). The program will see $200 million distributed over five years, for cost-sharing for projects focused primarily on flood mitigation, and will begin on April 1, 2015 (PSC, 2015)
of the program. For subsidies to be cost-effective, policies will need sufficient uptake to justify the costs of consulting with residents and administering the fees. For example, if there were high uptake of a free survey service but low uptake of measures, this would not be cost-effective. After initial funds are distributed through a pilot program the program should be evaluated before further dissemination. In addition, choices would need to be made about the level of government that administers the program. The program could be a provincial initiative paired with mapping, or it could be administered by local governments but supported with resources from the province.

One possibility would be to offer the services of the pilot program to properties that have recently been eligible for disaster financial assistance. By using this criterion for allocation, the program administration could begin before mapping is complete. In addition, social vulnerability should be considered in resource allocation of the grant program to ensure equitable distribution to those most in need of support. After one year of implementation, the pilot program should be evaluated and reformed for maximum cost-effectiveness.

Once a pilot program has been implemented and evaluated, a grant program should begin in tandem with changes in Disaster Financial Assistance. This will give homeowners the option of accepting a subsidy towards floodproofing and remaining eligible for assistance in another flood event, or not building but losing eligibility for post-disaster assistance. It is estimated that the grant program will not cover full costs of floodproofing, but will be based on financial need. The choice of assistance paired with the removal of post-disaster aid will give individuals the ability to make an informed decision about the level of risk they are willing to accept.

In addition to impacting properties that have received DFA in the past, this policy change and grant program should be targeted at properties in the flood plain area as designated by new maps.

For new construction, developers will be required to disclose the level of flood risk on the new homes. If buildings are in the flood fringe and do not have adequate floodproofing measures, they will not be eligible for DFA in the case of a flood event, and this will need to be made clear to potential buyers.
Regulatory change is recommended as a final step to improve BC’s flood resilience. If regulatory change happens too quickly and without warning, it will cause strong pushback and will not be successful. Therefore it is recommended that other actions be undertaken first to begin the process of raising public awareness and increasing resources. In this step, the BC building code should be changed to mandate the use of water-resilient materials in flood-prone areas. However, this change should ensure that it is still possible to introduce the use of innovative methods. In addition, provincial maps should become adopted into floodplain bylaws under S.920 of the LGA. As this research did not explore bylaw options in depth, further research should be undertaken on incorporating flood-proofing regulations while preserving the liveability of dwellings for tenants.
Chapter 11. Conclusion

In the face of a changing climate, it is no longer economically, technically or environmentally sustainable to depend solely on more and higher infrastructural defences to protect communities from flooding. A move toward floodproofing represents a large shift in thinking in flood management. It is a shift toward reducing flood vulnerability while accommodating more water, as opposed to reducing flood hazards by protecting against water intrusions.

Unfortunately, we can be sure that extreme events will cause more flooding in BC’s future. These events will bring high costs, both in proactive adaptation efforts and through reactive responses. This research sets up a staged approach that transfers some responsibility for adaptation away from resource-stretched local governments towards both the province and individuals themselves.
References


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Harris, Tim. (2008). Feeling Secure or being secure? Why it can seem better not to protect yourself against a natural hazard. Flood Hazard Research Center


Kovacs, P. Sandink, D. (2013). Best practices for reducing the risk of future damages to homes from riverine and urban flooding: A report on recovering and rebuilding in southern Alberta. Institute for Catastrophic Loss Reduction (ICLR)


Lyle, T.S. (2001). Non-structural Flood Management for the Lower Fraser Valley, British Columbia. MSc thesis. Simon Fraser University, Burnaby, BC


Appendix A.

Map & Demographics of the Lower Mainland

Figure A-1: Map of the Lower Mainland.
Reprinted with permission from the Fraser Basin Council

Table A-1: Demographic characteristics of the Lower Mainland, 2008

<table>
<thead>
<tr>
<th>Demographic Characteristics of the Lower Mainland, 2008</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>2,580,000</td>
</tr>
<tr>
<td>Population Density</td>
<td>160 people/km²</td>
</tr>
<tr>
<td>Population living within flood plain – before climate change projections</td>
<td>324,465 (12.6%)</td>
</tr>
</tbody>
</table>

Source: FBC 2008
Appendix B.

Flood Hazard Management Legislation

The table below provides an overview of all relevant legislation, regulation, and policies pertaining to flood hazard management in BC.

*Legislation pertaining to structural works such as dikes is not reviewed in this section, as flood protection works located on private property that only protect that property are not subject to the Dike Maintenance Act

Table B-1: BC legislation/regulation/policy related to floodproofing

<table>
<thead>
<tr>
<th>Legislation/Regulation</th>
<th>Responsible Ministry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Charter</td>
<td>Community, Sport and Cultural Development</td>
<td>Provisions governing the ability of a building inspector to issue or refuse a building permit for land that is likely subject to flooding and other hazards</td>
</tr>
<tr>
<td>Land Title Act</td>
<td>Transportation and Infrastructure</td>
<td>Construction requirements in relation to flood plain areas: States that if the land may be subject to flooding either or both of the following conditions may be required: 1 – an engineered report 2- One or more registered covenants</td>
</tr>
<tr>
<td>Local Government Act</td>
<td>Community, Sport and Cultural Development</td>
<td>S.920 • Municipal governments may only designate areas as floodplains through the enactment of an official bylaw •This bylaw will specify corresponding flood construction levels and setbacks •Any new construction or reconstruction within the designated floodplain area must comply with these protection measures •In the case of building renovations, new flood protection measures are not required if the renovation does not exceed 25% of the building footprint •A local government, in making bylaws under this section, must consider the Provincial Guidelines S.919.1 and 920 •Official Community Plans (OCP) can establish a development permit area (DPA) to protect development from &quot;hazardous conditions&quot;, which include flooding. •In a DPA, am owner must obtain a development permit before subdividing or altering the land. This includes altering or adding to an existing structure or constructing something new</td>
</tr>
</tbody>
</table>
A development permit can set out requirements and conditions for development in that area. A DPA can establish flood-prone areas that must remain free of development.

<table>
<thead>
<tr>
<th><strong>Environmental Management Act</strong></th>
<th>Ministry of the Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides the Minister of MFLNRO with broad flood management powers, including the authority to establish guidelines and regulations. For example, the Ministry has published the Flood Hazard Area Land Use Management Guidelines that must be considered by local governments when adopting floodplain bylaws under Section 910 of the Local Government Act.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Compensation and Disaster Financial Assistance (DFA) (B.C. Reg. 124/95) S. 15, 30</strong></th>
<th>Ministry of Justice</th>
</tr>
</thead>
<tbody>
<tr>
<td>No assistance for structures in flood plain area unless the structure was determined to have been “properly flood protected”. Private claims (S.15); local government claims (S.30)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Flood Hazard Area Land Use Management Guidelines (2004)</strong></th>
<th>FLNRO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guidelines to assist local governments develop and implement management strategies for flood-prone areas. The guidelines are broken into five general sections, organized to address administration, floodplain mapping, application by natural hazard type, application by specific land use, and implementation measures.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>BC Building Code</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodproofing must address the following sections of the code:</td>
</tr>
<tr>
<td>• Retaining walls</td>
</tr>
<tr>
<td>• Handicapped accessibility</td>
</tr>
<tr>
<td>• Building separation requirements</td>
</tr>
<tr>
<td>• Insulation</td>
</tr>
<tr>
<td>• Structural and seismic loading and hydrostatic uplift</td>
</tr>
<tr>
<td>• Depth and design of foundation</td>
</tr>
<tr>
<td>• Furnace requirements</td>
</tr>
<tr>
<td>• B.C. Plumbing Code (AG, 2001)</td>
</tr>
</tbody>
</table>
Appendix C.

Semi-Structured Interview Guide

Note: As a semi-structured interview, these questions are a guideline. Questions will be re-phrased/paraphrased to suite the context of each interviewee, allowing interviewees the ability to discuss key ideas that may or may not be known to the interviewer.

Questions

1. Has increased risk of flooding due to climate change been taken into account in your work? Can you provide specific examples?
2. What policy challenges do you see emerging with increasing flood risk?
3. What flood-proofing policies are in place in your local government?
4. Are any site and/or building specific risk reduction measures used, such as wet or dry proofing?
   a. Do you see any advantages to using these measures?
   b. What do you see as the barriers/challenges to implementing these measures?
5. Do you think there is a public awareness of property-level flood protection measures?
6. Do you think there is awareness among the provincial and local governments about site-level flood protection measures? Any examples?
7. What do you see as the biggest challenges to flood management in BC, in general? What needs to be changed?
8. What policies do you think would improve the uptake of site-level measures? (discuss pros and cons of options below)
   - Reform the building code
   - Make current bylaw guidelines mandatory
   - Provincial mapping program
   - National flood insurance
9. Do you have any suggestions for participants that I should contact?
10. Are there any final comments you would like me to record before we conclude?
## Appendix D.

### Status of Floodplain Maps in Other Provinces

Table D.1: Status of floodplain maps in other provinces

<table>
<thead>
<tr>
<th>PROVINCE</th>
<th>STATUS OF MAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>Alberta Environment supervises the production of floodplain maps for communities as part of its Flood Hazard Identification Program.</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>The Saskatchewan Water Security Agency is the body responsible for floodplain mapping. The Saskatchewan government has not made any specific commitment to updating floodplain maps.</td>
</tr>
<tr>
<td>Manitoba</td>
<td>Many of the maps developed under the Canada-Manitoba Flood Damage Reduction Program are still in use. Floodplain maps are being considered for update by the provincial government.</td>
</tr>
<tr>
<td>Ontario</td>
<td>Conservation Authorities receive funds from self-generated revenues, municipal levies and provincial grants to manage flood control, which includes updating community floodplain maps.</td>
</tr>
<tr>
<td>Québec</td>
<td>In accordance with provincial planning legislation, municipal/regional governments must identify their own flood risk areas with the help and support of Ministère du Développement durable, de L’Environnement et des Parcs. No provincial program for flood mapping has existed since 2004.</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>The New Brunswick Department of the Environment and Local Government manages floodplain maps for communities, many of which date back to the Flood Damage Reduction Program. In 2008, the province signed on to the NRCan Regional Adaptation Collaborative program and received funding to update maps for some areas.</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>Maps are being updated through a mix of self-directed activities and activities as part of NRCan’s Regional Adaptation Collaborative program.</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>Flood risk management has focused exclusively coastal issues (storm surges and erosion) and inland flooding from extreme rain events.</td>
</tr>
<tr>
<td>Newfoundland and Labrador</td>
<td>The Newfoundland Department of Environment and Conservation manages floodplain maps and funds this through its provincial budget.</td>
</tr>
</tbody>
</table>

Sources: Herbert et al, 2014