

Promoting Flood Risk Mitigation Among Canadians Through Effective Risk Communication

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Amid reports of low levels of flood risk awareness and preparedness among Canadians, risk communication emerges as an important tool for encouraging public participation in flood risk management (FRM) and increasing collective flood resilience. In its most basic form, risk communication informs people of their risk and provides solutions to reduce it. Disaster studies scholars, however, assert that an individual's decision to take protective action from hazards is mediated by an array of social, economic and cognitive factors. To this end, there are growing calls to incorporate audiences' social and physical environment as well as insights from behavioural science into risk communication methods to increase their efficacy.

Whether relevant Canadian stakeholders consider those factors in their flood risk communication strategies is unclear, which raises several fundamental questions about flood risk communication in Canada, such as: What are the challenges and opportunities of incorporating risk perception and risk communication theory into flood risk communication practice? Is flood risk communication by key Canadian communicators (e.g., governments, insurance companies, civil society organizations and academic groups) achieving its goals of increasing the knowledge and capacity for flood preparedness of those at risk? If so, how is this assessed? This research aims to provide a comprehensive review of Canadian municipalities'—important flood risk communicators—flood risk communication practices relative to risk communication theory. Surveys of municipal staff from 18 large, flood-prone Canadian municipalities and interviews of 21 subject matter experts concerning household-level flood risk mitigation were conducted and the results were analysed using risk communication and risk perception literature; the latter is grounded in protection motivation theory, a widely-used behavioural framework in flood risk research.

The results indicate that most municipalities' flood risk communications should theoretically be raising residents' flood risk awareness and preparedness. Limited time and resources function as the greatest barriers to municipalities' flood risk communication efforts to the public; such barriers impede some municipalities' abilities to address known deficiencies in their flood risk communication practices. Public-private and public-public partnerships were identified as critical to overcome municipal resource constraints and to enhance the impact of flood risk education programs and/or flood risk communication messages.

The findings have implications for federal and provincial policies to expand local government responsibility for FRM, because they suggest that such decisions neglect the diversity of local governments with respect to their funding and capacities. Future research recommendations include the further application of evaluation frameworks to flood risk communication activities in light of the finding that Canadian flood risk communicators' metrics of "successful" flood risk communications are highly variable or altogether absent. In the absence of flood risk communication standards, its impact will remain intangible.

Acknowledgements

During our first-ever conversation, I posed this question to my soon-to-be supervisor Dr. Blair Feltmate, “Isn’t climate change adaptation throwing in the proverbial towel, because it means we’ve given up on mitigation?”. Blair promptly disagreed, and went on to discuss, with great zeal, the urgency of adapting to our irreversibly-changed planet in smart, pragmatic ways—alongside mitigation efforts, of course. I was quickly sold on the prospect of devoting my master’s research to a climate adaptation-focussed project, and am happy to have found a niche in the area of flood risk adaptation. Thank you for sharing your passion and knowledge, Blair. Your dedication to this field is an inspiration to me and many.

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Chapter 1.0 Thesis Introduction

1.1 Problem Statement

In recognition of the increasing severity and frequency of natural hazards and extreme weather events, the Government of Canada has embraced a “whole-of-society” approach to emergency management, disaster risk mitigation and climate change adaptation (Canada, 2018; Canada, 2019; Government of Canada; 2022a). The implications of this approach for flood management have been the subject of much scholarly attention owing to an array of technical, social, economic and policy challenges associated with transitioning to an integrated approach to managing Canada’s most common and financially costly natural hazard (Henstra et al., 2018; Oulahen et al., 2018; Shrubsole et al., 2003). A significant consequence of the whole-of-society approach on flood management is that it is no longer the sole domain of governments; private actors (e.g., individuals, insurers) are increasingly expected to share in the risks—and costs—of floods. Indeed, the whole-of-society approach is unprecedented in its emphasis on collective action to achieve disaster resilience, and is indicative of a wider paradigm shift taking place in North America and Europe in which various countries are transitioning to a decentralized approach to managing floods (Sayers et al., 2013).

Flood risk management (FRM) is a framework for the assessment, evaluation and mitigation of flood risks that aims to reduce not only the likelihood of flood events—as was the former convention—but flood impacts as well (i.e., exposure and vulnerability) (World Meteorological Organization [WMO], 2013). FRM is governed by policies and regulation that support non-structural measures of flood management (e.g., policies, risk communication, private flood insurance) and reduce dependency on structural measures of flood control (e.g., dikes and dams) (WMO, 2013). To be sure, structural measures of flood protection remain an important component of FRM regimes; it is the way that structural and non-structural tools are wielded that sets FRM apart from traditional flood management paradigms. FRM policy prescribes an enhanced level of collaboration among stakeholders in their coordination of strategies in order to achieve effective, adaptive flood management (Sayers et al., 2013).

Whether Canada has, or will be able to practically implement FRM has been called into question for a number of reasons, including an absence of widespread insurance availability and affordability (Calamai & Minano, 2017); decision-making biased toward conventional

(structural) methods of flood control (Shrubsole, 2013); weak leadership among upper levels of government to prioritize flood adaptation-related policy, to provide technical guidance, and to coordinate flood management strategies across jurisdictions (Oulahen et al., 2018); and a lack of public awareness of flood risks, which is not helped by the demonstrated myopia of the Canadian media in their framing of flood events (Thistlethwaite et al., 2019).

This study positions individuals as important stakeholders in advancing and legitimizing FRM. Civil society contributes to FRM through their adoption of personal flood risk mitigation measures; namely the purchase of flood insurance (a non-structural FRM measure), and the implementation of property-level flood protection measures (structural FRM measures) (Bubeck et al., 2012a; Thistlethwaite et al., 2020). Troublingly, Canadians' awareness of and preparedness for flood risks have been shown to be consistently low (Environics Analytics, 2021; Taylor-Butts, 2015; Thistlethwaite et al., 2017; Zioelcki et al., 2020). The public's low flood risk awareness and preparedness presents serious barriers to achieving the ideal of risk-sharing essential to FRM. Moreover, a largely unaware and unprepared public will continue to drive the national trend of more expensive and damaging flood events in Canada, for which all stakeholders bear the costs (Insurance Bureau of Canada [IBC], 2021). There is an urgent need for Canadians to become more engaged in flood risk mitigation.

Risk communication is an available tool for Canadian public officials to elucidate the expected roles of civil society in FRM and to facilitate their participation in flood risk mitigation (Henstra & Thistlethwaite, 2017; Zioelcki & Thistlethwaite, 2019). Enhancing natural hazards risk communication is enshrined as a priority in Canada's National Disaster Mitigation and Emergency Management Strategies under the areas of "Public Awareness, Education and Outreach" and, "Improve understanding of disaster risks in all sectors of society", respectively (Canada, 2018; Canada, 2019). Canada's commitment to flood risk communication is apparent at the federal level of government, which houses a national public awareness campaign called *Flood Ready* and has launched a \$63.8 million flood hazard mapping improvement program for provincial and territorial governments (Government of Canada, 2022b; 2022c). Provincial and municipal governments also play an important role in flood risk communication due to their mandate for land-use planning, development of flood hazard maps and emergency management plans, and related public education programming (Canada, 2019; Richardson &

Otero, 2012). Beyond government, insurance companies, academia, non-governmental organizations and civil society organizations are among the patchwork of Canadian stakeholders who increasingly engage with the public about flood risk and its mitigation (Canada Mortgage and Housing Corporation [CMHC], 2022; Canadian Red Cross [CRC], n.d.; IBC 2018; Institute for Catastrophic Loss Reduction [ICLR], n.d., Intact Centre on Climate Adaptation [ICCA], 2020a).

In response to its growing prominence, Canadian investigations related to flood risk communication have emerged in recent years (Agrawal et al., 2022, Bogdan et al., 2021; Evans & Feltmate, 2019; Andrey et al., 2022; Heldsinger et al., 2018; Henstra & McIlroy-Young, 2022; Henstra et al., 2019; MacIntyre et al., 2019; Phillips & Rajabali, 2020; Ziolecki & Thistlethwaite, 2019). The literature in Canada and abroad has contributed to a number of best practices for communicating to the public about flood risks. Best practices are often grounded in behavioural science and commonly include tailoring risk messages to the audience based on their geographic and social context as well as their flood risk perception (Demeritt & Nobert, 2014; Maidl & Buchecker, 2015; Ziolecki & Thistlethwaite, 2019). It is unclear whether this research has informed the risk communication practices occurring on the ground in Canada. It is therefore timely to review the applications of evidence-based best practices to flood risk communication in Canada as a potential means to inform and improve its nature.

1.2 Research Purpose and Objectives

The primary research question is:

- 1) How might flood risk communication stakeholders more effectively motivate Canadian homeowners and tenants to mitigate their personal flood risk using risk communication?

To address the focal question, the research investigates the following secondary questions:

- 2) Can the incorporation of risk communication theory into municipalities' flood risk communication methods help to target the underlying motivators and barriers to Canadians' adoption of residential flood risk mitigation measures?
- 3) What is the state of flood risk communication by municipalities relative to risk communication theory grounded in protection motivation theory (PMT), and what are the associated implications for the roles and responsibilities of municipal governments in flood risk management?

This study aims to provide insight on these matters by assessing a number of large municipalities'—key Canadian flood risk communicators—flood risk communication practices relative to risk perception and risk communication theory. The theory consists of a conceptual framework that integrates protection motivation theory (PMT) and related risk communication concepts. PMT emerges as the most prominent framework that has been applied to studies of households' flood risk perceptions and behaviours, but it has been underexplored in Canadian studies (Kuhlicke et al., 2020).

PMT offers a theoretical framework to understand the drivers of individual action, or lack thereof, on flood risk mitigation. The motivators and barriers to residential flood risk mitigation are perceived through the lens of PMT, in which it is theorized that individuals undertake protective measures against a perceived hazard when both their threat appraisal (perceived risk and perceived severity of risk) and coping appraisal (perceived efficacy and ability to cope with the risk) are high (Maddux & Rogers, 1983). According to the scholarly literature, risk communication should be specific, targeted, consistent, and straightforward (Bier, 2001; Demeritt & Nobert, 2014). Thus, municipalities' flood risk communication content will be analysed using the conceptual framework to assess the degree of alignment between theory and practice. Outcomes of this research aim to advance the potential to incorporate evidence-based practices into the design and dissemination of flood risk communications to ultimately increase their efficacy and uptake by citizens, and to optimize the use of communicators' resources.

The research sought to achieve the objectives through the following research activities:

- 1) Develop a flood risk communication best practices framework by integrating PMT constructs and flood risk communication research.
- 2) Determine the utility and relevancy of this framework in the Canadian context of flood risk communication by administering a survey to municipal flood risk communication stakeholders representing large municipalities.
- 3) Conduct interviews with municipal staff, industry, non-governmental and academic stakeholders to explore the survey themes more deeply and to validate and triangulate findings.

4) Determine the alignment between risk communication practice (from participants' data) and theory.

5) Explain the implications of the research for practice and for the literature. Provide targeted areas for improvement for Canadian municipal flood risk communication stakeholders' design, delivery and development of flood risk communication messages and/or educational programs. Discuss the implications of the findings on FRM in Canada.

This research fills an identified gap in the literature in its application of a theoretical perspective (Protection Motivation Theory) to an investigation of flood risk perception and risk communication. Canadian studies of flood risk perception and adaptive behaviours are primarily exploratory in nature, in spite of available theoretical frameworks that would enhance the consistency of the research (Chowdhury & Haque, 2011; Gray-Scholz et al., 2019; Haney & McDonald-Harker, 2017; Tanner & Árvai, 2018; Thistlethwaite et al., 2017). This research is novel in its examination of PMT in the Canadian context. This research also contributes to the scholarly literature by fulfilling the calls for the practical application of PMT to flood risk communications (Kellens et al., 2013).

1.3 Thesis Organization

This thesis is organized into six chapters. Chapter 1 serves as an introduction to the thesis. Chapter 2 reviews the relevant literature on flood risk management (FRM) to contextualize the importance of risk communication, especially that which is able to overcome persistent barriers to motivating personal flood risk mitigation among individuals. PMT is positioned as a theoretical framework for consideration by practitioners in their design and delivery of flood risk communications to the public and it is integrated with risk communication literature to serve as the central conceptual framework. Chapter 3 contextualizes the study area and provides a description of the research methods—surveys of municipal staff and interviews of subject matter experts. Chapter 4 presents the findings of the surveys and interviews and an analysis of those findings. Chapter 5 provides a discussion of those findings relative to the literature. Finally, Chapter 6 discusses the implications of the research findings for risk communication practice and FRM; offers recommendations and a conclusion; and includes study limitations and suggestions for further research.

Chapter 2.0 Literature Review

Part 1: Flood Risk Management in Canada

2.1 Evolving Arrangements for Flood Management

Floods are Canada's most common and financially costly natural hazard (IBC, 2021). The Canadian convention for flood management has traditionally been to rely on expensive structural infrastructure for flood protection and control (Henstra & Thistlethwaite, 2017). This model of flood management is known as a hazards-based approach because it focusses on the likelihood of flooding—often using a 1 in 100-year flood recurrence interval—as the central input for flood infrastructure development and management strategies (Henstra & Thistlethwaite, 2017). Where infrastructure fails, government disaster financial assistance is administered (Shrubsole, 2013). The hazards-based model has garnered criticism in Canada and beyond for its emphasis on flood probability, which does not consider flood exposure and vulnerability and thus accounts for neither changes to flood regimes associated with climate change nor for flood damages outside of monetary terms (Chakraborty et al., 2022; Henstra & Thistlethwaite, 2017; Koks et al.; 2015). Canada's model of government disaster relief has similarly been criticized because it focusses on returning the affected public infrastructure and properties to their pre-disaster state without regard for whether those pre-disaster conditions contributed to the extent of the damages (Sandink et al., 2016). An additional critique of Canada's disaster financial assistance model is that it creates a moral hazard whereby guaranteed post-disaster aid from the government offers little incentive for private actors to take on risk reduction measures of their own (Davies, 2020).

Over the past decade, countries such as the United States, Canada, China, those within the United Kingdom and Europe have begun pursuing more “holistic”, “integrated” alternatives to their hazards-focussed flood management strategies (Bubeck et al., 2017; Golnaraghi et al., 2020; Sayers et al., 2015). In these countries, a risk-based approach to flood management known as flood risk management (FRM) is increasingly positioned as superior to the hazards-based approach. The institutionalization of FRM has been most apparent in Europe, in which the principles of FRM have effectively been mandatory since 2015 (Bubeck et al., 2017; Hegger et al., 2016; Klijn et al., 2012). Indeed, the European Union's 2007 Floods Directive required member states to integrate the principles of risk management—mitigation, preparedness,

response, and recovery—into their flood management strategies by 2015 (Hegger et al., 2016). In its embrace of all tenets of risk management, FRM rejects the notion that structural measures alone are sufficient to manage flood risks. Instead, as illustrated in Figure 1, FRM expands the portfolio of flood management measures to include non-structural measures. Non-structural measures are inherently adaptive because they do not suppose floods can be resisted or controlled. Non-structural measures are aimed at reducing the effects of potential flood events on people and property by way of risk assessments and various technological, social, economic and institutional risk-sharing measures (e.g., flood insurance, risk communication, and land-use bylaws and zoning) (Golnaraghi et al., 2020; Henstra & Thistlethwaite, 2017).

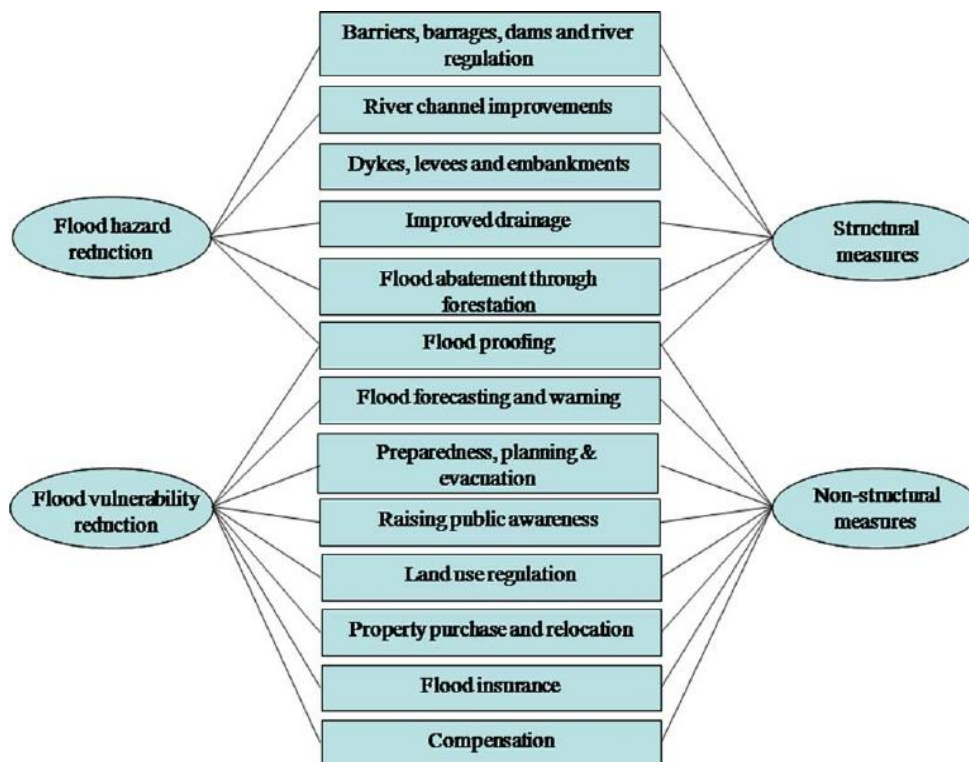


Figure 1. A range of FRM measures as categorized into conventional engineered, hazard-focused measures and non-structural, risk-focussed measures (Harries & Penning-Rowse, 2011).

The pace and direction of FRM development is not universal; it is influenced by a country’s historical, political, and geographic conditions (Bubeck et al., 2017). In Canada, recent federal policy initiatives by Natural Resources Canada, Infrastructure Canada and Public Safety Canada mark a transition toward risk-based flood management. Funding opportunities for disaster mitigation and adaptation-related projects; a federal task force assigned to the assessment of affordable private flood insurance options and relocation for Canadians at greatest flood risk; a national flood hazard maps improvement program; and a forthcoming

National Adaptation Strategy for climate change impacts are ongoing initiatives that signify the coordinated prioritization of risk reduction, and the resultant decreased reliance on structural defence and government disaster payouts (Government of Canada, 2020; 2021a; 2021b; 2022a; 2022c). Several non-structural measures of flood management, including disaster financial assistance, flood insurance, and the Flood Damage Reduction Program will be discussed in detail in the context of Alberta, as the events succeeding the 2013 southern Alberta floods are illustrative of the evolving arrangements for flood preparedness and recovery.

2.2 Honing Available Tools for Flood Management: Non-Structural Measures

Catastrophic floods in southern Alberta in June and July of 2013 resulted in an estimated \$6 billion in damages (Government of Alberta, 2014). The response and recovery expenses for the damages exceeded the threshold at which federal disaster financial assistance (DFA) is administered, prompting the Government of Alberta to appeal to the Government of Canada under its DFA Arrangements (DFAA) (Government of Alberta, 2014). Meanwhile, insurable damages associated with the floods amounted to \$1.7 billion in losses for the Canadian insurance industry in 2013 (IBC, 2021). After Albertans' persistent calls for insurers to accept their ineligible claims, insurers relented and began to offer overland flood coverage to eligible Canadians two years later (Thistlethwaite et al., 2020). In the meantime, the province's Disaster Recovery Program (DRP) filled the gap in uninsurable losses in order for affected homeowners, residential tenants, landlords, small business owners, not-for profit organizations, agricultural producers and condominium associations to access financial assistance (Meyers Norris Penny [MNP] LLP, 2015). Albertans' claims to the DRP reached almost \$3 billion by 2014 (MNP LLP, 2015).

Since 2013, the economic instruments available for flood recovery have changed considerably. A disaster must generate three times the damage to trigger DFAA as compared to 2013 owing to an increase in DFAA expense thresholds in 2015 (Public Safety Canada, 2022; Parliamentary Budget Office, 2016). As a result, provincial and municipal governments, the latter of which are mandated to lead emergency response, now shoulder more of the cost of disaster recovery (Henstra & Thistlethwaite, 2017). Another landmark advancement in non-structural measures of flood management was the introduction of private overland flood insurance in 2015, which, as mentioned, was a product of intense market demand following the 2013 Alberta floods (Thistlethwaite et al., 2020). Overland flood insurance availability was

accompanied by adjustments to many provinces' disaster aid programmes. For example, insurance eligibility revokes one's eligibility for provincial disaster aid, even if one has not purchased insurance (Government of Ontario; 2018; Emergency Management BC, 2016; Government of Manitoba, n.d.). In Alberta, additional changes to the provincial DRP guidelines limit funding to a one-time \$500,000 per homeowner (Government of Alberta, 2021). The province is also discontinuing its coverage of all eligible disaster costs. As a result, the collection of private-sector groups listed above (homeowners, residential tenants, landlords, small business owners, etc.) as well as municipalities must cover 10% of damages caused by natural disasters.

On the narrowing of Alberta's DRP criteria, the press secretary for Alberta's Minister of Municipal Affairs commented, "By incentivizing municipalities and homeowners to improve risk management we hope to start a conversation on the best ways to reduce the financial and human costs of disasters in Alberta," (Malbeuf, 2021). The Alberta government specifically lists the actions they expect the DRP reductions to spur on, "These changes will encourage Albertans to mitigate disaster risks by: purchasing appropriate insurance, reducing property development in high-risk areas, relocating to less disaster prone areas, mitigating their properties" (Government of Alberta, 2021). In both of their justifications of reduced disaster aid, the Alberta government alludes to a heightened emphasis on the responsibilities of individuals and municipal governments for flood management, which is characteristic of FRM. Indeed, countries shifting toward FRM frameworks display a marked shift from top-down flood management to decentralized flood management as well as the individualization and privatization of flood management such that the private sector (e.g., insurers, individuals) becomes involved in public functions (i.e., flood protection, response) (Meijerink & Dicke, 2008).

The heightened role of local governments in flood management is not new; it has been occurring since the federal government withdrew from the Flood Damage Reduction Program (FDRP) in 1999 (Canada, 2017; de Loë, 2000). The FRDP was introduced in 1975 and was seen as innovative for its consideration of non-structural measures for flood management, such as zoning to reduce development in floodplains, policy to bar access to disaster assistance by developments in designated floodplains, and the development of flood hazard maps (de Loë, 2000). FDRP agreements were established between federal and provincial governments, who

worked collaboratively and shared the costs of implementing FDRP principles. When it was announced that the FDRP agreements were not slated to be renewed, the federal government effectively stepped away from its central role in flood management, for which, under the *Constitution Act*, it never had any obligation to lead in the first place (Shrubsole et al., 2003). Still, the federal government had been the source of financial and technical assistance for provincial and municipal governments' flood management efforts for decades. The withdrawal of the federal government from flood management efforts left scholars wondering whether the trajectory of flood management in Canada, which was headed toward a more holistic approach—referred to as “an ecosystem approach” by de Loë (2000)—would revert to one wherein flood damages and reliance on government assistance continued to increase (Shrubsole et al., 2003). de Loë (2000) was not optimistic that provincial governments would be willing or able to abide by the principles of the FDRP without the funding and accountability provided by the federal government. In turn, he was skeptical that local governments would be capable or motivated to do so without committed leadership by their province. Alas, the pessimistic predictions by de Loë (2000) and company were largely correct. The only real relics of the FDRP are the flood hazard maps produced during that period, which some municipalities use to this day (Henstra et al., 2019). Flood losses have continued to increase, and local governments appear to be struggling to wield the tools that would help to reduce them (IBC, 2021; Thistlethwaite & Henstra, 2021).

2.3 Challenges and Opportunities for Local Governments and FRM

Patterns of increasing urbanization in Canada have led to a dominance of hard—impervious—surfaces over porous soil, wetlands and other vegetated land, which increases the volume and speed of surface runoff (Sandink, 2016). Impervious surfaces enhance flood risk, as does development in flood-prone areas, which is occurring as a result of increased urban sprawl (Sandink, 2016). This trend is leading to a troublesome combination in which more Canadians live in flood-prone areas; more water is entering stormwater systems as a result of the influx of people and hard infrastructure associated with urban growth; and increasingly unpredictable storm events and snowmelt seasons are occurring as a result of climate change. The result is more destructive and financially costly flood events. Nine of the ten costliest natural disasters in Canadian history affected medium and/or large urban centres (IBC, 2021). As for floods specifically, of the 241 flood events documented in Canada between 1990 and

2005, the costliest events occurred in major Canadian cities (Sandink et al., 2010). Flood events amass such significant economic losses in large urban centres because it is there that the nation’s wealth, population and capital are most concentrated. Municipalities are home to approximately 60% of Canada’s roads, drinking water and wastewater systems, utility services and other core infrastructure (Zerbe, 2019). In addition, nearly 75% of Canada’s population lives in large urban centres (populations of 100,000 and greater) and population growth rates continue to be fastest in urban centres (Statistics Canada, 2022).

Emergency response has long been a function of municipal government because of legislation that limits federal and provincial governments to act only when local governments can no longer support emergency response (Henstra, 2008; 2010). To be sure, municipalities respond to emergencies most often; it is estimated that Canadian municipal governments are the first line of emergency response in 90% of emergencies (Federation of Canadian Municipalities, 2006). There is thus a large incentive for municipalities to take on flood risk mitigation and adaptation activities to avoid the large economic and social losses associated

with flood response and recovery. Indeed, since all functions of the emergency management (EM) cycle are interdependent, an increased expectation for provincial and municipal government involvement in the earlier phases of the EM cycle (i.e., preparedness and mitigation) presupposes that they will in turn be more capable of managing the activities involved in the latter phases (i.e., response and recovery) (Figure 2). However, the 2021 southern British Columbia floods—which have amassed \$675 million in insured damages and have given rise to a class-action lawsuit against the City of Abbotsford and the Government of BC—paint a stark picture of the possible

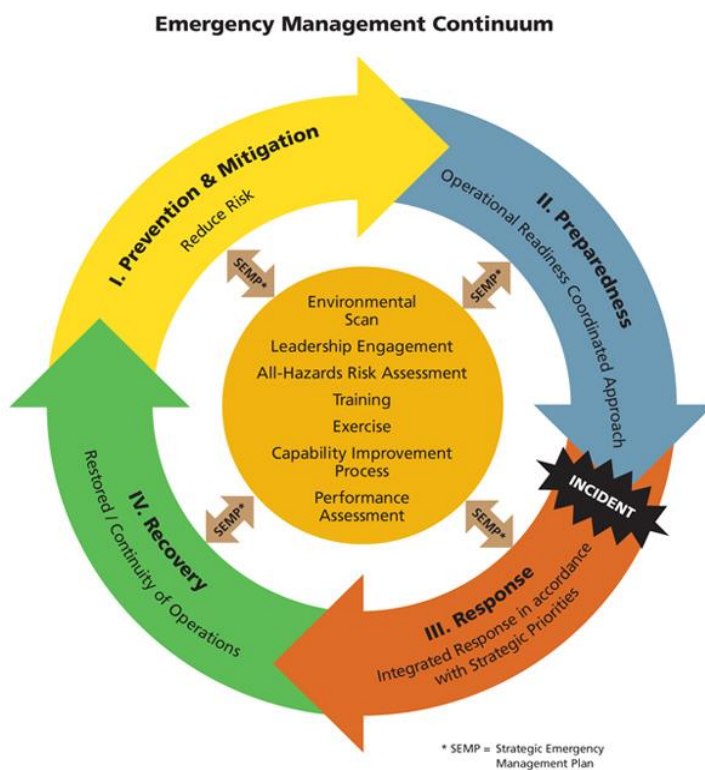


Figure 2. The four phases of the EM continuum (Canada, 2010).

consequences of transferring responsibility for all stages of flood management to local governments without the resolution of associated organizational and institutional challenges (McElroy, 2021; McSheffrey, 2022).

In 2003 and 2004, BC provincial legislation devolved floodplain designation, planning and responsibility to local governments. The resulting flood risk governance model was described as “broken” in a 2021 investigation of flood strategy development in BC, which was published just six months prior to the November 2021 floods in the Sumas Prairie (Ebbwater Consulting Inc, 2021, p. 118). Writers of the investigative report are not alone in their criticism of BC’s FRM system; one scholar stated that they had a “told-you-so moment” in the aftermath of the devastating floods (McElroy, 2021). The weaknesses of BC’s flood governance model were thoroughly outlined in the 2021 investigation, in which an absence of mandatory regulation and associated enforcement mechanisms; low public understanding of flood risk; ad hoc funding for EM and FRM; reactive rather than proactive flood management activities; high turnover within government; and poor coordination among neighbouring local governments were just a few listed contributors of the gaps in and challenges of the current flood governance model (Ebbwater Consulting Inc, 2021).

One of the most ubiquitous themes in the investigation was the reportedly unclear division of roles and responsibilities for FRM within and across levels of BC and federal government (Ebbwater Consulting Inc, 2021). Effective FRM policy requires different levels of actors to have defined, mutually agreed upon roles (Brown & Damery, 2002; Sayers et al., 2013). The unclear division of roles and responsibilities was said to be especially murky concerning non-structural elements of FRM (i.e., risk assessments, risk mapping, risk communication, land-use zoning). That is to say, while there are clear regulations for the management of structural measures (e.g., BC’s *Dike Maintenance Act*), regulation for non-structural elements of FRM is weak or absent. Non-structural measures of FRM address risk reduction (see Figure 1); the fact that non-structural measures are less regulated than their structural counterparts means that the current flood governance model remains entrenched in an historic preference for recovery and response activities compared to those related to mitigation (Ebbwater Consulting Inc, 2021). For instance, there is no BC provincial regulation to enforce the disclosure of flood hazard risks to the public and other relevant stakeholders;

thus, local governments may not, and do not, consistently disclose risks publicly (Ebbwater Consulting Inc, 2021). Failure to disclose flood risk limits public understanding of flood risk.

Flood maps are an available tool for the public disclosure of flood risks. Flood hazard maps are also intended to be the basis for provincial and municipal governments' land-use planning and development decisions in flood-prone areas across Canada (Canada, 2017). However, a 2019 study found that the majority of Canada's flood hazard maps are outdated and inaccessible owing to their technical nature, or, they are outright inaccessible because they have not been made available to the public (Henstra et al., 2019). Some flood hazard maps have not been updated since the flood mapping component of the FDRP was discontinued in 1997, at which point, provinces were charged with maintaining their maps, and local governments were expected to assist in developing mapping for new areas (Canada, 2017). The poor quality of Canada's flood hazard maps represents a gap in effective flood risk communication and a lack of risk-informed decision-making by provincial and municipal levels of government. Indeed, development has proceeded in designated flood-prone areas since the end of the FDRP, which leads to another area in which accountability for non-structural measures of FRM is weak—land-use regulation (Golnaraghi et al., 2020).

Issues concerning flood management and land-use regulation extend beyond BC (Richardson & Otero, 2012). Canadian municipalities have the authority to restrict land use and development in high-risk flood areas, but competing financial interests complicate the imposition of such restrictions. On one hand, limiting development in flood zones is attractive to municipalities. Municipal economies, infrastructure, and residential and commercial properties are most at-risk of enduring losses from flood events due to their high concentration of people, infrastructure and capital (Thistlethwaite & Henstra, 2017). On the other hand, prohibiting development involves forgoing the revenue otherwise gained from property taxes—municipalities' main revenue stream (Thistlethwaite & Henstra, 2017). It is true that federal funding programs for structural and non-structural flood risk mitigation projects have emerged in the past decade (i.e., the National Disaster Mitigation Program in 2015 and the Disaster Mitigation Adaptation Fund in 2018) (Government of Canada 201a; 2021b). Such grants may enable successful municipal applicants to take on FRM initiatives that they would otherwise be incapable of funding. Still, some grants require the recipient to finance over 50% of project costs—an amount that may be prohibitive for smaller municipalities with smaller tax

bases or those with more pressing priorities than flood risk (Government of Canada, 2021a; 2021b).

Moreover, although BC municipalities have considerable authority and responsibility for flood management, they have little top-down oversight or guidance from upper levels of government, which impedes their ability to implement the FRM measures that are increasingly expected of them (Ebbwater Consulting Inc, 2021). Others are in agreement that FRM in Canada lacks leadership, and that local governments across Canada generally require enhanced support from provincial and federal levels of government for climate change mitigation and adaptation efforts (Office of the Auditor General, 2018; Thistlethwaite & Henstra, 2021). There are, however, ways that municipalities can overcome public resource scarcity for flood risk mitigation and weak federal leadership for FRM; one way is to embrace one of the key items on the FRM agenda: to individualize and privatize responsibilities for flood risk reduction (Kuhlicke et al., 2020; Meijerink & Dicke, 2008).

There are a number of policy and economic instruments that can be administered by municipalities to more evenly distribute the burden of FRM (Thistlethwaite & Henstra, 2017; Zerbe, 2019). Some of these instruments involve sharing the cost of flood risk reduction with a diversity of stakeholders, which can occur through tools that generate municipal revenue for flood risk mitigation and adaptation-related projects (e.g., tax levies to fund stormwater management, user fees such as stormwater user fees); others involve sharing the responsibility of flood risk reduction with stakeholders, which can occur through financial incentive tools that promote action by property-owners, developers and builders (e.g., rebates for green roofs on new commercial and residential developments, subsidies for basement flood protection measure installation by homeowners); lastly, some mechanisms involve sharing the cost of floods; such as through catastrophe and resilience bonds and flood insurance (Thistlethwaite & Henstra, 2017; Zerbe, 2019). The results of risk-sharing include enhanced societal flood resilience, less costly flood recovery costs for municipalities, and a reduced need for municipalities to pay for flood-focussed adaptation of public infrastructure (Zerbe, 2019).

The involvement of property-owners in the latter two risk-sharing methods—cost and responsibility sharing for flood risk reduction—has been the subject of a considerable amount of scholarly debate because of citizens' widespread unwillingness, inability or lack of knowledge to adopt flood risk-mitigating behaviour (Botzen et al., 2019; Bubeck et al., 2017;

Kuhlicke et al., 2020; Oakley et al., 2020; Raška et al., 2020). Whereas the increased expectations for citizens' involvement in FRM requires a "new social contract" to be drawn up between governments and individuals, in many countries pursuing FRM, the heightened role of citizens in flood risk mitigation is as yet implicit and discretionary (Kuhlicke et al., 2020; Thaler et al; 2019, p. 1074). Meijerink and Dicke (2008) caution that if governments are moving in the direction of FRM, associated changes must be institutionalized in practices, policies or budgets or else give rise to a problem in which, "states count on the risk preparedness of its citizens, while the citizens trust their government to take care of them" (p. 510). The profound lack of awareness of and preparedness for flood risks among Canadians, as well as the many weaknesses in Canada's flood risk governance model outlined above suggests that at the very least, FRM is not yet institutionalized in practice (Environics Analytics, 2021; Ziolecki et al., 2020).

One way that municipal governments are attending to the inaction of residents in FRM is through risk communication, a non-structural tool of FRM. Communication of flood risk can help to link experts' expertise with the development of local-level flood resilience (Rollason et al., 2018). It can also enlighten the public about their responsibility for flood risk mitigation. Upon their discovery that 73% of Dutch citizens view flood protection as primarily a government responsibility, Terpstra and Gutteling (2008) prescribed clear communication about individuals' and the government's changing roles in FRM, as well as risk communication that is able to invoke a sense of urgency in citizens in terms of activating risk perception. Risk communication serves a variety of FRM objectives as well as those of disaster risk reduction at large: awareness raising, motivating and reinforcing behaviour(s) toward a specific risk, and facilitating the involvement of all actors in decision-making (Höppner et al., 2012). Through the processes of awareness raising, mutual decision making, and more, there is evidence that flood risk communication can positively influence individuals' decisions to implement structural flood risk mitigation measures and to purchase flood insurance (Botzen et al., 2013; De Boer et al., 2014, Haer et al., 2016). Thus, while the evidence suggests that municipalities are not poised to participate as extensively in all phases of FRM as is expected of them, they may attempt to share the burden of flood risk mitigation and adaptation with their constituents. To do so, municipalities must effectively communicate their expectations of citizens for flood risk mitigation, and, importantly, motivate citizens to uphold these expectations.

Part 2: Flood Risk Communication

2.4 Flood Risk Communication Practice in Canada

Risk communication is defined and studied differently across disciplines (e.g., public health, food science, disaster management) (McComas, 2006). Its intended outcomes vary even within disciplines; whereas some risk communication efforts intend to raise audience's awareness or change audience's views of risk, others go a step further and strive for audience participation in risk management (Frewer, 2004). Common among most descriptions of risk communication is that it is a necessary component of risk management, and it involves the exchange of risk information between experts (e.g., regulatory practitioners, academics, interest groups) and the public (McComas, 2006). Figure 3 represents one scholar's interpretation of the objectives of disaster risk communication, and highlights that risk communication encompasses all phases of the hazard cycle.



Figure 3. Risk communication objectives during all phases of the hazard cycle (i.e., mitigation/preparation, response and recovery) (Höppner et al., 2012).

The importance of risk communication in reducing disaster risks is articulated in the 2015 Sendai Framework for Disaster Risk Reduction, whose first priority “Understanding Disaster Risks”, centers on improving hazard information availability and accessibility for all (United

Nations, 2015). As a signatory of the Sendai Framework, Canada's 2019 Emergency Management Strategy similarly lists "Improve understanding of disaster risks in all sectors of society" as its second priority (Canada, 2019). As it relates to flood risks, this priority has taken the form of *Flood Ready*, a national public awareness campaign (Government of Canada, 2022b). The *Flood Ready* campaign was first announced at Canada's 2016 Roundtable on Disaster Risk Reduction, which focussed on the Sendai Framework's first priority (Canadian Underwriter, 2016). The *Flood Ready* website provides general tips about flood risk preparedness at the property- and community-level, but when it comes to more specific flood risk information, the website urges users to visit their provincial and territorial websites for more detailed resources, noting that, "Your provincial or territorial government is responsible for providing flood information to its residents, including flood maps and emergency preparedness information." (Government of Canada, 2022b).

Provincial/territorial governments are mandated to ensure the public's access to information on disaster risks. The federal government prescribes provincial partnerships with municipalities, non-governmental organizations, the private sector and communities to achieve effective education and outreach on disaster risks (Canada, 2019). Indeed, flood risk communications by local governments are generally more extensive and frequent than associated provincial/territorial initiatives (e.g., City of Calgary's residential flood preparedness [guide](#) (2021) versus the province of Alberta's equivalent [guide](#) (2017)) given that they can engage with their constituents more directly than upper levels of government; address local levels of flood exposure (e.g., local topography, municipal stormwater system characteristics); and relay appropriate emergency response measures due to their mandate for emergency response (Canada, 2019; Sandink, 2016). A quick scan of several large municipalities' websites finds that most have a landing webpage for flood information. Many also maintain social media pages dedicated to emergency management and/or post flood-related information on their main municipal social media account. The information varies in its scope; some websites host flood maps (e.g., City of Calgary), others have developed extensive guides for action before, during and after a flood (e.g., City of Moncton), and some redirect viewers to external websites (e.g., conservation authorities, ICLR, IBC, the Intact Centre) for more detailed information (e.g., The City of Toronto).

Flood risk communication is not only a function of Canadian governments; insurance companies and insurance broker associations, academic organizations and housing agencies are among the growing number of stakeholders who inform the Canadian public about flood risk and options for its mitigation by way of home flood protection guides and annual flood risk awareness campaigns, to name a few (CMHC, 2022; CRC, n.d.; IBC, 2018; ICLR, n.d., ICCA, 2020a). A collection of stakeholders who are missing from the above group are real estate agents and property sellers, who some scholars assert should be required to disclose flood risk information to potential buyers (Thistlethwaite et al., 2017). Although there is a plethora of stakeholders who provide flood risk information to Canadians, Canadians appear to expect, and even prefer this information from government sources. A 2021 survey of Canadians living in flood risk hazard areas found that people seek disaster preparedness information from the Internet (source unspecified), followed by the government (Environics Analytics, 2021). Focus groups with the same demographics and geographies of Canadians revealed that local governments were the top choice for natural hazard risk preparedness information (Andrey et al., 2022). A Canadian study by Evans and Feltmate (2019) found that residential participants wanted to receive flood risk information from sources that were not trying to sell them anything, hence, government was among their preferred flood risk educational resources. Coupled with calls for enhanced local-level responsibility for FRM, (see Section 2.3) municipal governments emerge as important communicators of flood risk mitigation information to the public (Canada, 2018).

That flood risk communication has become a core feature of Canada's disaster risk reduction and emergency management strategies represents an advancement toward more collaborative models of flood management. Still, in their comprehensive review of FRM in Canada, Golnaraghi et al. (2020) assert that "Effective flood risk communication is one of the most significant gaps in FRM in Canada" (p.29). The poor quality and availability of flood maps across Canada—as outlined in Section 2.3—contributes to the disparaging comments by Golnaraghi et al. (2020). However, national guidelines for the preparation of flood hazard and flood risk maps exist, (i.e., Federal Flood Mapping Framework, Federal Geomatics Guidelines for Flood Mapping), and the federal government recently invested \$63.8 million in a flood hazard mapping program for provincial and territorial governments (the Federal Hazard Identification and Mapping Program (FHIMP)) (Government of Canada, 2022b; 2022c). It is too

early to tell whether the FHIMP will positively impact experts' and the public's understanding of flood risk. Given that flood maps across Canada are actively undergoing changes, they will not be the flood risk communication format under focus in this study. This study is concerned with risk communication that is not standardized nor the focus of coordinated improvements. Similarly, flood risk communication that occurs as a response to an imminent or ongoing flood (i.e., warnings and advisories) will not be considered in this study. Flood warnings and advisories are fundamentally different from mitigation-oriented risk communication, which takes place outside of a crisis situation. During an active emergency, disaster managers are providing real-time information as the situation unfolds, thus, they are often relying on information that is incomplete (Thomas et al., 2007). This study is concerned with flood risk information of a preventative nature.

Moreover, the focus of this study is defined as communication concerning household and community-level flood risk mitigation. This study focusses on this form of flood risk mitigation communication as delivered to Canadians by municipal governments, whether or not the municipality designed or developed it (i.e., external resources that municipalities use will be considered).

2.5 The Need for Improved Flood Risk Communication in Canada

As scholars explore all manner of political and social changes involved in the shift toward FRM, the importance of public involvement in flood risk mitigation becomes more apparent (Hegger et al., 2016; Henstra et al., 2018; Klijn et al., 2012; Plummer et al., 2017; Raška et al., 2020; Sayers et al., 2015). Individuals can significantly reduce the risks and damages associated with flood events by adopting personal flood risk mitigation measures at the household level. The efficacy of private flood risk mitigation in reducing losses from floods has been strengthened by studies in central Europe, in which researchers compared damages to private property resulting from successive flood events to determine that the implementation of structural flood protection after the first flood event most strongly contributed to the decrease in economic losses for authorities and citizens following the second event (Bubeck et al., 2012a; Wind et al., 1999, Fink et al., 1996). Further, there are estimates that removing furniture and other assets in the home in advance of a flood event can reduce residential flood damages by up to 80% (Egli, 2002). Insurance is also effective in its ability to reduce losses from flood damages because it finances recovery. Insurance may also contribute to policyholders' flood

risk preparedness because the risk-based pricing model conveys the level of risk through price signals, and consequently, it may promote auxiliary risk-averse behaviours (Filatova, 2014). The value of personal flood risk mitigation measures makes Canadians' low levels of awareness of and preparedness for flood risks all the more concerning. Gray-Scholz et al. (2019) describe the state of flood risk awareness in North America as "one of the most vexing problems for public officials and emergency managers" (p.1).

Despite the increased availability of information on natural hazard-related risks and measures of preparedness, there remains a mismatch between the public's perception of flood risk and actual flood risk in Canada. When asked about the natural hazards and extreme weather-related risks facing their communities, floods—Canada's most common natural hazard—were named the greatest risk by only 42% of Canadians (Taylor-Butts, 2015). Low flood risk perception might be explained by the fact that not all Canadians have experienced a flood or live near a floodplain. However, flood experience and proximity to a flood hazard area show mixed results on Canadians' flood risk perception (as measured by risk awareness). A recent survey found that Canadians with recent experience with natural disasters—the type of hazard was not specified—were found to be more aware of their local hazard risk relative to those without experience (Public Safety Canada, 2021). The effects of physical vulnerability on natural hazard risk awareness are unclear, given that two separate Canadian surveys of those living in moderate to high-risk hazard areas did indeed find heightened awareness of locals' specific hazard risks relative to those who did not reside in those areas (Environics Analytics, 2021; Public Safety Canada, 2021). A study of Calgarians living in a flood-prone area also found that various geographic factors (i.e., elevation of the property above the river, sightline to the river) were significant predictors of awareness (Gray-Scholz et al., 2019). However, the results of a 2020 survey of Canadians living in designated flood risk areas found that a mere 6% were aware of their flood risk and nearly half (47%) were unconcerned about floods (Ziolecki et al., 2020). In the survey by Ziolecki et al. (2020), it is unknown what proportion of those who were aware of (6%) and concerned about flood risks (53%) had flood experience.

Even though one's physical vulnerability and experience with a natural hazard can increase their awareness, one's preparedness may be relatively unaffected. Canadians with past disaster experience and/or who lived in a moderate- to high-risk area were only 10% more prepared for future hazard risks relative to those without experience or those who lived

in low-risk areas (Public Safety Canada, 2021). As for flood risk preparedness, just over 30% of participants had installed backwater valves and sump pumps in each survey (Environics Analytics, 2021; Zirolecki et al., 2020). Canadians' limited preparedness for flood risk is also evident in the relatively low uptake of flood insurance, which was estimated to have been purchased by 34% of eligible Canadians in 2019 (IBC, 2019). Although, even if the market penetration of flood insurance was high, flood insurance not yet available in the areas of Canada most at-risk of experiencing overland floods, which renders it of little practical use in advancing flood risk resilience across Canada (Thistlethwaite et al., 2020).

Public "passivity" towards flood risk is not unique to Canada. For examples, scholars have observed the same behaviour in the Czech Republic, (Andráško et al., 2020); the Netherlands (Kievik & Gutteling, 2011); the United Kingdom (Park et al., 2020); and Sweden (Grahn & Jaldell, 2019). It is also not a new phenomenon. Researchers have long explored people's inaction toward disasters (e.g., Slovic, Kunreuther & White, 1974). Risk perception figures prominently in this research, as it is widely thought to be a predictor of protective action towards threats (Kohn et al., 2016; Wachinger et al., 2012). Risk perception describes an individual's internalized perception of risk—the hazard, their exposure and their vulnerability—and the results of these risk evaluations are not always consistent with fact. Indeed, in line with the shift toward more integrated perspectives of FRM, recent FRM research recognizes that flood management has focussed on "objective" risk assessments while excluding the "subjective" aspects of flood risk, which affect people's behaviours towards flood risks (Aerts et al., 2018; Lechowska, 2018). Knowledge of risk perception can reveal cognitive (rational) and affective (emotional) processes that are essential to risk judgement and subsequent action; the basis of this science is that high risk perception is associated with negative emotions, so individuals adjust their behaviours to reduce or avoid these negative emotions. Understanding risk perception factors helps decision makers determine the ways that individuals characterize and assess hazards, and as such, it has been increasingly studied in an attempt to anticipate individuals' responses to flood risks (Birkholz et al., 2014; Lechowska, 2018).

To understand the social and behavioural determinants of flood risk perception, researchers turn to behavioural models. Borrowing from the fields of public health, social marketing and cognitive and social psychology, behavioural models used to describe

behaviours towards natural hazards provide causal relationships among risk perception and a variety of proposed explanatory variables involved in behaviour change (Neuwirth et al., 2000). The models most widely explored with respect to natural hazards include the theory of planned action, the protection action decision model, and protection motivation theory (Grothmann & Reusswig, 2006; Terpstra & Lindell, 2013). Protection motivation theory (PMT) is one of the most prominent frameworks used to explain households' decision-making towards floods (Sebauer & Babcicky, 2021). PMT is similar to other behavioural decision theories such that it assumes that motivation for protection results from (a) a perceived threat; and (b) the desire to avoid potential negative outcomes of the threat (Rogers, 1975). Where PMT diverges from related behavioural theories is its inclusion of an individual's perceived control of the threat, coping appraisal (Grothman & Reusswig, 2006). In PMT, the motivation to protect oneself depends on the individual's evaluation of the threat (threat appraisal) against their ability to cope with it (coping appraisal) (Maddux & Rogers, 1983).

In the development of PMT, Rogers (1975) sought to explain how fear appeals—forms of communication that attempt to modify behaviour by arousing fear—can lead to changes in attitudes (i.e., intentions) that can ultimately lead to actual protective responses. The PMT model was revised soon after Rogers' seminal 1975 paper to provide a more general theory for persuasive, rather than fear-arousing, communication (Maddux & Rogers, 1983). The 1983 revisions to the model clarify that PMT does not attempt to explain the behaviour of individuals who are frightened into protective behaviours, it rather encompasses a number of cognitive processes that mediate one's intentions and/or behaviours towards threats, as spurred on by diverse communication stimuli (Maddux & Rogers, 1983). As shown in Figure 4, communication inputs to the PMT model may take the form of environmental sources of information, which is received from others, (e.g., verbal persuasion, observation) and intrapersonal sources, such as prior experience.

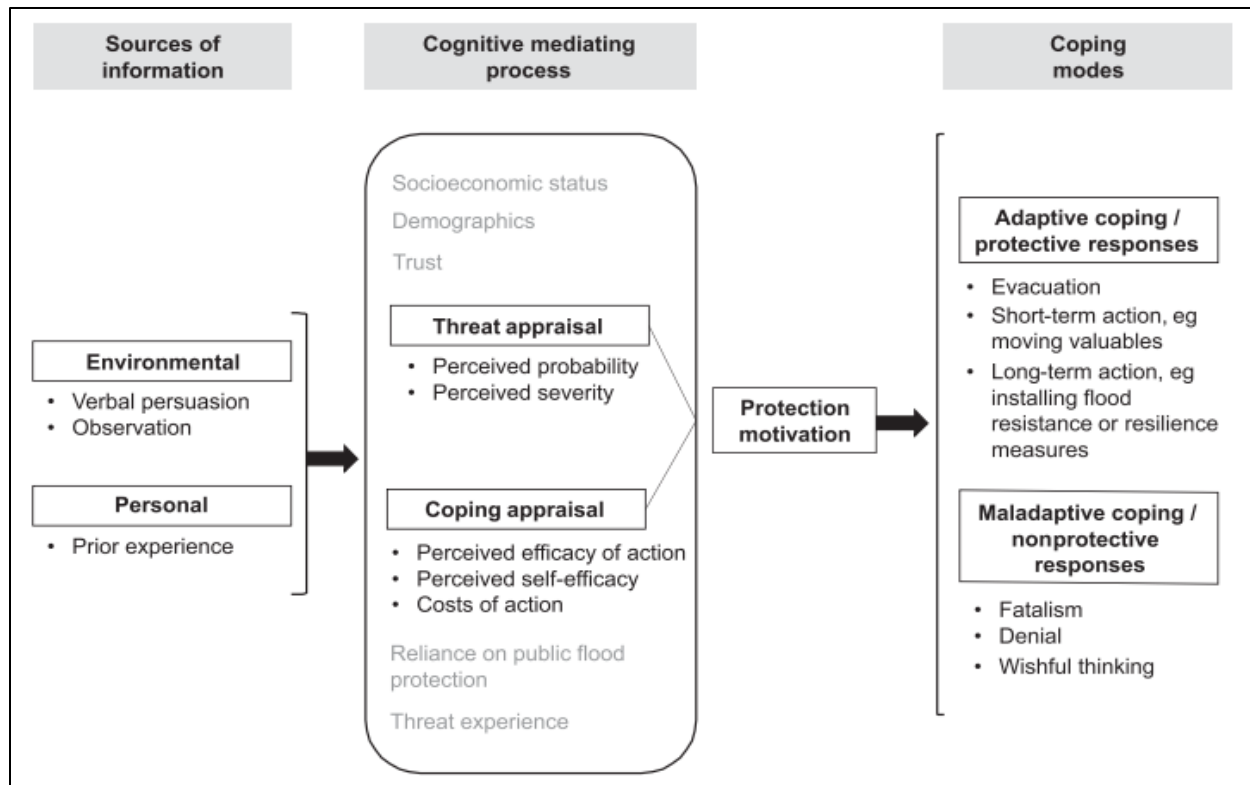


Figure 4. *The PMT framework in the context of flood risk behaviours (Weber et al., 2019).*

Since PMT provides a framework to analyse how sources of information can influence people’s action, or lack thereof, towards a threat, it offers a highly useful framework to understand how flood risk communication might lead to flood risk preparedness. For instance, flood risk communication might attempt to persuade individuals to move their valuables to the upper level(s) of their home by depicting scenes of a flooded basement, which might alter viewers’ threat appraisal. Providing the non-technical, low-cost flood protection measure of moving valuables might act on peoples’ coping appraisal. In turn, as illustrated in Figure 4, the associated protective response is to move valuables out of harm’s way.

Several studies published within the past decade address how PMT might inform flood risk communication. In their 2013 systematic review of flood risk perceptions, Kellens et al. (2013) developed a research agenda for future flood risk research. On the agenda, research on flood risk perception and communication was said to be “still in its infancy” (p. 32) and as such, the determinants and effects of flood risk communication were highlighted as subjects deserving future attention:

It is apparent that many perception studies refer to risk communication in their “further research,” but very few link both. More research should be conducted on people’s information preferences, on the effects of risk information on people’s behavior, and on fostering private adaptation. (Kellens et al., 2013; p. 32).

Studies have since emerged to redress this gap (Altarawneh et al., 2018). Many studies that link risk perception and risk communication use PMT, whether revised or expanded, as their theoretical framework (Banerski et al., 2020; De Boer et al., 2014; Dittrich et al., 2020; Fox-Rogers et al., 2016; Haer et al., 2016; Heidenreich et al., 2020; Rainear & Lin, 2021; Weber et al., 2019).

Moreover, there is an important opportunity for risk communication to target the determinants of flood risk behaviours, and in doing so, more effectively promote flood risk mitigation behaviours (Haer et al., 2016). Whether Canadian FRM stakeholders incorporate the such factors into their flood risk communication strategies is unclear. It would seem that the advancements in flood risk research serve little practical value unless they are able to inform the practices of those who engage with the public about flood risk. It is therefore timely to review the applications of PMT to flood risk communication in Canada as a potential means to inform and improve its nature.

2.6 Flood Risk Communication Theory in Canada

There has been an explosion of Canadian investigations relating to flood risk communication in recent years (Agrawal et al., 2022; Andrey et al., 2022; Bogdan et al., 2021; Evans & Feltmate, 2019; Heldsinger et al., 2018; Henstra & McIlroy-Young, 2022; Henstra et al., 2019; MacIntyre et al., 2019; Minano & Peddle, 2018; Phillips & Rajabali, 2020; Stewart & Rashid, 2011; Zirolecki & Thistlethwaite, 2019). Many of these studies attempt to provide a template for effective risk communication practices in Canada (in addition to a location in the United States (Henstra & McIlroy-Young, 2022)) by drawing on behavioural research and/or primary data on risk communication practice. Three of the listed studies have contributed to flood risk communication conducted on the ground. In their analysis of the Toronto and Region Conservation Authority’s (TRCA) Flood Risk Public Awareness and Education Program, Phillips and Rajabali (2020) note that the TRCA consulted reports by Heldsinger et al. (2018), Minano and Peddle (2018) and Zirolecki and Thistlethwaite (2019) in developing their program. It is

unclear whether this research is similarly informing Canadian municipalities' flood risk communication practices. Much more, it is generally unclear what informs Canadian municipalities' flood risk communication practices given that they are not the sole subject of any existing flood risk communication research in Canada, with the exception of a forthcoming publication by Agrawal et al. (2022). It is therefore timely to assess the relevance and utility of flood risk communication research in Canada in Canadian municipalities, while also addressing some of the gaps in knowledge that this research has brought to the fore.

The findings from the Canadian body of research on flood risk communication align with much of the research on effective, evidence-based flood risk communication conducted outside of Canada (Höppner et al., 2012; Maidl & Buchecker, 2015; O'Sullivan et al., 2012; Rollason et al., 2018). Common among studies of flood risk communication are the following findings/best practices:

- Flood risk information should be tailored to specific audiences, considering demographic and geographic characteristics.
- Flood risk communication should be communicated using simple, non-technical language.
- Public trust in the communicator is an important determinant of the relevancy and efficacy of the flood risk message.
- Addressing the public's risk perception is important for the development of effective flood risk communication strategies.
- Consultation with the public through a two-way dialogue is preferable to one-way communication because it fosters transparency about flood risk and credibility of the flood risk communicator to the public.
- Evaluation of risk communication strategies is necessary, but difficult.

To arrive at the above best practices, several of the Canadian studies solicited input from subject matter experts and practitioners (Henstra & McIlroy, 2022; Ziolecki & Thistlethwaite, 2019). Others solicited feedback from the consumers of flood risk communication themselves (Andrey et al., 2022; Phillips & Rajabali, 2020; Stewart & Rashid, 2011). Similarly, others called on the principles of social marketing (i.e., Community-based social marketing (CBSM)) to guide their recommendations for flood risk communications (Heldsinger et al., 2018; Henstra & McIlroy, 2022; Ziolecki & Thistlethwaite, 2019). Another proposed theoretical framework to support flood risk communication development is the mental models approach, which can effectively capture potential divergences between individuals' and experts' conceptualization

of risk (Heldsinger et al., 2018; Henstra & McIlroy, 2022). Indeed, the mental models approach was the only framework used by researchers that measures people's risk perception. The CBSM framework, on the other hand, operates by leveraging people's desires to abide by social norms to promote sustainable behaviour (McKenzie-Mohr, 2011). CBSM principles and tools are focussed on achieving pro-environmental behaviours, which is a fundamentally different goal than achieving protective behaviours; the former is underlain by the adjustment of behaviours in response to social norms, the latter, the adjustment of behaviours in response to perceived risks. Scholars have pointed out that the influence of risk perception might outweigh the influence of social norms for some people, and as such, there is a need for research that considers the interaction of risk perception and CBSM (Smith et al., 2019). Evidence to support the potential interaction of risk perception and social norms is evident in the research that asserts that risk perception can be borne out of cultural norms (Yonge et al., 2017).

As studies of individual flood risk mitigation behaviour continue to emerge in the flood risk research space, there are calls for methodological standardization in the measurement and analysis of flood risk perception in order to: determine evidence of causality through experimental and longitudinal designs (Kellens et al., 2013); refine existing theories to increase the robustness of their assumptions and implications (Kuhlicke et al., 2020) and increase comparability and generalizability of evidence to bridge findings across studies (Seebauer & Babicky, 2021). Thus, one gap in the Canadian flood risk communication research landscape is that methodology for measuring flood risk perception and behavioural intentions is absent, or, at least, it is not standard; this is in spite of available theoretical frameworks that would enhance the consistency of the research and allow for greater predictability in audiences' behaviours, such as protection motivation theory (Kellens et al., 2013; MacIntyre et al., 2018).

When people's risk perception and risk awareness are not considered in flood risk communication, communicators run the risk of embracing the flawed wisdom of the 'information-deficit model'. The information-deficit model has traditionally been adopted by scientists and policymakers to broach matters concerning risk or controversial issues; it assumes the public to be ignorant of the phenomenon at hand until experts enlighten them, whereupon the enlightened public will accept this knowledge and risk-adverse behaviours will ensue (Demeritt & Nobert, 2014; Fox-Rogers et al., 2016). Among the many shortcomings of this line of reasoning (e.g., political opposition to the changes being proposed), is the fact that

the model neglects the social, economic and behavioural factors involved in individual decision-making, including people's beliefs, values and risk perceptions. Risk perception, prior flood experience, attitudes towards personal risk reduction responsibility, financial incentives and barriers, socio-demographic characteristics and risk communication are among the growing list of factors shown to affect individual's decision-making towards floods (Birkholz et al., 2014; Entrof & Jensen, 2020; Lechowska, 2018; Oakley et al., 2020). The array of factors involved in individual decision-making underscores the importance of tailoring flood risk communications to the theorized determinants of protective behaviours as well as audiences' geographic and demographic circumstances.

Another gap in the research on risk communication in Canada and elsewhere is an absence of methods for evaluation and validation of risk communication (Maidl & Buchecker, 2015). Evaluating whether risk communications have been successful depends a great deal on the intended outcomes of the communications (McComas, 2006). The goals of flood risk communication, as addressed in the Canadian studies, are to improve the ability for flood risk communication to increase audience's flood risk awareness, preparedness and resilience. Similarly, for the purposes of this study, it is assumed that municipal governments' flood risk communications are intended to increase Canadians' knowledge (awareness) and skills to prevent, mitigate, respond to, and recover from floods (preparedness), as these are the objectives outlined in the federal government's EM Strategy, which ultimately influences all levels of government's EM public outreach and education (Canada, 2019). To achieve these goals requires widespread behaviour change toward flood risk mitigative behaviour among Canadians; therefore, an indicator of "successful" risk communication would be to determine whether risk communication has led to direct changes in the audiences' behaviour—a challenging goal, to be sure. However, a benefit to incorporating models like PMT into risk communication practice is that individuals' behaviours can be predicted based on the hypothesized model. This predictability is valuable for risk communicators given the enduring uncertainty about whether, and how, the communication will elicit the intended behavioural outcomes in audiences (Demeritt & Nobert, 2014).

Only Ziolecki and Thistlethwaite (2019) outlined indicators of flood risk communication efficacy that are currently practiced by practitioners; others proposed theoretical or otherwise vague measures (Heldsinger et al., 2018; Henstra & McIlroy, 2022). An investigation of flood

risk communicators' actual indicators risk communication efficacy should be further explored to advance the literature and to provide practitioners with more options for program and/or communication material evaluation.

Lastly, despite the fact that the research on flood risk communication alludes to challenges experienced by flood risk communicators, the only evidence in Canada of these issues comes from the report by Zirolecki and Thistlethwaite (2019), in which participants representing industry, academia, governments, nongovernmental organizations shared challenges for effective flood risk communication in Canada. Among the main challenges were a lack of collaboration for flood risk communication among relevant stakeholders, and a lack of resources to conduct effective flood risk communication. Additionally, a study by Stewart and Rashid (2011) found that a number of rural Manitoban municipalities lacked the necessary resources and skills to improve their flood risk communications in the decade following the 1997 Red River flood. Since the report by Stewart and Rashid (2011) is dated and specific to rural Manitoba, and it is unknown whether the participants in the study by Zirolecki and Thistlethwaite (2019) represented pan-Canadian perspectives, it appears pertinent to further report on the barriers to flood risk communication efforts across Canada, and to document the existing or potential solutions to resolve these barriers.

Acknowledging the foundation of flood risk communication research in Canada and the associated gaps in knowledge, it becomes pertinent to explore the state and nature of flood risk communication in Canadian municipalities. Upon reviewing the Canadian research on flood risk communication, a conceptual framework was developed to understand the relationships between PMT, risk communication and flood risk behaviour, and to ultimately determine how these concepts may come together to inform evidence-based flood risk communication. The conceptual framework was compared to Canadian municipalities' flood risk communication strategies by way of surveys and interviews.

This study also investigated Canadian municipalities' evaluation of their flood risk communications and identify challenges to risk communication, given that these are both areas in which there is a paucity of knowledge. The subsequent section outlines the integration of flood risk communication best practices with PMT to form the conceptual framework.

2.7 Conceptual Framework

The challenges of motivating individual action on flood risk are commonly discerned through PMT because of the “fitness” of the framework (Westcott et al., 2017, p.6). Originally applied in health sciences (Floyd et al., 2000), researchers have heeded the advice of Grothmann and Reusswig (2006), who were among the first to apply PMT to a study of flood behaviours, to expand the framework to aid in the understanding of behaviour towards natural hazards. PMT has been applied in the context of earthquakes (Lindell & Perry, 2000; Mulilis & Lippa, 1990), wildfires (Martin et al., 2008), floods (see above), and more. Floyd et al. (2000) state that PMT is applicable for, “any threat for which there is an effective recommended response that can be carried out by the individual” (p. 409). Hence, PMT can be applied to a variety of behavioural problems in society to understand the divergence between experts’ recommendations for protective action against individuals’ uptake of those actions.

In PMT, the cognitive path to protection motivation is stepwise. First comes threat appraisal, which is composed of two cognitive (rational) components: perceived risk, which is described as an individual’s assessment of the probability of a threat (is this likely to occur to me? Am I vulnerable?), and risk severity, which is described as their perception of the consequences of a threat (how bad will the damage be?). PMT suggests that the cognitive process of threat appraisal may evoke an affective (emotional) response, such as fear or worry. Whether fear is required to proceed to the next phase is contested (Bamberg et al., 2017). Nevertheless, one’s assessment of the risk severity and their vulnerability to the risk precedes coping appraisal. Coping appraisal involves an individual’s assessment of how they might respond to the threat. It consists of two components: response efficacy, meaning the perceived effectiveness of a protective response, and self-efficacy, which refers to one’s beliefs about their ability to carry out that response. In determining whether or not one is able to take an effective protective action, an individual may weigh the associated costs (response costs) and benefits (response efficacy) of the action. Response costs (e.g., money, time, effort) influence whether the process carries on to form an intention to protect oneself and ultimately, a protective response (Bubeck et al., 2018). Coping appraisal may be undermined if response costs are deemed to be too great.

Protection motivation is an intervening variable between learning about a threat and deciding to act on it—it does not necessarily provide a measure of actual behaviour, but of

behavioural intentions (Maddux & Rogers, 1983). When both threat appraisal and coping appraisal are high, they combine to form protection motivation, which directs one's activity toward protective responses. The outcome of these two perceptive processes may lead to one of two responses: protective or non-protective responses (Grothmann & Reusswig, 2006). The former prevents harm, financial, physical or otherwise, and the latter does not—with the exception of psychological harm (e.g., denial, fatalism). In the context of personal flood risk mitigation, protective responses include property-level measures such as installing window well covers and clearing eavestroughs of debris, and they also refer to non-structural responses such as purchasing overland flood insurance and disseminating flood-related information among social networks.

To capture the literature on PMT and flood risks, a literature review was completed. During July and August 2021, an electronic search of PMT was conducted for the years 1975-2021 on the databases Web of Science and on Scopus. The year 1975 was selected as the lower end of the literature search as it is the year that Protection Motivation Theory was developed (Rogers, 1975).

PMT literature were selected based on four criteria adapted from a meta-analysis of flood risk perception and risk communication by Kellens et al. (2013).

- (1) The work is peer-reviewed;
- (2) The research is based on empirical data that relates to homeowners and/or tenants, or at least private actors;
- (3) The research is applied to flood risks (e.g., river, storm surge, pluvial, etc.);
- (4) The perception of, or the public attitude toward flood risk is measured (either qualitatively or quantitatively) using a framework guided or influenced by Protection Motivation Theory.

In order to find as many articles as possible in this context, the following search keys were designed to be searched for in the title, abstract, and keywords of all entries in Scopus and Web of Science, respectively.

flood* AND {protection motivation theory}

and

flood* AND "protection motivation theory"

The use of an asterisk enabled finding articles with “flood,” “floods,” or “flooding”. Curly brackets around “protection motivation theory” ensured the search results conserved the exact phrase in Scopus, and double quotation marks ensured the same for Web of Science. The total number of articles found in both databases (Scopus and Web of Science) was 96 (44 and 52, respectively). By removing 41 duplicates, the net number was reduced to 55 articles. The abstract of each article was then reviewed, which led to the removal of 7 articles that were out of scope. The net total of articles was 48.

Eight of the 48 articles focussed on the relationship between PMT and risk communication, and some alluded to the implications of the research on risk communication. The results of the literature review informed the development of the conceptual framework. A conceptual framework is a useful tool to guide the development, collection, and analysis of research, especially qualitative research, when one theory fails to completely address the phenomena being study (Walden University, n.d.). Conceptual frameworks show relationships among ideas and variables in relation to the research study; they include one or more formal theories as well as related concepts and empirical findings from the literature to show these relationships (Walden University, n.d.). PMT alone does not provide a framework for flood risk communication, it must be combined with risk communication concepts in order to do so. Then, PMT can be “superimposed” onto flood risk communication strategies via a conceptual framework (Westcott et al., 2017, p. 7). A summary of key findings concerning flood risk behaviours and PMT is outlined below.

Threat appraisal is in essence an individual’s risk perception (internalized perceptions of hazard, exposure and vulnerability) (Rainear & Lin, 2021). As empirical studies on flood risk behaviours test the influence of risk perception on flood risk mitigation, risk perception repeatedly fails to predict individual flood risk mitigation (Babcicky & Seebauer, 2019; Poussin et al., 2014). For instance, even if one’s risk perception of a hazard is high, denial (a non-protective response) can dampen the negative feelings associated with the high risk perception—as can the perceived inability to control one’s risk, which can lead to apathy (another non-protective response) (Bubeck et al., 2012b). Additionally, fear, which is often the product of threat appraisal, has been shown to be initially effective in altering individuals’ behaviours, but this efficacy dwindles with time, and it also may be undermined if the level of fear is too great (Grothmann & Reusswig, 2006; Richert et al., 2017). High levels of fear can lead

to paralyzing effects such that the individual is too overcome by fear to act (Banerski et al., 2020). Further, results consistently reveal stronger empirical correlations between coping appraisal and flood mitigation behaviours than between threat appraisal and flood mitigation behaviors (Botzen et al., 2019; Bubeck et al., 2013; Grothmann & Reusswig, 2006; Kievik and Gutteling, 2011). For instance, a high degree of self-efficacy, the belief in one's abilities to control their threat risk, positively influences receptivity to flood related information and the uptake of mitigation measures (Bubeck et al., 2013).

Additionally, expanded frameworks for PMT have been shown to better explain individuals' adaptative behaviour towards floods than the two variables of threat and coping appraisal and their four components. Prior flood experience, social capital, trust, reliance on public flood protection are among the constructs that have been added to the 1983 version of the framework (Andráško et al., 2020; Babicky & Seebauer, 2019; Grothmann & Reusswig, 2006; Hudson et al., 2020; Rainear & Lin, 2021). Demographics including age (Heidenreich et al., 2020; Pagliacci et al., 2020; Tabe-Ojong et al., 2020) and income (Bubek et al., 2012; Grothmann & Ruesswig, 2006) may also influence one's protection motivation towards floods.

The potential implications of integrating PMT with risk communication practices are valuable, but unexplored in Canada. PMT has been applied to assess household's attitudes and behaviours toward flood risk in Europe (Andráško et al., 2020; Bubeck et al., 2018; Grahn & Jaldell, 2019; Grothmann & Reusswig, 2006; Pagliacci et al., 2020; Poussin et al., 2014; Raška et al., 2020; Richert et al., 2017), Ghana (Tabé-Ojong et al., 2020), Vietnam (Reynaud et al., 2013) and the United States (Botzen et al., 2019). It has also been used to inform flood risk communication in Europe (Banerski et al., 2020; De Boer et al., 2014; Dittrich et al., 2020; Haer et al., 2016; Heidenreich et al., 2020; Weber et al., 2019), the United Kingdom (Fox-Rogers et al., 2016) and the United States (Rainear & Lin, 2021).

The literature suggests that the content of flood risk communication should focus on the potential of flood-mitigation measures to effectively reduce or avoid flood damage, as well as on information about how to implement such measures in practice (i.e., to stimulate coping appraisal). Communicating the risk (probability and consequence) of a flood is, however, required to raise threat appraisal above a certain threshold to register as a concern to an individual. Messages should activate threat appraisal by explaining the level of risk and the

severity of consequences, but the emphasis should be placed on conveying the efficacy of available mitigative responses. As for the delivery of messages, the top-down strategy fails to stimulate threat appraisal because it is unable to address the specific risk perceptions and concerns of individuals and communities. In contrast, a bottom-up approach to conveying flood risk communication can be designed to address the information needs of the public.

Most studies that extend PMT onto flood risk communication do not parse out specific language for communication, they rather provide recommendations for risk communication practices (Banerski et al., 2020; De Boer et al., 2014; Dittrich et al., 2020; Fox-Rogers et al., 2016; Haer et al., 2016; Heidenreich et al., 2020). As such, the following conceptual framework outlines specific interventions that are predicted to lead to mitigative outcomes.

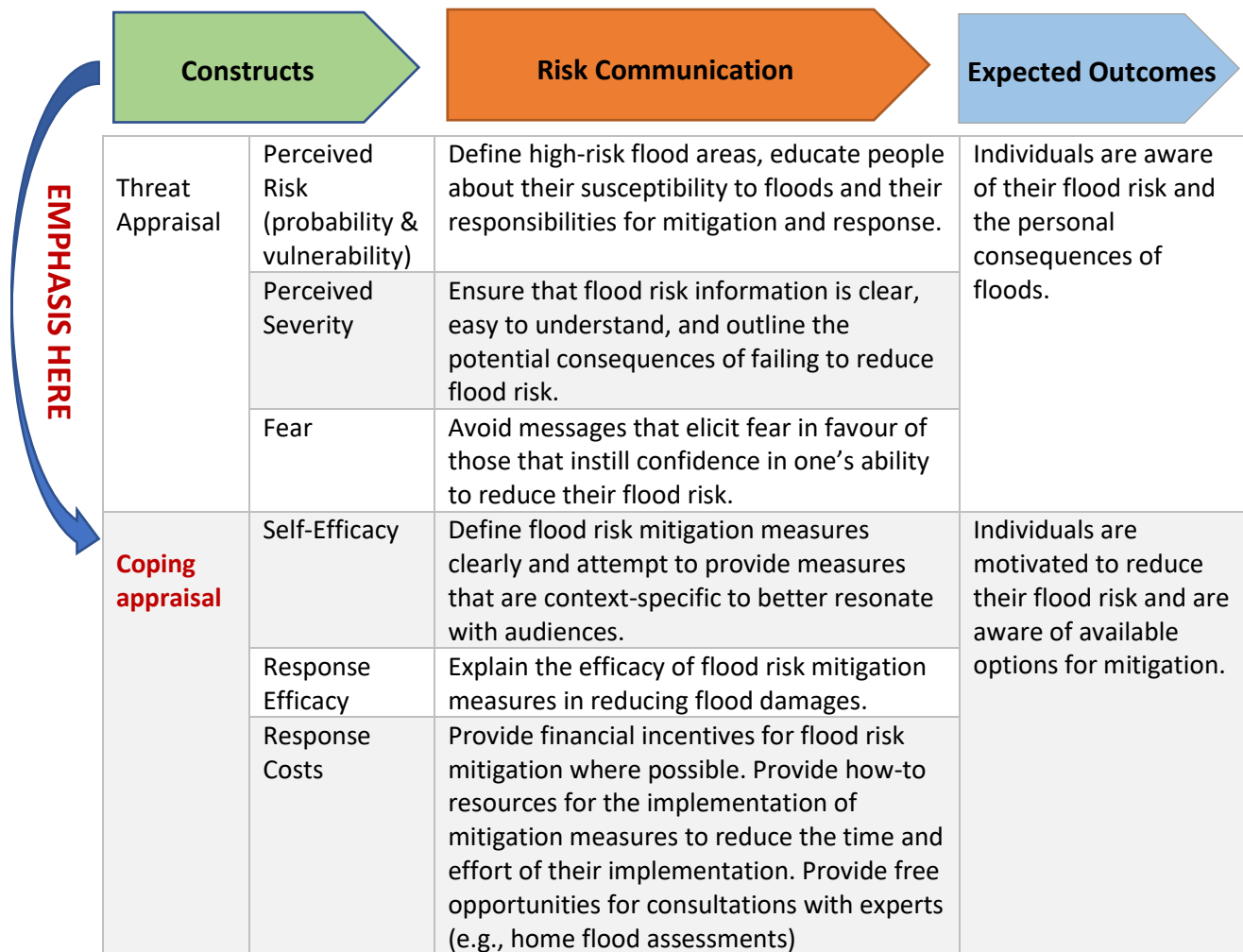


Figure 5. A conceptual framework of the application of PMT to risk communication.

Chapter 3.0 Methodology

3.1 Methodological Approach

This chapter describes the research methods applied in the qualitative study. The purpose of this section is to detail the qualitative methods used to assess the state of key Canadian flood risk communicators' (FRCs), and especially municipal FRCs' (MFRCs), risk communication in the context of personal flood risk mitigation. This chapter analyses the methodologies used to conduct the surveys of 19 municipal staff and interviews of 21 subject matter experts by describing the recruitment of participants, survey and interview methods, data collection, and coding analysis undertaken. This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #43487).

This research takes a qualitative approach to advance the understanding of the motivators and barriers to individual action on home flood protection in Canada. The research questions and direction are guided by PMT and risk communication theory. In the first phase, an integrated PMT-risk communication conceptual framework was developed by conducting a literature review (Chapter 2.0). Then, a critical review of flood risk communication content from the sample municipalities was conducted to scope the nature and state of these resources (Section 3.2). The results of the critical review and the conceptual framework informed the development of surveys and interviews targeted to relevant Canadian FRCs. Surveys offered clear, meaningful comparisons between evidenced-based risk communication strategies and that which is currently taking place on the ground in Canada. Then, interviews allowed for more nuanced comparisons between theory and practice, and offered meaningful insights for the implications of the current state of flood risk communications on FRM.

Owing to the research design and the small sample sizes, statistically generalizable insights cannot be drawn from the survey or interviews (Creswell & Creswell, 2018). Research activities were designed to generate qualitative feedback on the design, delivery, and challenges of flood risk mitigation communications by a representative sample of Canadian stakeholders. Nevertheless, the contributions of this research to theory and practice are valuable for disaster management and risk communication, which have been identified as requiring theory development (Thomas et al., 2007). Insights from the surveys and interviews do not serve as generalizations so much as a baseline for which further exploration of flood risk communication may occur.

3.1.1 Paradigms, Epistemological and Ontological Considerations

The underlying philosophy of one's research guides the choice of questions to explore and the means to attempt to answer them (Creswell & Creswell, 2018). Thinking critically about which ontology and epistemology is adopted in one's research eases the researcher's process of identifying what is most important in the research topic at hand (Fryer, 2020). This qualitative research design will be guided by a pragmatic approach within a critical realist ontology and constructivist epistemology.

Flood risk mitigation is a timely issue. Practical solutions to encouraging residential flood risk reduction must be developed based on the best information available. The 'best' information in this context is that which reveals what would best motivate Canadians to become involved flood risk reduction. In this study, PMT is brought forward as a potential explanatory mechanism for individual flood risk behaviours. Critical realism accepts that theories such as PMT may be accepted as potential causal mechanisms for phenomena, dependent on context and subjective meanings, but not as "universal law" (Fryer, 2020). Indeed, the predictive power of PMT is unclear and may be context-specific (Bamberg et al., 2017; Kuhlicke et al., 2020). The role of context must be addressed in the epistemology, especially given that this research study takes place in Canada, but is generalizing from other parts of the world. Further, the epistemological assumptions for understanding this research approach are constructivist, which supposes that knowledge is the product of social development and interaction (Creswell & Creswell, 2018). At the core of this research problem is the mismatched perception of flood risk and probability between experts and the public. The existence of this flood risk perception gap suggests that people's understanding of the world is subjective and does not always reflect objective reality. In this way, risk can be considered as a judgement, not a fact (Aven & Kristensen, 2005).

3.2 Flood Risk Communications Audit

Prior to conducting surveys and interviews of municipal staff, it was necessary to gain an understanding of the nature and state of the flood risk communication resources available to Canadians. Thus, a critical review of the available digital flood risk communication resources of all municipalities in the survey sample was conducted. The review determined whether or not the municipality had an online repository of flood risk communication resources available

to the public, and the general characteristics of those resources (e.g., the proposed structural and non-structural protective actions, existing subsidies, the use of graphics and maps). The language and the framing of the discourse were largely not considered in the review. Additionally, as mentioned above, examining specific features of available flood maps is beyond the scope of this study.

During the critical review, the researcher detected the presence of themes that pointed to several MFRCs’ promotion of community-level flood resilience (versus household-level flood resilience). The positive role of social capital on protective motivation has been proposed (Babcicky & Seebauer, 2017); as such, it was determined that information related social capital should be included in the review. Social capital is not material—it encompasses the resources such as trust and support linked to social networks; hence, inductive codes were developed to detect words and meanings linked to this feature. For instance, “Talk to your neighbour about flood risk”, aligns with the values of community flood resiliency according to the literature on flood risk communication, but it requires a different process to detect than statements concerning insurance or structural flood mitigation measures, which are more direct (e.g., “Install window well covers on basement windows”). Codes are presented in Table 1.

Codes were developed by reviewing the literature on social capital and flood risks (Babcicky & Seebauer, 2017; Kuhlicke et al., 2020; Lechowska, 2018; Rufat et al., 2020), as well as reviewing the best practices for flood risk communication developed by practitioners and researchers (Heldsinger et al., 2018; Ziolecki & Thistlethwaite, 2019). It is assumed that the words in Table 1 share the same meaning (Vaismoradi et al., 2013).

Table 1. *Community-level flood resiliency codes*

| Risk Communication Construct | Proxies |
|------------------------------|---|
| Community flood resiliency | communit*, friend*, family*, neighbour*, together, collab*, help*, share, network |

Results of the communications audit can be found in Appendix A. All resources in the audit were accessed on Google using a generic search term consisting of: “Flood risk mitigation for residents of [X municipality]”. Google was used because it is the most popular search engine in Canada (Statista, 2022). It is unlikely, however, that all residents would arrive at these resources in the same manner as the researcher. Inherent to this study is the assumption that

municipalities are important flood risk messengers to their constituents; even so, it is misguided to assume that residents would unanimously favour their municipal government as the first source of information on flood risks. Much more, residents may not be actively looking for information on flood risk mitigation when they encounter it. Thus, to understand municipalities' online presence with respect to flood risk information, as well as how residents might come to learn about personal flood preparedness initiatives in their localities, the researcher assumed the position of an urban resident keen to learn about flood protection.

The researcher conducted three tests in three different locations to determine whether the generic search term “flood prevention” instead of “flood protection in [municipality]” would generate results from municipal websites and/or social media channels. The researcher conducted this search in three cities included in the study, Vancouver, Toronto and Ottawa, during personal visits. Since Google defaults to track users' locations unless otherwise disabled, most results are targeted to a user's geolocation.

In each of the three tests conducted, local municipalities were among the top five sources in the results list. For instance, the City of Vancouver's flood risk reduction webpage was the third search result generated when the researcher was located in Vancouver. The City of Vancouver's website came after that of the federal government and was followed by several neighbouring municipalities' websites, as shown in Figure 6. Paid advertisements for products and/or services for flood protection were the top result in all three tests. Moreover, it is conceivable that a resident of any of the municipalities in the sample would be met with their own

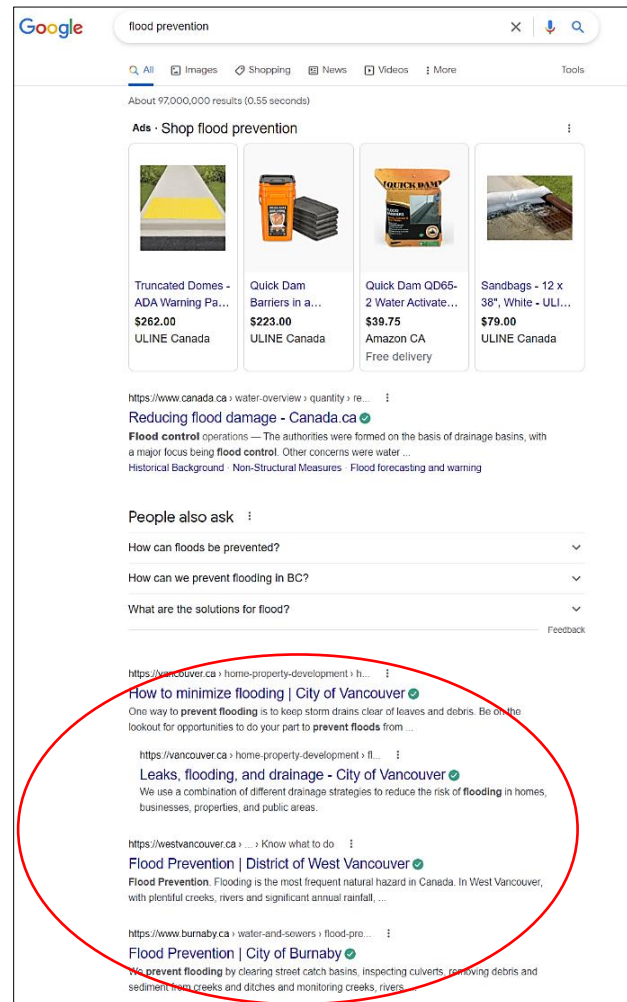


Figure 6. Search results from a Google search of “flood prevention” when the researcher was located in Vancouver, BC. (Google, 2022)

municipalities' and/or local municipalities' flood risk communication resources when looking up a generic phrase related to flood risk online, assuming their location services are enabled.

The resources analysed were only those that are available online; as such, they do not represent the extent of municipalities' flood risk communications—in-person events, posters and mailers are non-digital flood risk communication channels commonly employed by Canadian flood risk communicators (Partners for Action, 2020). Hence, surveying municipal representatives is necessary to learn about the sample municipalities' flood risk communications that are not accessible online. Additionally, since the audit only analyses the finished communication product, surveys are required to gain insight about the methods and information underlying the choices made in designing, developing and delivering flood risk communication messages with respect to geographic, social and behavioural considerations.

3.3. Survey

3.3.1 Purpose and Objectives

The survey addresses:

- 1) The communication channels employed by municipalities for flood risk communication messages to residents;
- 2) The information that municipalities rely on for the development of flood risk messages and educational material and/or program development to residents;
- 3) Municipalities' evaluation of their flood risk communications

The objective of the survey was to explore MFRCs' consideration of PMT constructs and proposed best practices for risk communication in their design and delivery of flood risk communications, and their perceived value of these constructs and practices. MFRCs' alignment with PMT components and risk communication theory has implications on the impact of their flood risk communications and on FRM.

3.3.2 Survey Participants

A review of the organizational structure of all municipalities in the sample determined that a number of municipal divisions have responsibilities for FRM and therefore, many

different municipal staff may be directly involved with or influence the flood risk information that residents engage with (Figure 7).

| Municipal Division | Key content expertise |
|-----------------------------|---|
| Emergency Management Office | Convening other divisions; general emergency management communications and outreach |
| Fire and Emergency Services | Content development with respect to evacuations |
| Police | Content development with respect to evacuations |
| Communications | Review of communication materials, direct contact information such as 311 triaging |
| Stormwater/Wastewater | Urban (pluvial) flooding |
| Engineering | Mapping, mitigation, and remediation studies |
| Planning and Development | Planning policy, permit and regulation public inquires |

Figure 7. An example of the various municipal divisions with expertise in FRM from a study of flood risk outreach and education in the Greater Toronto Area (Phillips & Rajabali, 2020).

Respondents are referred to as municipal flood risk communicators (MFRCs). MFRCs are defined by the researcher as city staff (of legal working age) in emergency services, emergency management, engineering, and associated communications departments in Canada who either: develop, design and deliver flood risk communication messages and/or educational programs to residents, or; oversee the development, design and delivery of flood risk communication messages and/or educational programs to residents. The survey’s sample of FRM stakeholders is reflected in two Canadian studies. Two separate investigations of municipal and provincial/territorial flood preparedness in Canada sought the opinions of senior municipal staff and provincial Deputy Ministers and Senior Advisors, respectively (Feltmate et al., 2020; Feltmate & Moudrak, 2021).

The survey recruitment process involved contacting MFRCs by email using a predetermined recruitment letter. Some municipalities in the sample publicly list the email addresses of all and/or senior staff members of departments/divisions, and thus, the researcher could readily contact staff who were anticipated to be appropriate study participants (i.e., according to the researcher’s definition of a MFRC). For those municipalities whose staff members’ emails were publicly unavailable, the researcher sent the recruitment letter to a generic municipal email address (e.g., the municipalities’ Emergency Management

division email address) or completed an online query form to inquire about the correct point of contact for study recruitment.

Of the 48 MFRCs' contacted between October and December 2021, 19 officials from 18 municipalities were recruited to participate in the survey. Two MFRCs from one municipality, Mississauga, independently completed the survey. A diverse range of professional positions within the 18 municipalities are represented, including emergency management officials (e.g., emergency management coordinators, managers, directors, fire chiefs, public safety officials); engineers; environmental practitioners (e.g., biologists, water coordinators, research officials); and communications specialists. The identities of survey respondents were anonymized.

3.3.3 Study Area

Municipalities are the focus of this study owing to the large social and economic losses they endure from flood events. Historical commerce, transportation and agricultural activities established majority of Canada's villages, towns and cities along rivers, streams or coastal areas and hence, they are flood-prone (Shrubsole, 2013). Capital cities of all provinces and one territory were targeted in addition to 10 major cities that are at high risk of flooding, whether coastal, riverine or pluvial (Moncton, NB, Montreal, QC, Gatineau, QC, Mississauga, ON, Brampton, ON, Saskatoon, SK, Calgary, AB, Richmond, BC, Surrey, BC, Vancouver, BC) (Table 2). Capital cities are all classified by Statistics Canada as medium to large population centres, with the exception of Whitehorse, YT (Statistics Canada, 2017). The 10 additional cities are also medium to large population centres and are associated with the capital city as part of a census metropolitan area (e.g., Gatineau with Ottawa, Surrey with Vancouver). Territorial capital cities of the Northwest Territories and Nunavut were not selected. A 2019/2020 study consulted with the cities of Yellowknife and Iqaluit about their municipal-led residential property flood risk mitigation practices, and they self-reported them as not applicable; thus, it was assumed that the state of residential flood risk mitigation would not have changed in under two years (Feltmate & Moudrak, 2021). However, a municipal staff member from the City of Whitehorse, Yukon was included in the survey because of the city's absence in the aforementioned study. Representatives from Gatineau, QC, Winnipeg, MB, Edmonton, AB, and Victoria, BC did not participate in the survey.

| Municipality | Population |
|--------------------|------------|
| St. John's*, NL | 110,525 |
| Charlottetown*, PE | 38,809 |
| Halifax*, NS | 439,819 |
| Moncton, NB | 75,401 |
| Fredericton*, NB | 63,116 |
| Québec City*, QC | 549,459 |
| Montreal, QC | 1,762,949 |
| Gatineau, QC | 276,245 |
| Ottawa**, ON | 1,017,449 |
| Toronto*, ON | 2,794,356 |
| Brampton, ON | 656,480 |
| Mississauga, ON | 717,961 |
| Winnipeg*, MB | 749,607 |
| Regina*, SK | 226,404 |
| Saskatoon, SK | 266,141 |
| Calgary, AB | 1,306,784 |
| Edmonton*, AB | 1,010,899 |
| Vancouver, BC | 662,248 |
| Surrey, BC | 568,322 |
| Richmond, BC | 209,937 |
| Victoria*, BC | 91,867 |
| Whitehorse*, YT | 28,201 |

Table 2. Municipalities included the survey sample and their population sizes

This study's broad geographic scale is valuable in its ability to highlight a diversity of current strategies, challenges and trends in flood risk communication by Canadian municipalities. Given that this research is indiscriminate with respect to the flood types addressed in risk communications, a large geographic scale is also useful because it captures all flood types experienced in Canada.

3.3.4 Survey Design

Surveys were conducted upon receiving ethics clearance. Upon providing consent for survey participation, participants could access the online survey hosted on Qualtrics survey software using a personalized individual link. Survey data collection took place from October to December 2021. The complete survey can be found in Appendix B.

A 10-question survey was developed upon conducting the preliminary flood risk communications audit and a literature review of PMT and risk communication, from which a conceptual framework was developed (see Chapter 2). The survey measured the four components of PMT as well as its two subcomponents (perceived risk, perceived severity, fear (subcomponent), self-efficacy, response efficacy and response costs (subcomponent)) in addition to five elements of risk communication: communication frequency, communication channels, communication strategy, and communication impact measurement. The application of PMT and risk communication theory to the assessment of municipalities' flood risk communication practices provided an evidence-based framework for which to evaluate the content and delivery of the communication content. Any identified parallels

*Provincial/territorial capital

**National capital

Population counts were derived from the 2021 Census of Population with the exception of Gatineau, for which the latest data was from the 2016 Census.

between municipalities' flood risk communication and the PMT-risk communication framework suggested that municipalities' communication strategies abide by PMT pathways for motivation, and thus were effective under this framework. In contrast, any identified gaps in the communication strategies suggested the need for improvement(s).

Evaluation of Risk Communication Constructs

All ten survey questions explored risk communication constructs:

- Q1. Communication channels
- Q2-Q6. Tailored flood risk communications
- Q7. Frequency of flood risk communications
- Q8-Q9. Evaluation of flood risk communications
- Q10. Trusted sources for flood risk communications

Evaluation of PMT

Measurement of PMT components occurred in questions 6 and 10 of the survey. Whereas most studies of PMT and flood risk test its predictive power on flood mitigation behaviours directly (i.e., sampling residents), this study does so indirectly—through those that interact with residents regarding flood risk (i.e., municipal staff). For example, typical studies of PMT might involve questionnaires wherein researchers ask individuals to rank their neighbourhood's level of flood risk, and their agreeance with statements such as "I know how to protect myself and my property from a flood catastrophe" as measures of threat and coping appraisal, respectively (Heidenreich et al., 2020, p.6). These proxies for PMT are reframed such that participants are asked about the relative importance and utility of PMT components.

Question 6 asked about the relative importance of several PMT constructs in municipal flood risk communications:

6. To what extent are the following objectives important when designing the city's flood risk communication messages and/or flood risk educational programs to residents?

Question 10 about MFRCS' opinions about the potential positive influence of those constructs on personal flood risk mitigation:

10. To the best of your understanding, please rank the following factors in their ability to positively impact residents' participation in residential flood risk mitigation, with 1 being the most impactful in contributing to residents' participation and 10 being the least impactful.

The alignment with the questions and the PMT constructs is outlined in Table 3.

Table 3. Integration of PMT constructs in survey questions 6 and 10.

| CONSTRUCTS | | MEASUREMENT |
|-------------------------|---|---|
| Threat Appraisal | Perceived Risk (probability & vulnerability) | Residents who have previously experienced a flood(s) Residents who perceive floods as being likely to occur |
| | Perceived Severity | Residents with personal contacts who have previously experienced a flood(s) Residents with knowledge about flood-related threats and options for protection |
| | Fear | The message and/or program’s ability to evoke a fear-based response in residents about flood risk (i.e., worry, dread) Residents who are fearful of the consequences of flooding |
| Coping appraisal | Self-Efficacy | Residents who believe that they are capable of reducing their risks to floods |
| | Response Efficacy | Residents with knowledge about flood-related threats and options for protection |
| | Response Costs | Residents with the financial resources to participate in residential flood risk mitigation |

3.4 Interviews

3.4.1 Purpose and Objectives

Findings from the survey revealed the sample municipalities’ flood risk communication approaches relative to the conceptual framework. However, significant gaps in understanding remained about why the municipalities use these practices, and on which bases they are developing their communication approach. Secondary data could not necessarily fill knowledge gaps in these municipal-level flood risk communication trends. Developing a snapshot of the current state of Canadians municipal-level flood risk communication required conversations with subject matter experts in addition to publicly available data.

Additionally, interviews facilitated the triangulation of all data collection method findings. Indeed, triangulation, the accumulation of data across different sources, occurred by exploring similar themes in the content analysis, surveys and interviews (Creswell & Creswell, 2018). Qualitative research is more robust in its inclusion of three research methods, because if

the findings drawn from multiple types of stakeholders and different sources of information result in common outcomes, then they are more than likely to be true outcomes. If they do not yield common outcomes, the hypothesis can be rejected with greater certainty. Along with enhancing the validity of results, data triangulation can be used to create a more detailed picture of a research problem and to interrogate different ways of understanding a research problem (Creswell & Creswell, 2018).

3.4.2 Interview Participants

In conducting the communication review and the survey, it was identified that there are external, non-municipal stakeholders involved in the development and design of flood risk communication to residents (e.g., The Toronto and Region Conservation Authority is responsible for all riverine flood-related resources intended for City of Toronto residents). Overlooking the perspectives of non-governmental, academic and/or industry stakeholders who partner with, or whose communication resources are utilized by municipalities, would not accurately represent the nature and state of municipalities' flood risk communication to residents. As such, exclusively consulting with municipalities would lead to findings that are less relevant for municipalities' existing practices of flood risk communication. A diverse group of subject matter experts and practitioners was sought out to explore themes related to barriers and opportunities for flood risk communication by way of interviews.

There are two groups of participants in the interviews:

- 1) **MFRCs.** As in the survey, municipal flood risk communicators (MFRCs) are defined by the researcher as city staff in emergency services, emergency management, engineering, and associated communications departments in Canada who either: develop, design and deliver flood risk communication messages and/or educational programs to residents, or; oversee the development, design and delivery of flood risk communication messages and/or educational programs to residents.
- 2) **NFRCs.** Non-governmental flood risk communication stakeholders (NFRCs) are defined by the researcher as professionals employed in Canada in a Communications, managerial or related role who either: develop and design residential flood risk communication messages and/or educational programs, or; develop, design and deliver residential flood risk communication messages and/or educational programs to

property-owners. “Non-governmental” is not used in the traditional sense of the term; it is simply used to distinguish from FRCs within government. NFRCs may represent academia, industry, civil society organizations or non-governmental organizations.

MFRC interview participants represent a sample of large municipalities in Canada with a high risk of flooding, whether coastal and/or fluvial and/or pluvial. The municipalities consulted for the interviews are not necessarily those who participated in the survey. The municipalities that MFRC interviewees represent, as well as the identities of MFRCs, were not revealed to protect the identity of participants. Likewise, the names, professional titles and organizations/companies that the NFRCs represent were kept confidential. Interview findings were anonymized with the exception of two participants, who consented to have their name and organization associated with their quotations in any publication resulting from the research. All other participants’ quotations were denoted by “Key informant (KI) #”, and referred to as a MFRC or NFRC, e.g., “KI #5, NFRC”. Participants are referred to as FRCs when describing the entire group of participants.

Theoretical sampling was used to determine the sample size. A hybrid deductive–inductive qualitative approach to coding was employed, meaning that an initial codebook was developed before the interviews took place and additional unique themes emerged during the coding process. Thus, when no new themes were found from reviewing data relating to a category of investigation, it was concluded that the data was saturated. Reaching saturation in thematic analysis has shown to occur at 12 interviews when investigating high-level concepts among a relatively homogeneous group (Ando et al., 2014; Guest et al., 2006). As such, 12 MFRC participants were interviewed (MFRCs are a relatively homogeneous group), and 9 NFRCs were interviewed (n=21).

The interview recruitment process involved contacting MFRCs and NFRCs by email using a predetermined recruitment letter. Some municipalities/organizations/companies in the sample publicly list the email addresses of their employees, and thus, the researcher could readily contact those who were anticipated to be appropriate study participants (i.e., according to the researcher’s definition of a MFRC and NFRC). For those municipalities/organizations/companies whose employees’ emails were publicly unavailable, the researcher sent the

recruitment letter to a generic email address listed on the relevant website or completed a query form on the website to inquire about the correct point of contact for study recruitment.

3.4.3 Methods

Interviews were conducted to obtain a deeper understanding of the flood risk communication practices by Canadian municipalities. Interviews involved an assessment of the relevant organizational practices; inquiries about the associated trends, challenges and opportunities for communication improvement; and an exploration of MFRCs' and NFRCs' thoughts and opinions about flood risk communication. Interviews are not explicitly linked to the survey data, rather, they were used to ground the research in its assumptions and to give meaning to the survey findings. Interview questions were embedded with some redundancy from the survey to ensure consistency among the topics addressed in the data collection. However, subject matter was more general than the survey, and some questions were open-ended to encourage dialogue with participants.

Interviews were conducted upon receiving ethics clearance. Recruitment occurred between January 2022 to March 2022. Once consent was received via an online consent form hosted on Qualtrics, semi-structured interview discussions occurred online using Zoom Video Conferencing. Interviews took place from January 2022 to April 2022. All participants (n=21) consented to being recorded. Meetings were audio recorded to facilitate accurate collection of data and transcribed verbatim by Zoom. Transcripts were subsequently reviewed to detect and eliminate errors resulting from the Zoom transcription software. The duration of the interviews was between 35–70 minutes.

The interview was comprised of six predetermined questions from which the researcher guided the conversation and posed follow-up questions based on participants' responses (see Appendix C). Examples of themes that were explored in the interview include:

- Awareness of and details about flood risk materials/programs promoting individual and community flood preparedness
- Factors that influence residents and/or property-owners when considering personal flood protection actions
- Opinions about flood risk communication channels, data, tools and approaches needed in the future

Following the completion of each interview, some key informants provided additional resources to the researcher by email that they believed would prove useful for the study.

3.4.4 Analysis

The process of establishing themes occurred by assessing patterns in the discussion of various codes, as well as the number of interviewees who discussed a common code. If an interviewee returned to a code multiple times, it was still only counted once to avoid overrepresenting the relevance of any given code. The interview analysis was conducted using NVivo software and was guided by thematic analysis.

Thematic analysis is a widely used qualitative data analysis approach that involves searching for themes that emerge as being important to the nature of the research phenomenon (Xu & Zammit, 2020; Daly et al., 1997). Thematic analysis is both lauded and criticized for its flexible approach to data extraction across different theories, disciplines, and epistemological and ontological positions (Braun & Clarke, 2006). Criticisms of thematic analysis often stem from its inability to be demarcated from other qualitative analytical methods such as content analysis (Crowe et al., 2015; Vaismoradi et al., 2013). To address the methodological murkiness by which data is systemically coded and how themes emerge from the data, guides for thematic analysis use in psychology (Braun & Clarke, 2006), health care (Fereday & Muir-Cochrane, 2016; Braun & Clarke, 2014), sport and exercise (Braun et al., 2017) and education (Xu & Zammit, 2020) have emerged over the last two decades. Data were primarily analysed using Braun and Clarke's (2006) six-phase method of thematic analysis: 1) Familiarizing oneself with the data; 2) Generating initial codes; 3) Searching for themes; 4) Reviewing themes; 5) Defining and naming themes; 6) Producing the report. However, in order to allow for novel observations, coding proceeded using a "hybrid" approach by which deductive and inductive coding methods were employed (Fereday & Muir-Cochrane 2016; Swain, 2018).

Advantages of deductive coding are that it is systematic and contributes rigor to qualitative research. The advantages of inductive coding are that it is flexible, provides context for the code, and can deepen the meaning of research; combined, the hybrid approach to thematic analysis is a rigorous, comprehensive and meaningful method to bring meaning to the data (Fereday & Muir-Cochrane, 2016; Xu & Zammit, 2020).

A priori codes derived from the PMT theoretical framework and risk communication literature were determined deductively and integrated with data-driven *a posteriori* codes developed inductively during step 1 and 2 of Braun and Clarke's approach to thematic analysis (2006). The hybrid approach proved fruitful for furthering understanding of the alignment between PMT and risk communication and risk communication practice by FRCs, while also allowing for the data-driven exploration of the perceived barriers to citizens' awareness and action on flood risk, in addition to FRCs' barriers to communicating with citizens about flood risk.

Chapter 4.0 Results

4.1 Communications Audit

The results of the communications audit (Appendix A) determined that almost all municipalities have a website for flood risk information directed to residents, but there is a gap in the volume and quality of the information uniformly available flood risk information to urban residents across Canada. Options for structural flood risk mitigation are ubiquitous; non-structural flood risk mitigation measures are not. Even so, few municipalities appear to offer financial incentives such as subsidies and rebates for the installation of structural flood protection measures.

4.2 Surveys

How are municipalities communicating?

Communication channels:

- Most municipalities disseminate flood risk communication messages and materials to residents using a diverse range of communication channels, predominantly those that are online.¹
- Almost all (89%) municipalities publish written information on their municipal website concerning flood risk mitigation. Calgary and Ottawa are the exceptions, at which municipal websites are more commonly reserved for video content and interactive maps, respectively.
- Many (72%) municipalities commonly use online media, such as social media, to disseminate their messages.
- Under half (39%) of the municipalities in the sample commonly run workshops and information sessions relating to flood risk, whether online or in-person.
- Fewer still (28%) commonly conduct door-to-door canvassing and/or deliver flyers to homes.

¹ MFRCs were asked to report their municipalities' top three flood risk communication channels that were used prior to the COVID-19 pandemic to control for responses that reflected restrictions on in-person communication methods associated with COVID-19.

- Relatively smaller municipalities in the sample, including Whitehorse, Charlottetown, St. John’s, Moncton, and Regina were underrepresented in their use of the two previously listed communication channels (workshops, door-to-door canvassing). Instead, these municipalities favoured websites, online media and direct mail for their communication channels.

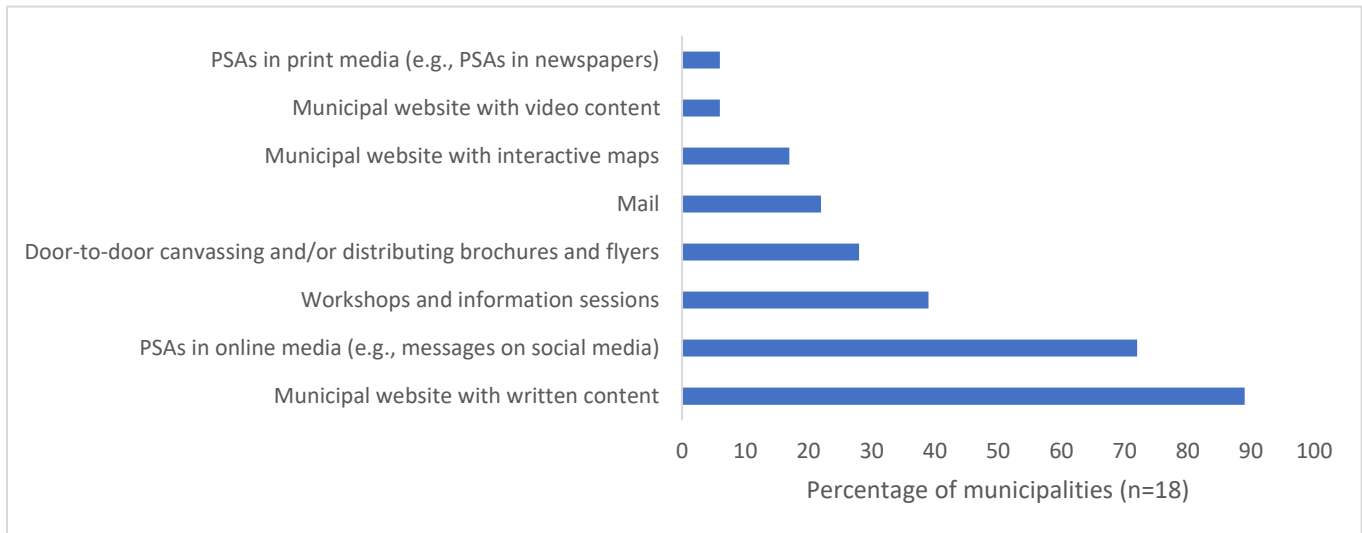


Figure 8. A summary of the top three most common flood risk communication channels used by municipalities in the sample

Who and what is considered?

Spatial and social considerations

- Half of the municipalities’ flood risk communication messages do not vary based on the neighbourhood in which they are being disseminated. For some, it depends.

Do the city’s flood risk communication messages vary based on the neighbourhood in which they are being disseminated?

| Yes | No | It depends |
|-----------|---------------|------------|
| Toronto | Mississauga | Calgary |
| Ottawa | Québec City | Montreal |
| Brampton | Richmond | |
| Surrey | Regina | |
| Vancouver | Moncton | |
| Saskatoon | Fredericton | |
| Halifax | Charlottetown | |
| | St. John's | |
| | Whitehorse | |

- Of those whose communication messages do vary by neighbourhood, messages are individualized considering one or both:
 - 1) The physical hazard that flooding poses to a neighbourhood; and,

2) The vulnerability of a neighbourhood to flooding (i.e., the sensitivity of the neighbourhood to flooding with respect to socio-economic, environmental and physical components).

The demographics of a neighbourhood were considered less in the development of neighbourhood-specific communication messages.

- Language considerations were also incorporated into some municipalities’ messages in order to individualize messaging, as were residents’ values as they pertain to flood risk.

Communication content:

Consultation with residents:

- There is an equal number of municipalities that seek and do not seek input from residents in their development of flood risk educational programs (e.g., workshops) and/or flood risk educational materials (e.g., home flood preparedness brochures) (28% do, 28% do not).
- Slightly more municipalities (33%) reported that their consultation with residents depends on the program and/or material they are developing.

Does the city generally seek input from residents in its development of flood risk educational programs and/or flood risk educational materials intended for residents?

| Yes | No | It depends | Unsure |
|-------------|-------------|-------------------|---------------|
| Ottawa | Montreal | Toronto | Richmond |
| Brampton | Québec City | Mississauga | St. John’s |
| Surrey | Regina | Vancouver | |
| Halifax | Moncton | Calgary | |
| Fredericton | Whitehorse | Saskatoon | |
| | | Charlottetown | |

When?

Communication frequency:

- The frequency of most municipalities’ (89%) flood risk communication varies seasonally.
- The frequency of flood risk communication in many municipalities (78%) depends on the probability of flooding in a given neighbourhood. This finding is at odds with the 50% of municipalities that reported that their flood risk communication messages do not vary based on the neighbourhood in which they are being disseminated.
- In many municipalities (67%), flood risk communications are also impacted by the weather and the presence of an ongoing flood event, respectively.
- Only one municipality, Ottawa, reported that the frequency of the city’s flood risk communication to residents remains constant for any given neighbourhood, at any time.

What matters?

- Highly valued intended outcomes of flood risk communications included its ability to inform residents of flood risk mitigation measures, imbue residents' with a sense of responsibility for flood risk mitigation, and to build their confidence (self-efficacy).
- Notably, informing residents about flood types was not widely considered important.
- Knowledge-sharing (community capacity) was ranked as extremely important or important by only half of participants.
- Most municipalities ranked the objective, "The message and/or program's ability to evoke a fear-based response in residents about flood risk (i.e., worry, dread)" as being unimportant or neither important nor unimportant.

Table 4. The importance of a variety of objectives in the design of municipalities' flood risk communication messages and/or programs

| Risk Communication Objectives | % Extremely Important or Important | % Slightly Important | % Neither Important nor Unimportant | % Unimportant |
|--|---|-----------------------------|--|----------------------|
| Informing residents of available flood risk mitigation measures | 100 | 0 | 0 | 0 |
| Clarifying residents' responsibility for property-level flood risk mitigation, response and recovery | 95 | 5 | 0 | 0 |
| Building confidence in residents' abilities to implement flood risk mitigation measures | 95 | 0 | 5 | 0 |
| Encouraging information-sharing among residents | 63 | 5 | 26 | 5 |
| Imparting knowledge of the various flood types and their associated risks to the home | 53 | 21 | 21 | 5 |
| Eliciting a fear-based response about flood risk | 0 | 21 | 26 | 53 |

MFRCs were asked to rank the impact of a total of 10 risk communication and PMT constructs on influencing residents' adoption of personal flood risk mitigation measures. See Table 3 (Section 3.3.4) for an analysis of the PMT constructs.

There was little consensus on their relative positive influence:

- Prior experience with floods was considered impactful by 74% of respondents, with 58% ranking it as the most influential factor and an additional 16% ranking it

among the top three most influential factors in impacting personal flood risk mitigation.

- Perceiving floods as being likely to occur was ranked within the top three most impactful features by 32% of participants.
- Having financial resources was only deemed to be highly impactful to 26% of participants, with 11% ranking it the most influential factor and 15% within the top three.
- Living in a basement or having a basement in one’s home was one of the least perceived impactful features for influencing uptake of mitigative behaviours, with 79% of participants ranking it in their bottom three.
- Knowledge of flood insurance considerations was a fairly unimpactful factor for 52% of respondents, with 26% ranking it as the least impactful factor and an additional 26% of participants ranking it in their bottom three.

Measuring what matters?

- Just under half of the municipalities measure citizens’ engagement with their municipal flood risk communication messages and/or educational content.
- Social media engagement, residents’ attendance at events, MFRCs’ participation and engagement with residents at information sessions, and follow up surveys after events were some of the listed flood risk communication metrics.

| <i>Does the city measure residents' engagement with municipal flood risk communication messages and/or educational content?</i> | | |
|---|-------------|---------------|
| Yes | No | Unsure |
| Ottawa | Quebec City | Toronto |
| Surrey | Saskatoon | Mississauga |
| Vancouver | Halifax | Montreal |
| Richmond | St. John’s | Whitehorse |
| Calgary | | |
| Regina | | |
| Charlottetown | | |

4.3 Interviews

4.3.1 Flood Risk Communication Strategies: Trends and Changes

Against the backdrop of increasingly frequent and intense flood events, many FRCs' flood risk communication strategies are in a period of change.

"We are sort of getting ready to abandon the word 'season' on flood, and just have our materials ready and targeted to the regions that they're [floods] in." (KI #82, NFRC, personal communication, 2022).

While the specific language used in flood risk communications was not a focus of the interviews, the above comment illustrates a broader shift in the way that FRCs are framing flood risk to the public such that it is framed as a part of regular life. Interviews revealed current and predicted trends in the approaches and tools used for FRCs' flood risk communication strategies. Barriers to effective risk communication and opportunities for improvement were also thoroughly explored.

Communication Methods and Channels

As in the survey, participants said that they make use of a wide range of communication channels in their flood risk communication strategies. Most participants spoke in favour of the balanced use of digital and face-to-face (hereafter referred to as "in-person") communication channels. This balance was said to be desirable owing to the existence of trade-offs between impact and reach associated with each communication channel—that is, digital methods allow for greater reach, but lower impact (i.e., behaviour change, motivation) and vice versa.

Digital and in-person communication channels tended to serve distinct purposes; the former was more frequently associated with broad communication methods and the latter with targeted communication methods.

Broad Communication Methods

Broad-based communication methods refer to communications that are broadcast to the entire messenger's audience and whose content is identical to any given recipient. Examples of broad flood risk communication methods listed by FRCs included social media blitz campaigns during flood season, and core messaging promoted year-round (e.g., "Be flood ready"), to name a few. Broad communication methods were practiced by all FRCs and were

typically conducted using digital communication channels. Billboards, mailers and information booths were non-digital, albeit less popular, channels by which some FRCs disseminate general flood risk information to citizens.

Digital channels used by FRCs included online webinars, YouTube videos, electronic newsletters, dedicated websites, app-based emergency alert systems, social media, and traditional media (news outlets). No consistent preference for digital communication channels was stated. However, several MFRCs said that their municipal websites had undergone changes in recent years or are currently undergoing changes to improve the website accessibility and appearance. This suggests that websites are a vital flood risk communication channel for municipalities, which was also reflected in the survey. It is also reflected in a study of social media use by municipal governments in Canada and the United States. Evans and Chen (2018) found that all 10 major Canadian municipalities in the study supported a variety of social media platforms, although they are seen as “secondary and complementary to the cities’ existing websites” (p. 29).

According to participants, digital communications are useful for conveying preventative, and especially, reactive flood-related information. The former type of information is typically housed on the FRCs’ website, while the latter is shared via mobile app-based warning systems and social media channels. One participant contrasted their use of digital communication for mass, warning-type messages with their increased use of targeted, preplanned communication campaigns:

We're moving into a phase now where we're looking at more targeted communication efforts rather than just broad, general, mass communication. ... we still do a lot of the ‘Big storm coming’, on Twitter, social media ... but they're not a campaign style, they're more on a reactive basis. (KI #22, NFRC, personal communication, 2022).

Thus, the use of digital communication channels is useful for the rapid dissemination of general flood risk information to a wide audience, but it is increasingly complimented by targeted methods of flood risk communication that are directed to specific segments of FRCs’ audiences.

Targeted Communication Methods

Targeted communication methods are localized communications that are tailored to a specific audience and relayed exclusively to that audience. Targeted risk communication is

distinct from broad communication in that it takes into account the audience's specific geographic, and sometimes social, context.

Development of Tailored Communication Content

Three NFRCs advised the use of behavioural science to enhance the development of tailored risk messaging, "You really have to do your homework in order to try to determine how can I target different subgroups in a community ... decision science and behavioral research plays into that" (KI #4, NFRC, personal communication, 2022). This NFRC was the first to admit that, "nobody's doing that work on the ground, I don't think". Indeed, only one of the three NFRCs who proposed the application of behavioural science to flood risk communication said that they were incorporating such insights into their risk communication initiatives. The consideration of target audiences' specific geographic and social context is resource-intensive as it is, which is evidenced by the uneven usage of targeted flood risk communication by FRCs.

In line with the survey results, about half of the interview participants reported that they employ targeted flood risk communications. Unlike the survey, however, interviews provided participants with the opportunity to expand on their response such that several NFRCs and MFRCs revealed an intention, or at least, a desire to pursue targeted communication efforts in the future. Moreover, targeted flood risk communication is a more relevant and valued component of MFRCs' communication strategies than the survey indicated.

Audiences who require tailored flood risk information were typically identified by FRCs at the neighbourhood level. These neighbourhoods were distinguished from others by their high risk of flood exposure (physical vulnerability), often in addition to one or more of the following features of the neighbourhood:

- Close proximity to flood control infrastructure (physical vulnerability)
- A dominance of multifamily residential properties and/or renters (potential social vulnerability)
- A low median income (potential social vulnerability)
- A large population of Newcomers to Canada (potential social vulnerability)

Multiple FRCs said that their consideration of demographics and social vulnerabilities is relatively new. For those interviewees who are hoping to begin conducting targeted risk communications, they said that they will consider socio-economic and socio-demographic characteristics of their audiences.

FRCs said that they identify target audiences with the help of flood hazard maps, census data, business records, direct engagement with residents, and/or indirect engagement with residents (i.e., via partnerships). Such information can be combined and analysed using Geographic Information Systems (GIS). The penultimate method listed that helps FRCs identify their target audiences—direct engagement with residents—was conducted by three MFRCs and one NFRC. Direct engagement occurred by surveying residents who were previously identified as having high physical and/or social vulnerability to flood risks in order to better understand their flood risk-related perceptions and needs. For example, one MFRC representing a small municipality shared their intention to conduct surveys to better customize programming and funding application decisions:

I'm going to start working on a survey about what residents feel their general knowledge is on flooding; their literacy of flood risk; what they do at home; and what they'd like to see from programs, to just give us some base information that will help future programming, future grant applications (KI #72, MFRC, personal communication, 2022).

The above quotation demonstrates that learning about one's audience can optimize flood risk mitigation efforts in the long term. Still, since conducting one-on-one surveys was said to be labour-intensive, it is unsurprising that it was not commonly conducted by MFRCs representing larger municipalities, nor by organizations that serve large numbers of residents.

Another way that FRCs identify their audiences for tailored risk communication initiatives is through partnerships. One NFRC spoke of a new, in-house tool that optimizes their organization's flood risk mitigation efforts, as well as that of municipalities and other partners. The tool generates optimized risk mitigation and resiliency investment strategies with regard to flood resiliency. Inputs to the tool range from flood hazard data to demographic data. The tool effectively allows for the user to compare different flood risk mitigation investment decisions, taking into consideration the social, health, and economic impacts of those decisions. The results help to inform where, and how, the user will carry out a flood resiliency program or project, which is valuable as "the tool helps municipalities prioritize with limited resources" (KI #11, NFRC, personal communication, 2022). This tool can only be accessed by partners of the organization. Technology of this sophistication was not described as being developed by any other FRC in the sample. Thus, partnerships may benefit FRCs because of their uneven access

to resources and varying levels of expertise for flood risk mitigation strategies. The role of partnerships will be discussed in more detail below.

Delivery of Tailored Communication Content

Targeted communication methods were most commonly conducted in person via door-knocking campaigns, workshops, events and home flood assessments. Many FRCs shared a belief that in-person communication is more effective than all other forms, which could explain why it is most frequently employed when communicating to priority areas. Indeed, many FRCs discussed the positive influence of in-person communication on residents' behaviour change, and some went as far to say that it is a prerequisite for motivating emergency preparedness, "you have to have a personal contact with that person, and you have to convince them in person. It's very, very unlikely that you can motivate people to get personally prepared simply with media" (KI #31, MFRC, personal communication, 2022). Research on the flood risk communication channels that are most effective at promoting behaviour change is ambiguous (Banerski et al., 2020; Heidenreich et al; 2020).

FRCs did not attribute all benefits of in-person communication to the direct interaction between themselves and residents; in fact, one MFRC explicitly dismissed the use of a "top-down" approach when talking to residents about climate risks. Instead, some FRCs suggested that communities themselves control the levers of disaster resilience, but they need to be encouraged and enabled to do so. "the solution is really community-led, no individual can bear that responsibility [of flood protection]" (KI #6, MFRC, personal communication, 2022). One proposed way to empower communities—or, to "help them help themselves" as one participant put it—is to foster connection among community members. As described in the following quotation, social connections are thought to lay the foundation for disaster resilience:

The in-person [workshops] will allow us to build that capacity and resiliency among the community of residents. By creating an opportunity where people get to know their neighbours, understand who might be vulnerable, hopefully there'll be additional capacity for people to support each other in the event of an emergency (KI #19, MFRC, personal communication, 2022).

Not all FRCs are able to regularly engage with residents in person due to the size of their target audiences and capacity limits at their organization/municipality/company. For instance,

one MFRC representing a mid-sized municipality described a highly individualized communication campaign, “we deliver the flood information door-to-door with fire department. We have a list of every flood prone street in the city ... we visit all 600 of those properties every spring in advance in the flood”. In contrast, FRCs representing large urban centres and those that serve large urban centres said that in-person communication methods are not always feasible. This does not mean that they have abandoned their targeted risk communication methods, rather, that they run fewer targeted campaigns than they would prefer, or, that they make use of technology to convey targeted messages.

Geo-targeted social media advertisements, customized flood mapping for specific communities, and QR codes on customized flood risk materials (i.e., door hangers) were among the digital communication methods that large municipalities have adopted for their targeted communications. The use of digital communications for targeted communications does not resolve an issue that many FRCs raised about digital channels, which is that their relative ease of transmission comes at the cost of their impact.

“We're doing a lot more digital now, but ultimately, the best form of communication is one-on-one”, alleged a MFRC representing a large municipality. Not only does their comment convey their high regard of in-person communications, but it also implies a degree of compromise present in their municipality’s flood risk communication strategy such that for better or worse, digital communications have become more prevalent with time. As mentioned, many FRCs advocated for a balance between digital and in-person communication channels. A hybrid model of digital and in-person communications is thought to balance the trade-offs between efficacy and resources associated with each channel.

To that effect, FRCs said that partnering with community groups can help to lessen the strain of flood risk communication on resources. Partnerships allow FRCs to “capitalize” on the existing connections between residents and those organizations (e.g., community centres, places of worship, etc.) such that messages can be outsourced to the partner, and, much more, the message is more likely to be well-received because it is conveyed by a trusted entity. “Hey, you already have a relationship with these people, you’re trusted. Can you disseminate this information?”, or ‘Can we bring people together to do a workshop or presentation tailored to this specific group?’” mused one MFRC about the added value of working with community organizations on targeted communication campaigns (KI #58, personal communication, 2022).

Additionally, some FRCs described the advantages of two-way communication, whereby FRCs solicit input from residents through public forums, whether online or in-person. Two-way communication was only actively employed by a couple of FRCs in the sample, where it was used specifically to inform residents about upcoming infrastructure projects (e.g., town halls about a new flood control project). However, several FRCs described the untapped value of two-way communication in the improvement of personal flood risk mitigation programming and materials. “It would be interesting to have roundtables with people with localized flood risk. You know, “Here’s some [flood risk] materials, here are some other materials, which ones resonate with you?” [Through] citizen focus groups, I think you would get some really interesting insights” said subject matter expert Twyla Kowalczyk (personal communication, 2022). Ms. Kowalczyk has unknowingly alluded to the design of a research project led by the Canadian Red Cross with the University of Waterloo’s Partners for Action research team, wherein Canadians were asked to provide feedback about sample messaging concerning flood, wildfire and earthquake preparedness—the results of which are forthcoming (Partners for Action, n.d.). This project reflects a push toward people-centred, data-based planning in education campaigns, which Cheryl Evans, Director of Flood and Wildfire Resilience at the Intact Centre on Climate Adaptation, has observed in recent years. “Many agencies are using two-way means of designing and measuring campaign impacts, such as via social media platforms, on questions and answer portals on websites, electronic and in-person surveys and virtual and in-person community discussion forums” (personal communication, 2022). Ms. Evans shared that this participatory approach to flood risk education is underpinned by the idea that incorporating peoples’ feedback and values into programs is key to their relevancy and efficacy.

Two-way communication was also framed as being potentially useful in flood response, for instance, one participant described their desire to develop a crowdsourced mapping application for the purpose of relaying real-time data about the stormwater system to citizens and utility services alike. This tool was described in hypothetical terms and was not something that would be pursued by their company any time soon.

Ultimately, technology, especially social media, continues to revolutionize FRCs’ capacity to reach large portions of their audience. Reach has increased for the majority of interviewees’ flood risk communication content. Reach is a highly sought-after trait of risk communication

initiatives and is often considered a metric of their success, as discussed in the Impact Measurement section. FRCs pursuing targeted communications might have to concede on their reach in favour of impact, as highlighted in the follow quotation: “now we're adding on the targeted [communication] items each year, so the reach may not be increasing significantly, but the quality of the in-depth connections to key audiences is increasing each year” (KI #19, MFRC, personal communication, 2022). Interviews signalled the beginning of an evolution in flood risk and/or emergency management education and outreach away from a ‘one size fits all’, one-way dialogue approach to those that are more bespoke.

Some of the more specific changes that FRCs would like to see in the communication channels and the contents of their flood risk communication materials and campaigns are as follows: an increased focus on flood types that have traditionally received less coverage by the FRC and/or the media, (e.g., pluvial flood risk, inland flooding in a coastal city), partnerships between municipalities and community organizations, and a return to in-person events as COVID-19 restrictions ease.

4.3.2 Barriers to Enabling Flood Risk Mitigation

Barriers to Residents’ Flood Risk Awareness and Preparedness

FRCs were asked to identify key barriers to residents’ awareness of and preparedness for flood risks. Responses were analysed and a list of 14 major barriers to learning about and taking steps to prepare for flood risks emerged.

Barriers to awareness included:

1. Knowledge (i.e., lack of knowledge of flood risk, flood risk types)
2. Lack of prior flood experience

Barriers to preparedness included:

3. Cost of residential flood risk preparedness
4. Knowledge of residential flood risk preparedness measures (i.e., lack of technical knowledge)
5. Lack of personal responsibility for flood risk mitigation

6. Temporal distance from a flood event (i.e., time elapsed since a flood event decreases preparedness)
7. Apathy toward flood risk
8. Denial of flood risk
9. Fatalism about flood risk preparedness

Barriers to both awareness and preparedness included:

10. Emotional barriers (e.g., fear, trauma) to flood risk awareness and preparedness
11. Social and cultural barriers to flood risk awareness and preparedness
12. Systemic barriers to flood risk awareness and preparedness
13. Other priorities outcompeting flood risk awareness and preparedness
14. The 'levee effect' (infrastructure enables inaction)

The top barriers to awareness and preparedness were knowledge and cost, respectively.

The knowledge barrier to awareness refers to residents' lack of knowledge of their flood risk, flood types, and knowledge of terms associated with flood risk. The most common knowledge-related comments concerned residents' misperception that flood risk is solely determined by one's proximity to a body of water—mainly rivers. Many interviewees identified that there is a pervasive, misguided assumption among citizens that flooding only occurs in low-lying, river-adjacent areas. And indeed, the three interviewees who did not cite knowledge as a barrier to residents' flood risk awareness were MFRCs whose municipalities are exposed to coastal and/or riverine flood risk (two of which are bisected by rivers). As one MFRC put it, "we're on the river; we deal with spring flooding every year, so there really are no barriers. ... you'd have to be living under a rock in [this city] to not get inundated with all kinds of flood information". These findings suggest that proximity to a body of water is linked to individuals' flood risk awareness.

However, few interviewees made a direct link between flood risk awareness and proximity to a body of water and were instead critical of this perception amongst citizens, suggesting that it is ultimately counterintuitive to resident's preparedness for large riverine flood events and pluvial events. Many more interviewees suggested that prior flood experience, not proximity to a body of water, is predictive of residents' awareness of, and, in some cases, their preparedness for flood risk. For instance, one participant noted that successive flood

events have raised the affected communities' awareness without the municipality's intervention. Some noted that prior experience also raises residents' flood risk preparedness. The survey of MFRCs similarly found that prior experience was deemed highly important in influencing residents' mitigative behaviours.

The cost barrier refers to residents' inability and/or unwillingness to finance personal flood risk mitigation measures. The cost barrier is related to the knowledge barrier given that several interviewees mentioned that residents do not know the actual cost of specific flood risk mitigation measures, they rather assume it will be costly. This finding runs contrary to the survey finding that few survey respondents (26%) felt that access to financial resources strongly impacted residents' participation in residential flood risk mitigation.

Upon determining residents' barriers to flood risk awareness and preparedness, a follow-up interview question investigated FRCs' methods to address those barriers through risk communication. The most common method to overcome residents' barriers to awareness and preparedness is to increase the accessibility of the message, such as through language considerations and disseminating information via multiple communication channels; as well as partnerships that increase the reach, impact and quality of flood risk communication.

The role of promoting community-level flood risk mitigation to overcome systemic barriers to residents' flood risk mitigation came up, which is noteworthy given that the interview subject matter concerned household/individual-level mitigation, not mitigation at the community level.

Appendix D provides a detailed summary of the barriers to residents' flood risk awareness and preparedness and the associated means to overcome those barriers, as identified by interviewees.

Barriers and Solutions to FRCs' Flood Risk Communication Efforts

Six major barriers to interviewees' flood risk communication efforts to residents emerged from the interviews. The barrier identified by most FRCs concerned their limited capacities for flood risk communication. The description of each barrier is accompanied by corresponding solutions proposed by FRCs. The most widely proposed method to overcome barriers is through partnerships. The Institutional barrier has the fewest solutions of all barriers.

Knowledge

Several FRCs identified that a barrier to communicating with residents about flood risk mitigation related to a lack of knowledge of residents' flood-related behaviours and values; namely, not knowing the state of residents' flood risk awareness and preparedness, and, not knowing the flood risk mitigation measures residents have or have not undertaken.

With regard to the former, one NFRC said that without a comprehensive understanding of the factors contributing to the public's flood risk awareness and preparedness, their organization's communication with residents will not be wholly effective nor equitable. This NFRC said that internal and collaborative research projects related to social vulnerability and behavioural science are helping to fill this knowledge gap at their organization. Similarly, two municipalities have collaborated with university research groups to work on best practices for flood resilience.

Three MFRCs shared that citizen surveys and/or interviews on flood risk literacy, barriers and drivers to flood protection and/or assessments of values related to land use in floodplains have helped to scope residents' awareness and preparedness levels and subsequently guide their flood risk communications programming. A couple of MFRCs also added that their community partners, mainly social services agencies (governmental and non-governmental), strongly contribute to their understanding of communities' needs because they have "a close pulse on some of these vulnerable populations".

Additionally, Cheryl Evans noted that because the municipal staff who develop flood risk communications programs are typically non-experts in behaviour change communications, they might hire external experts to build their expertise and assist in program development. The practice of hiring experts for program development was uncommon in this study's sample of municipalities; only one MFRC mentioned that their municipality had on one occasion hired a consultant to review and improve their flood educational content. That cost was identified as a barrier to communications by many MFRCs could explain why this practice was not commonplace among municipalities. Meanwhile, a couple of NFRCs shared that they hired experts in social marketing and behaviour change communications, respectively, to assist in the promotion of projects geared to residents.

As for the latter knowledge barrier, MFRCs identified a knowledge gap concerning residents' flood risk mitigation behaviours. MFRCs were the only FRC to identify this gap, likely because municipal governments are typically uninvolved in the implementation of residential structural flood protection measures and private flood insurance. In contrast, one NFRC mentioned that they have approximate numbers of backwater valve installation rates in certain areas because of their work with the manufacturers.

MFRCs spoke of a desire to know whether, and in which locations, residents had purchased insurance or implemented lot-level flood protection in order to determine the areas in which more concerted outreach and education efforts were needed, as illustrated in this comment:

It would be great if we could just get information from insurance companies or private contractors and say, 'Give us all your information on who's having work done for flooding', 'Who's making those claims?', but that's not something a municipality can do, really. (KI #72, MFRC, personal communication, 2022)

As proposed by one MFRC, municipalities seeking information on citizens' flood risk mitigation behaviours might consider reviewing rebate and/or subsidy program participation data, if applicable. Citizen participation in municipal flood protection-related rebate and/or subsidy programs was also considered a metric of successful risk communications by several participants.

Where municipal flood protection-related rebate and/or subsidy programs do not exist, Cheryl Evans proposed that the third-party agencies that deliver flood risk protection-related services to residents, such as home flood protection inspections and assessments, can provide municipalities with aggregate data of their findings, assuming the municipality has a contract or some form of arrangement with the delivery agency. Ms. Evans' advice highlights the value of private-public partnerships to fill communicators' knowledge gaps.

One MFRC believes that knowledge is siloed in their municipality, which creates gaps in flood risk knowledge in the EM department. For instance, while the engineers at their municipality might be experts on flood risk, "I'm not an expert on flood risk", disclosed this MFRC. Consequently, their municipal EM department's approach to public education on hazard risks is a generalist, all-hazards one. Building "a better connection to the data" among EM practitioners, such as by attending conferences and accessing disaster literature, was framed as

a solution to growing their hazard-specific knowledge, but is ultimately hampered by the consistently high demands on EM practitioners' time. These sentiments align with those of a participant in Zirolecki and Thistlethwaite's (2019) flood risk communications workshop, who described emergency management personnel as being "overextended" (p.13). In their 2019 study, it was found that the pressures on EM personnel's time detracted from their ability to develop effective and well-crafted communication and outreach campaigns, which was also reflected in this study and is described in the Capacity barriers section (Zirolecki & Thistlethwaite, 2019).

The concept of 'siloed knowledge' was also discussed by a MFRC who believes that municipalities and other key players in the climate resilience space do not consider the links between climate change adaptation, emergency management, sustainable development and risk communications knowledge in their approach to community resilience. These systemic, missing links impede progress toward achieving "an adapted vision of risk", that is, models of community climate resilience that cater to the climate risks and social vulnerabilities specific to a given community. Partnering with community groups, university research groups, and consulting with other municipalities pursuing similar climate goals was discussed as a means to "break these silos" and expand collective knowledge.

For some FRCs, knowledge barriers extended beyond private flood risk mitigation and involved broader unknowns about the implications of climate change on flood risk management. For instance, one MFRC explained that coastal adaptation will involve significant changes to municipal planning in ways that are not entirely known. Discussions of potential solutions to coastal adaptation can thus be challenging because of their potential to produce undesirable reactions in residents, such as confusion or fear, in response to the inherent uncertainty of those solutions. In their interviews of Canadian government officials and subject matter experts in land use planning, climate change adaptation, and flood management, Oulahen et al. (2018) similarly found that government officials' communication and engagement with the public on climate change impacts were limited by their own uncertainties about climate change projections, denial, and fear of the magnitude and cost of impacts.

In Ontario, this barrier was less relevant given that under the *Conservation Authorities Act*, Conservation Authorities (CAs) are legislated for planning and development regulation in floodplains. Indeed, FRCs working in Ontario spoke highly of CAs because of their expertise for

flood forecasting and planning. Whereas cities have artificial boundaries, CAs are delineated by watersheds and are thus able to take a holistic approach to flood risk mitigation and adaptation. Partnerships between CAs and their local municipal partners are valuable for “leveraging [CA’s] expertise” for water resource management.

Another MFRC noted that flood management strategies are not only personal, but they are also political. Arriving at solutions to flood risk adaptation, especially those involving land use and development (e.g., managed retreat), is thus personally and politically fraught. Lastly, a NFRC discussed that their employer has historically focussed on emergency recovery. As flood risks evolve, however, there is pressure from citizens and government for the company to be involved in emergency mitigation, which they lack knowledge of and believe to be the domain of government, not industry.

Cost

The cost of flood risk communications was another barrier to FRCs’ flood risk communication efforts. Cost was most often discussed with respect to the dissemination of communication materials and/or programs (e.g., paid advertising, hiring staff to run programming), as opposed to the development of the communication (e.g., research, graphic design).

Some MFRCs noted that diversifying communication channels, while important, is expensive. For example, paying for advertisements on a variety of social media platforms as well as in local news outlets is costly, especially given that the message is in competition with mainstream media distributed by “big corporations with money coming from revenue” (KI #8, MFRC, personal communication, 2022).

To reduce the cost of flood risk communications, municipalities have been known to turn to NFRCs for their flood risk resources. A few NFRCs have received requests from municipalities to use their communication materials, and they noted that requests more commonly come from smaller municipalities, who they suspect have relatively small budgets for outreach and education. Groups like the Canadian Red Cross may also be contracted out by municipalities to run flood risk preparedness programs. “[partnership is] a way to overcome this challenge of finances, but it's also a necessity. We can't just do it alone, there's other groups that already are active on the field and do a lot of great work”, advised one MFRC.

Another cost-saving strategy is to prioritize high-risk neighbourhoods as the target of flood risk communications. One FRC's company uses location-based social media advertising and conducts in-person communications exclusively in neighbourhoods at high-risk of riverine flooding.

However, one MFRC cautioned that these "granular" communication efforts still only reach a fraction of the high-risk population:

Reaching them [citizens] in a targeted, genuine manner is very labour intensive. We have the broad campaign that reaches all [citizens] ... We then try to reach target groups in a more in-depth manner, but that is costly to develop customized messaging. We might be able to do a couple of communities per year where we reach out and do door hangers, or host in-person meetings, but that's at best going to reach 10% of the population in those flood-impacted communities (KI #19, MFRC, personal communication, 2022)

This municipality intends to continue to conduct both "broad" and "in-depth" campaigns, but they are seeking ways to improve the cost-efficiency of the latter campaign type. This MFRC's comments are in line with a NFRC who believes that "specialized services", which they define as in-person workshops and information sessions, reach far fewer people than "broad based marketing", namely, digital communications. However, the benefit of specialized services is that they are more conducive to promoting behaviour change than their unspecialized counterparts. This NFRC did not discuss the cost of specialized risk communications, which highlights the fact that financial barriers to risk communications may be more significant among municipalities than FRCs representing industry, non-governmental organizations and academia.

Several low-cost, low resource communication strategies that were proposed include reusing content from previous years, developing "evergreen content" on websites (i.e., content that remains relevant for long periods of time), and developing online newsletters for recipients who self-select their interest in receiving flood-related information.

Lastly, though flood risk alert messages are not this study's focal flood risk communication type, it is worth noting that one MFRC discussed the prohibitive cost of developing flood forecasting tools. Flood forecasting has implications for flood risk alerts and warnings to the public. This municipality was able to access flood forecasting data through

partnerships with local conservation authorities, who improved their forecasting systems upon receiving funding from the provincial government.

Capacity

A lack of capacity (i.e., time and resources) to develop educational materials and/or carry out programs was identified as a barrier among almost all MFRCs, making it the most significant barrier for MFRCs' flood risk communication efforts to citizens. Small team sizes and competing priorities were the main reasons for MFRCs' limited capacities for flood risk communication.

For most MFRCs, supplementing their flood risk mitigation resources with those developed by external organizations and/or other levels of government is a key way to overcome capacity limits. Resources developed by the Intact Centre on Climate Adaptation and the Insurance Bureau of Canada were widely used. Additionally, several MFRCs spoke positively about their provincial government's emergency preparedness and/or flood preparedness resources for citizens, with one MFRC noting that provincial resources, although useful, must be "fine tuned" to make them more relatable to their municipality. On the other hand, one MFRC said that their province provides "zero support" when it comes to public education, and lamented the paucity of up-to-date resources of that nature provided by their province.

One MFRC explained the reasons for their municipality's outsourcing of flood risk mitigation materials, adding that this practice is especially true for smaller municipalities:

The large part is the convenience of having something that's pre-prepared; and knowing that you're able to trust where it's coming from, whether it be an established government, non-profit group, or academic institution ... usually it's been quite vetted and those fact sheets and educational handouts ... [have] gone through graphic designers... Whereas if we were to do that ourselves ... you would be taking a lot of staff, taking a lot of capacity just to produce something that's going to be probably saying the same thing. It's really, especially for smaller municipalities, it's a convenience. (KI #72, MFRC, personal communication, 2022)

Partnerships with conservation authorities, community groups, insurance associations and neighbouring municipalities was said to help all FRCs overcome capacity limits for

outreach and education, especially for digital communication. Each partner may “amplify” the reach of any given message online by sharing it with their network. Amplified messages reach more people than one group would be able to reach alone, not to mention, such messages attract media attention. This requires an alignment of values and terminology, though—the partner re-sharing a message must agree with the contents of the message.

In response to their limited capacity to deliver in-person workshops, one municipality is exploring the idea of a flood risk protection training program for building managers. Once trained, the building managers would be responsible for running workshops with the residents of their buildings, which effectively transfers some of the responsibility of knowledge-sharing onto external stakeholders and allows the municipality to reach more citizens.

However, identifying, negotiating with and collaborating with appropriate partners can be onerous. As is volunteer coordination. A few NFRCs discussed the challenges of working with partners on flood risk messaging and programming—though these efforts were deemed to be worthwhile. Somewhat paradoxically, one NFRC said that their limited time and resources means that they cannot engage with partners, even though doing so would help to relieve their capacity issues; the cycle of limited resources appears to be a challenging one to break.

The existence of a dedicated staff member for outreach and education, such as a citizen engagement or stakeholder engagement job position, which some municipalities had, allows for the development and sustainment of partnerships. One MFRC noted that such a position is not within their municipality’s EM department’s budget. While the EM department develops all flood risk-related messaging, digital messaging is disseminated by a variety of departments (e.g., Parks and Recreation) on behalf of the EM department. In this way, internal collaboration at the municipality helps to manage the EM department’s limited capacity for online flood risk communications.

Another way to overcome capacity limits to flood risk communication is to conduct social research that can be generalized to communities of interest. One NFRC identified that their organization hopes to use research to identify patterns associated with compounding hazard and social risks. In this way, they may adapt their programming in different communities without having to conduct research in each community. “If we were able to go in and analyse, understand, consult with, engage with each community, that would be done, but we don't have those kinds of resources—that's crazy”, they reflected (KI #14, NFRC, personal

communication, 2022). Few MFRCs with capacity barriers discussed the use of research as a tool for their flood risk communications strategies, which suggests that conducting research is not feasible when there are challenges to developing and delivering materials and programs to begin with. Ensuring that all FRCs, even those without research project capabilities, have access to relevant research insights could be helped by online knowledge-sharing repositories/hubs and partnerships among FRCs.

One NFRC said that enhancing local capacity is one of the means by which their organization overcomes their limited capacity to carry out programming. Enhancing local capacity was described as strengthening municipal authorities' and grassroots community-based organizations' capacities to reduce hazard risks such that they do not have to call on external organizations to support their risk reduction measures— “teaching person to fish, rather than fishing for them”.

Lastly, one MFRC's experience of the reactive nature of EM feels that its characteristic reactivity is product of the limited capacities of EM practitioners to work proactively. They believe that a “just-in-time” approach to hazards preparedness means that hazards mitigation programming might not be a priority relative to the latter phases of the EM cycle. Challenges related to EM and disaster risk management and their effects on flood risk communication were raised during several interviews, and relate to the “Institutional” barriers section below.

Institutional

Many MFRCs described challenges related to collaboration; both internally—among municipal departments—as well as externally—with other levels of government. External partnerships between municipalities and public health agencies, environmental not-for-profit organizations, civil society organizations, neighbouring municipalities, research organizations, First Nations bands, utility providers and conservation authorities were largely not associated with challenges, rather as means to overcome them.

As for internal collaboration, one participant described the challenge of cross-disciplinary as well as cross-hierarchal collaboration on sustainability projects within their municipality. They believe that the interconnectedness of climate change impacts demands collaboration by municipal staff in various departments and roles, and spoke of a desire for heightened internal engagement in such projects to achieve better outcomes. Similarly, a NFRC

remarked that water and stormwater management require an integrated approach, but that the division of water-related functions in municipalities is divided amongst departments (e.g., Roads, Parks, Planning) that are typically disconnected from one another. The same was said about flood management on the whole, “provinces are responsible for resource management ... and emergency management, and they push that responsibility down to local governments, and the rubber hits the road there. ... one of the things that that does is it heavily fragments the management of flood” (KI #4, NFRC, personal communication, 2022).

Another MFRC noted that flood risk messaging is fragmented among the various municipal authorities involved in flood management (e.g., Public Works, EM, etc.). The result is that the flood-related content accessible to the public (i.e., on the city’s website) may be redundant or, worse, inconsistent. The municipality plans to redress this internal confusion by adapting their website to be more public-focussed rather than to reflect the organizational structure of the municipality.

In addition, one MFRC described their desire to establish community partners in their flood risk education and outreach efforts. However, the decision to form partnerships does not rest with their department because of the municipality’s division of communication responsibilities.

Also, several MFRCs said that there is competition related to the projects, events and current issues that various municipal departments wish to engage the public about, especially on their social media platforms. There is also competition among the various municipal programs that citizens may participate in; both of which may combine to reduce—or as one participant put it, “dilute”—the impact and frequency of flood risk communications.

Another set of institutional barriers related to inconsistencies and/or inaccuracies in communications concerning the nature of floods and their mitigation. One NFRC bemoaned the sometimes-misleading depictions of flood events by the media, for instance, a newspaper article concerning a heavy rainfall flood event accompanied by a photograph of an unrelated riverine flood event. This NFRC argued that false portrayals of flood events are damaging to the public’s understanding of personal flood risk because they, “help perpetuate these myths [that] flooding only occurs on bodies of water”.

A related barrier concerned the circulation of inappropriate information about flood risk protection measures intended for property owners and renters by some FRC stakeholders. One NFRC said that they have encountered claims that backwater valves provide protection from flooding without an associated description of which types of flooding. Such claims were said to confound flood types and mislead residents about appropriate mitigation measures. Inaccurate information about floods and their mitigation by the media and FRCs themselves was labelled as problematic because of the narrow window of opportunity to engage with and educate people about flood risk. A couple of FRCs said that people are unlikely to repeatedly review flood-related information or visit flood protection-related websites— “you have one chance”—and so it is important that the information they receive is high quality. Some FRCs standardize their messaging with one another. A couple of FRCs said that they maintain a relationship with local partners to help align their terminology on flood risks.

Some of the barriers to communicating with residents about flood risk transcend organization-specific challenges and point to broader policy and institutional challenges associated with public and private participation in FRM and EM. As a result, the suggested actions to overcome these barriers were often long-term-oriented, hypothetical, and/or unknown altogether.

Large-scale issues that were identified as ultimately affecting the viability and advancement of effective flood risk communications to the public include:

- Chronic “short-termism” within government that creates barriers to the establishment and/or funding of climate-related projects.
- A systemic emphasis on disaster relief and response rather than disaster risk reduction.
- A systemic framing of climate adaptation and emergency management as mutually exclusive.
- An absence of a financial process within government to screen for climate-related projects (e.g., sustainability criteria).
- An absence of mandated municipal disaster risk management plans (emergency management plans are mandated).
- Development decisions that do not adequately consider future flood risk.
- Building standards that do not adequately consider present and/or future flood risk.
- Multilevel governance of emergency management systems in Canada that delegate much of the responsibility for flood management to local governments, even those without the resources to do so.

With regard to the last bullet point, one MFRC said that even though they do not coordinate their work with their province, they have seen an increased focus on climate change adaptation work by their province. Generally, a number of MFRCs see their provincial governments as being largely uninvolved in public education about emergencies. One MFRC had this to say about their provincial government, “provincially, they set the policy, but they provide zero support to us in terms of actually educating the public” (KI #67, MFRC, personal communication, 2022). Another MFRC noted that they do not see the province as playing a role in citizen engagement because that is the domain of municipalities and the social sector, “our province does the [flood] mapping, there's not a whole lot of active awareness building that goes along with that. ... I wouldn't say I've seen a really active role in building citizen capacity from the province, I think that's more a municipal and social sector role.” (KI #29, MFRC, personal communication, 2022).

As previously mentioned in the “Capacity” barriers section, some MFRCs did view their province as being helpful for providing up-to-date flood risk information and ready-made emergency preparedness and/or flood preparedness resources for the public.

On the role of the federal government in supporting public education concerning natural hazards preparedness, one MFRC relayed that “Public Safety Canada, years ago used to have literature that municipalities could order and hand out ... I haven't seen any literature come out of them in like a decade.” (KI #67, MFRC, personal communication, 2022). Another MFRC said that any information provided by the federal government will be necessarily broad, albeit too broad for municipal purposes. One NFRC identified that under the *Constitution Act*, the federal government has very little jurisdiction in flood management, and so “expecting the [Federal] government stand up and say we're going to take leadership here ... it's not only unfeasible, it just ain't gonna happen because it's not their jurisdiction and nobody's going to dabble in an area that's not theirs to dabble in” (KI #4, NFRC, personal communication, 2022).

Technological

Technological barriers to reaching the public were not widely discussed. Some of the comments concerning technology included limited budgets and expertise for developing mobile applications and other digital content, such as the production of high-quality videos for social media. One municipality combats their inability to produce large amounts of high-quality digital content by uploading video content on free platforms such as YouTube. They also draw

in a wider audience by ensuring that their partners use common language and terminology about flood risk, so that all information online in their region redirects users back to the municipal website.

A couple of FRCs asserted that ensuring the balanced use of both physical and non-digital communications assets are important, given that not all residents have access to a computer or smart phone, or may find online navigation challenging. Simplifying the structure of websites and mobile apps ensures that all levels of online users can find them useful.

Another MFRC discussed their former reliance on provincial data for flood forecasting, which was often not refined enough for local conditions and was thus misleading. The municipality now largely relies on their own software for forecasting, but they acknowledged that this may not be possible for all municipalities.

Social

FRCs faces a variety of barriers to communicating with residents about flood risk that are associated with social and cultural factors. Most widely listed were challenges associated with cultural competence; accommodating the various language of audiences; a lack of public trust in flood risk messengers, specifically government and insurance industry stakeholders; and reaching the wider population as opposed to the minority of those with prior experience to flooding, or those who are “eco-conscious, early adopters”. These groups were said to be inherently more “tuned in” to flood risk messaging.

While identified as being more interested in flood risk messaging, those with recent flood experience were also identified as a challenging audience because of their emotional response to authorities around the subject of flooding. Providing the opportunity for direct consultation with municipal staff, such as question-and-answer sessions, was suggested as a means to provide flood-affected residents with information in manner that is productive and trust-building.

Some FRCs stated that there is an absence of social connectivity among residents, which detracts from neighbourhood-level resilience to emergencies. A couple FRCs suggested that there needs to be more emphasis on social capital as a means to improve flood resilience, but that it is difficult to ascertain the level of social capital among residents in the first place, since it is intangible. “I know who my neighbors are ... those things make us more resilient, but how

do you quantify connections with neighbours? If you know that person's name? If you know you know what their skills and weaknesses are?" reflected one MFRC.

Solutions to social barriers varied in their complexity. For example, to address language barriers, a MFRC described the process of using census data to determine the dominant languages spoken in a neighbourhood and subsequently accessing translation services. On the other hand, there is no easy fix to address widespread mistrust in the government by the public, as one NFRC described:

Municipalities ... don't really hold a high standard of trust with the general public—they think we're always trying to get more money out of them, misuse tax dollars The problem is the other entities at the table don't bring a whole lot of trust either: the insurance industry, the federal, provincial governments. Finding partners ... that can help support that message that says 'You, customer/citizen, you have to play a role in this as well' is difficult (KI #22, personal communication, 2022).

Several other social barriers described by FRCs overlapped with residents' barriers to flood risk awareness and preparedness (i.e., apathy, denial, fear, a lack of personal responsibility) as these qualities also present obstacles to FRCs' communication to the public. Again, conducting behavioural research, carefully timing the dissemination of information, providing in-person opportunities to engage with citizens directly and appealing to residents' values (e.g., framing issues through the lens of a community's values; aesthetics or "curb appeal", using "environmental frames" in a seemingly environmentally conscious neighbourhood, running family-friendly events, providing budget friendly options) were suggestions for FRCs to overcome barriers related to their audiences' biases and emotions.

4.3.3. Impact Measurement

"Defining success is a tough one, because how do you measure what hasn't happened?" (NFRC, personal communication, 2022).

As the above comment suggests, assessing whether flood risk communications are having their desired effects is most apparent in the aftermath of a flood.

FRCs' desired outcomes for their communications are generally to increase their audience's awareness of and preparedness for flood risks.

There are three dominant methods by which FRCs measure the impact of their flood risk communication:

- 1) **Website and social media analytics** (e.g., volume of website visits, engagement on social media posts) is a common method to evaluate flood risk communication strategies.
- 2) Whether the **damages and associated costs of flood events decrease** over time for residents, insurers and government alike.
- 3) **Tracking the volume of complaints, requests and inquiries to the FRC** (e.g., tracking number of requests made through the municipal 3-1-1 system and city councillors).

As for the first listed metric, many FRCs described the inadequacy of using the engagement rates of risk messages as a means to evaluate communication goals given that interacting with a communications material and/or program does not necessarily prove that the intended outcomes have occurred.

Indeed, one MFRC relayed their incredulity of evaluating their outreach and education goals through presentation attendance:

It [evaluating] was, how many presentations did I do, and how many people did I talk to? ... But we didn't track behavior change, and I could tell you that probably not that much behavior change happened. People said that they loved my presentation and they learned a lot, but there was no follow up of 'Did you make any changes? Did you write a plan? Did you talk to your family? Did you meet a new neighbour?' (KI #58, MFRC, personal communication, 2022).

Another participant cautioned, "just because I walked by a booth and got a pamphlet for something doesn't necessarily mean that I took that action in my home. How does that prove that you're having the outcome that you want?" (Twyla Kowalczyk, personal communication, 2022). Ms. Kowalczyk expressed that the strategies for measuring outcomes must be improved. Nevertheless, she defended the practice of tracking online and in-person engagement data, since without it, the communication channels and strategies capable of reaching the most people would be unknown.

As for the second listed metric, one NFRC articulated, "in theory, what should happen is that the disaster assistance should go down" (KI #82, personal communication, 2022). FRCs

discussed the objectives of reduced property damage and reduced reliance on disaster relief, whether from the government or insurers. This indicator is only apparent once a flood event has unfolded, which relates to Twyla Kowalczyk's comment that preparedness is "a lag indicator, not a lead indicator" (personal communication, 2022).

With regard to the third listed metric, FRCs suggested that receiving fewer calls, complaints or requests from residents indicates that citizens have put in place measures that enable their "self-sufficiency" in the recovery process, rendering this an effective metric of whether risk communications are having their desired impact.

In all of the methods, the only method that is able to reveal whether behaviour change can be directly attributed to risk communications involves 1) surveying residents who have implemented property-level flood protection measures and/or purchased insurance about their motivations for doing so; and, 2) following up with residents who attended events to enquire about whether they have made any changes related to flood risk mitigation. A number of FRCs encouraged tracking data related to the implementation of property-level flood protection (PLFP) measures through the proxy of measuring participation in related subsidy programs.

In some conversations with participants, it appeared that whether the change in behaviour was a direct result of the FRCs' communication efforts was less important than whether the change had happened itself. That is, some FRCs felt that so long as residents are safe and capable of responding to a flood event, flood risk mitigation and emergency management in general is advancing. Others were more concerned with the direct impacts of their work, "how do I measure how much of that [reduction of complaints and concerns raised by the public] is due to the work my team does?" posed one NFRC.

McComas (2006) found that health risk managers' evaluation of their public outreach efforts is typically focussed on the procedural elements of the outreach (i.e., who and how many participated in the process) or on the outcomes of the outreach (i.e., whether the outreach process improve the decisions of those who participated). The results in Table 5 show that FRCs focus most on procedural-oriented elements of flood risk communication. Indeed, communication impact metrics are categorized by their point in time in the flood hazard cycle (i.e., before, during and after a flood).

Table 5. Indicators of effective flood risk communication used by interview participants

| Before the flood (Preparedness and Mitigation) | During the flood (Response) | After the flood (Response and Recovery) | Other |
|--|--|--|--|
| <ul style="list-style-type: none"> - Analysis of website and/or social media engagement, especially directly following an education initiative - Application and participation rates in municipal subsidy programs, rebate programs - Attendance at events and workshops - Download rates of emergency alert system app - The volume and nature of responses generated from online and/or in-person surveys of citizens concerning flood risk - QR code access rates* - Personal flood protection measure implementation (e.g., sump pumps, insurance purchased). - Amplification of flood risk-related messages by other outlets and/or earned media (e.g., special interest stories, coverage of events) - The number of engagement opportunities available for citizens (e.g., community | <ul style="list-style-type: none"> - Fewer complaints, requests and inquiries to the city and utility services during a flood event - Measuring the responses of citizens against the predetermined order of operations for emergency response, e.g., “the flood playbook” - Citizens’ contribution to real-time monitoring through online tools (i.e., using a “pin” to map the location of a manhole that is overflowing, to report heavy flooding on the street)** | <ul style="list-style-type: none"> - Fewer complaints, requests and inquiries to the city, utility services, insurance companies and/or agencies involved in emergency response and recovery. - Less public reliance on the government. - Less costly (fewer damages) for residents, city, province, insurers alike - The alignment of the flood response and recovery with the principles of emergency management and disaster risk reduction (e.g., reduce losses of citizens, responders, property). - The use of quantifiable models for resilience to measure actual resilience post-flood - Gauge responses from citizens during post-flood community engagement | <ul style="list-style-type: none"> - Public acceptance of inevitable change related to flood risk management (e.g., managed retreat)* - Improving the quality of connections to target audiences* - Normalizing climate adaptation and “sustainable choices” among the public, decision makers and industries via the market or the development of new standards - Evidence that citizens are heeding risk communication beyond flood risk, e.g., preparedness for snowstorms and ice storms are proxies for flood risk preparedness* - Developing building standards for flood resilience in the same vein as energy efficiency building standards** |

| | | | |
|---|--|--|--|
| <p>discussion portals, Q+A forums in-person or on websites)</p> <ul style="list-style-type: none"> - Subscription rates to flood risk-related newsletters* - Tracking the language and behaviour of citizens concerning flood protection facilities online and in-person, respectively* - Empowering residents who are interested in being advocates and spokespeople for flood risk mitigation in their neighbourhoods* - Voluntary, proactive engagement by residents in advance of flood season* - Assessing the commercialization of lot-level flood protection programs and measures by insurers and by contractors/suppliers, respectively* - Stormwater user fee amounts* - Having supportive and positive feedback from residents during flood-related programming and about new flood control infrastructure projects | | | |
|---|--|--|--|

Methods that were only practiced by one FRC in the sample are denoted with an asterisk to indicate their uncommonness. Methods that are not currently practiced by FRCs, but are ideas or potential future metrics of citizen preparedness for a given municipality/organization/company are denoted with a double asterisk.

Chapter 5.0 Discussion

5.1 Survey

Municipalities' flood risk communications aligned with theory in the following ways:

- Municipalities prioritize informing residents of their flood risk and ways to reduce it.
- Municipalities use a diversity of communication channels for flood risk mitigation information (e.g., social media, webinars, flood maps).
- Municipalities generally communicate about floods during the time of year at which they are most likely to occur.

Indeed, the results of the survey found a partial alignment with the PMT framework for most municipalities, such that municipalities place a high degree of importance on the ability of their flood risk communication to inform residents of flood risk mitigation measures; to imbue residents' with a sense of responsibility for flood risk mitigation; and to build confidence in their abilities—these traits are thought to stimulate response-efficacy and self-efficacy (coping appraisal) (Botzen et al., 2019; Bubeck et al., 2013; Kievik and Gutteling, 2011). Similarly, most municipalities do not believe it is important for their flood risk communications to evoke a fear-based response in residents in order to achieve their goals. Instead, MFRCs believe prior flood experience to be an important predictor of individuals' flood risk mitigative behaviours, which aligns with PMT. Prior experience increases threat appraisal and coping appraisal—those with past flood experience perceive their vulnerability to flooding as greater than those without experience, and they also are more likely to have learned about their capabilities to cope with floods following a flood event (Andrasko et al., 2020; Heidenreich et al., 2020; Kellens et al., 2011; Seebeauer & Babicky, 2020).

Municipalities reported that they use a diversity of communication channels, which is in accordance with proposed best practices for risk communication. However, relatively smaller municipalities in the sample (i.e., Regina, Whitehorse, Charlottetown, St. John's, Moncton) were underrepresented in their use of workshops and door-to-door canvassing for flood risk mitigation-related information. This suggests they may be limited in their capacity to deliver communications by more direct channels requiring substantial resources (print materials, delivery services, staffing for door-to-door canvassing). This is in spite of research that suggests that a variety of communication channels should be pursued for flood risk communications (Demeritt & Nobert, 2014; Heldsinger et al., 2018). The ideal communication

channel for risk communication of all kinds depends on the purpose of the communication effort, meaning that communicators should have a variety of risk communication channels at their disposal depending on the specific objective (Bier, 2001; Fitzpatrick-Lewis et al., 2010).

Municipalities also reported that their flood risk communication commonly depends on the season, which aligns with existing best practices. Results from a study of Canadians' awareness of and preparedness for natural hazards found that most people discuss natural hazards during the season in which they are most likely to occur (Andrey et al., 2022). The same was also said in a study on flood risk communication which advocated for communicators to "Leverage calendar milestones" such as seasonal markers of flood season (Henstra & McIlroy-Young, 2022, p. iii). Thus, natural hazards risk preparedness campaigns should coincide with the season in which they are most likely to occur to meet people's expectations and biases for this information.

Municipalities' flood risk communications showed deficiencies in the following ways:

- Targeted methods of risk communication are not commonly conducted (50% do not).
- A minority of municipalities (36%) employ participatory processes for designing flood risk communication.
- Most municipalities (74%) do not consider financial resources to be highly impactful in influencing residents' decisions to adopt flood risk mitigation measures.
- Less than half (37%) of municipalities evaluate residents' engagement with their flood risk communications.

MFRCs diverge from PMT in their importance placed on the financial resources for flood risk mitigation. Only 26% felt that access to financial resources strongly impacted residents' participation in residential flood risk mitigation. In contrast, studies of response costs (time, money, effort), a subcomponent of the PMT variable coping appraisal, found that perceptions of the monetary costs of protective actions are negatively associated with the implementation of flood risk mitigation measures (Hudson et al., 2020; Poussin et al., 2014). Indeed, coping appraisal may be undermined if an individual feels the costs, especially monetary costs, are too high.

Additionally, the alignment with several flood risk communication best practices was mixed. For one, the development of tailored risk communications was lacking. Under half of the municipalities in the sample tailor their risk communications to their audiences. The majority

deliver the same messaging to the municipal public. The United Nations guideline on DRR communication says this about disaster risk messaging that is geared toward an entity vaguely referred to as 'the public': "the public comprises all people in society, spanning old, young, rich, poor, male, female, urban, rural etc. Yet, if you target everyone, you target no one" (UNISDR, 2017, p.2). Demographics such as age and income have been shown to influence an individual's adoption of flood risk reduction measures (Botzen et al., 2008; Brody et al., 2017; Bubek et al., 2012; Heidenreich et al., 2012; Henstra et al., 2018; Grothmann & Rueswig, 2006). Cultural and linguistic competencies have been shown to be important considerations for natural hazard risk messaging (O'Sullivan et al., 2012; Yong et al., 2017). MFRCs ought to consider the socio-demographics and socio-economics of their audience, where possible.

Secondly, participatory processes for designing flood risk communication were also lacking. About a third of municipalities consult with residents in their development of flood risk communication materials and/or programs. Without consulting with residents, MFRCs are engaging in a one-directional communication of natural hazards risk. These one-way, top-down approaches often neglect to consider an individual's ability to cope with that hazard because they are intended for a general audience. In contrast, two-way communication allows for participatory processes of information generation, where there may be an exchange of experiences and opinions (Attems et al., 2009). Given the importance of personal experience and vicarious experience produced by social communication in promoting protection motivation, participatory processes of communication, such as information sessions, may more effectively promote protective behaviours towards flood risks (Terpstra et al., 2012).

Lastly, under half of the municipalities measure citizens' engagement with their municipal flood risk communication messages and/or educational content. Evaluation is necessary to determine whether risk communications are having their intended effects (McComas, 2006). For those MFRCs that do not monitor the outcomes of their risk communications, it is unclear how they determine whether their communication efforts are advancing their goals. For those who are unsure of these evaluation techniques, this suggests that there is a diversity of municipal stakeholders involved in flood risk communication to residents. Further investigation is needed.

Ultimately, that there is research that explores flood risk behaviour not yet incorporated into risk communication means that the current research serves no practical

value. In contrast, the development of evidence-based communication strategies may help to optimize the use of public and private sector resources and protect more people.

Key gaps in knowledge that emerged out of the survey thus go as follows:

- What influences municipalities' choice of communication channel concerning flood risk? Are there specific barriers associated with some channels and not others?
- What are the barriers to municipalities' flood risk reduction communication efforts to residents?
- How feasible is it for municipalities to adopt tailored risk communication that necessarily takes into account citizens' socio-economic status and socio-demographics?
- How do municipalities define success as it relates to their flood risk communication activities?

The interviews provided the opportunities to uncover potential reasons for these remaining questions. An exploration of risk communication constructs and FRM was more relevant in the interviews than the application of PMT.

5.2 Interviews

It would appear that the cautionary words of Meijerink and Dicke (2008), as quoted earlier, are only partially true. Meijerink and Dicke (2008) warned that FRM must be institutionalized in practices, policies and budgets or else give rise to a problem in which, “states count on the risk preparedness of its citizens, while the citizens trust their government to take care of them” (p. 510). Indeed, there are widespread barriers to citizens' flood risk awareness and preparedness. However, the flood risk communicators interviewed in this study do not expect that residents are widely participating in flood risk mitigation activities—they are well-aware of residents' barriers to flood risk mitigation and they attempt to target them directly through their flood risk communication efforts.

The results indicate that advances in technology, an increased set of actors with vested interests in flood risk mitigation, and an embracing of the concept of community capacity to achieve disaster resilience are among the most significant factors that MFRCs and NFRCs identified as contributing to ongoing or predicted changes in their approach to flood risk communication. At the helm of these changes was said to be large cities, conservation authorities and industry.

In line with the survey results, about half of the interview participants reported that they employ targeted flood risk communications. The challenges for municipalities, in particular, to develop tailored flood risk communications have been documented elsewhere. A study of risk communication systems in Europe, the UK, Canada and the United States found that private companies such as insurance companies and consulting firms were more able to develop tailored flood risk information to clients, whereas government communication systems, whose services are free, adopt one-way communication methods with broad-based information about flood risks (Attems et al., 2020).

Related to this, six major barriers to interviewees' flood risk communication efforts to residents emerged from the interviews. Several of the identified challenges were similar to those articulated by participants in a Canadian study by Zirolecki and Thistlethwaite (2019). Given the similarity in subject matter and sample strata to that of the Communicating Flood Risk to Canadians study by Zirolecki and Thistlethwaite (2019), the results of this study are ripe for comparison. Indeed, participants in both studies represent municipal government, non-governmental organizations, industry and academia. Common barriers identified in this study and that of Zirolecki and Thistlethwaite (2019) were challenges related to collaboration within and among government and external partners, as well as the resourcing of communications campaigns. However, in this study, additional challenges related to knowledge gaps, technology and systemic and social issues were brought forward.

FRCs can improve the understanding of flood risk and engagement of their audiences in FRM using flood risk communication, but they cannot do so alone. In contrast to the study by Zirolecki and Thistlethwaite (2019), challenges associated with partnerships, while identified by participants, were not found to be as great of a barrier, but rather as a means to overcome barriers. Partnering with organizations that are generally perceived as trustworthy, altruistic and community-minded, such as non-profit organizations and community groups, on the delivery and programming of communications was proposed by many FRCs as a solution for overcoming trust barriers. In expanded frameworks of PMT, trust in authorities is a positive predictor of protective motivation (Bamberg et al., 2017; Fox-Rogers et al., 2016; Birkholz et al., 2014). Partnerships can also overcome knowledge barriers related to a potential target population, as well as to help develop targeted risk communications. A study of the flood risk communications of Austrian municipalities found that an absence of targeted communication

channels and contents, specifically for migrant groups in the area, could be remedied by mutual dialogues with the migrant groups, as well as a collaborative approach between stakeholders and institutions working in disaster risk management and climate change adaptation, such as municipal emergency services and associations that work with migrants (Weber et al., 2019). In this study, partnerships with public- and private-sector actors were very common for helping to overcoming FRC's challenges to achieving effective flood risk communication.

For most MFRCs, supplementing their flood risk mitigation resources with those developed by external organizations and/or other levels of government is a key way to overcome capacity limits. Resources developed by the Intact Centre on Climate Adaptation and the Insurance Bureau of Canada were widely used. Of note, one NFRC believed that insurance brokers are an "untapped" flood risk communicator. Brokers have a direct line of communication with residents during two opportune time windows: during a prospective policy holder's initial conversation with the broker and during insurance renewal. Given that many Canadians residing in cities have been repeatedly found to be unaware of their insurance coverage for flooding, increased communication of flood risk by the insurance industry would help to fill this specific knowledge gap (Sandink et al., 2007; Sandink et al., 2010; Sandink, 2016).

Chapter 6.0 Conclusion and Recommendations

Unbeknownst to many Canadians, homeowners and tenants are responsible for property-level flood risk mitigation. The Government of Canada's shift toward individualizing and privatizing protective action towards flood risks—in a time of increasing flood risk—has rightly been accompanied by increased public engagement about flood risk by all levels of government, NGOs, academia and insurers. However, it is unclear whether, and which, types of flood risk communication strategies are effective in their goals of galvanizing action and raising flood risk awareness among the public.

There is a need for standardized, evidence-based flood risk communication in Canada. Fortunately, there is a burgeoning field of research that explores the motivators and barriers to individual action on flood risk mitigation and effective ways to communicate about them. Therefore, if flood risk communication practices align with risk communication theory, they may better target the complex factors involved in people's flood risk decisions. This research has investigated the potential applications of one such theory, PMT, in addition to several proposed flood risk communication best practices to flood risk communication by an important group of Canadian flood risk communicators. 18 municipalities' flood risk communication strategies were compared to PMT using surveys. Then, select municipal and industry, academic and non-governmental flood risk communication stakeholders working in close proximity to municipalities were interviewed. Potential recommendations for flood risk communication were determined in order to optimize municipalities' communication resources and enable greater flood preparedness among Canadians. Recommendations are presented below.

6.1 Implications for Practice

Five novel recommendations for Canadian municipalities' flood risk communication strategies and methods emerged from the findings on residents' barriers to flood risk awareness and preparedness (see Appendix D), as well as MFRCs' and NFRCs' barriers to developing and delivering effective risk communication (see Section 4.3). Since participants represented academia, industry and non-governmental organizations from around the country, the recommendations may also be relevant to Canadian educational not-for-profits, community groups, insurance companies and other stakeholders concerned with public outreach to achieve individual- and community-level flood risk mitigation. They go as follows:

1. Frame the benefits of residential flood risk mitigation in monetary and non-monetary terms.

Municipalities are encouraged to discuss the advantages of personal flood risk mitigation as they relate to financial benefits and as they align with residents' values (non-monetary benefits). Disclosing a variety of advantages of flood risk mitigation might increase its appeal to residents. Also, given that most municipalities do not subsidize the implementation of a number of, or any, structural flood risk mitigation measures, it is misleading to consistently label such measures as low cost. Unless measures are very inexpensive, attempt to demonstrate the advantage of these measures in non-monetary terms that have been determined to be important to residents (e.g., environmentalism, property value, property aesthetics, etc.). Learning about residents' values requires two-way dialogues with residents in which they exchange information relating to their opinions and values with the communicator.

2. Imbed metrics for evaluation of flood risk communications into the design of flood risk communication resources and programs.

Action-oriented evaluation frameworks for flood risk communication activities should be pursued in light of the finding that Canadian flood risk communicators' metrics of effective flood risk communications do not directly assess whether flood risk mitigation has taken place.

3. Reserve resource-intensive flood risk communication efforts for targeted methods of flood risk communication.

Keep cost and effort minimal for flood risk information that is intended for a wide audience. Instead, dedicate resources to the development of tailored flood risk communication efforts (i.e., in-person communication, new technologies) to specific audiences (e.g., to residents in areas of high flood risk), if possible.

Advancements in technology have allowed for MFRCs to drastically increase the reach of their communications without having to engage in resource-intensive communication practices. Once an acceptable level of audience reach has been attained, and "evergreen" content (i.e., content that remains relevant for long periods of time) has been developed and published on a reliable digital communication channel, such as the home page of a flood protection section of a municipality's website, municipalities are advised to pursue targeted communications to high-risk areas, which may or may not be digital. While time, cost and

staffing were all concerns related to the development of tailored information, the apparent benefits of tailored risk communication provide a strong argument for its adoption.

4. To increase residents' sense of personal responsibility for flood risk, provide opportunities for residents to 'buy-in' to the stormwater system (e.g., adopt a catch basin programs, community flood protection leaders).

Residents' awareness of their responsibility for flood risk mitigation and recovery was identified as a barrier to their preparedness. Most methods to redress an absence of personal responsibility were resource-intensive—involving one-on-one conversations between communicators and residents (see Appendix D). The use of opportunities which actively engage community members in flood risk mitigation appears promising in its ability to lead to auxiliary, community-level benefits.

5. Enhance community-capacity to flood risks, not only individual capacity.

There is a tremendous opportunity to reduce flood risk at the level of the home that is not being utilized, but it must not be prioritized at the expense of preparing for flood risks at the community level. "Building community capacity" was discussed by a couple of MFRCs as a goal of their broader flood risk mitigation capacity. Community capacity involves the capacity for people to support each other in the event of an emergency, which necessarily involves increasing social connections, or social capital. Enhancing community capacity helps to achieve the objectives of risk-sharing imbedded in FRM. Community events and workshop can help to foster connections among community members. Thus, municipalities should include community-level flood risk resilience in their flood risk communication goals.

Several other recommendations emerged that are not novel. They include:

1. Form partnerships with trusted stakeholders that have a direct line of communication with residents.

Partnerships may allow MFRCs to overcome issues relating to trust, credibility, capacity, and expertise of flood risk communication. For example, MFRCs might outsource the delivery of flood risk communication information to trusted sources on their behalf and/or request for their message to be amplified by the partner.

Some of the partnerships listed by participants were novel in the Canadian literature on flood risk communication. They included partnerships between municipalities and community associations, community centres, social support agencies, insurance industry associations, building managers, academic organizations.

2. Ensure a diversified range of flood risk communication channels.

Attempt to achieve a balance between digital and in-person communication channels. While neither is objectively better than the other, they serve different purposes. No single digital communication channel emerged as being more effective than another with respect to raising public awareness of and preparedness for flood risks.

3. Increase the frequency of flood risk messages during flood season and after a flood event.

Ensure that flood risk communication messages are delivered during flood season and after flood events. Personal experience and vicarious experience—produced by social communication—are thought to be important determinants flood risk action (Terpsta et al., 2009). As such, risk communication messages during flood season will target these mechanisms. Similarly, media and public interest is higher following a flood event, which MFRCs can use to their advantage.

4. Use non-technical, straightforward language.

Use plain language to accommodate for all audiences' linguistic, cultural and technical competencies.

6.2 Implications for the Literature and FRM

Many of the results in this study validate existing knowledge. For instance, all 14 economic, cognitive and social barriers to residents' flood risk awareness and preparedness identified by interviewees confirm those found in the literature (e.g., cost of flood risk mitigation, complacency toward mitigation, lack of trust in entities delivering information concerning flood risk mitigation). Thus, the challenges to raising awareness and inciting action on flood risk among Canadians do not appear to be unique to Canada, rather, they appear to be universal. That achieving individual-level flood risk mitigation is an issue of human

behaviour—influenced by one’s context, certainly, but a human behaviour issue nonetheless—underscores why objective, behavioural models like PMT can be applied to inform experts’ understanding of audiences’ flood risk perceptions and opinions. Indeed, the results of the interviews validate PMT in that FRCs identified knowledge and cost as being the main barriers to residents’ flood risk awareness and preparedness. That threat appraisal (perceived risk and severity) and coping appraisal (response costs) are low suggests that the motivation to protect oneself is absent (Maddux & Rogers, 1983).

Similarly, the results validate existing knowledge on the state of flood risk communication in Canada, including the challenges experienced by FRCs, such as collaboration with internal and external partners, limited time and resources for outreach and education relating to flood risk mitigation (Agrawal et al., 2022; Andrey et al., 2022; Evans & Feltmate, 2019; Heldsinger et al., 2018; Henstra & McIlroy-Young, 2022; Henstra et al., 2019; MacIntyre et al., 2019; Minano & Peddle, 2018; Phillips & Rajabali, 2020; Stewart & Rashid, 2011; Ziolecki & Thistlethwaite, 2019). However, in this study, additional challenges related to knowledge gaps, technology and systemic and social issues were brought forward. Also in contrast to existing studies, challenges associated with partnerships were found to be a significant means to overcome barriers. Thus, this research is novel in its identification of the importance of public-public and public-private partnerships to overcome issues relating to trust, credibility, resources and expertise of flood risk communication by Canadian FRCs.

Both residents’ and MFRCs’ barriers to flood risk mitigation and flood risk communication, respectively, have implications for FRM. If citizens and municipalities are unaware and unable, respectively, to meet the ideals of FRM, this suggests a significant policy-practice gap that will impede progress on widespread flood risk mitigation.

For example, in the interviews, residents’ awareness of their responsibility for participation in FRM was identified as a barrier to their preparedness. Similarly, Canadians’ lack of personal responsibility for flood risk was revealed in a study of flood risk awareness by the Toronto and Region Conservation Authority (Phillips & Rajabali, 2020). These results counter those of two successive surveys of Canadians, in which Canadians accepted some responsibility for protection of their property, and less so for flood recovery (Thistlethwaite et al., 2017; Ziolecki et al., 2020). There appears to have been little, or even a backsliding of progress, toward the policy priority of, “strengthening the sense of personal responsibility for

flood mitigation to further reduce dependence on public disaster assistance”, as recommended by Henstra et al., (2018) in their exploration of Canadian public attitudes and expectations for FRM (p.8). Indeed, Canadians must accept that they have some responsibility for flood management in order to participate in it. Several proposed solutions to address Canadians’ lack of personal responsibility for flood protection are outlined in Appendix D.

In their study of the ‘trickling down’ of FRM from upper to lower levels of government in Sweden, Hedelin (2017) found that a lack of clarity in roles and mandates for FRM actors impeded the development of procedures for public participation in FRM. Thus, the ability for municipalities to develop clear, consistent messaging about Canadians’ roles in FRM is likely limited by institutional and legislative challenges in government. In other words, the lack of established roles for individuals in FRM is both limited by, and perhaps a product of, the current FRM paradigm in Canada.

An additional challenge relates to financing flood risk mitigation. It appears that few municipalities are able to subsidize and/or provide rebates for the implementation of structural residential flood protection measures. The Intact Centre has a resource available for existing provincial and municipal flood protection subsidy/grant programs, and it demonstrates that there are limited municipal programs (ICCA, 2020b). Of the three participants who indicated that their organization/municipality offers subsidies for residential structural flood protection measures, only one of them was a MFRC. This is in spite of the interview finding that cost is the most significant barrier to residents’ flood risk preparedness. Some municipalities seem to know that an absence of financial incentives contributes to inaction, “some of the main barriers that we’re trying to work on is the lack of rebates or any financial incentives for our residents to take action in protecting their properties” (MFRC, personal communication, 2022). Interviewees said that they promote low-cost measures for residential flood risk mitigation, but specific measures were not widely listed.

Thus, while municipalities might know that the cost, or at least, perceived cost of flood risk mitigation is a barrier to residents’ flood risk preparedness, this is not reflected in their practices. Whether or not this is because municipalities lack the budgets to offer such programs is unclear. Interviewees did not comment on the budgets of municipalities outside of their limited budgets for outreach and education, with the exception of this MFRC, “Prevention is

always the one that is lacking in terms of budgeting because until something happens, then you see that there's a need. But even then ... there's many other priorities in the city” (KI #17, MFRC, personal communication, 2022). Given that the sample included large municipalities, which have a stronger tax base for investment in FRM initiatives (e.g., infrastructure, citizen programming), it is expected that most Canadian municipalities, and especially smaller municipalities, face resources constraints for flood risk communication efforts (Zerbe, 2019).

The findings are valuable in their identification of existing barriers to Canadian municipalities’ abilities to effectively communicate with residents and in doing so, to provide opportunities for addressing them.

6.3 Limitations and Future Research

Survey sample

The selected municipalities included provincial, territorial and national capitals and/or large Canadian municipalities. As a result, the sample is skewed towards municipalities with relatively large budgets and comparatively well-developed FRM and EM programs. Despite this, it is expected that these results can be generalized to other Canadian municipalities given that many municipal participants identified barriers to flood risk communication and FRM generally related to resources and capacity, which are expected to be common constraints for this activity among municipalities.

Interview and Survey Implications

Nascent transitions in the types of outreach programs and communication channels by which municipalities and other FRCs are using to communicate with citizens means that the relevance of this research will not necessarily endure for years to come. Moreover, this research encapsulates a point in time; flood risk communication by FRCs is expected to evolve during and after the period of this study.

Protection Motivation Theory

It is not possible to determine whether PMT elucidates the factors involved in behaviour change more than any of the number of available, related theories, simply because risk perception is too poorly understood for any theoretical framework to be held up as a disciplinary standard. Still, PMT shows promise in its ability to accurately describe the risk perception mechanisms involved in private flood risk mitigation (Richert et al., 2017). Several limitations of PMT are outlined:

- 1) Studies that seek to determine the direction of influence between risk perception, protective responses and non-protective responses using PMT rely on cross-sectional data, in which causal relationships are inferred without temporal stability, but from theoretical considerations alone (Seebauer & Babczyk, 2021). Limited longitudinal data makes it unclear whether, and to what degree, PMT components are interrelated. Bubeck and Botzen (2013) point to the possibility that threat appraisal and protection motivation, which are often positively correlated, may affect one another in ways that can only be captured over time; for instance, if an individual carries out a flood risk mitigation measure, their threat appraisal of flooding may decrease as a result of taking a protective measure (since their desire to take action is theorized to have been motivated by a desire to reduce their threat, in the first place). If threat appraisal is reduced, it dampens the overall correlation between threat appraisal and protection motivation. Other researchers counter that these proposed feedback effects are difficult to detect, because they would require a significant number of individuals in a sample to have already taken action, which is often not the case (Babczyk & Seebauer, 2019). Limits to knowledge are to be expected in the relatively new paradigm of FRM and demand of the researcher a heightened sense of intention, reflexivity and adaptability in the research approach (Creswell & Creswell, 2018).

- 2) Much of the work related to flood risk perceptions has focused on the individual. In the adoption of PMT as a theoretical framework, this research is no exception (Kuhlicke et al., 2020). Some researchers posit that social contexts must be more central to explanations of flood risk behaviour, arguing that individual-focussed theories position the individual as being affected by their community but incapable of affecting their community (Thaler & Seebauer, 2019). A one-way power dynamic between an individual and their environment has long propped up the prevailing epistemology underpinning risk communication—the information deficit model—in which the public is assumed to be unaware of their risk until experts disseminate knowledge (Demeritt & Nobert, 2014). On the contrary, evidence of behaviour changes from bottom-up contexts, such as through public engagement, and community participation could be effective in promoting flood risk mitigation behaviours (Demeritt & Nobert, 2014). More recently, theories focusing on collective factors (e.g., shared cognitions) are being

applied to understand the motivations behind flood-related adaptive behaviours (Bubeck et al., 2013).

- 3) Property-level flood protection measures and private insurance are the main tools for which homeowners and tenants may become actively involved in FRM in Canada. Rates of uptake of these two tools are currently low; thus, it cannot be ascertained the exact degree private adaptive measures and actions are effective in reducing flood risk across Canada. Studies of their efficacy have been primarily conducted in Europe.

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Appendices

Appendix A: Digital Flood Risk Communications Audit

| Municipality | Available Residential Flood Preparedness Resources (Online) | Contents of Resources | | | Flood Type(s) Outlined |
|--------------------|--|--|---|-------------------------|-------------------------------|
| | | Property-level flood protection measures? (structural) | Insurance and/or community-level mitigation? (non-structural) | Subsidy/Rebate Program? | |
| St. John's*, NL | - Municipal website - Links to external websites (the Intact Centre). | Yes | No | No | - Coastal - Basement |
| Charlottetown*, PE | - No dedicated flood webpage - Archived posts on municipal website and Twitter for past educational events - Free online home flood protection course | N/A | N/A | N/A | N/A |
| Halifax*, NS | - Municipal website - Municipal social media pages - Emergency notification system - Links to external websites (federal government website) | Yes | Yes, both | No | - Pluvial |
| Moncton, NB | - Municipal website - Home flood preparedness guide - Links to external websites (the CMHC). | Yes | No | No | - Pluvial - Spring freshet |
| Fredericton*, NB | - Municipal website - Infographics and fact sheets - Flood maps - Municipal social media pages - Links to external websites (provincial and federal government websites) | Yes | Yes, insurance | No | - Riverine - Pluvial |

| | | | | | |
|------------------|--|-----|---------------------------|---|--|
| Québec City*, QC | - Municipal website - Flood map - Municipal social media pages - Municipal infographics and fact sheets | Yes | No | Yes, backwater valve subsidy program | - Riverine - Pluvial |
| Montreal, QC | - Municipal website - Links to external websites (provincial) | Yes | No | No | None |
| Gatineau, QC | - Municipal website - Links to external websites (IBC, CRC, utilities, province, etc.) | Yes | Yes, both | No | - Spring freshet |
| Ottawa**, ON | - Municipal website - Links to external websites (public health, federal government) | Yes | Yes, both | Yes, the Residential Protective Plumbing Program | - Riverine - Sewer back up |
| Toronto*, ON | - Municipal website | Yes | No | Yes, Basement Flooding Protection Subsidy Program | - Basement |
| Brampton, ON | - Home flood protection guide (regional, multi-city and local conservation authorities) | Yes | Yes, both | No | - Riverine - Sewer back up |
| Mississauga, ON | - Home flood protection guide (regional, multi-city local conservation authorities) | Yes | Yes, both | No | - Riverine - Sewer back up |
| Winnipeg*, MB | - Municipal website - Flood map - Links to external websites (provincial and federal government, CRC) | Yes | Yes, both | No | - Basement - Overland - Riverine |
| Regina*, SK | - Municipal website - Catch basins map - Adopt a catch basin program | Yes | Yes, community resilience | No | - Overland |
| Saskatoon, SK | - Municipal website - Email newsletter - Links to external websites (Intact Centre, licensed plumbers) | Yes | Yes, both | No | None |
| Calgary, AB | - Municipal website - Flood maps | Yes | Yes, both | No | - Overland - Basement |

| | | | | | |
|-----------------|--|-----|---------------------------|--------------------|--|
| | - Home flood protection guide - Links to external websites (utility companies, public health resources) | | | | - Riverine - Stormwater back up - Sewage back up |
| Edmonton*, AB | - All resources housed on EPCOR's website | Yes | Yes, insurance | Yes, through EPCOR | - Basement flooding - Pluvial |
| Vancouver, BC | - Municipal website - Adopt a catch basin program | Yes | Yes, community resilience | No | - Pluvial |
| Surrey, BC | - Municipal website - Flood maps - Links to external websites (provincial government, CRC) - Flood preparedness guide | Yes | Yes, both | No | - Pluvial - Fluvial |
| Richmond, BC | - Municipal website - Links to external websites (provincial government, IBC) | Yes | Yes, insurance | No | None |
| Victoria*, BC | - Municipal website - Municipal fact sheet | Yes | Yes, community resilience | No | - Pluvial |
| Whitehorse*, YT | - Municipal website - Municipal alert system - Link to external website (territorial government) | Yes | No | No | - Snowmelt |

*Provincial/territorial capital

**National capital

Appendix B: Survey of Municipal Flood Risk Communication Stakeholders

Please enter your title, the municipal department and the municipality (hereafter referred to as “the city”) you are responding on behalf of.

1. Which of the following forms of communication did the city most commonly use to disseminate flood risk communication messages and materials to residents *prior* to restrictions on in-person interactions associated with COVID-19?

Please select the three most common forms of communication.

- Door-to-door canvassing and/or distributing brochures and flyers directly to homes
 - Workshops and information sessions
 - By mail (e.g., fact sheets distributed with utility bills or property tax mailings)
 - Municipal website with written content
 - Municipal website with video content
 - Municipal website with interactive maps
 - Public service announcements (PSAs) in print media (e.g., PSAs in newspapers)
 - PSAs in online media (e.g., PSAs in the form of photos and videos on social media platforms)
 - PSAs on television
 - Mobile applications
 - Other (please specify)
2. Does the city generally seek input from residents in its development of flood risk educational programs (e.g., workshops) and/or flood risk educational materials (e.g., home flood preparedness guides) intended for residents?
 - Yes
 - No
 - It depends
 - Unsure
 - Not applicable, the city does not currently develop any flood risk educational programs and/or flood risk educational materials for residents
 3. Do the city’s flood risk communication messages vary based on the neighbourhood in which they are being disseminated?
 - Yes, the city’s flood risk communication messages are individualized for any given neighbourhood
 - No, the city’s flood risk communication messages are general in nature and are applicable for any given neighbourhood
 - It depends
 - Unsure

If “Yes” or “It depends” selected, participants will be directed to questions 4 and 5

4. What are some of the ways the city might individualize its flood risk communication messages to a given neighbourhood?
 - Presenting flood risk information in multiple languages
 - Delivering flood risk information using multiple communication channels (i.e., municipal websites, print materials, billboards)
 - Incorporating residents' opinions and perceptions of flood risk (as determined through city-led community consultations, open houses, workshops) to develop flood risk communication messages/materials
 - Other (please specify)

5. Please select the type(s) of information the city uses to individualize its flood risk communication messages to a given neighbourhood.
 - The physical hazard that flooding poses to a neighbourhood (e.g., the frequency of flood occurrences in an area, its topographic features)
 - The vulnerability of a neighbourhood to flooding (i.e., the sensitivity of the neighbourhood to flooding with respect to socio-economic, environmental and physical components)
 - The demographics of a neighbourhood (e.g., residents' income, age, gender, ethnicity)
 - Other (please specify)

6. To what extent are the following objectives important in the design of the city's flood risk communication messages and/or flood risk educational programs to residents?
 - * For each bullet point, a 5-point Likert-scale of Importance is displayed.*
 - The message and/or program's ability to inform residents about practical solutions to reducing adverse consequences of flooding
 - The message and/or program's ability to instill a sense of confidence in residents about their ability to implement solutions to reduce adverse consequences of flooding
 - The message and/or program's transparency about residents' personal responsibility for residential flood protection, recovery and response
 - The message and/or program's ability to evoke a fear-based response in residents about flood risk (i.e., worry, dread)
 - The message and/or program's ability to encourage information-sharing by residents (i.e., sharing flood risk mitigation information to neighbours, friends and family)
 - The message and/or program's ability to inform residents about different types of flooding (e.g., coastal, fluvial, pluvial, surface water floods) and their associated risks to one's home

7. The frequency of the city's flood risk communication to residents varies depending on:
(please select all that apply)
- The season
 - The weather
 - The amount of time since the last major flood
 - The presence of an ongoing flood event
 - The probability of flooding in a given neighbourhood
 - The frequency of the city's flood risk communication to residents remains constant for any given neighbourhood, at any time.
 - None of the above (please specify)
8. Does the city measure residents' engagement with their flood risk communication messages and/or educational content? (e.g., follow-up surveys after city-hosted workshops, social media analytics of the city's flood-related content on social media)
- Yes
 - No
 - Unsure

If "Yes" selected, participants will be directed to question 10

9. How does the city measure the efficacy of their communication methods?
- Please provide as much detail as possible.
10. To the best of your understanding, please rank the following factors in their ability to positively contribute to residents' participation in residential flood risk mitigation, with 1 being the most likely to positively contribute to residents' participation and 10 being the least likely.
- Click and drag the statements to rank them.

- 1) Residents who have previously experienced a flood(s)
- 2) Residents with knowledge about flood-related threats and options for protection
- 3) Residents with the financial resources to participate in residential flood risk mitigation
- 4) Residents who are fearful of the consequences of flooding
- 5) Residents perceive floods as being likely to occur
- 6) Residents who believe that they are capable of reducing their risks to floods
- 7) Residents who have a basement in their home or live in a basement dwelling
- 8) Residents with personal contacts who have previously experienced a flood(s)
- 9) Residents who receive flood risk mitigation information from a trusted source
- 10) Residents who have spoken to their insurance company about flood insurance considerations

Appendix C: Interview Questions and Themes

Interview themes are detailed in the bulleted items. The content in the square brackets represents the phrasing specific to MFRC and NFRC participants, respectively.

1. Can you please explain your understanding of the role of the following stakeholders in promoting residents' personal flood risk mitigation?:

- Municipal governments
- Provincial governments
- Federal government
- Non-governmental stakeholders

- Ongoing transferring of responsibility for flood risk management from federal governments to individuals, local levels of government, non-governmental and industry stakeholders

2. Have you observed any changes in the volume, frequency and/or methods of [X organization's] [the City of X's] communication of flood risk mitigation to residents during your time working with [X organization] [the City of X]?

- Ongoing transferring of responsibility for flood risk management from federal governments to local levels of governments and other non-governmental stakeholders
- Evolution of flood risk communication channels and the options for communication to the public (i.e., digital versus in-person communication channels)

3. To the best of your understanding, why might municipalities form partnerships with external stakeholders or make use of external resources, such as those developed by research groups and insurance industry associations, for their flood risk communication efforts to residents?

- Investigation of Canadian municipalities' outsourcing of aspects of residential flood risk mitigation information to a range of organizations and institutions

4. What do you think are some of the main barriers to residents' flood risk awareness and preparedness?

- Exploration of Protection Motivation Theory variables (i.e., individual risk perception, ability to cope with floods)

a) In your opinion, does [X organization] [the City of X] consider any of those factors (those listed in the above response) when designing flood risk mitigation resources for residents? Are those factors incorporated into the design and delivery of communication resources?

b) To what extent can flood risk messaging be tailored to individuals or neighbourhoods?

5. What do you think are the major barriers or constraints in municipalities' flood risk communication efforts to residents?

Probe: financial, technological (e.g., lack or deficit of communication technology available to city), institutional (role of other levels of government), knowledge (scaling down knowledge to lay audience), social (reaching all members of the population, relationship building between cities and residents), etc.

a) Can you think of any changes in the types of data, the information channels or the programs for residential flood risk communication that will be needed in the future?

6. In your opinion, what are the benefits of flood risk mitigation messaging to the public?

a) How do, or how may, municipalities evaluate the impact of these benefits? (Define success)

Appendix D: Barriers to residents' flood risk awareness and preparedness and proposed solutions

| | Barrier | Illustrative quotations by FRCs | Overcoming barriers through risk communication |
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| AWARENESS BARRIERS | Knowledge of flood risk, flood risk types, technical knowledge | <p>“some people, for lack of a better term, they're just oblivious.”</p> <p>“I think people who are in the floodplain ... have a heightened risk awareness, but the other types of flooding—sanitary sewer backup, or extreme storms that come in the summer that can flood areas that aren't in the floodplain— there's not a lot of awareness”</p> <p>“One of the main barriers we're seeing is that people have the perception that if they don't live near a body water that they're safe; and it's not the case, because a great number of floods in Canada occur to heavy rainfall events, particularly in urban areas.”</p> <p>“it [flood risk information] can be awfully technical - and I think one of the biggest barriers is reaching people using language that they understand.”</p> | <ul style="list-style-type: none"> ● Ensure that the structure and the content of risk messages is accessible. <ul style="list-style-type: none"> ○ Content: Avoid technical language in favour of simple language. Messages should be available in multiple common languages to the region. Message should build awareness and skills such that they are direct and actionable. ○ Structure: If messages are being disseminated on multiple platforms or by multiple partners, always ensure consistency of the terminology and recommended actions. If possible, design websites such that residents may be redirected to relevant flood pages when they search terms related to flooding. Distribute messages via a variety of communication channels (e.g., direct mail, online). ● Conduct educational events, campaigns (e.g., door-to-door education) and/or have a presence at public events (e.g., webinars, information booths at community events) in at-risk* communities ● Use paid advertising on social media to increase the reach of the message |
| | Lack of prior flood experience | <p>“...unless they have experienced a flood in the past, they are unaware that they may be at risk, nor are they interested to discover if they are.”</p> | <ul style="list-style-type: none"> ● Clearly disclose flood risk to those at risk, even if it has been many years since an event ● Immediately following a flood event, take advantage of the temporary, high levels of interest of the |

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| | | <p>“Until people see how it would affect themselves, they may be rather unaware of the potential impact.”</p> <p>“it unfortunately does take incidents to increase the awareness level... then you think about how it might affect your own home and your own property”</p> | <p>media and the public to promote flood risk mitigation content</p> |
| PREPAREDNESS BARRIERS | Cost of residential flood risk preparedness | <p>“you're in a battle with the dollar I have in my pocket today versus the dollar I may or may not need to spend later. Meaning if I flood, I worry about that dollar then, but today, I'm buying granite countertops.”</p> <p>“selling you a coffee crisp is considerably different than trying to convince you to put a few thousand dollars in to protect your home. There's some heavy-duty psychology involved in it”</p> | <ul style="list-style-type: none"> • Promote low-cost mitigative measures (e.g., create an evacuation plan, move valuables upstairs) • Offer free services such as home flood assessments • Disclose the potential financial benefits resulting from the implementation of certain flood risk mitigation measures • Develop resources that consider homeowner status (i.e., renters versus homeowners) • Develop resources that consider housing types (e.g., apartments, single-family residences) • Portray residential flood mitigation measures as aesthetically attractive, specifically with the use of landscaping |
| | Knowledge of residential flood risk preparedness measures | <p>“there is not a lot of information or awareness about the limits to insurance and what's covered based on where people live, that's a really important barrier.”</p> <p>“people do not know how to select reliable contractors. They also don't know how to compare bids or work. This unease contributes to inaction.”</p> <p>“taking action is overwhelming for people: what do I do? Where do I start? ... It's technically overwhelming ... It is a lack of information on those technical aspects as well.”</p> | <ul style="list-style-type: none"> • Always accompany flood risk information with options for protection and/or include external links/resources that can provide options for protective measures • Encourage consultations with insurance brokers about flood insurance |
| | Lack of personal responsibility for flood risk mitigation | <p>“we get into these discussions with community stakeholders that actually start, ‘You are responsible to protect my home, not me’, that's the position we start in a lot of times.”</p> | <ul style="list-style-type: none"> • Have one-on-one conversations with residents affected by floods to clarify their roles and responsibilities for flood risk preparedness and recovery |

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| PREPAREDNESS BARRIERS | | <p>“there's a lot of people that are renting that don't understand their risks or don't understand what's their responsibility versus a homeowner...”</p> <p>“It's that inertia that, 'It's not my problem because I'm all paid up with my insurance'.”</p> <p>“The understanding that, 'This is a local government problem, I pay my taxes, they should deal with this, it has nothing to do with me', with little understanding that a great deal of flooding problems ... on the private lot have really nothing to do with municipality.”</p> | <ul style="list-style-type: none"> • Have one-on-one conversations with residents when rolling out local flood-related programs (e.g., flood control infrastructure projects, residential LID programs) to clarify their roles and responsibilities for flood risk preparedness and recovery • Provide opportunities for residents to 'buy-in' to the stormwater system (e.g., adopt a catch basin programs, community flood protection leaders) • Highlight the connectedness of the watershed/stormwater system (e.g., “Flooding affects everybody living in X”) |
| | Time (time since a flood event is inversely correlated with the motivation to prepare) | <p>“We're getting farther and farther away from the flood, and while it was such a traumatic event for many people ... I think for a large portion of people it is becoming less of an issue.”</p> <p>“When it dies down and nothing's happened you think to yourself, 'I'm in the clear, I might not even have to worry—this is a one in 100-year storm, I've got another 93 years—I don't need to do anything'.”</p> | <ul style="list-style-type: none"> • Maintain consistency in the frequency of flood risk communication campaigns • Add a sense of urgency to messages for at-risk* audiences |
| | Apathy toward flood risk | <p>“the biggest thing is complacency amongst the residents. That's the one we see all the time and it's super frustrating.”</p> <p>“people just don't feel that it affects them that much, and so until it affects them, they don't see why they would participate in educational programs or awareness programs on risks.”</p> | <ul style="list-style-type: none"> • Explain why a neighbourhood is being targeted. Be specific about their level of flood risk. • Highlight connectedness of the watershed/stormwater system (e.g., “Flooding affects everybody living in X”) • Collect insights from social research (e.g., behaviour change models) and incorporate them into outreach and education strategies • Provide opportunities for residents to 'buy-in' to the stormwater system (e.g., adopt a catch basin programs, community flood protection leaders) |
| | Denial of flood risk | <p>“...you hear it all the time, 'Oh, I never thought that would happen to me, that might happen to my neighbour, but it's not going to happen to me</p> | <ul style="list-style-type: none"> • Explain why a neighbourhood is being targeted. Be specific about their level of flood risk. |

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| | | <p>because somehow I'm different' ... there's a book called <i>The Ostrich Paradox</i> about this bias we humans have." "They either don't think about it [flood risk], or they just they don't want to think about it"</p> <p>"there is a very real mindset of 'I'll do it later', and 'it's not a big concern' ... but there is just that complacency and the lack of urgency across the board."</p> | <ul style="list-style-type: none"> Collect insights from social research (e.g., behaviour change models) and incorporate them into outreach and education strategies |
| | Fatalism about flood risk preparedness | "people need encouragement, they need to feel that it [flood risk mitigation measures] would work ... 'I'm so small, what difference can I make?'" | <ul style="list-style-type: none"> Convey the positive difference that residents can make through their protective actions Assess the impact of lot-level measures (e.g., volume of water diverted from storm sewers following a series of downspout disconnections) and present these results to residents to encourage action. Or, present data from external projects |
| BOTH: AWARENESS AND PREPAREDNESS BARRIERS | Emotional barriers (fear, trauma) to flood risk awareness and preparedness | <p>"some of the barriers immediately following the flood were more towards emotional trauma, and it was still such an emotional topic for people that it was difficult to have a constructive conversation."</p> <p>"there's some really difficult conversations involved with helping some people understand that maybe where they live is just not a good place to live, and it could take a generation or two to convince people to let go of something like that..."</p> | <ul style="list-style-type: none"> Combat fear by increasing confidence in residents' abilities to protect themselves by giving them low-cost, low-tech solutions Target messages to flood-affected residents differently than those for the general population, especially in the years following a major flood event (e.g., affirming the support of the municipality to the affected residents during spring flood season) |
| | Social and cultural barriers to flood risk awareness and preparedness | "We may see individuals move to a community that do not have a linguistic contact within that community; language could be a significant barrier. And they may not have a resource in that area or close by that can assist with translation of information..." | <ul style="list-style-type: none"> Account for linguistic and cultural competencies by consulting with demographic data Develop straightforward, general emergency preparedness resources instead of those that are hazard-specific Appeal to people's values (e.g., aesthetics - "curb appeal", safety, property value, environmentalism) in messaging |

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| <p>Systemic barriers to flood risk awareness and preparedness</p> | <p>“it [awareness and preparedness] does vary among social, economic, demographic situations—different groups have been traditionally underserved, under resourced.” “we see that ... people that rent are less likely to be prepared” “It's difficult for us [city staff] to ... get into apartment buildings. ... how do you get information to people?”</p> | <ul style="list-style-type: none"> • Coordinate with stakeholders that serve under-resourced populations (i.e., community support agencies) • Consider the diverse needs of audiences, especially those whose functional needs are not always considered in the design of recommended emergency preparedness and response measures • Strengthen community capacity by providing opportunities for community network-building, building connections |
| <p>Other priorities outcompeting flood risk awareness and preparedness</p> | <p>“with COVID, there's other things that are top of mind for people more than disasters or climate change” “We respond to complaints or trauma or whatever is most pressing. ... We don't tend to really get ahead of the curve and plan ahead” “Awareness is a bit of an artifact around the ability of municipalities to get the information in front of residents, because there's so many competing sources of information ... it is a very saturated media landscape; flood risk mitigation is not as interesting as many other subjects”</p> | <ul style="list-style-type: none"> • Explain why the neighbourhood is being targeted. Be specific. • Add a sense of urgency to messages for at-risk* audiences • Target the values of homeowners (e.g., aesthetics - “curb appeal”, safety, property value) in messaging • Provide opportunities for residents to ‘buy-in’ to the stormwater system (e.g., adopt a catch basin programs, community flood protection leaders) |
| <p>The levee effect (Infrastructure can enable inaction)</p> | <p>“Some [citizens] want these big dikes and things that they feel would protect them and will keep the water out, when sometimes we know that's a false sense of security.” “I think that feeling of protection as we build more and more infrastructure will also be a risk to personal preparedness. ... it will be another big shift in people's perceptions”</p> | <ul style="list-style-type: none"> • Implement education strategies related to stormwater facilities and/or flood control structures that residents may come in contact with • Explain that infrastructure is one of many available tools for flood risk mitigation. Clarify that property-level measures are still recommended to reduce the risk of personal flood damages. |

*For the purpose of this study, at-risk refers to populations at risk of experiencing flooding because of their geography.