UNIVERSITY OF WATERLOO

INTACT CENTRE
ON CLIMATE ADAPTATION

TREADING WATER: IMPACT OF CATASTROPHIC FLOODING ON CANADA'S HOUSING MARKET

- Sold Price
- Days on Market
- Houses on Market
- Mortgage Arrears & Deferrals

Supported by:

intact

CMHC SCHL

GRI GLOBAL RISK INSTITUTE

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The Intact Centre on Climate Adaptation (Intact Centre) is an applied research centre at the University of Waterloo. The Intact Centre was founded in 2015 with a gift from Intact Financial Corporation, Canada's largest property and casualty insurer. The Intact Centre helps homeowners, communities and businesses to reduce risks associated with climate change and extreme weather events. For additional information, visit: www.intactcentreclimateadaptation.ca

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Executive Summary

The most costly impact of climate change affecting Canadians is residential basement flooding, that is often made worse through poor land-use planning and management.

With about 9% (3.3 million) and 11% (3.9 million) of the Canadian population residing in 1-in-100 and 1-in-200-year floodplains, respectively, these percentages are expected to increase as floodplains expand in response to more extreme precipitation driven by climate change (Mohanty and Simonivic 2021) and to the loss of natural infrastructure (e.g., forests, grasslands and wetlands that act as "sponges"). Also, outside the boundary of floodplains, residential flooding is impacting an increasing number of homes and communities due to high intensity precipitation events – referred to colloquially as "water bombs" – that render historically safe communities vulnerable to flooding.

Against this backdrop, this study examined whether catastrophic flooding affects Canadian residential real estate (house sold price, days on market and number of listings) and mortgage markets (arrears and deferrals). The primary audience to which findings of this report bears direct relevance includes homeowners, mortgage providers, municipalities and financial regulators.

Five cities that experienced one-or-two catastrophic floods (i.e., events triggering upwards of $25 million in insurable claims), from 2009-2020, were considered in the real estate component of the study: Grand Forks (British Columbia: 2018), Burlington (Ontario: 2014), Toronto (Ontario: 2019), Ottawa (Ontario: 2019 and 2017) and Gatineau (Quebec: 2017). Two cities were considered relative to the impact of flooding on mortgage arrears and deferrals. Aggregated mortgage arrears and deferrals data was provided by a Canadian financial institution which requested that the cities analyzed remain anonymous.

Relative to study design, the impact of flooding on the real estate and mortgage markets was measured for periods of six months pre- vs. post-catastrophic flood event. For example, if a flood event occurred on January 1, 2020, the time period under investigation would include six months pre-flood (July 1, 2019 to December 31, 2019) and six months post-flood (January 1, 2020 to June 30, 2020). Attribution of "flood only impacts" was determined by juxtaposing (or "subtracting out") changes in nearby non-flooded control communities (i.e., areas with virtually identical demographic and housing characteristics) over identical times of six months pre- vs. post-flooding. Thus, all data presented in this report reflects the isolated or "net effects" of flooding.

3.3 million
Canadians live

in the
100-year floodplain

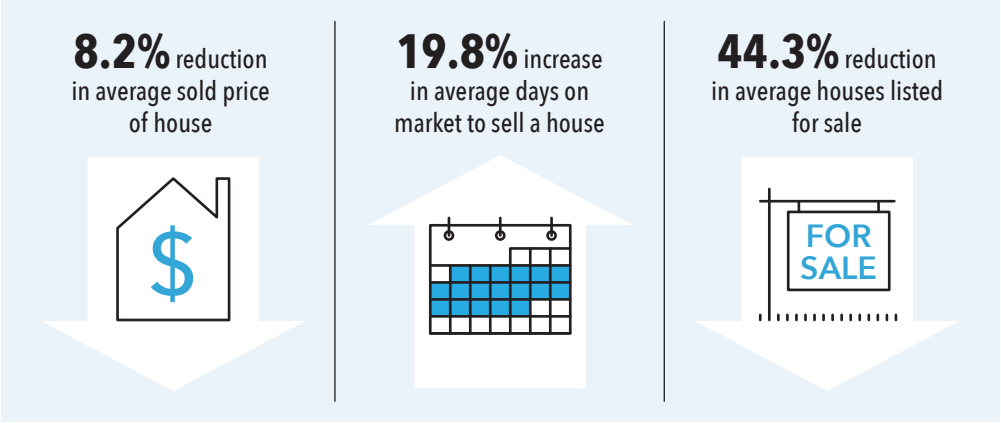
3.9 million
Canadians live

in the
200-year floodplain

The primary audience to which findings of this report bears direct relevance includes homeowners, mortgage providers, municipalities and financial regulators

Residential Real Estate

The net impacts of catastrophic flooding on residential housing, averaged across the five aforementioned cities (and six flood events), for six months pre- vs. post-flood event, were as follows:



As context, for a house that would sell at the Canadian average price of $713,500 (as of December 2021; WOWA 2021), if the neighbourhood was subject to catastrophic flooding, and assuming the average 8.2% impact of flooding on price, the house would be sold for $654,993, reflecting a "flood discount" of $58,507.

A 19.8% longer time period to sell a house in a flooded community may not be material to sellers, as the median time to sell a house in Canada is 65 days (Realtor 2021), which would translate into an additional 13 days on market. This longer time frame may reflect caution on the part of buyers practicing due diligence when purchasing a house in a flood prone community.

A 44.3% reduction in the number of houses listed for sale following a catastrophic flood may be due to: (a) expectation of a lower listing price in the aftermath of flooding, (b) waiting for the "stigma" of flooding to pass, and/or (c) time required to remediate a house following flood damage prior to listing (Hino and Marshall 2020; Sanders et al. 2020). Arguably, 44.3% fewer house listings reflects stress on those who would otherwise position their house on the market – additionally, stakeholders in the real estate sector, including real estate agents, stagers, lawyers, mortgage brokers and lenders, would also realize an impact (Zhang and Leonard 2019).

A case study (Fredericton, NB) suggested that for communities within cities that flood on a near annual basis for at least a decade (vs. one or two catastrophic floods per decade), the impact of flooding can be priced into the real estate market permanently.

Residential Mortgages

When evaluating the net impacts of catastrophic flooding on residential mortgage arrears and deferrals for two Canadian cities, for six months pre- vs. post-flood event, the results showed no consistent or material impact. Post-flood mortgage arrears and deferrals increased in the flood-impacted region of one community (relative to the non-flood impacted control), while in the second city, the results reversed. This outcome suggests that factors other than flooding may be consequential to mortgage arrears and deferrals (Balmbra 2021).

Importantly, the rate of mortgage arrears and deferrals in flooded vs. non-flooded communities largely fell within market norms. The total number of arrears and deferrals in flood-impacted and control regions ranged from 0.32 – 7.07 per 1,000 homes over a six-month period, which translates to a worse-case scenario of 1.18 arrears and deferrals per 1,000 homes per month. The consequences of flooding appear to be relatively immaterial regarding mortgage arrears, particularly considering that impacts would generally last only a few months post-flood (Zhang and Leonard 2019).

Mitigating Residential Flood Risk

Currently, available and/or suggested developments to help limit the impact of flooding at the community and/or individual house level include, but are not limited to, the following:

- **Home Flood Protection Guidance:** Banks, credit unions, real estate brokers, mortgage providers and Property & Casualty insurers are increasingly distributing the infographic Three Steps to Cost-Effective Home Flood Protection, to provide direction to homeowners regarding practical actions to lower risk of basement flooding. Most steps in this infographic are deployable with no special expertise and for minimal cost. https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2021/03/3-Steps-to-Home-Flood-Protection_March-2021_Space-for-Partner-Logo.pdf

- **Climate Adaptation Home Rating Program (CAHRP):** The federal government of Canada launched the CAHRP in 2021, as a companion to EnerGuide home energy audits. CAHRP can help homeowners to navigate the flood retrofit process, and expand on the eligibility requirements of the Canada Mortgage and Housing Corporation's (CMHC) deep home retrofit program and Canada Greener Home Grants to include more climate resilience/flood risk mitigation measures. https://liberal.ca/wp-content/uploads/sites/292/2021/08/wildfires-ENG-1.pdf

- **Flood Risk Maps:** Federal, provincial, territorial and municipal governments are updating flood risk maps to aid city planners, developers, engineers and municipal risk officers to identify and remediate areas at high risk of flooding. These maps, where publicly available, may guide homeowners to make informed decisions to limit flood risk.

- **Residential Flood Risk Scores:** Federal, provincial, territorial and municipal governments should develop a system that establishes a flood risk score for any residential property, based on address/postal code (as exists in the US - https://floodfactor.com/).

- **Natural Infrastructure:** Federal, provincial, territorial and municipal governments should develop and enforce guidelines and standards to retain and restore natural infrastructure (e.g., forests, grasslands, wetlands) to limit current and future flood risk. In addition to government led initiatives, residents should also be proactive and use natural infrastructure, for example, to a greater extent on their personal properties (e.g., wild gardens and naturalized driveways).

- **Community Flood Risk Mitigation:** Through guidelines supported by the Standards Council of Canada and the National Research Council,

communities can act now to identify areas at high risk of flooding, and subsequently deploy actions to mitigate risks (in some cases flood risk protection may be beyond practical and cost-effective remediation). https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2019/01/Weathering-the-Storm.pdf

The "**bad news**" regarding the impact of flooding on residential housing is that climate change and extreme weather-related flood risk, at times combined with poor land-use planning, will get more challenging across many regions of Canada (IPCC 2021), and if left unchecked, will increasingly distress the residential housing market. The "**good news**" is that Canada has developed, or is in the process of developing, a wealth of guidance to help homeowners and communities to mitigate flood risk.

The challenge going forward is to apply known and evolving best practices, guidelines and standards to mitigate home and community-level flood risk with a sense of **urgency**, which is the applied and philosophical centerpiece of Canada's **National Adaptation Strategy** (https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/national-adaptation-strategy.html).

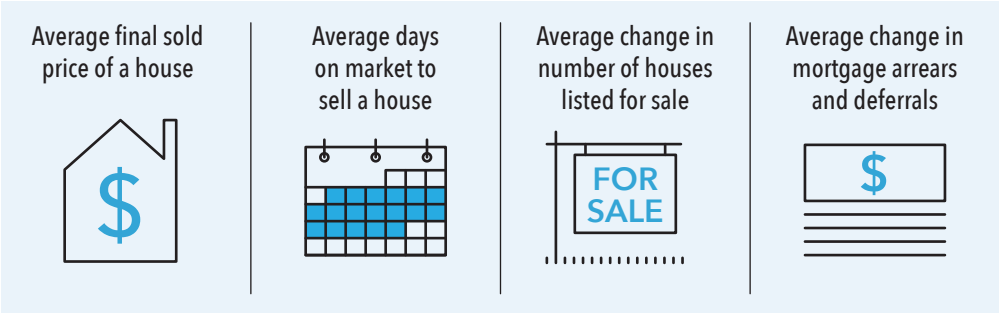
The challenge going forward is to apply known and evolving best practices, guidelines and standards to mitigate home and community-level flood risk with a sense of **urgency**

Introduction: The Landscape of Residential Flood Risk in Canada

Property-level residential flooding of detached, semi-detached and row housing is occurring more frequently across Canada, driven in part by "increasing trends in extreme precipitation in North America", which models and theory suggest will continue as the climate warms (Kirchmeier-Young and Zhang 2020).

With about 9% (3.3 million) and 11% (3.9 million) of the Canadian population residing in 1-in-100 and 1-in-200 year floodplains, respectively – and with flood risk on the rise (Mohanty and Simonovic 2021; IPCC 2021) – if left unchecked flooding may impact the "safety and soundness of the Canadian financial system" (OSFI 2021).

Testimony to the adverse impact of flooding is the increase in Canadian home insurance premiums of 20-25% over the period 2015-2019, with more than half of this upturn attributable to flood damage (Moudrak and Feltmate 2020). The Property & Casualty ("P&C") insurance implications of residential flooding are material and understood. What is not known, and therefore is the focus of this study, is the impact severe flooding may have on Canada's housing market, relative to:



Quantitative documentation regarding the effects of flooding on real estate parameters is available primarily from the United States and the United Kingdom (Belanger et al. 2018). Consistent with this, a North American examination of catastrophic loss impacts on real estate values has shown that "the homeowner has the most financial risk associated with climate impacts" (Chopik 2019).

Canadian studies have tended to be more anecdotal, yet insightful – as suggested by Appraisal Institute of Canada CEO Keith Lancastle, *"challenges stemming from climate change have resulted in individual property owners seeing reductions in the value of their property, or the need to take additional steps to help protect that property from the impacts of climate change"* (Meyer 2020).

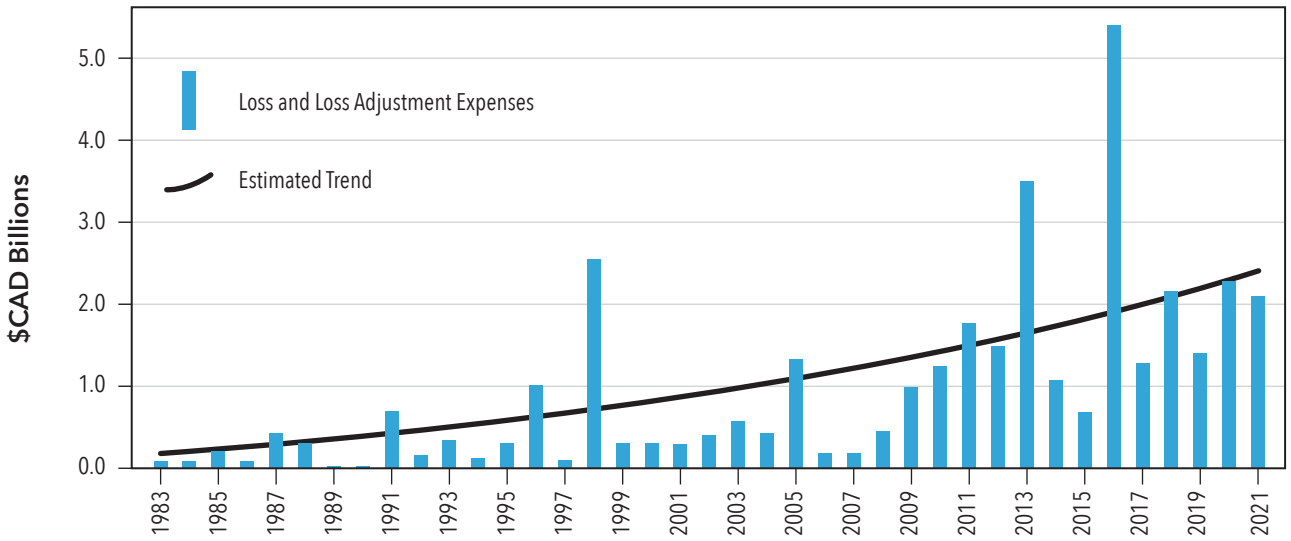
If left unchecked flooding may impact the "safety and soundness of the Canadian financial system"

A North American examination of catastrophic loss impacts on real estate values has shown that "the homeowner has the most financial risk associated with climate impacts"

As profiled in Canada's Changing Climate Report 2019 (ECCC 2019), and by the *Intergovernmental Panel on Climate Change* (IPCC 2021), climate change and extreme weather are effectively irreversible, and will continue to challenge Canada's real estate market. Although initiatives within Canada, and globally, to mitigate greenhouse gas emissions (e.g., Canadian Net-Zero Emissions Accountability Act 2020) and sequester carbon are commendable, these efforts will slow, but not stop, climate change.

Relative to insurable losses, flooding is the most pervasive and costly extreme weather risk in Canada (Feltmate et al. 2020). More specifically, catastrophic insured losses (i.e., events that trigger > $25 million in claims) associated with extreme weather in Canada over the period from 1983-2021 are presented in Figure 1. From 1983-2008, insurance losses averaged $250-$450 million per year. From 2009-2021 losses increased, averaging $1.96 billion per year, and for 12 of 13 years (finishing 2021) annual losses were in excess of $1 billion per year. The causal factor driving over 50% of the escalating claims was "too much water in the wrong place", and specifically, residential basement flooding.

Figure 1: Catastrophic Insurable Claims ($ Can/billions) in Canada, 1983-2021. Blue bars represent loss + loss adjusted expenses. $1 in insured loss reflects an "insurance gap" of $3-4.

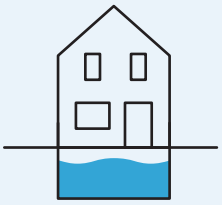


Source: IBC (2022) & CatIQ (2022)
Note: claims have been normalized for inflation ($2021) and per capita wealth accumulation.

In addition to increasing residential insurance premiums, cap rates (i.e., the maximum level of flood insurance available) for basement flooding are trending lower, while the percentage of homes in cities across Canada deemed uninsurable relative to flooding is migrating upwards (IBC 2020; Malik 2019). Beyond the financial impacts, in worst case scenarios severe flooding has *"turned basement apartments into death traps."* (Zaveri et al. 2021).

The insurance ramifications and general stigma of flooding may affect the price that buyers are willing to pay for a home (Ortega and Taspinar 2018; Macdonald 2019). Beyond the mental stress of owning a flood prone home, the financial burden of a higher insurance premium, lower flood risk cap and/or lack of insurance coverage, may make a property undesirable to a potential buyer in the absence of an adjustment on purchase price (Chopik 2021).

The average cost of remediating weather-induced flooded basements in Canada is $43,000 (Moudrak and Feltmate 2019). If homeowners are without flood insurance, or if flood insurance is limited at a low cap, then restoring an impacted basement can be a sizable financial challenge. This may be especially true for homeowners under conditions where they are "cash strapped" (48% of Canadians report a monthly surplus of < $200; CPA 2019). As such, the cost of basement flood remediation could factor into the purchase/sale price of a property.



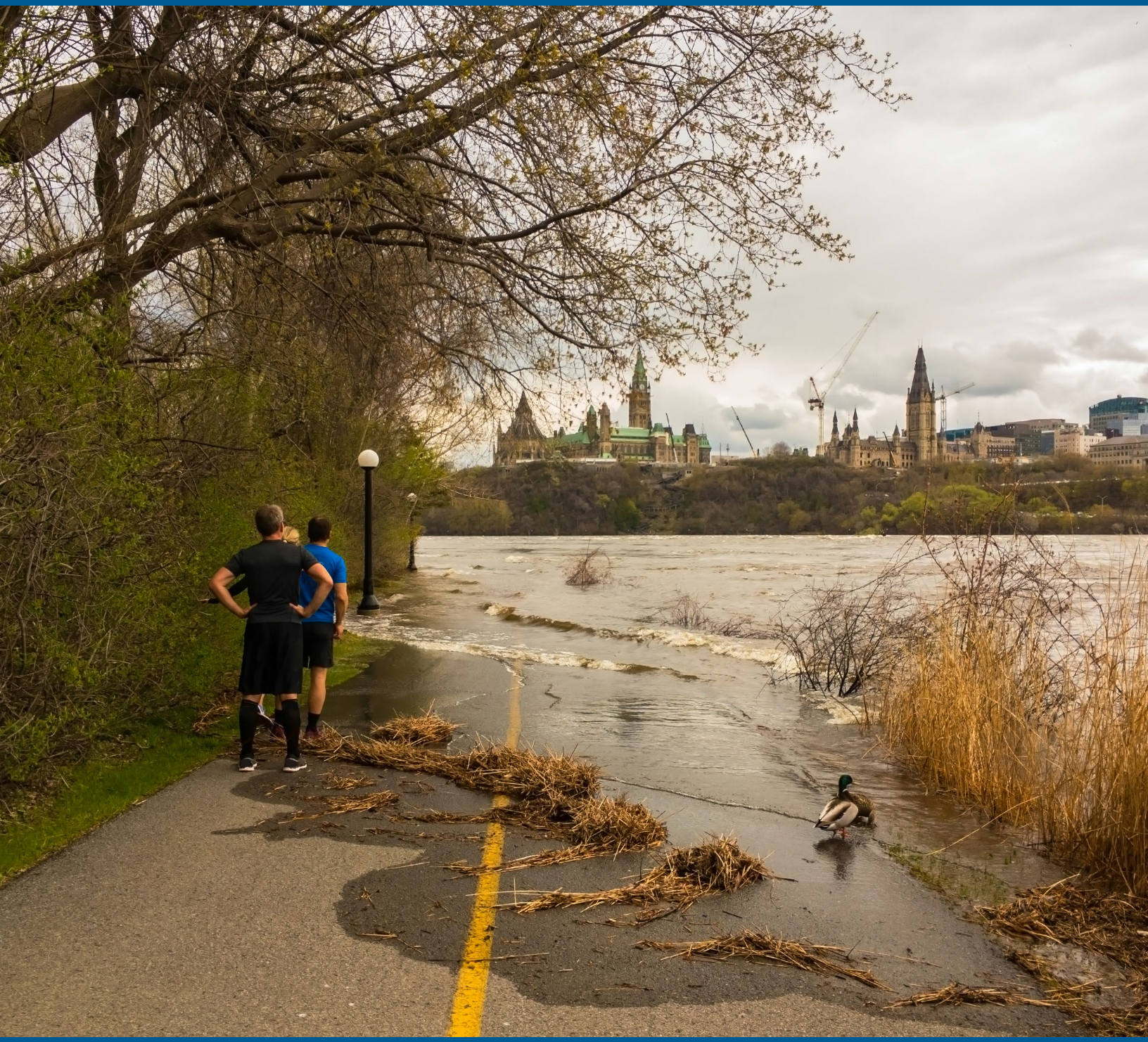
$43,000
Average cost of remediating weather-induced flooded basements in Canada

Flood risk could influence the potential for mortgage arrears, either today or in the future if flood risk is left unchecked. For example, flood risk resulting in a substantial increase in an insurance premium could prove problematic for a homeowner with limited liquidity (i.e., those with limited surplus monthly cash flow). Alternatively, following a flood, if insurance coverage was materially below remediation costs, or there was no flood coverage, homeowners might have to draw down on limited funds to remediate damage (for which not acting is not an option with a basement full of sewer water), thus potentially forcing the owner into mortgage arrears.

To address these issues, the quantitative method to assess the impact of catastrophic flooding on the Canadian real estate and mortgage markets follows below. Additionally, practical and cost-effective actions that are within the power of homeowners and communities to "get ahead of the curve on flood risk", rather than chasing it, are profiled.

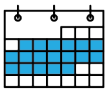
Flood risk could influence the potential for mortgage arrears... in the future if flood risk is left unchecked

Method: Drilling Down on Flood Risk



The impact of community-level residential flooding was assessed relative to four categories of response variable:

Average final sold price of a house



Average days on market to sell a house

Average change in number of houses listed for sale

Average change in mortgage arrears and deferrals*

* Mortgage arrears refers to a contractual agreement that has not received payment on interest or principal by its due date, and that is generally not agreed upon by the lender and borrower. Mortgage deferrals refers to the inability of the borrower to make timely payments on interest or principal owed. In these instances, borrowers may defer contractual payments, and restart regular payments once the deferral period expires. The lender and borrower generally agree upon deferrals.

City and Community Selection Criteria

Cities and communities considered for inclusion in the study were those that experienced significant flooding, following the rationale that if flooding had the potential to be impactful, it would manifest under a worst-case scenario (otherwise referred to as a "sledgehammer" effect; Schindler 1987).

Consistent with the above rationale, flood-impacted cities and communities included in the study shared at least two of the following three characteristics:

a. experienced P&C insurance claims post-flood event > $25 million (i.e., the definition of a "catastrophic" event)

b. magnitude of flooding > 1-in-50 year event (i.e., a major flood), and

c. community did not have a history of catastrophic level flooding, as otherwise flood risk may be priced into the market

The geographic range of cities included in the study was Pan-Canadian (representing western, central and eastern Canada). Cities in Canada's territories were not included, as historically flooding has tended to be less problematic in most northern communities (Feltmate and Moudrak 2021).

Residential housing examined in the study was either detached, semi-detached or row housing (1-2 story dwellings only).

The period over which flood events were considered was 2009-2020, during which time insured losses related to natural catastrophic events escalated to an average of approximately $2 billion per year, compared with $422 million per year from 1983-2008 (Feltmate and Moudrak 2021). In 2021 alone, insured losses were $2.1 billion. Accordingly, the potential for catastrophic flooding to impact residential housing and mortgage arrears, if at all, would be most evident from 2009 onwards.

Canadian cities/communities meeting the above criteria were identified utilizing several sources, including media reporting of major flood events in Canada from 2009 onwards, and public reports issued by IBC (http://www.ibc.ca/on/disaster/water/flooding-in-canada).

Provinces and cities that met the above criteria included:

- **Provinces:** British Columbia, Ontario, Quebec, New Brunswick
- **Cities:** Grand Forks (BC), Burlington (ON), Toronto (ON), Ottawa (ON), Gatineau (QC)

Inclusion of the above cities in the study was also dependent on the availability of data pertaining to:

- **Real Estate:** Average change in (a) sold price of a house, (b) days on market to sell a house, and (c) number of houses listed for sale, and
- **Mortgage:** Average change in (a) mortgage arrears, and (b) mortgage deferrals

The primary real estate brokerages that helped to secure real estate data were Sotheby's Realty Associates® and Whitehill Realty International Inc®.

Aggregated mortgage arrears and deferrals analyses were performed for two flooded communities (within Canada), based on anonymized data made available by a Canadian financial institution which requested that the cities for which the data was provided remain anonymous.

Control for Spatial Pseudoreplication

Real estate value and mortgage arrears considered in this study could be influenced by factors unrelated to catastrophic flooding (e.g., a factory closing, coincident with a flood, could depress housing prices in a community independent of the flood). To limit the erroneous conclusion of flood effects when none were present (i.e., Type 1 errors; Sokal and Rolff 1981), changes in real estate and mortgage variables

were quantified in flooded vs. non-flooded communities, in close promixity, over identical time frames (as described below). The net differential, or delta, in variable changes between flooded vs. non-flooded communities could then, with confidence, be attributed to flooding and not to extraneous factors. For example, if the average price of housing in a "flood-impacted" community increased 6% for six months pre- vs. post-flooding, and increased 10% in the "non flood-impacted" control, the impact of flooding on price would be the delta, or minus 4%.

To limit the misattribution of flood impact between flooded vs. non-flooded communities, due to spatial psuedoreplication (Hurlbert 1984), care was taken to ensure both communities had similar characterists in terms of the following:

a. geographic proximity (< 1 km apart), or contiguous

b. population density/size (+/- 5%)

c. demographics (age distribution of home owners, educational level, income level, marital status, languages spoken)

d. average sold price of houses, average days on market, average number of houses on market (prior to flood events that impacted flooded communities)

e. own vs. rent

f. houses considered in both communities included detached, semi-detached and row housing, 1-2 story dwellings only

Community Descriptive Characteristics

Characteristics of flooded vs. non-flooded control communities examined in this study are presented in Table 1.

Table 1 (a-f): Descriptive statistics of flooded vs. non-flooded control communities (all data/statistics pertain to 2021: https://www.realtor.ca/en 2021).*

a) Grand Forks, BC (2018) 		Flooded Community	Control Community (non-flooded)
	Median age	55	51
	Household income	$63,883	$66,388
	Education status	15% university, 21% highschool, 37% diploma, 25% apprenticeship, etc.	11% university, 35% highschool, 21% diploma, etc.
	Marital status	43% married, 22% single, 11% common law, 21% divorced/widowed, etc.	46% married, 22% single, 14% common law, 13% divorced/widowed, etc.
	Languages	96% English, 4% other	87% English, 6% Russian, 7% other
	Ownership	80% own, 20% rent	79% own, 21% rent

b) Burlington, ON (2014)

	Flooded Community	Control Community (non-flooded)
Median age	44	39
Household income	$99,452	$89,095
Education status	29% university, 27% highschool, 22% diploma, etc.	33% university, 25% highschool, 20% diploma, etc.
Marital status	51% married, 21% single, 10% common law, 10% divorced/widowed, etc.	51% married, 26% single, 8% common law, 10% divorced/widowed, etc.
Languages	82% English, 18% other	82% English, 18% other
Ownership	83% own, 17% rent	84% own, 16% rent

c) Toronto, ON (2019)

	Flooded Community	Control Community (non-flooded)
Median age	42	47
Household income	$99,664	$97,630
Education status	31% university, 25% highschool, 36% diploma, etc.	20% university, 29% highschool, 40% diploma, etc.
Marital status	53% married, 28% single, 7% common law, 11% divorced/widowed, etc.	42% married, 31% single, 5% common law, 16% divorced/widowed, etc.
Languages	66% English, 7% Italian, 12% other	52% English, 11% Italian, 19% other
Ownership	91% own, 9% rent	81% own, 19% rent

d) Ottawa, ON (2019)

	Flooded Community	Control Community (non-flooded)
Median age	36	41
Household income	$87,710	$84,924
Education status	19% university, 25% highschool, 39% diploma, etc.	26% university, 25% highschool, 31% diploma, etc.
Marital status	42% married, 35% single, 9% common law, 6% divorced/widowed, etc.	40% married, 32% single, 9% common law, 9% divorced/widowed, etc.
Languages	70% English, 8% French, 12% other	68% English, 8% Italian, 10% other
Ownership	45% own, 55% rent	60% own, 40% rent

e) Ottawa, ON (2017) 	**Flooded Community**	**Control Community (non-flooded)**
Median age	38	38
Household income	$83,056	$81,470
Education status	48% university, 24% highschool, 20% diploma, etc.	42% university, 22% highschool, 22% diploma, etc.
Marital status	48% married, 29% single, 9% common law, 10% divorced/widowed, etc.	41% married, 36% single, 8% common law, 8% divorced/widowed, etc.
Languages	65% English, 7% French, 16% other	61% English, 8% French, 17% other
Ownership	69% own, 31% rent	60% own, 40% rent

f) Gatineau, QC (2019) 	**Flooded Community**	**Control Community (non-flooded)**
Median age	43	38
Household income	$106,305	$108,334
Education status	31% university, 17% highschool, 30% diploma, etc.	41% university, 14% highschool, 22% diploma, etc.
Marital status	49% married, 22% single, 11% common law, 12% divorced/widowed, etc.	41% married, 26% single, 18% common law, 10% divorced/widowed, etc.
Languages	52% French, 36% English, 12% other	68% French, 11% English, 21% other
Ownership	62% own, 38% rent	63% own, 37% rent

* Note: Real estate analytics (average sold price, average days on market, average number of houses on market) were applied to all communities (a – f).

Results pertaining to the influence of community-level flooding, across Canadian communities, follow below relative to real estate and mortgage market impacts.

Results: Residential Flood Risk Revealed

Attribution of Flood Impact

The attribution of flooding, as the causal mechanism affecting real estate and mortgage arrears examined in this study, is definitive, based on controls to account for the spatial pseudoreplicative design of this study (Eberhardt and Thomas 1991; Hurlbert 1984).

Specifically, attribution of flooding to explain differences in real estate variables and mortgage arrears, between flooded vs. non-flooded control communities, rested on two precautionary steps. First, communities were contiguous or in close proximity (< 1 km), and as such, non-flood influences would likely have a blanket geographic effect. Second, there were no material differences between communities regarding *median age, household income, education status, marital status, languages spoken and home ownership* (see Table 1). Seemingly, therefore, flooded and non-flooded communities were financial and social analogues.

Additionally, across all communities (i.e., flooded and control), 93% (+/- 1%) of houses had finished basements. Detached, semi-detached and row housing characterized all communities in virtually identical proportions.

Real Estate Variables

Average Sold Price of Houses

Net change in the average sold price of houses, across five Canadian cities (and six flood events), spanning six months pre- vs. post-flooding, was 8.2% lower (ranging from -1.1% to -17.1%) in flooded vs. non-flooded communities (see Figure 2 a-f). Additionally, change in average sold housing price was consistently negatively impacted, without exception, in flooded vs. non-flooded communities, suggesting that

flooding was the causal mechanism affecting a lower sold price – i.e., the probability that an unknown or spurious factor would consistently mimic the expected impact of flooding on housing price is low (Balmbra 2021).

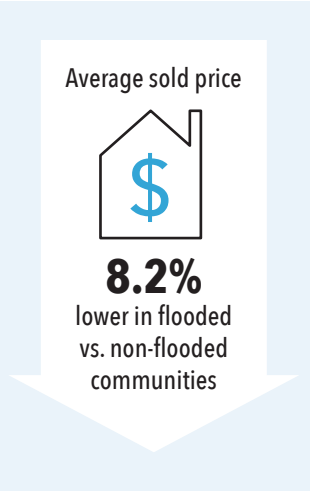
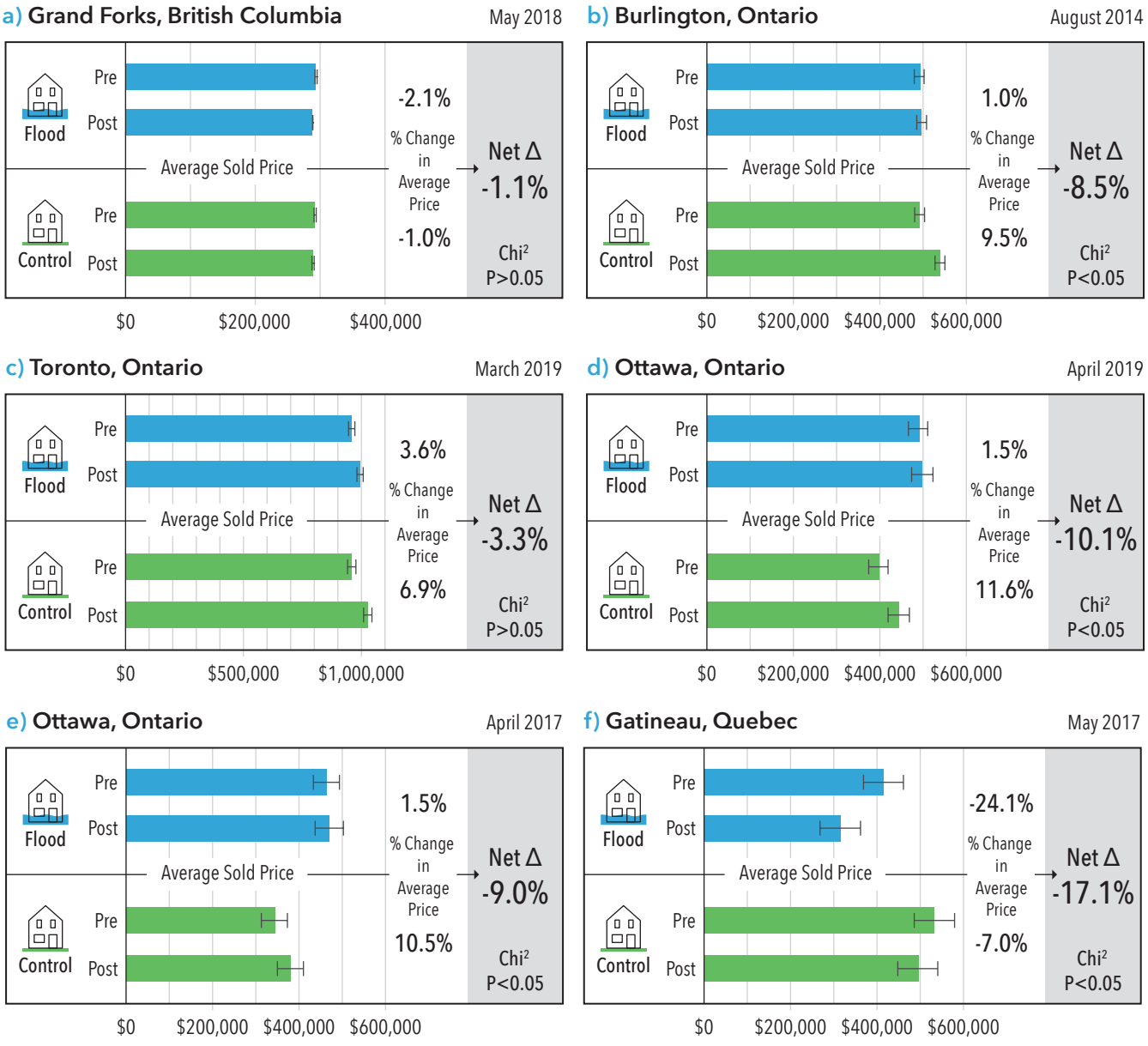


Figure 2 (a-f): Change in average sold price of housing in flooded (blue) vs. non-flooded (green) communities within identified cities, for periods six months pre- vs. post-flooding. The date on each chart is the month in which flooding occurred. Net Δ refers to the difference in percent change in house sold price between flooded and non-flooded communities, pre- vs. post-flooding ($Chi^2 < 0.05$ reflects a statistical difference in response variable between flooded vs. non-flooded communities). Note: Total number of houses sold across all communities analyzed ranged from 30-700 houses per community.



Average Days on Market

Net change in the average number of days on market to sell a house, across five Canadian cities (and six flood events), spanning six months pre- vs. post-flooding, was 19.8% longer (ranging from +1.2% to -73.8%) in flooded vs. non-flooded communities within those cities (see Figure 3 a-f).

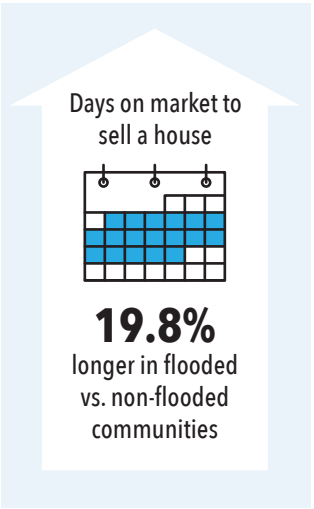
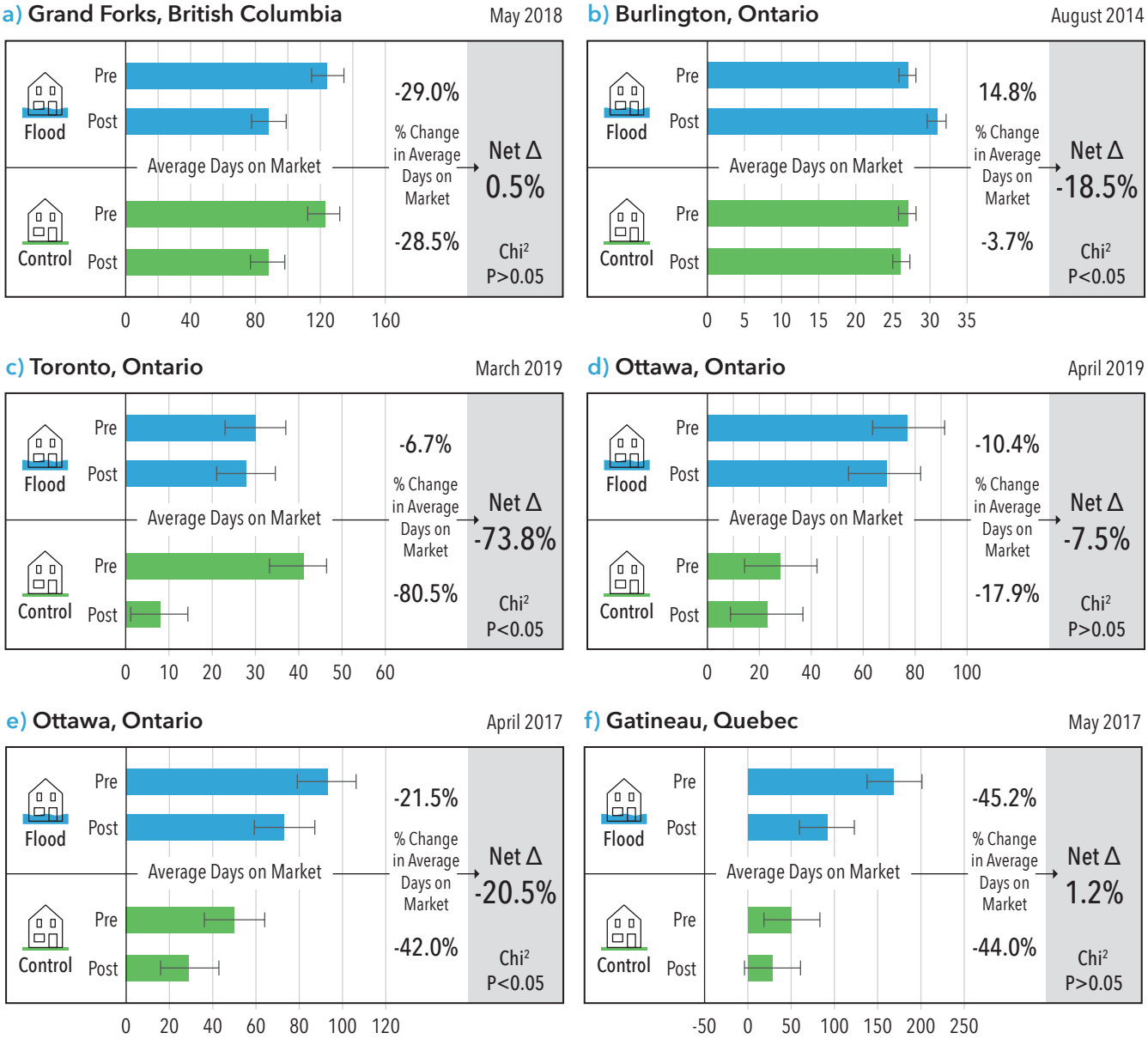


Figure 3 (a-f): Change in average days on market for houses sold in flooded (blue) vs. non-flooded (green) communities within identified cities, for periods of six months pre- vs. post-flooding. The date on each chart is the month in which flooding occurred. Net Δ refers to the difference in percent change in days on market between flooded and non-flooded communities, pre- vs. post-flooding ($Chi^2 < 0.05$ reflects a statistical difference in response variable between flooded vs. non-flooded communities).



Average Number of Houses on Market

Net change in the average percent of houses listed for sale, across five Canadian cities (and six flood events), spanning six months pre- vs. post-flooding, was 44.3% less (ranging from +19.7% to -100%) in flooded vs. non-flooded communities within those cities (see Figure 4 a-f).

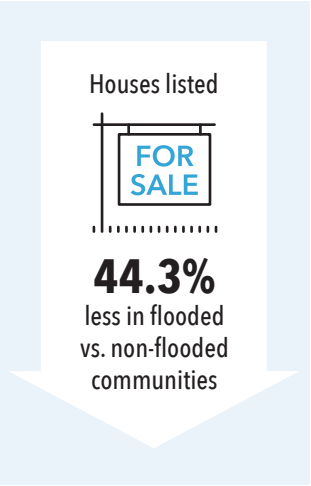
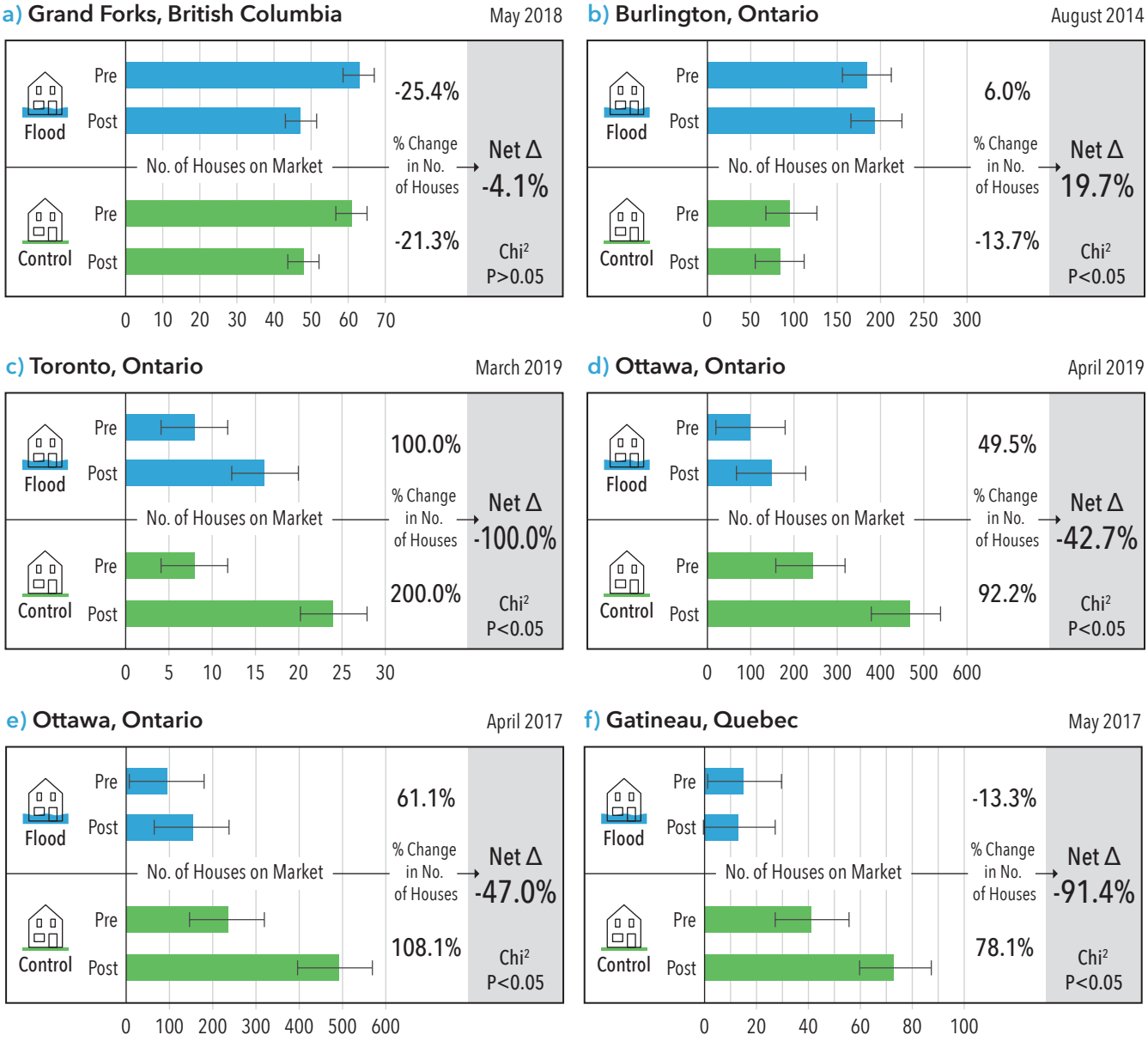


Figure 4 (a-f): Change in the average number of houses listed on the multiple listing service (MLS) market, in flooded (blue) vs. non-flooded (green) communities within identified cities, for periods of six months pre- vs. post-flooding. Net Δ refers to the difference in percent change in average number of houses listed between flooded and non-flooded communities, pre- vs. post-flooding ($Chi^2 < 0.05$ reflects a statistical difference in response variable between flooded vs. non-flooded communities).



Case Study – Fredericton

This case study considered the impact of catastrophic flooding on real estate parameters within a city subject to flooding on a near annual basis. The hypothesis was that under conditions where flooding is "often and predictable", the impacts of flooding should be permanently factored into the real estate market. Relative to flooding in a specific year, if the hypothesis is correct, there would be no statistical difference (over a period of six months pre- vs. post-flooding) between flood-impacted and non-flood control communities, regarding average sold price of a house, days on market to sell a house, and number of houses listed for sale.

As a candidate city, Fredericton, NB, met the criteria to test the above hypothesis.

Fredericton experienced major floods every year from 2008-2018, with the single exception of 2016. These floods varied in impact between communities within the city, due to varying combinations of heavy precipitation, ice jams, snowmelt, heavy snowfall and late spring thaw. Losses due to flooding ranged from $1.4-$25 million in insurable claims, with average losses of $13.4 million/year (excluding 2011, 2015 and 2017, for which specific $ losses could not be verified).

In April, 2019, Fredericton experienced a catastrophic flood (CBC 2019). For six months pre- vs. post this flood event, real estate variables were measured for flooded and non-flooded communities.

Fredericton, NB: Descriptive statistics of flooded vs. non-flooded control communities (all data/statistics pertain to 2021: https://www.realtor.ca/en 2021).

Fredericton, NB (2021)	Flooded Community	Control Community (non-flooded)
Median age	40	46
Household income	$77,510	$90,172
Education status	20% university, 21% highschool, 46% diploma, etc.	29% university, 18% highschool, 32% diploma, etc.
Marital status	53% married, 26% single, 11% common law, 9% divorced/widowed, etc.	51% married, 26% single, 8% common law, 10% divorced/widowed, etc.
Languages	92% English, 6% French, 2% other	85% English, 9% French, 6% other
Ownership	80% own, 20% rent	88% own, 12% rent

There was no statistically significant difference in the sold price of houses and days on market to sell a house, for the six months pre- vs. post-flooding, between flood and non-flood impacted communities in Fredericton relative to the 2019 flood (see figures on next page). This result is consistent with the hypothesis that regular and predictable flood risk does factor into home sale price and the time to sell a property.

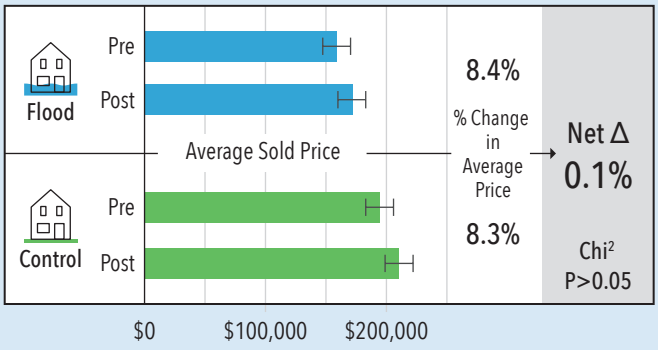
However, following the 2019 flood, the number of houses listed for sale in flooded communities was statistically less, compared to the non-flooded control, for six months pre- vs. post-flooding. Fewer houses listed for sale, post-flooding, may be attributable to:

a. expectation of a lower listing price in the aftermath of flooding,

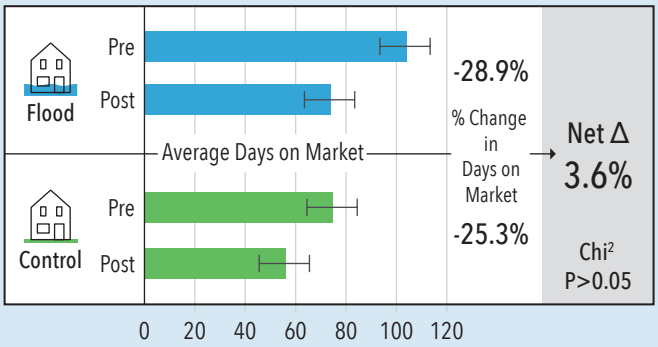
b. waiting for the "stigma" of flooding to pass, and/or

c. time required to remediate a home following flood damage prior to listing.

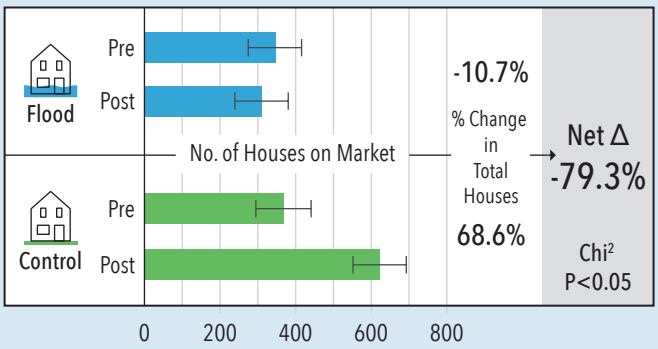
Average Sold Price
April 2019



Average Days on Market
April 2019



Average Number of Houses on Market
April 2019



The most notable outcome of repeated flooding across communities is the large-scale incorporation of flood risk into housing price, independent of a community being flooded in a given year

The most notable outcome of repeated flooding across communities is the large-scale incorporation of flood risk into housing price, independent of a community being flooded in a given year. Conversely, in communities where flooding is infrequent and not geographically pervasive, the impact of flooding on house price is community-specific.

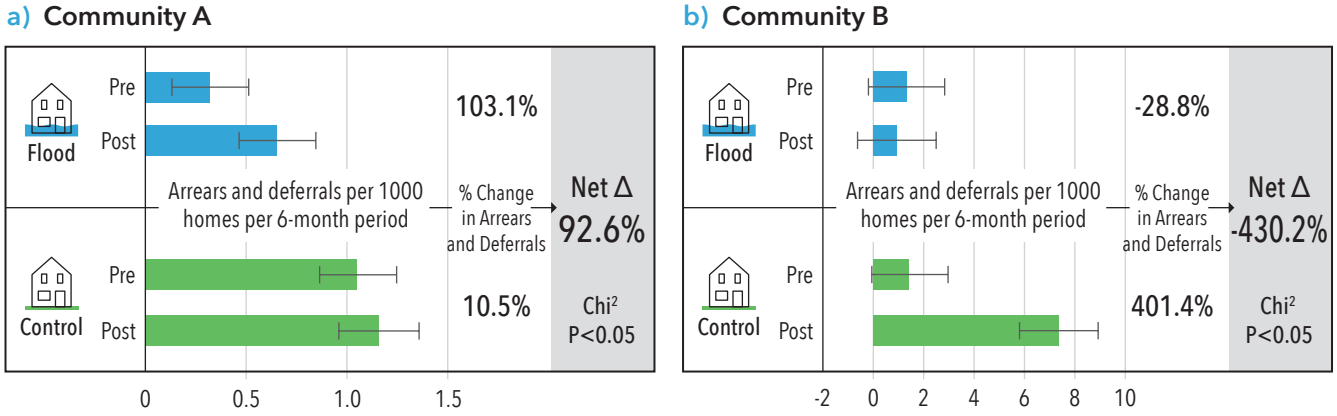
Mortgage Variables

Arrears and Deferrals

The net change in average mortgage arrears and deferrals, across two Canadian cities, spanning six months pre- vs. post-flooding, differed between communities A and B. In Community A, the mortgage arrear and deferral rate (per 1,000 homes) was higher in the flooded community, whereas in Comminity B, the arrear and deferral rate was higher in the non-flooded community (see Figure 5 a-b).

Notably, the total number of arrears and deferrals ranged from 0.32/1,000 homes (Figure 5a, pre-flood) to 7.07/1,000 homes (Figure 5b, post-control), in both cases over six months. Accordingly, the "worst case scenario" of arrears and deferrals of 7.07/1,000 homes, per six months, translates to 1.18 arrears and deferrals per 1,000 homes per month. This rate of mortgage arrears and deferrals, on a monthly basis, in flooded and non-flooded communities, suggests that flooding is not debilitating relative to Canada's residential mortgage market, particularly considering that impacts would generally last only a few months (Zhang and Leonard 2019).

Figure 5 (a-b): Change in the rate of mortgage arrears and deferrals, in flooded (blue) vs. non-flooded (green) communities within two Canadian cities, for periods six months pre- vs. post-flooding. Net Δ refers to the difference in percent change in total number of mortgage arrears and deferrals between flooded and non-flooded communities, pre- vs. post-flooding ($Chi^2 < 0.05$ reflects a statistical difference in response variable between flooded vs. non-flooded communities).



**Note: Based on data availability the above correction for mortgage arrears and deferrals per 1000 homes does not distinguish between homes with/without mortgages. According to Statistics Canada, the national average of homeowners having not paid off the mortgage on their principal residence equals 57% (as of 2016) (Statistics Canada, 2019).

The implications of flooding to the Canadian residential real estate market follow below, presented with practical and affordable actions to mitigate risks at the household and community-level.

Discussion: Keeping Canada's Housing Market Above Water

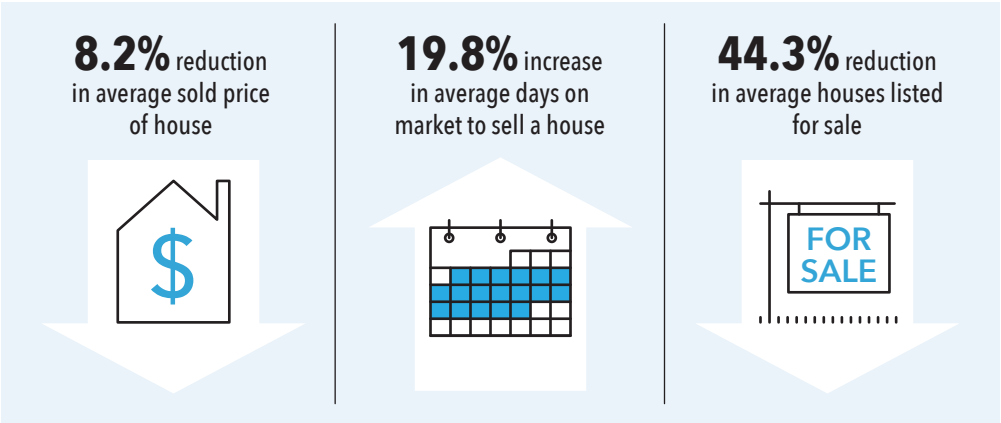
The magnitude and frequency of climate change and extreme weather-related flood risk is becoming increasingly challenging globally (IPCC 2021), and across many regions of Canada (ECCC/Bush and Lemmen 2019). The consequences of this risk convey material costs to real estate markets internationally (Mackenzie 2021) and within Canada, with relevance to the primary stakeholders of this report: homeowners, mortgage providers, municipalities and financial regulators.

Over the period 1983-2008, catastrophic insurable claims in Canada hovered around $250-450 million per year, whereas from 2009-2021 claims average $1.96 billion per year, with more than half of this escalation attributable to flooding (IBC 2022; CatIQ 2022; Feltmate and Moudrak 2021). It was against this backdrop that this study examined the impacts of catastrophic flooding on Canada's residential housing and mortgage markets.

For every city examined, the percentage change in the average sold price of homes was lower (less advantageous), **without exception**, in flooded vs. non-flooded communities

Housing Market

The impact of intermittent catastrophic flooding on the residential housing market within communities across five Canadian cities and six flood events (Grand Forks, BC, 2018; Burlington, ON, 2014; Toronto, ON, 2019; Ottawa, ON, 2019 and 2017; Gatineau, QC, 2017) was significant. Average **flood impacts** on the real estate housing market, for periods of six months pre- vs. post-flooding, were:



Notable was the fact that for every city examined, the percentage change in the average sold price of houses, over the six-month period pre- vs. post-flooding,

was lower (less advantageous), **without exception**, in flooded vs. non-flooded communities. For most homeowners their home is their prime investment and retirement fund, therefore, any compromise to the intrinsic value of this investment is material (Claveau 2020; Macdonald 2019).

Transactionally, in the aftermath of flooding, the seller determines asking price and timing when listing a house for sale, and the buyer controls days on market and purchase price. Strategically, sellers and buyers would probably tend to under- and over-weigh flood risk, respectively.

Additionally, properties impacted by flooding would generally bear increased costs for maintenance and repair, and increases in property taxes related to municipal resilience and recovery investments. Overall, real estate with higher climate-related flood risk will have higher TMI costs (Taxes, Maintenance and Insurance) than lower risk properties (Chopik 2021).

Beyond the six-month post-flood period, the study did not examine whether real estate parameters might rebound, as some studies suggest could happen (Clayton et al. 2021; Pfeffer 2017; Zhang 2016). A longer timeframe of examination is suggested for the next stage of this study.

Under conditions where a city experiences significant flooding on a near annual basis, the impact of flooding can be incorporated permanently into the real estate market (Macdonald 2019). Evidence of this effect was observed in this study. More specifically, in Fredericton – which experienced ten major floods from 2008-2018 – for six months pre vs. post major flooding in 2019, no changes in average housing price and days on market were observed between flooded and non-flooded control communities. However, fewer houses were listed for sale in flood-impacted communities post-flooding, presumably due to the time required to prepare a house for sale following a flood (Beltran et al. 2018; Zhang and Leonard 2019).

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Real estate with higher climate-related flood risk will have higher TMI costs (Taxes, Maintenance and Insurance) than lower risk properties

Rental Market

Although not considered in this study, the impact of residential flooding is relevant to those renting basement apartments. When rental homes are impacted by disasters such as flooding, occupants have little say in when or how repairs are made, and research indicates that these properties recover from flood damage more slowly than owner-occupied residences (Wesseler 2021). Additionally, those renting basement apartments, as a group, tend to have lower incomes and are often forced to compete for reasonably priced housing in tight markets – as a result, renters can find themselves in poor-quality apartments in neighbourhoods struggling with inadequate infrastructure (Wesseler 2021). These suboptimal conditions can predispose those

with limited resources to pay up to half their wages for housing, making it difficult for them to save for emergencies (Hino and Burke 2021). In addition, only 50% of Canadian renters purchase tenant insurance, leaving half of renters exposed to personal property loss (e.g., loss of clothing and furniture), liability costs (e.g., injury) and/or additional living expenses (e.g., extended stay in a hotel) should a home become uninhabitable following a weather induced flood event (CBC 2018; Belairdirect 2021). Accordingly, unexpected flood costs, compounded by the potential for lost time from work to remediate an apartment, can lead to homelessness. Clearly, residential flooding is a challenge for homeowners and renters alike.

Residential flooding is a challenge for homeowners and renters alike

Mortgage Market

In contrast to the substantial impacts of flooding on multiple characteristics of the real estate market, there was no material impact on mortgage arrears and deferrals.

Criteria to qualify for a mortgage in Canada appears to be sufficiently robust that homeowners have adequate resources to absorb flood costs and restore their homes, post-flood, without compromising their mortgage. In jurisdictions where mortgage qualification is less robust (e.g., in various states across the United States), borrowers may suffer defaults (Duprey et al. 2021).

Criteria to qualify for a mortgage in Canada appears to be sufficiently robust that homeowners have adequate resources to absorb flood costs and restore their homes, post-flood, without compromising their mortgage

Additionally, despite an average cost of $43,000 for weather-induced basement flooding in Canada, homeowners may absorb the costs by drawing upon sewer-backup and/or overland flood insurance (overland flood insurance became available in Canada starting on or about 2015, in the aftermath of catastrophic floods in Calgary and Toronto in 2013) (Feltmate and Moudrak 2021).

Mortgage Securitization

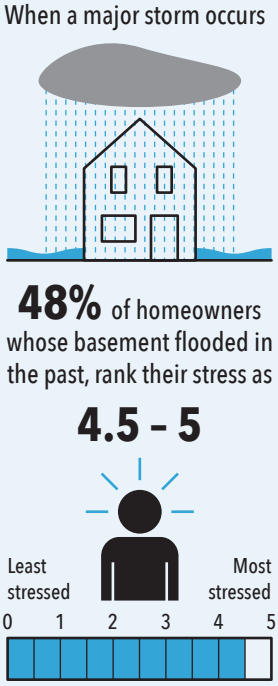
Devaluation of a residential property due to flooding is relevant to both mortgage providers and their insurers (e.g., Canada Mortgage and Housing Corporation, Canada Guaranty Mortgage Insurance Company). Mortgage approvals and rates depend, in part, on the loan-to-value ratio of an insured property. If the "value" of a mortgaged property is compromised by "unanticipated flood risk", lenders and insurers may erroneously approve, or misprice, mortgage rates and

To minimize this risk against a backdrop of escalating flood impacts across Canada, mortgage providers and insurers could make home flood assessment a mandatory condition for coverage

mortgage insurance. To minimize this risk against a backdrop of escalating flood impacts across Canada (ECCC 2019), mortgage providers and insurers could make home flood assessment a mandatory condition for coverage. Additionally, as flood susceptibility evolves, the capital reserves of lenders (e.g., those under the authority of such agencies as the Office of the Superintendent of Financial Institutions) might require adjustment depending on future risk.

Actions to Mitigate Residential/Community Flood Risk

Clearly, the consequences of catastrophic flooding are material to the Canadian residential housing market. Arguably, the consequence of greatest concern to homeowners would be property devaluation (Macdonald 2019). Adding to the financial burden of home remediation is the psychosocial or mental health stress Canadians experience in the aftermath of flooding. For up to three years following a basement flood event, on a stress scale of 0-5 (with five being the worst), 48% of impacted homeowners rank their stress as 4.5-to-5 when a major precipitation event occurs, supported by such typical statements as, *"It's something you never want to experience again in your life"* (Decent and Feltmate 2018).



Against this background, the discussion now turns to practical, meaningful and cost-effective means to limit risk of community-level and residential flooding. The demand for disclosure of climate-risk is an important precursor to *caveat emptor* (buyer beware), empowering the homeowner to understand, accept and respond to climate-risk and resilience in the context of property ownership (Chopik 2019). Additionally, communities and residents do not have to be victims of circumstance regarding flood risk – although risk may not be eliminated, it can be managed by implementing a number of flood mitigation measures, guidelines and standards developed in Canada since approximately 2015 forward.

Communities and residents do not have to be victims of circumstance regarding flood risk – although risk may not be eliminated, it can be managed

Actions and guidelines to limit home and community-level flood risk include, but are not limited to, the following.

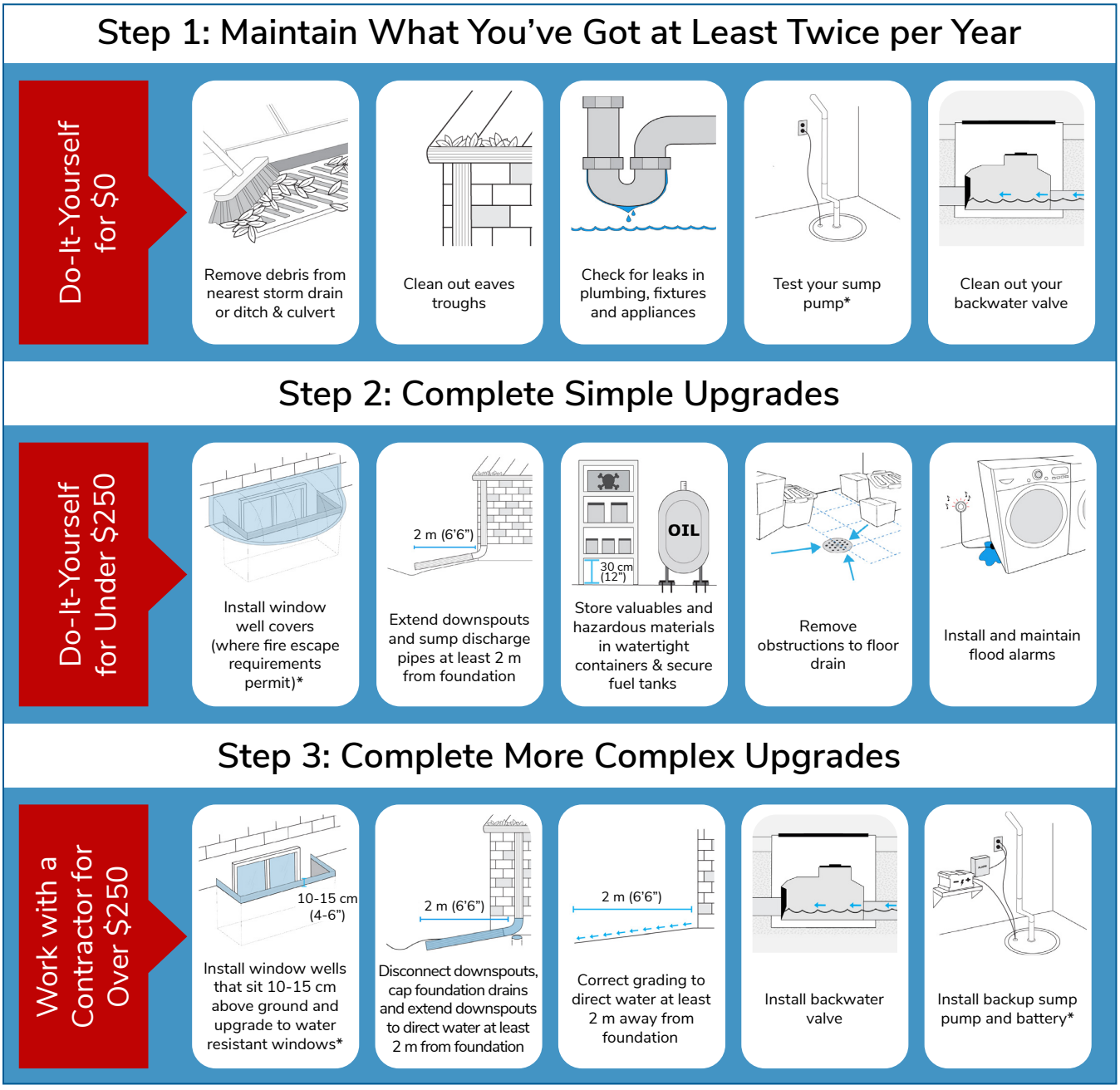
Home Flood Protection Guidance

Banks, credit unions, real estate agents/brokers, Property & Casualty insurers, and municipalities are increasingly distributing the infographic, *Three Steps to Cost-Effective Home Flood Protection*, to customers/clients (see Figure 6). This infographic provides practical actions homeowners can take to reduce their risk of basement flooding. Most steps in this infographic can be undertaken by homeowners or renters, with no special expertise required, and for little cost (generally for less than

a few hundred dollars). https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2021/03/3-Steps-to-Home-Flood-Protection_March-2021_Space-for-Partner-Logo.pdf.

When a mortgage provider, real estate agent or insurance broker presents the *Three Steps to Cost-Effective Home Flood Protection* guidance to homeowners, it is received as a "value add" service. Lenders, agents and brokers often send the flood protection infographic to customers/clients, twice per year (spring and fall), as a reminder to prepare their home for flood risk – in so doing, they build customer/client loyalty.

Figure 6: Three Steps to Home Flood Protection. Step 1 = actions for $0, Step 2 = actions for < $250, Step 3 = actions for > $250.



Climate Adaptation Home Rating Program (CAHRP)

As suggested by the federal government of Canada, "*as climate change intensifies, it will only become more important for Canadians to understand what positive, affordable and practical measures they can take to protect their homes and communities against flood*." In response, CAHRP was launched in 2021, as a companion to EnerGuide home energy audits.

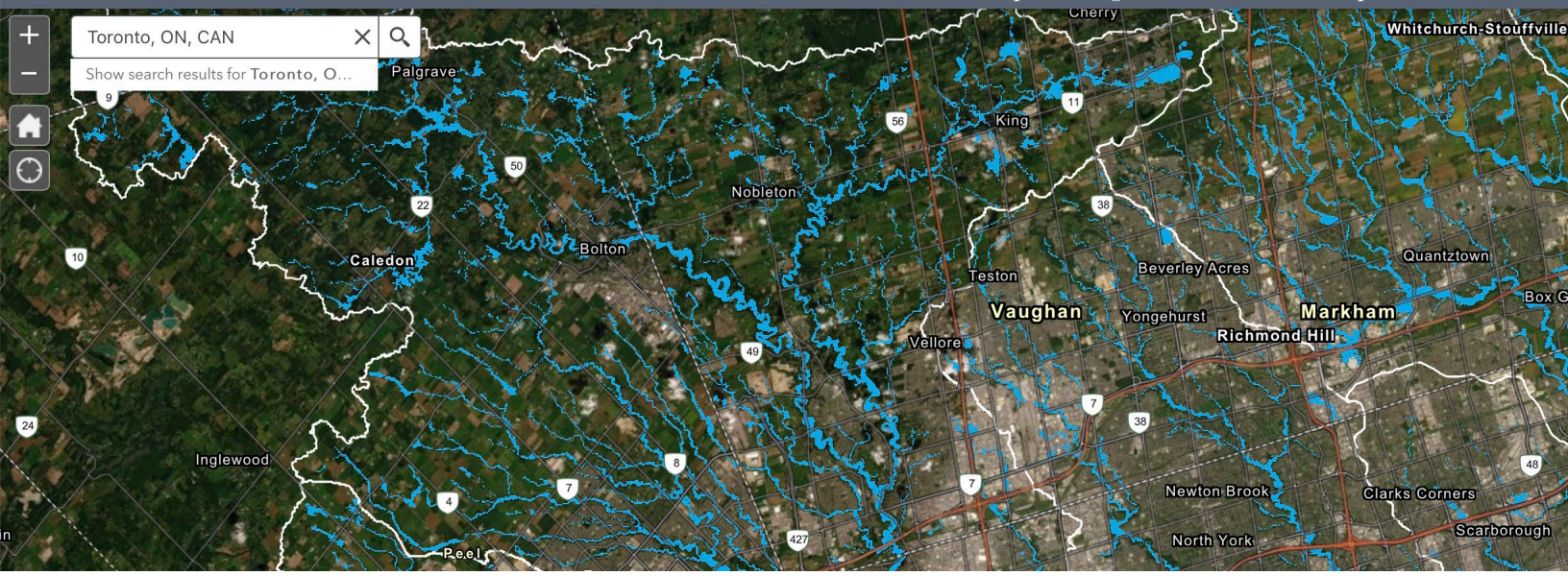
CAHRP will help homeowners to navigate the flood retrofit process and expand on the eligibility requirements of the CMHC deep home retrofit program and Canada Greener Home Grants to include more climate resilience/flood risk mitigation measures. https://liberal.ca/wp-content/uploads/sites/292/2021/08/wildfires-ENG-1.pdf

Flood Risk Maps

Federal, provincial, territorial and municipal governments are updating flood risk maps to aid city planners, developers, engineers and risk officers to identify and remediate areas at high risk of flooding. In the Federal Government of Canada Budget 2021, $63.8 million was dedicated, over three years, to Natural Resources Canada, Environment and Climate Change Canada, and Public Safety Canada, to work with provinces and territories to complete flood maps for higher risk areas in Canada (GOC 2021a).

As flood risk maps become available, homeowners, municipalities, builders and developers should utilize this resource to deploy flood risk measures for homes and properties at risk today, and avoid building in areas subject to flood risk tomorrow.

Toronto & Region Conservation Floodplain Viewer Source: https://arcgis01.trca.on.ca/floodplain/



Residential Flood Risk Scores

Federal, provincial, territorial and municipal governments should develop a system to establish a flood risk score for any residential property, based on address/postal code (as exists in the US - https://floodfactor.com/).

> Approximately 142 million addresses in the US can receive a flood risk score, for free, on a ten point scale (Brinkhurst 2020). A system such as this – *sensu* ***Flood Factor Canada*** – would motivate homeowners to protect their property from flood risk in cases where scores were not favourable.
>
> As suggested by the designers, First Street Foundation: "*the most important element of Flood Factor is its simplicity. Behind the scenes, the team at First Street Foundation has created a first-of-its-kind methodology that adjusts for the reality of a changing climate and how it will impact flood risk into the future, accounts for local adaptation, and incorporates the four major contributors to flooding: tidal, rain, riverine and storm surge, all at the level of granularity needed to calculate flood risk for individual properties. Despite the complexity of the modelling, the user experience is accessible and compelling*" (Brinkhurst 2020).

Canadian homeowners and renters would benefit greatly, by way of home flood protection, if they had access to a *Flood Factor Canada*-style system, which could also be added to real estate listings. This system would serve to *pull*, rather than *push*, Canadians to protect their home from flooding.

Natural Infrastructure

Federal, provincial, territorial and municipal governments should develop and enforce guidelines and standards to retain and restore natural infrastructure (e.g., forests, grasslands, wetlands), in both urban and rural areas, to limit current and future home and community-level flood risk. This guidance may consider both risk assessment and planning policy reform. In the Federal Government of Canada Budget 2021, $200 million was dedicated to Infrastructure Canada, over three years starting 2021-22, to establish a **Natural Infrastructure Fund** to support natural and hybrid (built) infrastructure projects to mitigate flood risk (GOC 2021a).

This directive, as presented by the Federal government, "*will improve social well-being, mitigate the impacts of climate change, and prevent costly natural disasters.*" Home flood protection touches upon all three of these benefits.

> As suggested by Brindamour and Feltmate (2021), "*Forests, grasslands and wetlands aren't simply decoration on the landscape. They help with flood management and protect us from drought, remove carbon emissions and provide clean water, all while supporting a diverse habitat for plants and animals. Joint research between the Intact Centre and the Insurance Bureau of Canada report that through the preservation of wetlands, we can reduce flood damage costs by up to 40 per cent. Natural infrastructure also helps to keep our cities cool. On a sunny day in an urban centre, building and road surfaces can get up to 50 degrees hotter, while natural surfaces remain closer to air temperatures. It's clear why natural infrastructure is quickly gaining momentum as a front-line climate adaptation solution. Climate mitigation, adaptation and economic benefits make nature a winner. We need to protect the natural infrastructure we have and restore what we've damaged.*"

In addition to government led initiatives, residents should also be proactive and use natural infrastructure, for example, to a greater extent on their personal properties (e.g., wild gardens and naturalized driveways).

Community Flood Risk Mitigation

Canada has a wealth of community-level, focused flood risk mitigation guidelines, created and supported by such organizations as: Standards Council of Canada, National Research Council, Canadian Standards Association, professional associations, insurance providers, conservation authorities and their equivalents, NGOs, academics, and builders and developers (Moudrak and Feltmate 2019).

These guidelines provide a practical and cost-effective framework to help larger cities, and smaller communities with limited resources, to identify regions within their boundaries that are subject to flooding, while outlining actions to keep people and property out of harm's way.

Examples of community-level flood and risk mitigation

measures are profiled in Figure 7. By definition, as communities improve their flood risk profile, benefits will accrue to residential housing. By deploying flood risk measures "before the big storms hit", communities and homeowners may avert the need to deploy thousands of sandbags (generally under time-limited conditions). Sandbags should be a measure of last resort in a community prepared for flood risk.

As communities improve their flood risk profile, benefits will accrue to residential housing

Figure 7: Examples of flood risk and mitigation measures applicable to communities and residential housing. Refer to CSA Group's Guideline on Basement Flood Protection Risk Reduction, CSA-Z800-18, for comprehensive practices to address storm and sewer back-up failures.

Categories	Examples of Flood-Resilient Design Considerations
Riverine/Fluvial Flooding Occurs when water levels in watercourses rise and spill over their banks. Flooding is a natural river process but may be exacerbated by climate change, as well as past human intervention in the watershed. Riverine flooding is often seasonal, with contributing and compounding factors including snowmelt, spring thaw, extreme rainfall, ice and debris jams.	• Proactively maintain and replace culverts, bridges, dikes, levees, pump stations and other flood-control structures, and resize these structures during infrastructure replacement/renewal cycles to accommodate extreme weather event conditions. • Proactively manage vegetation and maintain riparian buffer zones – vegetated "buffer-strips" – along watercourses, including debris removal. • Flood-proof properties on flood plains through the use of elevation, flood-resilient materials and design, and the elevation of mechanical and electrical equipment, to achieve a level of tolerable flood risk as defined by a local, regional or provincial/territorial authority. • Upstream of populated areas, attenuate and store stormwater and runoff using natural systems and grey infrastructure. • In high-risk areas, build community-scale structural flood mitigation works (such as berms and dikes) to supplement other flood-proofing measures. • In areas of chronic flood concern, buy out property owners and/or relocate properties. • Establish forecasting and warning systems that can provide sufficient operational lead time to deploy flood-protection measures in case of a flood emergency.
Overland/Pluvial Flooding Occurs when excess stormwater flows over private properties, entering homes through their lowest openings (such as basement windows and doors) and causing damage.	• Proactively clear catch basins and culverts. • Remove snow from critical overland flow paths before the spring thaw. • Regrade lots and roadways to carry overland water away from properties, onto rights-of-way. • Attentuate and store stormwater and runoff using natural systems and grey infrastructure.
Storm/Sanitary Sewer Back-up Occurs when the storm and/ or sanitary sewer systems are overloaded, causing surcharge and backup into basements.	• Install backwater valves on storm and sanitary sewer laterals. • Disconnect roof leaders from storm and sanitary sewers. • Seal and bolt manhole covers in low-lying areas, where stormwater accumulates and has a higher risk of contributing to sewer surcharge. • Implement stormwater diversion projects (for example, install pipes to carry excess stormwater from overwhelmed areas to areas with greater capacity).
Foundation System Failures Occurs when foundation drainage systems fail and water enters basements though foundation drains or seeps through foundation walls.	• Disconnect downspouts and sump pump discharge pipes from foundation drains. • Install sump pumps and sump pump backup power systems, equipped with alarms. • Repair foundation cracks and install flood-damage-resistant materials in basements during home renovations. • Install an impermeable layer of soil around homes (that is, in foundation backfill areas) to reduce the risk of water infiltration and seepage through foundation walls.

Conclusion

In December 2020, as part of its strengthened climate plan, the Government of Canada committed to develop Canada's first **National Adaptation Strategy** with provincial, territorial and municipal governments, Indigenous Peoples, and other key partners.

A key directive of the strategy is to identify key priorities to "*unite actors across Canada through* ***shared priorities***, ***cohesive action***, *and a* ***whole-of-Canada*** *approach to reducing climate change risks*" (GOC 2021b).

No ***shared priority*** will unite Canadians from coast-to-coast more than protecting their homes, owned or rented, from flooding. As this study quantified for the first time, flooding in Canadian communities compromises the residential real estate market in three material ways: (a) lower average sold price of houses, (b) increase in average number of days on market to sell a house, and (c) reduction in average number of houses listed on market. The ***cohesive action*** to limit the residential impact of flooding is in-hand, starting with the newly minted (2021) **Climate Adaptation Home Rating Program** (CAHRP) to be developed as a companion to EnerGuide home energy audits.

The National Adaptation Strategy's recognition of a ***whole-of-Canada*** approach is key to advancing home flood protection. The IPCC (2021) reported that there will be no "new normal" on climate change, but rather escalating extreme weather. With flood protection at its centerpiece, the **National Adaptation Strategy** could help to secure what for many Canadians is their **#1** financial investment – their home.

No ***shared priority*** will unite Canadians from coast-to-coast more than protecting their homes, owned or rented, from flooding

There will be no "new normal" on climate change, but rather escalating extreme weather

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