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Climate Risk on the Rise: Canada's Approach to Limiting Future Climate Impacts

Daniel Filippi and Kathryn Bakos

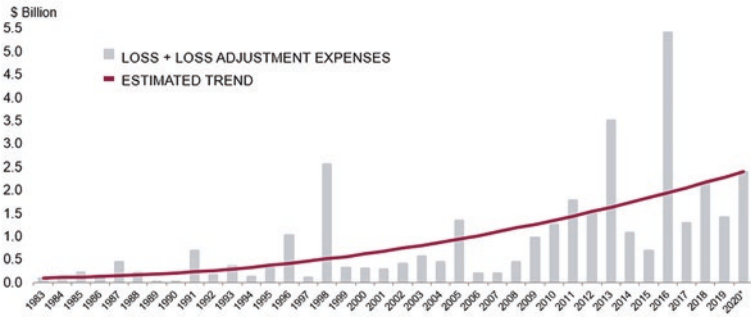
1 Introduction

The United Nations Intergovernmental Panel on Climate Change (IPCC) projects that global warming is effectively irreversible and extreme weather events such as floods and fires will continue to increase in frequency, intensity, and duration throughout the twenty-first century (IPCC, 2019). Due in part to these extreme weather events—combined with aging infrastructure, increased urbanization, loss of natural infrastructure, and lack of protection measures at the household level—there has been a total loss of \$2.98 trillion USD globally (2010–2019) in direct economic damages and insured losses, which is \$1.1 trillion USD higher than in the previous decade (Aon, 2019). Specifically, in regard to Canada, Property and Casualty (P&C) insurance claims have doubled every five years since the 1980s (Fig. 16.1; Kirchmeier-Young & Zhang,

D. Filippi (✉) • K. Bakos
University of Waterloo, Waterloo, ON, Canada
e-mail: daniel.filippi@trca.ca; kbakos@uwaterloo.ca

Insured Catastrophic Losses in Canada

*A catastrophic loss = 1 event costing \$25 million or more in insured damages



Source: IBC Facts Book, PCS, CatIQ, Swiss Re, Munich Re & Deloitte
Values in 2020 \$ CAN
* 2020 preliminary



Fig. 16.1 Costs of extreme weather: Catastrophic insurable losses (\$CAD). (Note: Graph of catastrophic insurable losses in Canada from 1983 to 2020. Total losses normalized for inflation, per-capita wealth accumulation, and set in 2020 CAN dollars (as of November 2020). This is a comparison of “apples to apples”) (IBC, 2020a)

2020; Insurance Institute of Canada, 2020). These catastrophic losses (“cat loss”) refer to any extreme weather event that results in \$25 million CAD or greater insurable loss (IBC, 2020a). Figure 16.1 shows a discernable upward trend in losses averaging more than \$1.2 billion CAD annually since 2009 (Feltmate et al., 2020).

Compounding this issue, the Canadian government’s Disaster Financial Assistance Arrangements (DFAA) payments, which refer to funds transferred to provincial/territorial governments to provide financial relief for costs associated with natural disasters, have increased nearly tenfold between 2004 and 2014 (GOC, 2020). In the coming years, DFAA will increase its current trajectory and average over \$900 million CAD per annum with \$673 million CAD (-75%) going toward flood-related relief (Fig. 16.2; PBOC, 2016). These amounts exceed resources as the program budget has only averaged \$100 million CAD per year since its inception in 1975 (PBOC, 2016).

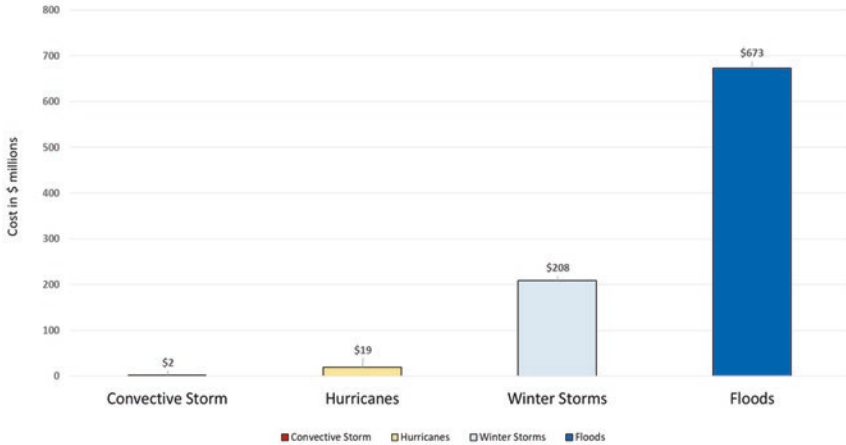


Fig. 16.2 Estimated Disaster Financial Assistance Arrangements (DFAA) annual weather costs. (Note: Estimated DFAA annual weather-associated costs in government funds (millions), with figures provided by the Office of the Parliamentary Budget Officer (PBO) [Story, 2016])

Canadian homeowners, municipalities, businesses, and all levels of government must begin adapting to severe weather events by incorporating measures to mitigate risks around households, corporate structures, and natural habitats. If changes are not made within Canada the economy will continue to suffer extreme losses, which will have direct and indirect implications throughout economic systems. IBC states that due to under-insurance, 60–80% of economic losses resulting from extreme weather events are borne by taxpayers (IBC, 2014). It is the Canadian economy, specifically the Canadian taxpayer, who experiences the physical, financial, and psychosocial implications of extreme weather events. A joint report completed by the Federation of Canadian Municipalities (FCM) and the Insurance Bureau of Canada (IBC) estimates that an investment from all three levels of government of \$5.3 billion CAD a year will be required to fund the municipal infrastructure and local adaptation measures necessary to reduce the impacts of climate change in Canada (IBC, 2020b). This type of funding will help lower economic costs and, in turn, the stresses associated with extreme weather events.

To begin addressing community-level impacts, devising initiatives that homeowners can take must be an initial step. Approximately 10% (or 800,000 households) of Canada's population is located in areas deemed "high-risk" flood zones (Moudrak & Feltmate, 2017). A study conducted by the University of Waterloo found that of 2300 Canadian participants living in areas deemed at high risk under Canada's Flood Damage Reduction Program (FDRP), 94% were unaware their homes were at risk of flooding (Thistlethwaite et al., 2017). Furthermore, fewer than 28,000 km of river systems in Canada have been mapped for flood risk; and of these, approximately 50% were mapped before 1996 under the FDRP, meaning maps are 25 years out of date (Nadarajah, 2016). Canada's FDRP began producing necessary flood risk maps for urban areas across Canada in 1975 (except Prince Edward Island and the Yukon Territory, as both were viewed as "low risk"), with over 1000 communities and associated floodplains mapped (Sandink et al., 2010). The program was successful in helping Canada to redirect investment and key infrastructure developments (residential, municipal, and commercial) away from flood-prone areas. Canada was a global leader in flood preparedness and mapping during this time, as countries within Europe and the Caribbean requested assistance and direction on how to develop similar programs (McClearn, 2019; Henstra et al., 2019). In 1996, the FDRP ended due to federal government budget cuts, and floodplain mapping became the primary responsibility of individual provinces. Wealthier provinces, such as Ontario, continued mapping flood zones with support from conservation authorities, while cash-strapped provinces, like those in the Maritimes, experienced a reduction in flood-mapping activities overall (McClearn, 2019; Conservation Ontario, 2019). As a result, access to accurate and up-to-date flood maps varies across the country, province-to-province.

Canada is no longer the leader it once was due to inaccurate flood mapping, alongside exceedingly large payouts being issued due to rising extreme weather events. The less prepared the country continues to be for climate change-related extreme weather events, the more residents, companies, and municipalities will be the hardest hit by extreme weather events. For example, in 2019, Quebec's premier, François Legault, offered homeowners located within the province's floodplains a maximum of

\$250,000 to purchase homes and/or properties, so residents could relocate elsewhere; this is the highest expropriation offer in Canada to date (Perreaux, 2019; Flavelle, 2019). The average home price in Quebec is \$340,000 (as of 2020), while the average for the rest of Canada's housing stock is \$531,000 (Statista, 2020a, 2020b). Residents who accepted this offer from Quebec's government were potentially "on the hook" for a minimum of \$90,000 to pay off mortgages, if they had not already done so. In addition, a flooded basement (a main reason for increasing "cat losses") in Canada costs on average \$43,000 to repair, which tends to not be fully covered by a homeowner's insurance. Assuming no insurance coverage or a low cap rate, restoring a basement may prove cost-prohibitive for owners, specifically for the 48% of Canadians who reported a monthly surplus of less than \$200 in 2019 (Simpson & Chhim, 2019). As a result, homeowners are generally uninformed and lack the necessary resources to protect themselves against ever-increasing flood risks (Carrick, 2019); without proper planning and foresight, mortgage defaults could increase.

2 Canada's Efforts in Climate Adaptation

2.1 Standards & Guidelines

With support from organizations such as the Standards Council of Canada, National Research Council, and Canadian Standards Association, practical and cost-effective guidelines and standards have been developed to mitigate many forms of extreme weather risk across Canada.

Below are examples of standards which highlight ways Canada can prepare for flood events at the household and community level.

1. *CSA Z800*: This guideline outlines the top 80 visual inspections homeowners can conduct around a home to limit the likelihood of flooding. This guideline was the basis of the Home Flood Risk Assessment Training (HFRAT) course developed by Intact Centre on Climate Adaptation (ICCA) and offered to professional home inspectors, engineers, technicians, and developers (CSA Group, n.d.).

2. *CSA W204*: This standard was developed to be used by municipalities in implementing requirements and recommendations for the design of flood-adaptive greenfield development, along with the adoption/implementation of natural infrastructure and built/gray infrastructure. It includes general principles of community-level design, new planning recommendations, and policies to better protect new communities (SCC, 2019).
3. *CSA W210*: This standard includes new recommendations and an applicable framework for screening both flood hazards and vulnerabilities within current residential communities. The standard highlights how to identify and prioritize various flood risk preparedness actions for large and small municipalities with varying levels of capacity (Filippi, 2020).

2.2 Site-Specific Guidance

Site-specific guidance is necessary in helping Canadians achieve practical and cost-effective means to reduce household flood risk through programs similar to the Home Flood Protection Program (HFPP). The Intact Centre on Climate Adaptation (ICCA, University of Waterloo) developed the HFPP, which includes three key elements:

1. *Free online resources/education materials*: electronic and paper fact-sheets, how-to videos, information on participating communities, and local flood protection subsidies available within municipality (Evans & Feltmate, 2019).
2. *Home flood protection assessment*: Similar to a home inspection, 90-minute onsite flood risk assessment services are made available to homeowners including an easy-to-read summary report (Evans & Feltmate, 2019).
3. *Customized outreach strategy*: Program planning and promotions developed in collaboration with local municipalities, emergency services, conservation authorities, community groups, media outlets, and insurance providers to complement and enhance ongoing flood risk reduction efforts (Evans & Feltmate, 2019).




THREE STEPS TO COST-EFFECTIVE HOME FLOOD PROTECTION


Complete these 3 steps to reduce your risk of flooding and lower the cost of cleanup if flooding occurs. For items listed under step 3 check with your municipality about any permit requirements and the availability of flood protection subsidies. *Applicable only in homes with basements

Step 1: Maintain What You've Got at Least Twice per Year


Do-It-Yourself for \$0




Remove debris from nearest storm drain or ditch & culvert



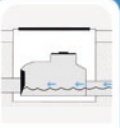
Clean out eaves troughs



Check for leaks in plumbing, fixtures and appliances




Test your sump pump*



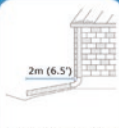
Clean out your backwater valve

Step 2: Complete Simple Upgrades


Do-It-Yourself for Under \$250



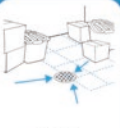
Install window well covers (where fire escape requirements permit)*




Extend downspouts and sump discharge pipes at least 2m from foundation



Store valuables and hazardous materials in watertight containers & secure fuel tanks



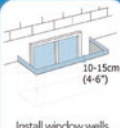
Remove obstructions to floor drain



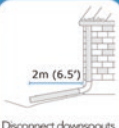
Install and maintain flood alarms

Step 3: Complete More Complex Upgrades


Work with a Contractor for Over \$250



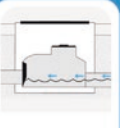
Install window wells that sit 10-15cm above ground and upgrade to water resistant windows*




Disconnect downspouts, cap foundation drains and extend downspouts to direct water at least 2m from foundation



Correct grading to direct water at least 2m away from foundation



Install backwater valve



Install backup sump pump and battery*

Note: Not all actions will be applicable to each home. Completing these steps does not guarantee the prevention of flooding.

INTACT CENTRE
ON CLIMATE ADAPTATION

For Additional Resources Visit:
www.HomeFloodProtect.ca



Fig. 16.3 Three-step document to home flood protection. (Note: Three-step document created by ICCA highlighting simple and cost-effective adaptation actions to limit the risk of flooding in and around the home [Moudrak & Feltmate, 2020])

Figure 16.3 summarizes the top 15 actions that homeowners can take to reduce flood risk. The program's results indicate that direct conversations between homeowners and trained flood risk mitigation professionals are effective in motivating residents to take action to reduce flood risk at the household level. These results led the ICCA to develop multiple training programs for home inspectors, real estate agents, mortgage professionals, insurance brokers, and municipal employees (ICCA, *n.d.*). This training allows homeowners to acquire information confidentially from trusted professionals on how to best protect their homes.

2.3 Financial Standards and Disclosure Guidelines

In addition to standards and guidelines that prepare Canadian households and communities for flood events, Canada has passed official regulation that requires publicly traded companies to disclose material climate risks through the Canadian Securities Administrators (CSA)—Staff Notice CSA-51-358. For approximately ten years, the CSA have required publicly traded companies disclose material climate risks. Fiduciary duty requires the disclosure of this information, as it could affect the decision of an investor to buy, hold, or sell stock in a given company (OSC, 2020; BOC, 2019). These implications could directly affect the Canadian economic system, influencing the livelihoods of citizens and the distribution of community resources. The problem, however, is that securities commissions simply do not know which climate risks are material; as a result, they cannot enforce their own mandate. To correct this oversight, securities commissions should prioritize establishing a core group of climate risks, specific to each industry sector, which issuers should be required to report.

Relative to climate change, the outstanding challenges for investors are to identify which extreme weather events have the highest probability of affecting individual industry sectors/sub-sectors and assess whether potential investee companies have implemented appropriate actions to mitigate extreme weather risks specific to sectors/sub-sectors (Feltmate et al., 2020). In this regard, the ICCA has developed a practical means to factor climate change and extreme weather risk into portfolio

management, consistent with the direction proposed by the Task Force on Climate-Related Financial Disclosures (TCFD) (Feltmate et al., 2020).

The Climate risk matrices (CRMs) prioritize the top one or two means by which each category of extreme weather (e.g., flood, fire, wind) may negatively impact industry sectors, while simultaneously identifying actions companies should take to mitigate prioritized risks (including probable and tail risks), per Fig. 16.4 (Feltmate et al., 2020). This directive allows climate risk information to be understood and interpreted by investors, enabling them to price risk and ensure the efficient allocation of investment capital (BOC, 2019). Although CRMs address the needs of investors, value is also available to securities commissions (to guide

	Flood	Fire	Wind Storm	Ice and Snow Loading	Thawing Permafrost
Key Climate Risk Impacts	Flood-induced high water levels result in inadequate electrical clearances below lines that are hazardous to the public	Fire along transmission corridors can cause outages if corridors are not adequately clear of brush Vegetation/tree contacts with transmission lines can cause arcing, fires and outages	Vegetation/tree branches can fall onto T&D lines causing outages T&D lines can be brought down by wind forces	T&D lines and structures can collapse under heavy ice loading	Thawing/discontinuous permafrost can displace transmission tower foundations, causing structural collapses and outages
Mitigation Measures	Ensure structures are tall enough for safe clearance under foreseeable flood levels, or lines are installed underground	Conduct patrols (visual inspection of utility equipment and structures) in fire prone areas Clear vegetation along transmission corridors	Clear vegetation along transmission corridors Install anti-galloping devices on conductors and ensure structures are designed to withstand winds	Install visual monitors to detect ice loading. Before ice loads build, boost current to melt ice (i.e., short the line)	Modify structure/ designs to readily permit adjustment of towers when line patrols identify permafrost thaw displacement
Key Questions to Determine Readiness to Mitigate Climate Risk	What percentage of T&D lines in flood-prone areas have sufficient clearance to safely accommodate a 1:200 year flood without de-energizing the line?	What percentage of total length of overhead transmission lines in wildfire-possible areas are closer than 10 metres horizontally to tree branches?	What percentage of total length overhead Transmission lines in tree areas are closer than 10 metres horizontally to tree branches that are higher than the conductors?	Are overhead lines that are susceptible to icing monitored by cameras that observe icing on the conductors?	Are your transmission structures, in discontinuous permafrost areas, of a design where the structured footings can be adjusted without de-energizing the line?
Excellent Answer	> 75%	None	< 5%	Yes	Yes
Good Answer	50% or higher	< 10%	< 25%		Yes, the most recent ones

Fig. 16.4 Climate risk matrix for electricity transmission and distribution industry sector. (Note: Climate risk matrix—electricity transmission and distribution (material highlighted in red reflects prioritized areas of focus applied to portfolio management) [Feltmate et al., 2020])

expectations on climate risk relative to disclosure), credit rating agencies (to identify borrowers' key climate risk liabilities), and boards of directors (to set a framework in which board members can ask appropriate climate risk-related questions of management) (Feltmate et al., 2020).

3 Case Study of Global Climate Adaptation Efforts

Although climate adaptation practices, policies, guidelines, and tangible actions have been developed, Canada must begin to take note of counterpart program innovations at both the government and private industry level, given the relative success seen in these countries.

3.1 The Netherlands: A Three-Tiered Approach

Canada and the Netherlands are very similar when it comes to their overall “vulnerability” rating, as reported by the United Nations University’s Institute for Environment and Human Security (UNU-EHS). In 2020, the Netherlands received a vulnerability score of 24.87%, while Canada received a score of 26.89%. A lower vulnerability score indicates that a country is less likely to be environmentally, socially, and economically devastated by extraordinary circumstances, while also indicating the ability to recover quickly if a major event does occur. With this in mind, the Netherlands is less vulnerable than Canada, even though it possesses an “exposure” score three times higher than Canada’s (31.72% compared to 10.36%). Exposure scores are calculated by the likelihood of a natural hazard (sea-level rise, earthquakes, etc.) occurring in a given country. These two indices, “vulnerability” and “exposure”, are calculated together to assign a country’s “WorldRiskIndex” score, per Fig. 16.5. As a result, the Netherlands ranks 65th out of 181 countries in terms of its WorldRiskIndex score of 7.89% (which is considered high risk), while Canada ranks 156th with a WorldRiskIndex score of 2.79% (which is considered very low risk) (Bündnis Entwicklung Hilft, 2020).

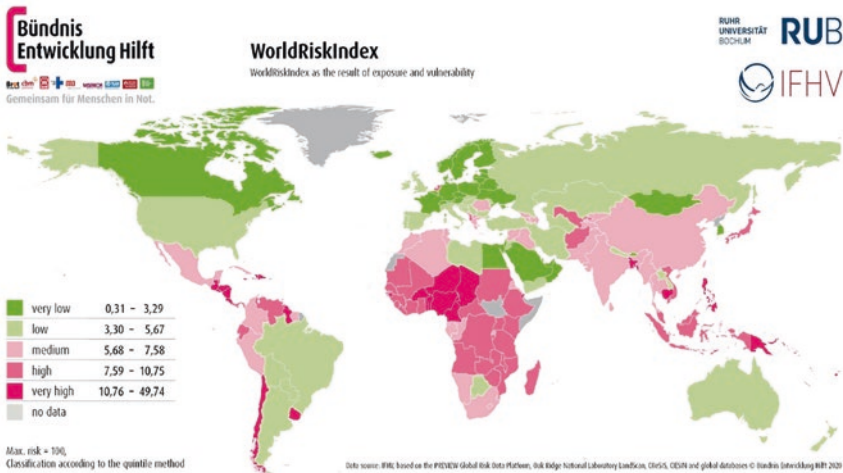


Fig. 16.5 “WorldRiskIndex” map. (Note: A Country’s “WorldRiskIndex” is created by combining a country’s “vulnerability” and “exposure” scores. Although Canada’s WorldRiskIndex score is much lower than the Netherlands, Canada’s higher vulnerability score means the Netherlands would rebound from major disasters faster [Bündnis Entwicklung Hilft, 2020])

Even though the Netherlands possesses a much higher exposure and overall risk score, the country is more likely to recover from an event compared to Canada due to its innovative approaches to limiting major disasters, due in part to lessons learned from the North Sea Flood of 1953 (which killed more than 1800 people and evacuated another 100,000) (Hall, 2013). Innovations after the North Sea Flood resulted in major improvements to the country’s coastal defenses, flood management practices, policy reform, and early-warning systems. The Dutch have begun working with blue-green infrastructure, allowing rivers more space to meander and flow out into natural floodplains, which assists in reducing floods’ impact on residential areas. Additionally, common urban infrastructures such as garages, parks, levees, and public squares now act as emergency catch basins and reservoirs during major flood events (Esteban et al., 2020; Morrison, 2019; Kimmelman, 2017).

Finally, all three levels of government are responsible for how the Netherlands handles flood risk management, ensuring quick recovery

from extreme weather events, unlike in Canada, where the responsibility lies with varying government bodies depending upon the province.

The three levels of government involvement in the Netherlands are as follows:

1. **The Municipality**

- Municipalities are able to access data, maps, and so on from the Rijkswaterstaat (Ministry of Infrastructure and Water Management) and forecast incoming rainfall events to determine whether warnings or evacuations are necessary (Esteban et al., 2020). Municipalities in the Netherlands have adopted a three-step approach (Capture, Store, and Drain) to handling excess water, which has led to various multi-faceted public spaces assisting in flood management, in addition to being gathering places for communities (Dai et al., 2017).

2. **Water Boards** (*Waterschappen or Hoogheemraadschap*)

- Regional government bodies are responsible for water management (water quality, flood adaptation, etc.). There are currently 21 water boards that represent the 12 provinces of the Netherlands. These boards hold elections every four years and function independently from the country's other government bodies (Sten, 2019; Toonen et al., 2006; Kiesraad, n.d.).

3. **Rijkswaterstaat**

- Over time, the Rijkswaterstaat (Ministry of Infrastructure and Water Management) has developed and made available pertinent information for flood adaptation planning, which includes up-to-date flood maps and simulations. Municipalities across the Netherlands can access this information to better prepare for future flood events and better design adaptive community strategies (Esteban et al., 2020; Government of the Netherlands, n.d.).

Canada must institute more sound, uniform, and collaborative approaches at all three levels of government to ensure property and peoples' livelihoods are less affected by the devastating impacts of natural disasters.

3.2 FEMA in the United States

The United States handles flood insurance and risk much differently from Canada. Although standard homeowners' insurance does not cover flood damage (similar to Canada), the federal government works with insurers to alleviate the impacts of flooding (i.e., hurricanes, heavy rains, etc.). In 1968, the National Flood Insurance Program (NFIP) was created and offered to eligible renters, homeowners, and businesses (FEMA, n.d). The NFIP is administered and run by the Federal Emergency Management Agency (FEMA), under the US Department of Homeland Security (DHS) (FEMA, n.d). The program has become the country's main flood insurer, backing over five million homes and businesses and providing 96% of all flood coverage in the United States (Zou, 2020). The second major function of the NFIP is to develop and modernize flood mapping. By continually mapping flood hazard areas/zones, associated regulations and flood insurance requirements can evolve. This program is duly named "Risk Mapping, Assessment, and Planning" (Risk MAP). The Risk MAP program sets annual coverage premiums, while determining which properties are eligible for subsidies (Zou, 2020). In this way, flood insurance premiums are set based on risk, but homeowners who have prebuilt structures located in the floodplain, prior to the Risk MAP program being initiated, are exempt from higher premium rates and still receive coverage (Zou, 2020). Finally, the NFIP works in collaboration with approximately 90 different private insurance companies to offer flood insurance to property owners and renters. Unlike Canada, it is the US federal government, and not individual insurance companies, setting rates (FEMA, n.d.).

Problems do arise, however; as the NFIP and FEMA are subject to approval by Congress and are impacted by the federal government's changing mandates and election cycles. Furthermore, any new home or business located in a FEMA- and NFIP-deemed "high-risk" flood zone

that possesses a mortgage from a listed government-backed lender is required by law to have flood insurance (FEMA, 2020). This stipulation makes sense to protect the mortgage originator's investment, but makes things quite difficult for owners. Some owners are unable to afford the legally mandated high rates, leading to buyers being priced out of the market (FEMA, 2020). The requirement for business/home owners to have flood insurance is not instituted in Canada, regardless of the location or the perceived risk of flooding (McLachlan, 2021).

Ultimately, the program's core requirements are sound, allowing for fair and equitable insurance coverage to be accessed by owners living in high-risk zones and encouraging flood protection measures to be implemented to ensure insurance subsidies and/or reductions.

Canada should look to institute an updated and more equitable program that ensures affordable flood coverage for all. With this, Canadians would understand the significance of flood insurance, and benefit from a fulsome coverage policy, while reducing the likelihood of mortgage defaults. The Canadian federal government could look to implement these types of programs through Public Safety Canada.

3.3 Flood Re

In the United Kingdom (UK), a relatively novel approach attempts to ensure residents are protected from flooding. This example offers an interesting look into how reinsurance firms could operate in the near future.

Flood Re is a reinsurance pool, specifically for flood insurance, that offers coverage to both residential and smaller commercial properties deemed by the UK's mapping program to be "high risk" (IBC, 2019). Flood Re utilizes a pool of money to pay out individual insurance firms for claims paid to customers. Created in 2013, this pool of funds was established to allow individuals to pay for subsidized flood insurance. If claims following a flood event surpass the pool of money within Flood Re's reserves, then a specific levy can be imposed by the program, which calls on insurance companies associated with the program to provide further funding (IBC, 2019). The full amount of risk-based coverage costs will increase incrementally until 2039 (IBC, 2019), and within this

timeframe, it is expected that the UK government will contribute to de-risking the country's most vulnerable properties to the point where traditional insurance purchasing and operations will be reinstated (IBC, 2019).

The reinsurance pool started as a result of increased flooding events due to climate change, urban development, and densification, which caused many insurance providers to become wary of offering flood insurance or simply couldn't afford to as a growing number of people were located in floodplains or other high-risk areas. Meanwhile, other insurers offered coverage, but costs were too high for average homeowners to afford; as a result, it was thought that this could lead to a number of homeowners opting to not pay for flood insurance to protect their homes. As a result, the federal government intervened and collaborated with private insurers, leading to the development Flood Re, a non-profit to ensure high-risk areas were offered affordable insurance (King, 2020).

Flood Re is the first of its kind to receive a sign-off from private insurers and backing by government legislation to offer available and affordable insurance coverage to those at the greatest risk in the country—the program directly affects approximately 350,000 homes (IBC, 2019). Even with many positive features, the program has faced scrutiny, including claims of its inability to offer enough risk reduction incentives to invest in flood-adaptive actions. This could potentially lead to more inequality between subsidized premiums and technical risk prices, as Flood Re had not considered the potential of increased frequency in flood events due to continued climate change impacts.

Although the Flood Re program possesses shortcomings, it deserves considerable recognition as an example of how governments and private industry can collaborate and limit the impacts of climate change. Since Canada was the last G8 country to offer overland flood insurance, an example of how Canada is lacking leadership in regard to flood insurance offerings (Gollom, 2017), implementing a program like Flood Re, could be a monumental step forward. If established, this could create a meaningful reinsurance-style partnership with insurance providers, while offering "build back better" subsidy requirements and stipulations to ensure more robust and accountable offerings to Canadians coast-to-coast.

3.4 Global Adaptation Measures: Disclosure of Risk

The European Environmental Agency (EEA) released a report in 2018 assessing the risk climate change poses to various member countries and determined how this information could assist in developing adaptation policies (EEA, 2018). The EEA report highlighted that adaptation would ensure that the EU is better prepared to handle the impacts of heat waves, floods, droughts, and so on (EEA, 2018). The report's aim was to promote a better understanding among experts and policymakers involved in adaptation planning, contributing to more informed decision-making in key vulnerable sectors across Europe (agriculture, fisheries, infrastructure development, etc.) (EEA, 2018).

In concert with this report, the TCFD, an international framework, considers physical, liability, and transition risks, while identifying what constitutes effective financial disclosures across industry sectors (TCFD, 2020). Global governments and companies now have recommendations to measure and respond to climate change risks better, while encouraging alignment with disclosure needs (TCFD, 2020). This type of framework allows climate risk information to become more widespread and useful within investment decision-making (TCFD, 2020). By utilizing this information, investors can understand the financial implications associated with climate change, emphasizing the importance of transparency in pricing risk and opportunities (TCFD, 2020). Ultimately, this will lead to allocating capital to companies that have identified climate risk and implemented adaptation measures to protect against these impacts (TCFD, 2020).

Society's failure to integrate the impacts of climate change into economic decision-making puts investors, financial institutions, credit rating agencies, capital markets, and so on at unnecessary risk (Moudrak & Feltmate, 2020). A recent example of taking a step in the right direction, the Government of New Zealand passed legislation requiring the disclosure of climate-related risks to comply with the TCFD (Reuters, 2021).

As more frameworks (Sustainability Accounting Standards Board (SASB), CDP, GRI, etc.) evolve though, disclosure recommendations vary and lack consistency. The market is calling for more practical

disclosure information and comparability that would come with standardization (SEC, 2021). Currently, not all companies do or will disclose without a mandatory framework resulting in the misallocation of capital, so a standard comprehensive framework is required to produce consistent, comparable, and reliable data that investors need (SEC, 2021).

4 How Can Canada Better Adapt to Climate Change?

Canada needs to determine how extreme weather impacts communities, as a whole. By utilizing standards and guidelines already developed by organizations such as the Standards Council of Canada, National Research Council, and the Canadian Standards Associations, the country can assess and operationalize risk mitigation measures at the community level. Canada is moderately prepared when it comes to adaptation planning, municipal resilience projects, and instituting available federal and provincial funding for climate change implementation; however, more needs to be done. Canada must learn from the likes of the United States' NFIP program, the UK's Flood Re reinsurance program, and the countrywide watershed management of the Netherlands' three-tiered approach. Learning from the Netherlands, adaptation is simply a function of how a country anticipates the impacts of climate change and incorporates this into the function of daily life. Canada could use this as a blueprint for steps that can be taken now and forecast significant measures in the coming years to prevent risks associated with climate change in the near future.

As previously stated, Canada was once revered for its flood management, but today a lack of preparedness now defines the country's climate change response. Canada must look to alternative options, with governments working with private industry and implementing specific bodies/committees of government to focus solely on watershed management in all provinces. New regulations, codes, and guidelines must be developed to take into account new climate modeling data to help build "future-proof" climate-resilient cities across the country. Additionally, the federal

government, through the Ministry of Natural Resources (NRCan) and Public Safety & Emergency Preparedness Canada, must work with the country's Indigenous governments, provinces, and territories to effectively develop and provide all Canadians with access to accurate and updated flood mapping. A nearly comprehensive inventory is tentatively set to be completed by the end of 2022; if completed, this effort will be a step in the right direction (Meyer, 2020; Trudeau, 2019). Finally, according to the Insurance Bureau of Canada, there should be an option for Canada to create a "high-risk flood pool of properties that would not otherwise be offered affordable insurance (or any flood insurance)" (IBC, 2019, p. 11). Homeowners would still need to pay premiums that reflect individual risk levels, but coverage under this option should be affordable, capped, and/or subsidized (IBC, 2019, p. 11). Responsibility is in the hands of government investment and taxpayers, which will be essential in "lowering the public safety and personal financial risk of those Canadians living in high-risk areas" (IBC, 2019, p. 13).

Furthering steps taken by the Canadian Securities Administrators and New Zealand's Federal Government, Canada, and countries around the world, should implement federal legislation requiring the disclosure of climate-related risks that comply with one globally recognized framework, while establishing a core group of climate risks, specific to each industry sector, which issuers would report to ensure securities commissions (and other agencies) know which climate risks are material.

This is key to developing guidance that contributes to improving the resiliency of communities, and business that operate within those communities, particularly in regard to climate adaptive infrastructure and determining where the allocation of funds can lead directly to preventing loss. Additionally, homeowners, municipalities, and/or businesses that disclose and adapt against risks should receive discounts on insurance premiums, mortgage interest rates, and gain access to interest-free loans. With more widespread and financially accessible adaptation actions, Canadians can have a positive impact at the individual level while also contributing to reducing growing levels of insurable and uninsurable losses, and DFAA payments.

Finally, throughout this chapter, flooding has been shown to be a high cost and key concern for Canadians. On a global scale, coastal flooding

alone could amount to \$14.2 trillion worth of losses by 2100, representing 20% of global Gross Domestic Product (GDP) (Kirezci et al., 2020). GDP tends to fall short of incorporating environmental factors into its valuation, so a standardized risk-based assessment including impacts from severe weather events and externalities must be incorporated into GDP calculations allowing for a more realistic representation of economic performance (iPolitics, 2020). As an example, under current GDP calculations, rebuilding following storm damage (damage that could have been averted had adaptation occurred) has a positive influence on GDP. This is a “false economy” measure, meaning this was money that suffered an opportunity cost, as it is now unavailable for building necessary community assets such as roads, schools, and medical and community centers (iPolitics, 2020). Armed with this understanding, Canada should move away from “false economy” measures and toward incorporating negative externalities into decision-making (iPolitics, 2020).

5 Conclusion

As the IPCC admonishes, global warming is effectively irreversible, and extreme weather events will continue to increase in frequency, intensity, and duration. The growing magnitude of extreme weather events will continue to challenge citizens, communities, governments, businesses, economies, and so on globally. As these impacts unrelentingly unfold, Canada must allocate resources to assist homeowners, communities, and businesses in adapting against climate change.

Utilizing standards, codes, and guidelines already developed, Canada can assess and operationalize risk mitigation measures at community levels and institute collaborative approaches throughout all three levels of government, such as the Netherlands' three-tiered approach, to minimize the devastating impacts of climate change. Canada can ensure affordable flood coverage by looking to the United States' FEMA model, while programs like Flood Re in the United Kingdom could help guide the creation of meaningful partnerships with private insurance providers and offer “build back better” subsidies to ensure more robust and accountable offerings are provided to Canadian homeowners.

Canada must continue to expand efforts to distribute free online resources/education materials, incorporate flood protection assessments into property inspections, and customize outreach strategies that complement and enhance ongoing flood risk reduction efforts. Opportunities and investments must be available for governments to work collaboratively with private industry to institute specific bodies/committees that focus solely on watershed management in all provinces. New climate modeling data should be used to develop future regulations, codes, and guidelines that will help build climate-resilient cities, while effectively developing and providing access to up-to-date, publicly available, flood maps to all Canadians.

Canada should follow through with federal legislation requiring crown corporations and private sector businesses to disclose climate-related risks and opportunities in compliance with global financial frameworks, contributing to the resiliency of business operations throughout the country. Finally, Canada must ensure that GDP calculations incorporate negative externalities into decision-making, moving away from “false economy” measures, so capital can be redirected to resilient infrastructure development.

Armed with insights from these global examples, Canada has the potential to become a strategic leader in the global fight against climate change; all we need to do is take the first step.

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