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Flood Insurance in Canada: Implications for Flood Management and Residential Vulnerability to Flood Hazards

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Abstract Insurance coverage of damage caused by overland flooding is currently not available to Canadian homeowners. As flood disaster losses and water damage claims both trend upward, insurers in Canada are considering offering residential flood coverage in order to properly underwrite the risk and extend their business. If private flood insurance is introduced in Canada, it will have implications for the current regime of public flood management and for residential vulnerability to flood hazards. This paper engages many of the competing issues surrounding the privatization of flood risk by addressing questions about whether flood insurance can be an effective tool in limiting exposure to the hazard and how it would exacerbate already unequal vulnerability. A case study investigates willingness to pay for flood insurance among residents in Metro Vancouver and how attitudes about insurance relate to other factors that determine residential vulnerability to flood hazards. Findings indicate that demand for flood insurance is part of a complex, dialectical set of determinants of vulnerability.

Keywords Flood · Insurance · Flood management · Vulnerability · Hazard · Metro Vancouver

Introduction

Flood risk poses a unique and complex challenge in Canada. Floods are by far Canada's most frequent natural disaster; over the last decade alone they have caused billions of dollars in damage and directly affected hundreds of thousands of people (MMM 2014; PSC 2014). Municipal and provincial governments have long and proud traditions of managing land use in flood-prone areas and building infrastructure to reduce flood risk. Provincial and federal governments have responded to flood disasters with financial assistance for communities and citizens affected by flood losses. The Canadian property and casualty (P&C) insurance industry finds itself in a complicated role in this challenge; it is, in essence, neither here nor there. Insurers do not provide coverage against overland flood damage to homeowners in Canada. Despite this exclusion, water damage has become the principal source of claims for insurers, surpassing fire and theft combined (KPMG 2014). This profound shift in claims is causing the industry to re-evaluate its role in managing flood risk in Canada.

The industry is, and has been for some time now, exploring the viability of offering overland flood insurance to homeowners. Many other developed countries have some type of arrangement in which insurance coverage is available for residential flood damage. Recent flood events in Canada, including the 2013 disasters in southern Alberta and the Greater Toronto Area, have served to cast public attention on what has largely been an internal discussion. The media have given voice to frustrated homeowners who have learned that their insurance policy does not cover damage caused by flooding or that their rates have increased following a flood. Such media coverage contributes to a reputational risk for insurers. At the same time, gaps in insurance coverage are seen as a missed business opportunity in what is a mature, competitive industry. If insurers decide to offer coverage of residential flood damage in Canada, it will not, of course, be for an altruistic vision of reducing risk for all Canadians; it will be to minimize their own risk and maximize profits.

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As such, the introduction of private flood insurance in Canada will have implications for flood management and the vulnerability of Canadians to flood hazards. It raises questions around how it will exacerbate already unequal vulnerability to flood hazards and whether it can be an effective tool in limiting development in areas exposed to the hazard. Flood insurance privatizes flood risk and creates losers and winners as part of a suite of institutional arrangements that influence peoples' vulnerability to hazards. There is a lack of research that investigates the implications and issues surrounding the introduction of residential overland flood insurance in Canada. Two recent reports commissioned by members of the insurance industry have assessed the viability of flood insurance in Canada but do not critically engage many of the complex, competing issues surrounding the topic (Sandink et al. 2010; Thistlethwaite and Feltmate 2013). This paper seeks to address this research gap by examining how the introduction of such an insurance product will affect residential vulnerability and interact with other factors, or "determinants," that influence vulnerability.

The paper begins by situating the role of the insurance industry within the current arrangement of flood risk management in Canada and then outlines what are seen as the requirements for insurability and some international models of flood insurance. It then reviews previous research on the willingness of residents to pay for flood insurance and how demand for insurance relates to other factors that contribute to vulnerability to flood hazards. A case study on flood insurance in a Canadian city is undertaken in Metro Vancouver, and a residential survey investigates attitudes toward flood insurance and how they relate to other determinants of residential vulnerability to flood hazards. The findings of the study contribute to an understanding of how the introduction of flood insurance will affect the vulnerability of Canadians.

Flood Risk and the Canadian Insurance Industry

Flood risk is currently an important topic on the minds and in the boardrooms of members of the P&C insurance industry in Canada. Recent flood events, such as the 2013 disasters in southern Alberta and Greater Toronto Area, have reminded Canadians of the consequences of their exposure to flood hazards. These disasters also brought to the public's attention the fact that home insurance policies in Canada do not cover damage caused by overland flooding. Homeowner damage claims from these and other floods have been met with a range of responses from Canadian insurers, ranging from full payment to no payment and withdrawal of coverage. Many Canadians falsely believe that their home insurance policy covers damage caused by overland flooding. A 2004 survey of 2100 homeowners across Canada found that nearly 70 % believed their insurance policy covers flood damage (Sandink et al. 2010). This proportion may be lower now due to recent discussion of the exclusion in the media, but it indicates that a large number of people do not fully understand their home insurance policy. The reaction of this Hamilton, Ontario homeowner has been echoed frequently by flood victims across the country (Kernaghan 2009):

> I don't have insurance for flooding. I thought I did. It was a big shock to me. I was with the same insurance company for 40 years. I paid all that money and now, nothing.

This gap in coverage is problematic for the insurance industry too, being at once a reputational risk and a missed opportunity for potential growth. Denying claims detracts from an insurer's reputation among existing and potential customers. Even if denying a claim is the correct response according to the policy contract, such an action hurts the chance of a customer renewing their policy with the insurer. At the same time, including overland flood coverage in a policy is seen as a potential new line of business for insurers in what is an otherwise highly competitive and mature industry in Canada. As long as the risk is priced accurately and customers are willing to pay the premium, an insurer would be motivated to offer the coverage.

The nature of flood risk in Canada appears to have changed in recent years, prompting consternation from insurers, but the hazard is not new. Floods have long been Canada's most frequent natural disaster (PSC 2014). A major reason the insurance industry is paying closer attention to flood risk is that water damage has recently become the principal source of claims. Water damage has now surpassed fire and theft, the two foundational perils of the industry, in claims made and paid out (KPMG 2014). For example, Aviva Canada, one of the largest providers of home insurance in the country, reported that 51 % of all property claims in 2013 were for water damage. Even with the Alberta and GTA disasters removed, water damage still would have accounted for more than 40 % of all claims for the company (Aviva 2014).

This shift in the source of claims is having a profound effect on insurers because they have not been underwriting the risk accordingly. Water damage covered by a homeowner's policy, like that caused by indoor plumbing problems, malfunction of appliances, or water entering the home through an opening caused by extreme wind, is underwritten and the risk is applied in the premium. Some home insurance policies include coverage of water damage caused by sewer backup. If it is not included, most homeowners can add sewer backup coverage to their

existing policy as an optional endorsement. Damage caused by sewer backup is at least partly the source of increasing water damage claims. Water damage that is caused by overland flooding, however, is excluded from home insurance policies and not underwritten directly into the premium. Overland flooding can be the result of severe rainfall or riverine or coastal flooding and cause property damage by entering a home through doors or window wells, for example. Where a problem arises is in the ambiguity on the claims side of the business. An insurer may decide to pay out a water damage claim despite it not being covered as stipulated in the policy contract. When the source of the water damage is difficult to determine, or there is some kind of external pressure, an insurer may make a business decision that paying out the claim is in the best interest of the company. The nebulous nature of paying water damage claims has contributed to this shift in the industry.

Insurers are considering offering overland flood insurance in order to properly underwrite flood risk and "firm up" their book of business. Flood insurance is a risk transfer mechanism that spreads the cost of flood losses over time and space. If flood insurance is bundled with coverage of other hazards, such as fire, wind, hail, and lightning, it also spreads the risk across perils. Insurers pool premiums paid by policy holders across these scales so they can pay out claims related to losses distinct in location and time. Primary insurers most often purchase reinsurance from the international reinsurers to cover their losses beyond a predefined limit. Insurers and reinsurers invest revenues in the markets, where investment returns can overcome underwriting losses. As such, the insurance industry is at once both local and global (Sturm and Oh 2010). It is this ability to move capital across scales that allows the industry to manage risk.

Flood Management in Canada

Flood hazard management in Canada is a complex arrangement of efforts by municipal, provincial, and federal governments, as well as some special purpose agencies (e.g., conservation authorities in Ontario) (de Loë 2000; Shrubsole 2000, 2007; Sandink et al. 2010). Governments and these agencies use a combination of structural and non-structural measures to mitigate flood risk. Flood control structures like dams, dykes, and levees were primarily relied upon until approximately the late 1960s when an increased emphasis was placed on non-structural measures such as land use planning to limit development in floodplains. Generally, provinces set policy guidance and minimum standards for municipalities and other local agencies to carry out flood management in their jurisdiction. Currently, the main role of the federal government is to provide affected residents and communities with financial assistance following a disaster, under Disaster Financial Assistance Arrangements (DFAA) in cooperation with provincial governments. The federal government formerly played a role in non-structural flood mitigation with the Flood Damage Reduction Program (FDRP) and is currently advocating a fledgling National Disaster Mitigation Strategy (NDMS). If private flood insurance is to be made available to homeowners in Canada it will occupy a role within the current suite of public flood management efforts and will have an impact on the functioning of these other measures.

Flood Damage Reduction Program and Flood Hazard Mapping

The FDRP was launched by the federal government in 1975 to support joint federal-provincial initiatives to limit development in flood-prone areas (Bruce 1976; Watt 1995). A major contribution of the program was to support flood hazard mapping and identification of floodplains. The development of flood hazard maps under the FDRP laid the foundation for flood risk identification throughout much of the country. Although some provinces had existing policy and procedures for floodplain management (e.g., conservation authorities in Ontario), the FDRP made national a high standard of flood risk identification and a commitment to non-structural flood mitigation measures. The federal government entered into individual agreements with the provinces on identifying the regulatory flood standard, based on local situation. For example, in British Columbia the regulatory flood is 1:200, many provinces use the 1:100 standard, while in Ontario three different regulatory flood magnitudes are applied by region. After the FDRP was wound down during the 1990s, provinces have been individually responsible for maintaining and updating their flood hazard maps. Provinces have made uneven efforts toward this end, and furthermore, within each province, municipalities have shown different levels of willingness and ability to manage floodplain development. In some cases, the original flood hazard maps created during the FDRP remain as the most current maps.

The state of existing flood maps in Canada presents some challenges for the introduction of flood insurance. Mapping created under the FDRP and other government programs for the purposes of floodplain management are considered flood hazard maps. These maps are useful for land use planning and other management decisions but are not ideally suited as flood risk maps for the purpose of insurance underwriting. Risk maps would identify degrees of probability, using information about frequency and severity of flooding, that an insurer could use to set

differential rates based on location (Sanders et al. 2005). Hazard maps are commonly used by insurers to underwrite flood insurance in Europe, however, where true risk maps are often not available (van Alphen et al. 2009). The provincial and regional differences in flood hazard mapping create an additional challenge for insurers in assessing risk-based rates as they would have to work through the inconsistency in flood return periods. Access to the maps is another challenge as they are housed in so many different agencies. Perhaps most problematic is the age of many maps. Outdated maps do not accurately identify current hazards, let alone projected flood risk due to climate change impacts, and thus cannot be relied upon for underwriting. As land use and the built environment change with urbanization, so too does flood risk (Nirupama and Simonovic 2007), which is not reflected in outdated maps. Insurers that write commercial flood insurance in Canada have, however, demonstrated that it is possible to work with less than ideal flood maps to deliver an insurance product (Sandink et al. 2010).

The current state of flood maps in Canada is identified by insurance executives as a major impediment to offering flood insurance to homeowners (Thistlethwaite and Feltmate 2013). If the UK model is any indication, however, poor quality flood maps are not necessarily a barrier to offering flood insurance, as premiums there do not always correlate well to risk. Those living outside the floodplain are oftentimes paying the same amount for flood insurance as those at high risk (Penning-Rowsell and Pardoe 2012). In this case, cross-subsidization makes up for poor risk identification. Canadian insurers may decide to individually or collectively create new flood risk maps, rather than rely on governments to update existing maps. Insurers could justify such an expense as an investment to protect their risk. This approach would allow insurers to map flood risk according to their needs and keep the information confidential, as insurers in the UK have done (Crichton 2002).

Disaster Financial Assistance Arrangements

After a disaster in which uninsurable losses exceed the ability of the municipal government to cover, the provincial and federal governments have established a way to work together to provide financial assistance to the affected community. DFAA is a discretionary agreement designed to help provinces with the costs of post-disaster response and repairing infrastructure and personal property to pre-disaster condition. Initiated in 1970, this arrangement follows a per-capita cost-sharing formula between the federal and provincial government. In this formula, the first dollar of damage per person in the province is the responsibility of the provincial government's disaster assistance program. As damage increases beyond this threshold, the federal contribution increases proportionately. Table 1 describes the DFAA cost-sharing formula. The allocation of disaster financial assistance is the responsibility of the province. Provincial financial assistance programs set their own standards of what damage costs will be covered.

Between 1970 and 2011, the federal government paid out approximately $2 billion in financial assistance to the provinces. The number of events requesting federal assistance and amount paid out per event both increased over this time (PSC 2011). These trends call into question the long-term sustainability of the arrangement but it would appear that the federal government values its role in helping Canadians through their "time of need" (PSC 2011, ii). The availability of overland flood insurance would affect provincial and federal post-disaster financial assistance. Since residential flood damage would be an insurable peril, it would not be eligible for government assistance. While this change would reduce the burden on Canadian taxpayers who contribute to DFAA, governments would lose an important role in post-disaster recovery and rebuilding. Government financial assistance is designed to help residents return to a pre-disaster state by compensating them for close to the pre-disaster value of only essential items. This is significantly different than the payout of an insurance claim, which would cover the full new cost of replacing all items.

The classification of flood as an insurable peril would raise the question of what happens when a homeowner who does not have flood insurance suffers flood damage. Under the intentions of DFAA, provincial and federal governments would not provide financial assistance to a homeowner in this situation. Given the public attention this would create, governments may find it difficult to resist assisting such citizens. Such a situation will be encountered if flood insurance is made available to residents, regardless of how it is delivered. If it is an optional product, many residents will choose not to purchase flood insurance. If it becomes a mandatory part of home insurance policies, it will increase premiums, and more people will not insure their homes because the cost is prohibitive. If insurers offer flood insurance but refuse to cover residents in locations

Table 1 DFAA cost-sharing formula

Eligible disaster costs (per capita)	Federal share (%)	Provincial share (%)
First $1	0	100
Next $2	50	50
Next $2	75	25
Remainder	90	10

Source: PSC 2011

deemed too high of a risk, governments will retain the responsibility for assisting them. Thus, it is clear that flood insurance will not totally relieve governments of their current responsibility for providing financial assistance to flood victims.

National Disaster Mitigation Strategy

After the 1996 Saguenay River flood, the 1997 Red River flood, and the 1998 eastern Canada ice storm together affected 20 % of the Canadian population and drew heavily on DFAA, the federal government initiated a consultation process to develop a NDMS (OCIPEP 2002; Hwacha 2005; PSC 2008). The purpose of the NDMS is to prioritize improvements in hazard mitigation as a cost-effective part of disaster management and to encourage the integration of mitigation in decision making at all three levels of government. Adopted as a strategy document in 2008, an important objective of NDMS is to link with a revised DFAA wherein 15 % of the funding is provided for mitigation purposes (e.g., building new infrastructure with greater capacity) (PSC 2008, 2011). Rather than continuing to simply repair a community to its pre-disaster state, this provision allows for improvements to be made toward hazard mitigation that will reduce future risk. The idea is that spending part of the financial assistance on mitigation measures will offer an improved return on investment by rebuilding the community in a safer way.

Flood Insurance: International Models and Requirements for Insurability

Canada is unique among G8 countries in that insurance coverage of overland flood damage is not available to homeowners (IBC 2014). Other countries have different models of flood insurance, which include four general arrangements of public or private delivery with optional or bundled coverage (Crichton 2008). In a public model, insurance coverage is provided or backed by government, whereas in a private model, insurance is provided by private insurers. With optional coverage, people can choose whether to purchase coverage of flood damage, whereas with bundled coverage, flood insurance is included with coverage against other perils. For example, the United States has a public and optional model, France has a public and bundled model, Germany has a private and optional model, and the United Kingdom has a private and bundled model. In both of these public models, private insurers play a large role.

In the US, the federal government financially backs the National Flood Insurance Program (NFIP), sets premium rates, and identifies flood risk areas. State and local governments regulate land use and development in floodplains. Private insurers sell policies to homeowners in eligible communities on behalf of the government but do not bear any of the risk. Public subsidization of flood insurance premiums has caused a number of widely noted problems, including a failure to discourage development in the floodplain (e.g., Burby 2001; Michel-Kerjan 2010). In France, private insurers purchase reinsurance from the government-run reinsurer at reduced rates, which enables them to include catastrophe insurance in standard home insurance policies (Michel-Kerjan 2001). In Germany, natural hazards insurance, which covers flood damage, is offered by private insurers as an optional supplement to home insurance policies but the take-up rate is relatively low (Thieken et al. 2006). British insurers have an informal, and often tenuous, agreement with the government wherein they will insure flood loss in all but the highest risk areas if the government provides adequate flood infrastructure, hazard mapping, and land use management (Crichton 2008). In a review of international models of flood insurance, Sandink et al. (2010) propose that a private and bundled model similar to that used in the UK is best suited for Canada because insurers would be able to set their own risk-based rates and governments would maintain responsibility for reducing risk.

Proponents of insurance as a tool to reduce risk identify three major functions of insurance: to reimburse damage costs; enable the spread of risk over time, space, and perils; and encourage actions to reduce exposure and vulnerability (Treby et al. 2006 after Arnell 2000). For a peril to be considered insurable, a number of conditions must be met. Crichton (2002) uses the mnemonic BASIC MUD to identify these conditions:

- B Big enough "book" of business
- A Adverse selection minimized
- S Sustainable so that risks can be spread over time
- I Information available about hazard, vulnerability, and exposure
- C Consistent with existing insurance practices, systems, and laws
- M Moral hazard low
- U Uncertainty about potential loss
- D Demand exists for insurance

Challenges for Flood Insurance: Adverse Selection and Moral Hazard

Adverse selection is perhaps the most difficult challenge to overcome in the insurability of flood damage (Hausmann 1998). Adverse selection occurs when only those living at high risk are interested in purchasing flood insurance, and when insurers are interested in selling insurance to only

those living at low risk. In this way, insurers and policy holders select against each other (Crichton 2008). The problem is inherent when flood insurance is an optional product, and results in premiums being prohibitively high in order for insurers to cover the risk assumed and therefore low market penetration. Adverse selection can be overcome by bundling flood coverage into home insurance policies but this requires cross-subsidization of risk, wherein those at low risk are paying for some of the risk of those living in higher risk areas.

Moral hazard is another challenge of insurability, in which those who have flood insurance do not take any actions to reduce their risk. This is especially a problem when premiums are kept artificially low by subsidization. When rates reflect risk they can incentivize mitigation behavior, and thus reduce moral hazard. This problem affects both residents and local governments, who may be tempted to approve development in areas of greater flood risk if the hazard becomes an insurable peril. In managing moral hazard and adverse selection, however, an insurer is not so much interested in reducing losses as making sure that losses are not greater than expected (Bennett 1999 after Heimer 1985).

Willingness to Pay for Flood Insurance and Determinants of Vulnerability

Vulnerability to hazards – "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard"—is affected by insurance coverage (Wisner et al. 2004, 11). If flood insurance is available and one can afford to purchase it, the coverage theoretically serves to reduce household vulnerability to flood hazards by covering (most of) the cost of flood damage. But not everyone will be able to pay for flood insurance, and some of those who can afford it will choose not to purchase the coverage (Priest et al. 2005). Thus, having or not having flood insurance is a factor that contributes toward differential vulnerability to flood hazards among a population. Flood insurance is one of a number of institutional arrangements that work together to influence vulnerability to flood hazards. Other determinants of vulnerability, like hazard perception, amenity values, self-protection, attribution of responsibility, and social vulnerability, factor together to make individuals more or less vulnerable to flood hazards than others (Collins 2008; Author forthcoming). Examining the relationships between willingness to pay (WTP) for flood insurance and other determinants of vulnerability can provide an understanding of what produces unequal vulnerability.

Previous studies outside of Canada have used residential surveys to investigate factors related to demand for flood insurance (Kousky 2011). These studies found that perception of risk, assessment of potential damage costs, previous experience with the hazard, the price of insurance, income level, and education level are among the factors that are significantly associated, at least in some cases, with an individual's decision to purchase hazard insurance (e.g., Baumann and Sims 1978; Kunreuther 1979; Palm and Hodgson 1992; Pynn and Ljung 1999; Blanchard-Boehm et al. 2001). Although studies have mixed findings, the dominant view is that there is a positive relationship between perceived flood risk and willingness to purchase flood insurance (Kunreuther 1996, 2006; Botzen and van den Bergh 2012). Botzen and van den Bergh (2012) find that perception of flood risk is more important than actual risk in the demand for flood insurance. Laska (1990), however, does not find a significant relationship between risk perception and flood insurance purchase. Hung (2009), on the other hand, finds a negative relationship between these variables. Many peoples' perception of risk is lower than their actual risk, however, so they choose to not purchase insurance (Slovic et al. 2000). Social norms, like when people hear that their neighbors are doing it, are an important influence on the decision to purchase flood insurance (Kunreuther and Michel-Kerjan 2009). Lo (2013) finds that demand for insurance is associated with perceived social norms, but not perceived flood risk.

Thieken et al. (2006) find that insured households undertook more mitigation during a flood than uninsured ones and speculate that this is because they are more aware of the risk. Studies have found that demand for flood insurance is positively related to previous experience with flooding (Krantz and Kunreuther 2007; Michel-Kerjan and Kousky 2010). Lo (2013), however, finds that previous experience is not predictive. Studies have found that willingness to purchase flood insurance declines slightly as the cost of the premium increases (Browne and Hoyt 2000; Kriesel and Landry 2004). Blanchard-Boehm et al. (2001) find that income and education level do not have a significant influence on insurance purchase. The authors find that the most significant factor in the purchase of flood insurance is the requirement to do so by mortgage lenders. However, the experience in the US has been that enforcing insurance purchase has little incentive for banks as there have been few consequences for not doing so (Blanchard-Boehm et al. 2001). Botzen and van den Bergh (2012) find a large proportion of homeowners in a river delta area of the Netherlands do not want to purchase flood insurance. The authors find that risk-averse individuals have a greater WTP for flood insurance, age and WTP have a negative relationship, household income positively influences WTP

for flood insurance, and property value has a negative relationship with WTP for flood insurance.

A small number of American studies have used actual NFIP policy data in the analysis and have found that those living in high risk areas, such as coastal areas, floodplains, and behind structural protection, as well as those with higher incomes and previous experience with flooding, are more likely to purchase flood insurance (Kousky 2011). Kousky (2011) adds to this empirical literature with a study of policy data from St. Louis County, Missouri, and finds that income, age, and education have no significant effect on flood insurance take up. When higher-income individuals do insure, however, they tend to purchase more coverage. In higher risk areas, more households are insured but previous experience of a flood does not predict insurance purchase. The findings of these studies, drawing on both residential surveys and insurance policy data, show that demand for flood insurance is related to other factors that influence peoples' vulnerability to flood hazards.

Case Study: Metro Vancouver Residents' Attitudes Toward Flood Insurance

Metro Vancouver can provide a case study to examine associations between individual attitudes toward flood insurance and other characteristics that determine vulnerability to flood hazards. Since flood insurance does not exist for Canadian homeowners, a residential survey must be used to collect this information from potential purchasers. Located on the Fraser River delta at the Strait of Georgia, Metro Vancouver municipalities are exposed to a number of flood hazards, including riverine, coastal, and urban flash flood caused by heavy precipitation (Forseth 2012). Although earthquake has long been a primary concern in this urban region, public attention on hazards has recently expanded to include flood risk, likely due to a combination of recent damaging events, urban development pressures, and increased awareness about climate change impacts. The municipal governments in Metro Vancouver have responded in varying ways to this growing concern. The City of Vancouver and the City of Surrey have introduced climate change adaptation plans that address flood risk at the local policy level. Many municipalities in Metro Vancouver have made a more long-standing effort to reduce earthquake risk, and the provincial government has improved building codes and other regulations to increase earthquake resilience. Additionally, earthquake insurance is available to residents in British Columbia as an optional endorsement on home insurance policies. In Metro Vancouver, 55 % of the total value of residential property is covered by earthquake insurance (AIR 2013). For these reasons, earthquake insurance resembles something of a precedent for Metro Vancouver residents and their insurance choices related to hazards.

The expensive real estate market in Metro Vancouver is well known in Canada, and Vancouver is considered the country's most expensive city in which to live (Cox and Pavletich 2014). The high current market value of homes in the region adds an additional consideration related to flood insurance. In the event of flood damage, there is a significant gap between what homeowners can expect to receive in disaster financial assistance and the current market value of their homes. The Disaster Financial Assistance program in British Columbia covers uninsurable losses to 80 % of the amount of total eligible damage that exceeds $1000 to a maximum of $300,000 (EMBC 2012). With such a large proportion of private properties worth significantly more than that value, this gap could be considered problematic. Compared to insurance policies that promise to replace the full value of the loss, disaster financial assistance may not come close enough to meeting the needs of many residents in Metro Vancouver. If they are aware of this, residents might be more willing to choose to privately insure their risk.

Further complicating matters, the funding structure of DFAA provides little incentive for municipalities to dedicate their limited resources to hazard mitigation. In the event of a disaster, the municipality is required to pay the first ten percent of the cost and the provincial and federal governments are responsible for the balance. This limited responsibility acts to dissuade municipalities from taking action because they know upper levels of government ultimately hold most of the liability. This municipal attitude is evidenced in the reluctance of some municipalities in BC to update how they define the floodplain. In 2003, the province mandated that municipalities whose floodplain by-law is not up to provincial standards will not qualify for DFAA in the event of a flood disaster. Some municipalities have reacted by not adopting a floodplain by-law rather than introducing one that is realistic for their community but deemed inadequate by the province (Stevens and Hanschka 2014). The BC Real Estate Association has taken a leadership role in lobbying the provincial government to update flood hazard maps across the province, without success to date.

Residential Survey

A survey was conducted in four neighborhoods in Vancouver and Surrey to investigate resident perceptions, attitudes, and behaviors regarding flood hazard issues, including flood insurance. The neighborhoods were selected to represent a range of social vulnerability. In Vancouver, the survey was conducted in the neighborhoods known as Kits Point and Marpole, and in Surrey, in the

Crescent Beach and Bridgeview neighborhoods. Kits Point and Crescent Beach have relatively low social vulnerability, while Marpole and Bridgeview have higher social vulnerability (Author in press). A self-administered survey was delivered to all of the slightly fewer than 400 homes in each neighborhood for a total population of 1540 homes ($N = 1540$). A total of 461 completed surveys were received from all neighborhoods ($n = 461$) for a response rate of approximately 29.9 % of surveys returned. This sample size compares favorably to that of other flood risk perception studies (Kellens et al. 2013). With this number of completed surveys from the survey population, the margin of error is less than ±4 %, 19 times out of 20. The survey asked residents questions around six determinants of vulnerability to flood hazards: perception of hazards and climate change, amenity values, institutional arrangements, social vulnerability, self-protection, and attribution of responsibility. Questions on institutional arrangements included several about insurance, the results of which are displayed in Table 2.

Most respondents (93 %) indicated that they have home insurance. A small minority of respondents reported that their insurance company actively encourages them to take actions to mitigate risks from hazards. Four percent have received advice from their insurer on how to reduce their risk. Six percent receive a reduction in their insurance rate for mitigation action they have taken on their property, such as installing a backwater valve or disconnecting their downspouts from the foundation drain. Take up on two optional endorsements that residents can add to their premium for additional coverage was quite different. Coverage for damage from earthquakes is offered to residents in British Columbia by most insurers and coverage for damage caused by sewer backup is available across Canada. Sixty percent of respondents reported that they purchase earthquake insurance. Slightly less than one-quarter (24 %) of respondents indicated that they have sewer backup insurance. More revealing, perhaps, is that 42 % were not sure if they have sewer backup insurance, indicating that the availability of this coverage is not well known to residents. When asked if they would be willing to pay for additional coverage on top of their current policy to cover damage caused by overland flooding, results were close to evenly split. Slightly more than half (52 %) of respondents indicated that they would be WTP for flood insurance. The remaining 48 % reported that they would not be WTP for flood insurance. Of those who are WTP, more than two-thirds (68 %) said they would only be WTP up to $100 per year for flood coverage. About 10 % of respondents said they would be WTP more than $200 per year. Survey findings indicate associations between attitudes about flood insurance and variables representing the other determinants, which are reported in Table 3.

Table 2 Residents' experience with insurance and attitudes toward flood insurance

Insurance variables	*N*	Percent
Have home insurance	461	
Yes	430	93.3
No	28	6.1
Not sure	3	0.7
Received advice from insurer	454	
Yes	20	4.4
No	400	88.1
Not sure	34	7.5
Receive a reduction for mitigation action	443	
Yes	28	6.3
No	354	79.9
Not sure	61	13.8
Sewer backup insurance	450	
Yes	106	23.6
No	153	34
Not sure	191	42.4
Earthquake insurance	449	
Yes	267	59.5
No	132	29.4
Not sure	50	11.1
WTP for flood insurance	454	
Yes	238	52.4
No	216	47.6
Yes, WTP	233	
<$100	158	67.8
<$200	53	22.7
<$300	12	5.2
<$400	4	1.7
>$400	6	2.6

Independent samples *t* tests and χ^2 tests were used to identify how other determinants of vulnerability might statistically differentiate those who are WTP for flood insurance from those who are not WTP for flood insurance. Independent samples t-tests were used to compare means between the groups—those WTP and those not WTP—in relation to other determinants when data for the dependent variable were ordinal, and χ^2 tests were used when the dependent variable is categorical data (Zumbo and Zimmerman 1993). The tests found statistically significant differences between the groups on a number of variables representing the determinants. There was not a significant association between WTP for flood insurance and previous experience of a flood. For perception of hazards, those who are WTP for flood insurance have a higher perception of both flood risk and sea level rise. They also have a higher perception of flooding specifically caused by heavy rain as

Table 3 Associations between WTP for flood insurance and other determinants of vulnerability

Variable	*T* test[a]	χ^{2b}
Experienced a flood in current home		2.76
Perception of hazards		
Flood hazards (all)	7.07***	
Sea level rise	5.6***	
Flooding caused by heavy rain	5.34***	
Sewer backup	2.09*	
Perception of climate change		
The climate is changing	2.74**	
There are more frequent and severe rainfall events now than there were 20 years ago	2.74**	
The risk of flooding that would affect property is increasing	5.19***	
Climate change is causing more extreme weather events	1.52	
Protective actions		
Knowledge about protective actions	1.22	
Would like to receive more information on how to reduce risk		34.12***
Have taken action to protect home from flooding		8.3**
Preventing damage is a high priority for my money and time	4.47***	
Backwater valve installed		0.76
Institutional incentives		
Purchase earthquake insurance		16.32***
Purchase sewer backup insurance		0.97
Attribution of responsibility for preventing damage from natural hazards		
Homeowner	0.97	
City	3.6***	
Insurance company	1.7	
In event of disaster, support expected to receive from		
Myself	1.55	
Insurance company	1.68	
Amenity values		
Natural environment benefits	2.76**	
Affordability	−0.44	
Social vulnerability		
Sex		0.99
Age	−1.07	
Education	−0.28	
Household income	1.18	

[a] Independent samples *t* test

[b] χ^2 test for independence (using Yates' correction for continuity)

* $P < .05$; ** $P < .01$; *** $P < .001$

well as by sewer backup. Those WTP for flood insurance have a higher perception that the climate is changing, that there are more frequent and severe rainfall events now than there were 20 years ago, and that the risk of flooding that would affect their property is increasing. There is not, however, a significant difference between the groups in their perception of whether climate change is causing more extreme weather events.

For protective actions, there is not a significant difference between the groups in their self-reported knowledge about actions they can take on their property to protect their home from flood damage. There are, however, significant associations between those who are WTP and those who have taken action to protect their home from flood damage, as well as those who would like to receive more information about such actions. Those WTP for flood insurance have a greater level of agreement that hazard mitigation is a high priority for spending their money and time. In terms of a specific protective action, installing a backwater valve in the main sanitary line to their home, there is not a significant association between WTP for flood insurance and having a backwater valve.

Questions on institutional incentives included two about optional coverage that homeowners can add to their insurance policy. It was found that there is a significant association between WTP for flood insurance and purchasing earthquake insurance but not between WTP for flood insurance and sewer backup insurance. In terms of attributing responsibility for preventing damage from natural hazards, those who are WTP for flood insurance felt that the city should have a higher level of responsibility than those not WTP. There was not a significant difference between the groups, however, in the level of responsibility that they feel a homeowner should have, as well as an insurer should have, in preventing damage from hazards. When asked on whom they would expect to rely for support in the event of a disaster, there were no significant differences between the groups for support they expect to receive from themselves or from their insurance company. In terms of the value that residents place on neighborhood amenities, those who are WTP for flood insurance place a higher value on natural environment benefits than those who are not WTP. There is not a significant difference between the groups on the value they place on the affordability of living in their neighborhood. Results on socio-economic characteristics that contribute to social vulnerability revealed no significant associations between WTP for flood insurance and a person's age, sex, education, or household income.

Discussion

Flood risk management in Canada is presently a public responsibility. Provincial and municipal governments, sometimes along with other local agencies, use non-structural and structural measures to attempt to keep people out of hazardous areas and flood hazards from where people live. If flood damage does occur, an arrangement exists for all three levels of government to work together to provide financial assistance to affected communities and residents. Since overland flood insurance is not available to homeowners in Canada, insurers do not play an active role in flood risk management but often play an ad hoc role in paying out claims to policy holders for water damage and in cases where the source of flood losses are unclear. It appears that there are two main reasons the arrangement exists in this way: because Canadians generally value the role of government in mitigating flood risk, and because insurers to date have not viewed coverage against overland flood loss as a profitable line of business.

After recent flood disasters have contributed to a public perception that flood risk in Canada is increasing, there may be pressure on the reasons for this arrangement. First, flood disasters show that public agencies cannot always meet their responsibilities to mitigate flood risk. Second, if flood risk is rising, flood insurance may be seen as a profitable venture for insurers. For insurers, it is not so much whether the overall risk is low; it is whether or not people are willing to pay for coverage against it. An insurer's primary interest is in maximizing premiums and minimizing claims, which reduces their risk, as opposed to reducing overall risk in the system. Insurers do not need to alter the nature of the risk because risk generates business: "there is no such thing as a bad risk, there are only mispriced risks" (The Economist 1994, p. 10 in Bennett 1999, p. 199). Therefore, insurers should not be counted on for keeping people from living in flood-prone areas because it is not their first priority. If they can price risk accurately and policy holders will pay the full or cross-subsidized rate, insurers will offer the product.

An important question then, if insurers move to provide the coverage, is how will flood insurance create losers and winners? And how will these losers and winners be different from those created by the current system of flood risk management? The introduction of flood insurance can be expected to create two sets of losers: those who cannot afford to purchase the coverage and those living at low risk subsidizing those at high risk with their premiums (Penning-Rowsell and Pardoe 2012). Those who cannot afford to buy insurance are of greatest concern because in the event of a loss they will not be covered and government will be supposed to not provide financial aid to them as the hazard is insurable. Whether to assist those people or not will be reduced to a political decision. Winners created by the product will be those living at high risk who can afford to pay the premium. The premium may indeed be affordable because it is subsidized by other policy holders living in lower risk areas. Those living at high risk are thus facilitated in their search for environmental benefits by not having to pay the full cost of the associated risks (Collins 2008). The current public arrangement may attempt to be fair to all members of society, but in practice there are uneven benefits which contribute to unequal vulnerability to flood hazards. Powerful groups of people are already facilitated in their desire to achieve environmental benefits without paying the full cost by taxpayer-funded infrastructure and disaster financial assistance, among other benefits (Author forthcoming). Will a private flood insurance scheme amplify the unequal vulnerability found in the current arrangement? Understanding how individual demand for flood insurance is associated with other determinants of vulnerability to flood hazards can provide insight into how such a scheme will affect Canadian households.

This study was the first to ask Canadian homeowners and renters about their attitudes toward flood insurance along with their perceptions of hazard risks, how they attribute responsibility for hazard mitigation, their behaviors to reduce risk, and personal socio-economic characteristics. Collecting this information enables an understanding of relationships between willingness to purchase flood insurance and other determinants of vulnerability to flood hazards among residents of a Canadian city. Survey findings reveal both expected and unexpected results. With most residents indicating that they have home insurance policies, it is evident that a culture of insurance and the administrative infrastructure required to deliver an insurance product already exist in Canada. Flood insurance could readily be added to a market with high insurance penetration if the demand or requirement for the coverage exists. Advocates of insurance as a tool for risk reduction argue that the insurance industry can play an active role in encouraging governments and homeowners to adopt measures to reduce risk (Crichton 2008). Evidence of the industry presently filling this role by promoting hazard mitigation behavior among policy holders, however, is not found in the survey results. With only four percent of respondents reporting that they have received advice from their insurer on how they can reduce their risk, and six percent indicating they receive a reduction in their premium for mitigation actions they have taken on their property, the influence of such a role appears to be limited in practice. Claiming this role without filling it leaves the insurance industry open to criticism that it is not interested in actually reducing risk.

Results on residents' take up of earthquake and sewer backup insurance provide comparative examples of optional coverage that homeowners can add to their policy. Sixty

percent of respondents indicated that they have earthquake coverage, which is reflective of 55 % of the total value of residential property in Metro Vancouver covered by earthquake insurance (AIR 2012). Earthquake risk is well known among the public in British Columbia, and the same survey found that earthquake risk is perceived to be higher than flood risk (Author forthcoming). Coverage at less than two-thirds of the population on a well-known risk indicates that (optional) insurance is not a universally accepted measure for risk reduction. Residents may not purchase additional earthquake coverage for a variety of reasons, including: they cannot afford it, they feel the cost of insurance is poor value based on the risk, they believe that in the event of an earthquake disaster the government will provide assistance, they object to the coverage on principle, or they simply have not bothered to add it to their policy (Priest et al. 2005). The same reasons would apply to the decision to purchase optional flood insurance. Just over half (52 %) of respondents said that they would be WTP for flood insurance. This proportion may reflect the slightly lower perceived flood risk as compared to perceived earthquake risk and resultant earthquake insurance take up. The survey also found a significant association between those who purchase earthquake insurance and WTP for flood insurance. This finding may indicate that risk aversion of individuals is an important factor in the decision to purchase flood insurance (Botzen and van den Bergh 2012). Sewer backup insurance take up is lower at 24 % but 42 % of respondents indicated they were not sure if they had the coverage. A significant association is not found between sewer backup insurance and WTP for flood insurance. Compared with 11 % of respondents who were not sure if they had earthquake coverage, it is clear that sewer backup insurance is not well understood by policy holders. This points to a need that insurers should address.

The survey finding that there is not a significant association between WTP for flood insurance and previous experience of a flood is not consistent with other studies that found those who have experienced flooding are more likely to purchase flood insurance (Krantz and Kunreuther 2007; Michel-Kerjan and Kousky 2010). Lo (2013), however, also finds that previous flood experience does not determine demand for flood insurance. Given the low number of survey respondents who had experienced a flood (8 %), this finding may be statistically questionable. The positive relationship found between WTP for flood insurance and perception of risk from flood hazards is consistent with the dominant findings of previous studies (Kunreuther 1996, 2006; Botzen and van den Bergh 2012). Although other studies have found no relationship (Laska 1990) or a negative relationship (Hung 2009), this relationship had not previously been tested for Canadian residents. The finding of significant positive associations between concerns about climate change impacts and WTP for flood insurance reinforces that those with higher perception of flood risk have greater demand for flood insurance.

These associations have implications for the introduction of flood insurance in Canada. The insurance industry can be expected to respond in a few ways if only those who perceive their risk to be high are willing to purchase flood insurance, which presents the problem of adverse selection. An optional product would have to be priced at such a high rate that it would be prohibitively expensive for some people at high risk. Many will view their risk to be lower than it actually is, so they will choose not to purchase the coverage (Slovic et al. 2000). Insurers may bundle flood coverage with other risks as a "catastrophe insurance" product or as part of a standard home insurance product, allowing cross-subsidization to reduce rates. Botzen and van den Bergh (2012) find that residents living in a more flood-prone area do not necessarily have higher demand for flood insurance, leading the authors to believe that concerns about adverse selection may be unfounded. It could be, perhaps, that perception of risk is more important in the decision to purchase insurance than actual risk.

The findings that WTP for flood insurance is not significantly associated with the level of responsibility that respondents feel homeowners or insurers should have in preventing and responding to disasters suggest that flood insurance would appeal to those with a variety of views on attribution of responsibility. Significant positive associations could be expected between WTP for flood insurance and the level of responsibility that residents think an insurer should have in preventing damage from hazards, as well as the level of support they expect to receive from their insurer in the event of a disaster, but were not found. One might presume that an individual who is willing to involve their insurance company in their personal risk management by purchasing flood insurance would view an insurer as having a high level of responsibility for preventing damage from hazards. Perhaps, though, their view is that they are taking more personal responsibility by fully insuring themselves. Those who are WTP for flood insurance feel that the municipality should have a high level of responsibility for preventing damage from hazards, which suggests that if flood insurance exists, citizens will still expect governments to be actively involved in hazard mitigation. This would support the position of insurers that governments must remain involved in reducing risk.

Variables that indicate homeowners taking a personal initiative to reduce their risk have significant positive associations with WTP for flood insurance. Undertaking mitigation measures, wanting to receive more information about what they can do to reduce their risk and prioritizing hazard mitigation as a personal expense were traits of those willing to purchase flood insurance. It stands to reason that buying flood insurance would be one of the measures that someone

with a personal sense of responsibility would take to reduce their risk. The finding by Thieken et al. (2006) that those who have flood insurance take more action during a flood seems to support this observation. Social vulnerability was found to be a determinant that did not predict WTP for flood insurance. The findings of previous studies are mixed on whether factors like age, income, or education level influence the decision to purchase flood insurance, but two US studies found that they did not in an existing program (Blanchard-Boehm et al. 2001; Kousky 2011). It seems intuitive that those with higher incomes would be more willing to purchase flood insurance but the case study does not bear that out. In the United Kingdom, where home insurance coverage is not mandatory but includes flood coverage, there is uneven uptake along income levels. Crichton (2002) finds that 30 % of poor households have insurance compared to uptake at 95 % of the overall population. The survey finds that those who value living in what they consider an affordable neighborhood are not significantly more or less likely to purchase flood insurance. WTP for flood insurance is found to be significantly associated with highly valuing natural environment benefits as a neighborhood amenity. This finding indicates that those seeking environmental rewards—rewards that may come with risks—are willing to pay a cost for living near them.

Conclusion

Insurers are considering offering flood insurance as a new product to Canadian homeowners. If private insurance is available to cover losses caused by overland flooding, it will have implications for the vulnerability of residents to flood hazards and how flood risk is managed in Canada. The introduction of private flood insurance raises questions around how it will exacerbate already unequal vulnerability to flood hazards and whether it can be an effective tool in limiting exposure to the hazard. How would the availability of flood insurance benefit some people more than others? How are the winners and losers created by the privatization of flood risk different from those in the current system of flood management? Would the introduction of flood insurance weaken public management efforts to keep people from living in flood-prone areas?

This paper attempts to address these questions by situating flood insurance within the current system of flood management and contributing some understanding of how demand for flood insurance relates to other determinants of vulnerability to flood hazards. Case study findings reveal some expected results, such as WTP for flood insurance is positively related to risk perception, but other results are not hypothesized, like socio-economic characteristics that contribute to social vulnerability do not predict WTP for flood insurance. These findings indicate that demand for flood insurance is part of a complex, dialectical set of determinants of vulnerability. Since the study is the first to examine how demand for flood insurance relates to other determinants of residential vulnerability in Canada, future studies could build upon the findings with comparative empirical evidence. Findings could then be analyzed against experiences with flood insurance in other countries. If private flood insurance enters the Canadian flood risk management landscape, an understanding of the implications for flood management and residential vulnerability to flood hazards will allow policy makers to make related decisions in the best interest of all Canadians.

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