

Making Flood Insurable for Canadian Homeowners

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Executive Summary

Homeowners cannot purchase insurance for overland flood damages in Canada. Governments have created financial assistance programs to help Canadian homeowners after flood events. However, insurance for flood damages is common in other developed countries. Flood insurance has many advantages over government relief programs for flood damage coverage. For example, risk based premiums and deductibles can provide incentives to encourage actions to reduce flood risk. Also, insurance companies have well established methods for assessing and paying claims, which can result in faster recovery. The purpose of this paper is to provide a discussion of what actions are needed to make flood insurable for Canadian homeowners.

Current approaches to flood management vary considerably across Canada. Important distinctions include the proportion of communities that have been mapped, the various government agencies involved in flood management, and the regulatory standards applied to define floodplains in each province. For this reason, it is very likely that any proposed insurance model would have to be adapted to and applied at the provincial level, rather than the federal level, which is common in most other countries.

Adverse-selection has been identified as a barrier to the implementation of flood insurance. This barrier can be overcome if flood insurance is bundled into homeowner insurance policies that cover other perils like fire and theft. To ensure economic viability for the flood insurance program, it may be necessary to exclude certain very high risk homeowners from the program. Government policies, not insurance, are the best approach to address the risk of flood damage for homes that have been allowed to locate in areas of very high risk. For example, governments may wish to enhance flood protection measures or acquire flood prone properties to bring flood risk levels down to an acceptable level.

Through a review of various international flood insurance models, the major finding of this report is that the approach best suited for Canada could be based on the approach that has been in place in the United Kingdom for the past fifty years. Flood insurance in Canada should cover all causes of flooding to avoid ambiguity when flood claims and payouts are made by insureds and insurers. Risk based premiums and deductibles will also be an essential feature of a flood insurance program for Canada. Homeowners with greater risk of flood damage should pay more for insurance protection, and those who work to reduce their flood vulnerability by adapting their buildings or properties to reduce risk should pay less. However, a small cross-subsidization between low risk and high risk insureds may be required to ensure that the proposed program remains economically viable.

Flood insurance must not incentivize building in flood prone areas, or encourage risky behaviour on the part of insured homeowners. Rather, flood insurance should complement existing flood management approaches applied by governments across Canada, and in many cases will likely require a renewed commitment by governments for non-structural and structural flood management.

Flood insurance will require a partnership between the insurance industry, governments and private homeowners. The role of insurers in a Canadian flood insurance model will be to provide flood coverage to all homeowners, aside from those occupying very high risk areas. As well, insurers should apply risk based insurance premiums and deductibles, keep track of environmental and structural changes that have implications for the flood risk of their policy holders, and participate in flood risk communications with their policy holders, including information on how individuals can reduce flood risk. Insurers should also monitor their accumulation of flood risk and ensure policy holders are aware of the characteristics of their insurance coverage.

For a viable flood insurance program in Canada, governments should work to increase flood risk assessment and reduce flood risk. To achieve this end, governments may choose to reduce flood risk through maintenance and enhancement of current practices that restrict development in flood prone areas, ensure continued investment in flood control measures, and work to increase public flood risk awareness. A viable insurance program will also require that public relief programs do not conflict with flood insurance.

Private homeowners should become aware of their own flood risks, and implement appropriate flood damage mitigation measures on their own property. Private property owners will have to participate in flood losses through retention of some of the damage costs through insurance deductibles. Risk based premiums and deductibles will help to ensure that higher risk property owners retain a higher proportion of the costs. Homeowners should also consistently communicate with insurance providers when improvements are made to buildings or when flood mitigation measures are installed to reduce the risk of underinsurance and ensure fairly priced premiums and deductibles.

The next step toward making flood insurable for Canadian homeowners would involve a discussion among insurance companies exploring their willingness to provide coverage. Do private insurance companies want to serve this need or would they prefer a further expansion of the public insurance sector? Would private insurance coverage for homeowners be similar to the flood coverage currently provided to commercial property owners in Canada? What commitments from the provincial agencies responsible for flood management would insurers like to secure before introducing flood coverage for homeowners? The Insurance Bureau of Canada would need to provide the leadership to resolve these questions and champion actions needed to make flood insurable for Canadian homeowners.

1 Introduction

Homeowners cannot purchase insurance for overland flood damages in Canada. Insurers provide homeowner coverage for damages caused by sewer backup, and flood is covered through comprehensive auto policies and is also available for commercial risk. Because most other severe and damaging perils, including wind and fire, are covered under typical homeowner insurance policies, most homeowners believe that their current insurance policy covers flooding. The industry's current inconsistent approach to flood coverage has left many homeowners confused and discontented with their insurance coverage.

Governments in Canada have created programs designed to assist homeowners after flood events, which are generally administered by provincial governments to "fill the void" left by a lack of flood insurance. However, insurance for flood damage in other developed countries has many advantages over government relief programs. In particular, the objective of insurance is to fully restore homeowners to the state similar to that before the flood, while relief seeks to reduce hardship. Further, risk based insurance premiums and deductibles can play a role in reducing flood risk, while relief can be most generous for those who did the least to reduce the risk of flood damage. The purpose of this paper is to provide a discussion of what actions are needed to make flood insurable for Canadian homeowners.

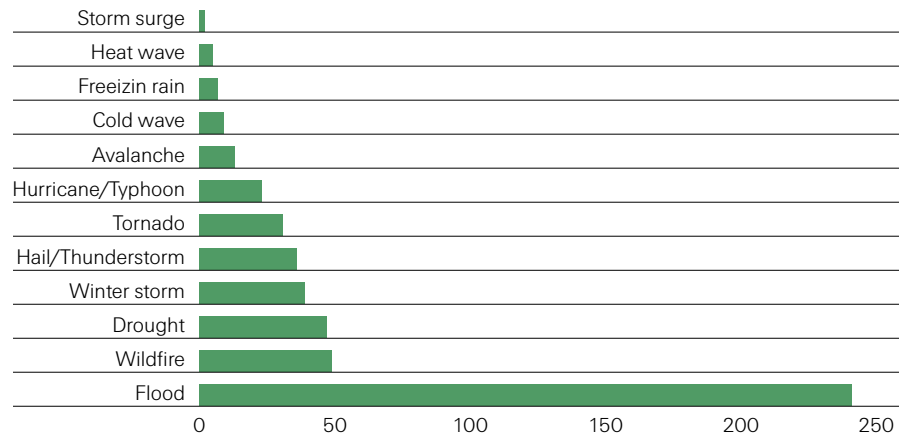
1.1 Outline of this Paper

This paper explores historical flood damages in Canada, current flood management practices at the national level in Canada as well as flood management practices for four case study provinces: Ontario, Québec, British Columbia and Alberta. International approaches to flood insurance are also explored, with a focus on models applied in the US, France, Germany and the United Kingdom. Finally, a possible model for insuring flood for homeowners in Canada is discussed.

2 Flooding in Canada

Floods are the most frequently occurring natural hazard in Canada. The Canadian Disaster Database (PSC, 2007) indicates that 241 flood disasters have occurred in Canada between the years 1900 and 2005, almost five times as many as the next most common disaster, which is wildfire (Figure 1). There are several causes of flooding in Canada, ranging from spring snowmelt to tsunamis in coastal areas (Environment Canada, 1993) (See Table 1). Flooding in Canada most frequently occurs during the spring snowmelt period (or “freshet”) (Shrubsole *et al.*, 2003).

Figure 1:
Meteorological and Hydrological
Disaster Occurrences in Canada,
1900–2005



Data source: Public Safety Canada, 2007¹

Actual flood damages are difficult to estimate for several reasons. Historical records for flood losses are often poor (Shrubsole *et al.*, 1993), and insurance and government relief programs do not typically provide total coverage for losses. For example, Shrubsole *et al.* (1993) identified an estimate of the flood damages caused by Hurricane Hazel in 1954, trended to 1989 dollars, ranging from CAD 152 million to CAD 760 million (CAD 234 million to CAD 1.2 billion in 2008 dollars) (Bank of Canada, 2009), whereas Public Safety Canada estimated the damages from the same storm as CAD 1 billion (PSC, 2007). Environment Canada (2008c) estimated the flood damages caused by Hurricane Hazel at CAD 25 million (1954) (CAD 205 million in 2008 dollars) (Bank of Canada, 2009).

As discussed in Section 4 of this paper, government relief programs do not provide full coverage for damages caused by flooding, so total payouts provided by governments for flooding underestimate total damages. Insurance figures do not represent total damages either, as insurance is available for only certain types of flooding or for specific clients. Further, it is difficult to estimate the overall economic impacts of flooding, including factors such as loss of business and impacts on agriculture (Environment Canada, 1993; Shrubsole *et al.*, 1993; Wiannecki & Gazendam, 2004).

¹ Events in the Canadian Disaster Database meet at least one of the following criteria: 10 or more people killed; 100 or more people affected/injured/evacuated or homeless; An appeal for national or international assistance was made; It was an event of historical significance; There was a level of damage/disruption such that the community affected could not recover on its own (PSC, 2007).

**Table 1:
Common Types and Causes of Flooding
in Canada**

Type of flooding	Description
Snowmelt runoff	The melting of accumulated winter snowpack, referred to as freshet flooding. Storm-rainfall flooding and ice jams often occur along with freshet flooding. Floods most frequently occur during the freshet in Canada. When the freshet is combined with rainfall, flooding can be extremely severe.
Storm-rainfall	Localized flooding resulting from extreme rainfall. Extreme rainfall often results in “flash flooding” (when the peak of the flood occurs within six hours after the rainfall) when it occurs on small watersheds.
Ice jams	Ice jam floods are caused by temporary blockage of rivers by ice fragment build-up. Ice jam flooding can occur both during ice formation and during break-up in the spring. Ice jams may result in flooding upstream, as well as downstream flooding when the dam suddenly fails.
Natural dams	Caused by the formation and failure of natural dams, including those caused by landslides, moraines and glaciers that block water flows, as well as glacial outburst floods (jökulhlaups). When a natural dam forms, flooding can occur upstream of the blockage, as well as downstream when the dam fails. Flooding caused by natural dams is often highly localized.
Coastal flooding	Coastal flooding can occur on the coasts of lakes, such as the Great Lakes, and along ocean coasts. Causes include: High wind and wave action, the combination of high estuarine flows and tides, storm surge, seiches, rising lake levels caused by wind setup, hurricanes and tsunamis.
Urban flooding	Includes flooding caused by overland flows (stormwater runoff, riverine flooding) and infrastructure flooding (including sewer backup). Urban flooding is exacerbated by urban surfaces and the concentration of development.
Structural failure	The failure or partial failure of engineered flood management structures, including dams and levees.
Groundwater	Groundwater levels may rise to a point where they exceed the lowest part of a building (basement). This water may then enter basements through cracks in foundation walls and floors. Saturated soils around homes may also lead to flooding.

Sources: Environment Canada, 2008a; Environment Canada, 1993; Hausmann, 1998; Sandink, 2009; Shrubsole *et al.*, 2003; Shrubsole *et al.*, 1993

With possible inaccuracies in damage estimates for large flood loss events in Canada in mind, several large flood events have been identified based on data from Public Safety Canada (2007), the Insurance Bureau of Canada (IBC) (IBC, 2008; IBC, 2000) and other sources. Table 2 provides “as-if” scenarios for large flood events. Economic flood losses from historical events were trended using the Collins and Lowe’s (2001) method. The historical losses reflect the price level and property exposure existing at the time of the event.

Flood risk varies considerably across Canada. The majority of Canadian homeowners (86%) live in the four provinces with the largest populations (Statistics Canada, 2010), so this assessments provides a more detailed review of flood experience in Ontario, Québec, British Columbia and Alberta.

Table 2:
Large Flood Disasters in Canada
and Estimated Total Costs
(trended to 2008)

Year	Province	Location/Area	Total Costs in millions CAD (trended to 2008)
1954	ON	Southern ON (Hurricane Hazel)	5,392
1948	BC	Fraser River	5,172
1950	MB	Winnipeg	4,652
1996	QC	Saguenay	2,699
1997	MB	Southern Manitoba	1,230
1948	ON	Southern Ontario	706
1993	MB	Winnipeg	618
2005	ON	Southern Ontario	¹ 587
2005	AB	High river, southern AB	¹ 519
1937	ON	Southern Ontario	470
1923	NB	Saint John River Basin	463
1955	SK/MB	Manitoba and Saskatchewan	362
2004	AB	Edmonton	303
1995	AB	Southern Alberta	285
1934	NB	Plaster Rock	198
1936	NB	New Brunswick	188
1999	MB	Melita	163
1916	ON	Central Ontario	161
1909	NB	Chester	149
1961	NB	Saint John River Basin	148
1987	QC	Montréal	147
1996	QC	Montréal and Mauricie Region	145
1920	ON	Southwestern Ontario	132
1920	BC	Prince George	131
2004	ON	Peterborough	129
1972	QC	Richelieu River	124
1983	NF	Newfoundland	115
1974	QC	Maniwaki	103

Data sources: Public Safety Canada, 2007; Shrubsole *et al.*, 1993.

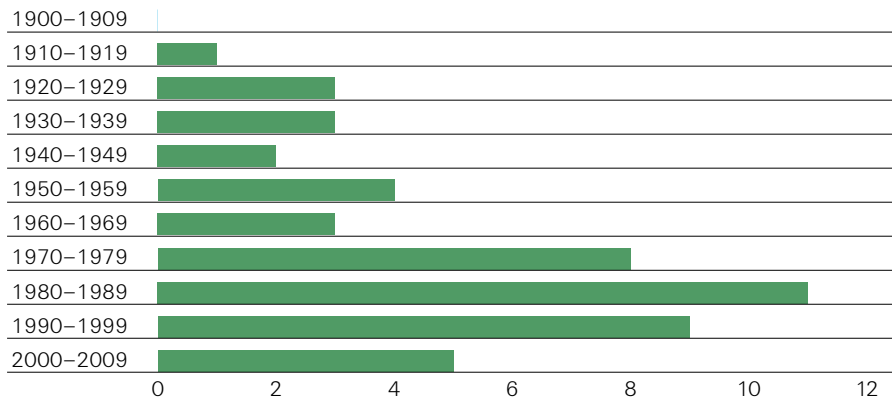
¹ Trended insured losses. Data source: IBC, 2008

Trending methods: Collins & Lowe, 2001

2.1 Flooding in Ontario

More flood disasters have occurred in Ontario between the period of 1900 to 2005 than in any other Canadian province, with 49 flood disasters (Public Safety Canada, 2007). Most of these events occurred in the period of 1970–2005 (see Figure 2). The majority of flooding in Ontario occurs during the spring freshet. Flooding throughout the year may result from spring rainstorms, summer thunderstorms, ice jams, and tropical storms and hurricanes (Environment Canada, 2008c; Wiannecki & Gazendam, 2004). Wiannecki & Gazendam (2004) revealed that close to half of the flood events that occurred in Ontario were a result of rain on snowmelt. The next most common, accounting for almost one third of the flood events, is heavy rain (Table 3).

Figure 2:
**Number of Flood Disasters in Ontario,
 1900–2005**



Data source: Public Safety Canada, 2007

Table 3:
**Causes of Flooding in Ontario,
 1990–2003**

Cause	Proportion of Flood Events (n=83)
Rain on snowmelt	47%
Rain	31%
Ice jam	17%
Wind	3%
Thunderstorm	2%

Adapted from Wianecki & Gazendam, 2004

In Ontario, a state of emergency/municipal disaster was declared almost every year between 1995 and 2003. Disaster relief assistance to municipalities has been provided by the province at increasing rates since that time, with some of the most extensive payments being made in the later time period within the scope of the Wianecki & Gazendam, 2004 report (2002–2003).

Hurricane Hazel remains the single most destructive flood event in Ontario’s history. Hurricane Hazel struck Toronto on Friday, October 15, 1954, generating flash flooding in and around the city. Throughout Ontario, 81 people lost their lives and over 4,000 families were left homeless (Environment Canada, 2008c; Giles, 1976). Hurricane Hazel produced winds that reached 110 km per hour and 285 mm of rain in 48 hours in the Toronto area (TRCA & ThinData, 2004).

Estimates of damages caused by Hurricane Hazel vary. Shrubsole *et al.* (1993) reported a range of flood damage estimates caused by Hazel in Ontario between CAD 152 million and CAD 760 million in 1989 dollars (or CAD 234 million to CAD 1.2 billion in 2008 dollars) (Bank of Canada, 2009). Environment Canada (2008c) estimated flood damages from Hurricane Hazel at CAD 25 million (CAD 205 million in 2008 dollars) (Bank of Canada, 2009), while the Canadian Disaster Database records damage estimates for Hurricane Hazel as approximately CAD 1.03 billion (PSC, 2007). Though flood damage estimates caused by Hazel vary widely, evidence suggests that the damages were extraordinary within the context of historical flood damages in Ontario, and Shrubsole *et al.* (1993) estimated Hurricane Hazel resulted in 40%–57% of all flood damages in the province in the time period 1837 through 1989.

The Timmins storm represents another significant event in Ontario's flood history. A severe thunderstorm affected the community in August 1961, which resulted in significant down-pours. The heavy rainfall resulted in flash flooding on Town Creek, which has a relatively small catchment area, and resulted in damage to private properties and infrastructure and the death of five people (Environment Canada, 2008c).²

Flooding along the Great Lakes shorelines has also resulted in damages during Ontario's history. Shoreline flooding was particularly severe when Great Lakes water levels were high, specifically in the years 1952, 1972–1973 and 1985–1987 (Environment Canada, 2008c). Lake Erie and Lake St. Clair are particularly vulnerable to damage during short duration, storm-caused floods, due to their shallow depths and high levels of development along their shorelines (Environment Canada, 2008c). Damages caused by flooding along Great Lakes shorelines between 1972–1973 were approximately CAD 25 million (CAD 123 million in 2008 dollars) (Bank of Canada, 2009; Environment Canada, 2008c). Damages resulting from shoreline flooding during the period 1985–1987 were approximately CAD 100 million (CAD 167 million in 2008 dollars) (Environment Canada, 2008c).

Several extreme rainfall events have resulted in flooding in Ontario. Some of the more severe events include the following:

- In 2002, the City of Peterborough was affected by a severe rainfall event that resulted in 200 mm of rainfall within an 11 hour period and approximately CAD 17 million in damages (Klaassen & Seifert, 2006).
- Severe flooding resulting from an extreme rainfall in Peterborough in July, 2004. Extreme rainfall resulted in flooding city-wide, and approximately 250 mm of rain fell in the northern sections of the City. This event resulted in approximately CAD 87 million in insurance payouts, and CAD 25 million in government disaster relief, of which over CAD 5 million was provided to private residents for non-insured damages (2004 dollars) (IBC, 2008; Klaassen & Seifert, 2006; Sandink, 2006; Oulahen, 2008).
- The 49th Parallel storm, which occurred in June 2002 was an extremely severe rainfall event which affected parts of northern Ontario, Manitoba and northern Minnesota. The rainfall event resulted in 200–400 mm of rainfall, and approximately CAD 31 million in damages. The flooding affected infrastructure (CAD 3 million in damages), 11 homes were damaged, and 13 First Nations communities (Acres International Limited, 2003 cited in Hebb & Mortsch, 2007).
- A series of storms and weather conditions brought severe rainfall to the Grand River watershed in southern Ontario over the dates of June 13–14, 2004. Heavy rainfall affected rural areas and several communities, particularly northeast of Kitchener, Ontario (Klaassen & Seifert, 2006).
- The August 19, 2005 severe rainfall storm in southern Ontario, which affected many communities within the Greater Toronto Area. Approximately 150 mm of rainfall was reported in some areas of Toronto, resulting in several thousand insurance claims and reports of basement flooding (Sandink, 2007). Insurance payouts for this event were estimated at CAD 500 million (approximately CAD 540 million in 2008 dollars), CAD 247 million of which were for damages caused by sewer backup (Bank of Canada, 2009; IBC, 2008; Sandink, 2007).
- Extreme rainfall in Essex County was recorded in July of 1989. The Harrow Agricultural Research Station recorded rainfall of 264 mm, however, local observers reported as much as 450 mm of rainfall concentrated in a small area. Damages to buildings and contents, infrastructure and crops were approximately CAD 36 to CAD 45 million (CAD 56 to CAD 69 million in 2008 dollars). Damages were limited due to the relatively flat topography and the location of the rainfall in a rural/agricultural area (Environment Canada, 2008c).

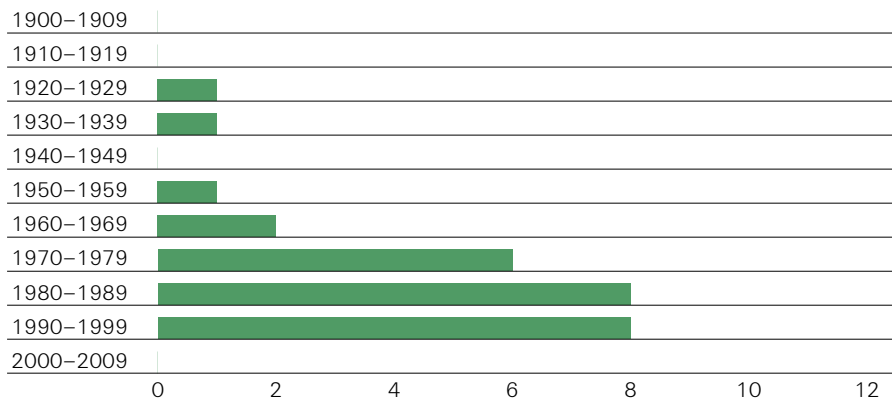
² The Timmins Storm flood magnitude serves as regulatory standard for floodplains in northern Ontario and southeastern Ontario. The Hurricane Hazel flood magnitude serves as the regulatory standard for much of southern and southwestern Ontario, including the cities of London and Toronto. The 1 in 100 year magnitude flood serves as the regulatory standard for the remainder of southeastern Ontario (Shrubsole *et al.*, 1997).

2.2 Flooding in Québec

Flood hazards are a concern for people living in Québec, given the province's numerous rivers and historical flooding problems. The magnitude of the flood problem in Québec can be illustrated by the fact that during the 1970 to 1988 period, Québec (with 24% of Canada's population) received 36% of the federal-provincial-territorial cost shared disaster assistance arrangements (Andrews, 1993 cited in Roy *et al.*, 2003) and from 1988 to present, it received roughly 51% (Roy *et al.*, 2003).

As in Ontario, the major cause of flooding in Québec is freshet flooding combined with rainfall. Major flood events in the province in the past have also resulted from ice jams and extreme rainfall (Environment Canada, 2008d). The Canadian Disaster Database reports 27 flood disasters in Québec between 1900 and 2005, with the majority of these events occurring in the period 1970-2005 (See Figure 3).

Figure 3:
Number of Flood Disasters in Québec,
1900–2005



Data source: Public Safety Canada, 2007

The Saguenay flood of 1996 was one of the worst natural disasters in Canada's history. The flood resulted from a severe rainstorm occurring from July 18 to 21, with up to 278 mm of rainfall during a 48 hour period (Natural Resources Canada 2008a; 2008b). The flood resulted in significant stream bank erosion, and caused significant damage to bridge and dam infrastructure. Approximately 1,350 homes were damaged, 6,000 people were evacuated and ten people were killed during the event (Natural Resources Canada, 2008b). As well, more than 600 landslides occurred as a result of the storm (Government of Canada, 2001). Damages from this event were estimated at CAD 1.7 billion (PSC, 2007). Insurance payouts resulting from this flood were estimated at CAD 207 million (CAD 269 million in 2008 dollars) (Bank of Canada, 2009; IBC, 2008).

Intense rainfall caused flash flooding in the Bois Francs region in August, 2003. Communities most affected included Tingwick, Warwick, Norbertville, Sain-Fortunat, Victoriaville and Chesterville (Natural Resources Canada, 2008a). Approximately 140 mm of rain fell in the Victoriaville area, and Tingwick experienced 139 mm in two hours, of which 80 mm fell within one hour (Natural Resources Canada, 2008a). The event resulted in severe stream bank erosion, as well as damage to bridges and roads, buildings and homes and crop damage. It was estimated that damages to bridges and roads in Tingwick was between CAD 5 and CAD 7 million (CAD 6 to CAD 8 million in 2008 dollars) (Bank of Canada, 2009; Natural Resources Canada, 2008a).

Further major flooding events and damages in Québec include:

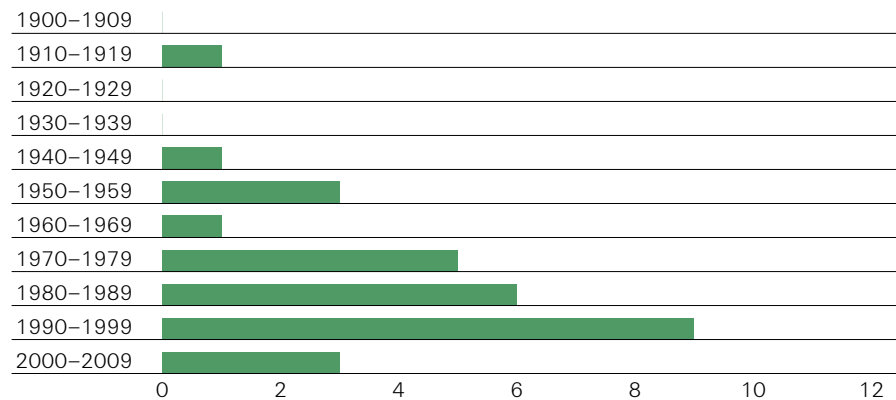
- An extreme rainfall event in August 1957 that resulted in approximately 250 mm of rainfall within six hours in the Thetford Mines area. Damages from this event were estimated at CAD 2 million (CAD 16 million in 2008 dollars) (Bank of Canada, 2009; Environment Canada, 2008d).
- Flooding in 1974 affected several hundred municipalities in the province. Flooding along the Gatineau and Ottawa rivers resulted in the majority of damages. 1,000 homes and 600 cottages were affected, and damages were estimated at CAD 60 million. CAD 21.8 million (CAD 96 million in 2008 dollars) in relief payments were made to those affected by flooding (Environment Canada, 2008d).
- A severe storm that resulted in 100 mm of rainfall in a very short time period caused flooding in the Montréal area in July 1987. Urban flooding resulted from the intense rain, which overwhelmed drainage and sewer infrastructure and flooded transportation systems within the city. Many buildings, including health facilities, malls and theatres were flooded, including approximately 40,000 homes during this event, and two people were killed. Damages for this event were estimated at CAD 40 million (CAD 67 million in 2008 dollars). Thirteen million dollars (CAD 22 million in 2008 dollars) in relief payments was provided to those affected by the flooding (Bank of Canada, 2009; Environment Canada, 2008d; Natural Resources Canada, 2008a).

Ice jamming, which occurs both during winter freeze up and during the spring freshet, creates a continuous flood hazard along the St. Lawrence River. Serious ice dam flooding has occurred in 1886, 1965 and 1968 which have resulted in millions of dollars in damage and several deaths (Environment Canada, 2008d).

2.3 Flooding in British Columbia

The mountainous and varied terrain of British Columbia creates a unique flood regime. Heavy rainfall combined with light snow in coastal mountain areas can create peak flows greater than those during the spring freshet, and in mountainous regions heavy rainfall has resulted in debris torrents (Environment Canada, 2008a). Debris torrents can also be caused by improper logging practices, where log jams are formed and then burst (Environment Canada, 2008a). The Canadian Disaster Database reports 29 flood disasters in British Columbia between 1900 and 2005 (PSC, 2007).

Figure 4:
Number of Flood Disasters in British Columbia, 1900–2005



Data source: Public Safety Canada, 2007

The Fraser River is the largest river in the province of British Columbia. Within the Fraser basin is substantial development and a large population, including communities within the Lower Fraser Valley. Within the drainage basin of the Fraser are Kamloops, Prince George, Quesnel and part of the Pemberton Valley. Significant infrastructure, including highways, railways and airports is located within the Fraser's floodplain (Environment Canada, 2008a). Approximately 300,000 people live within the Lower Fraser floodplain (Lyle & Mclean, 2008).

Significant development is protected by dyking along the Fraser River, including the communities of Chilliwack, Harrison Hot Springs and Agassiz, as well as portions of Mission and New Westminster. Island communities within the delta of the Fraser River are also protected by dykes (Environment Canada, 2008a). Communities that are protected by dyking are vulnerable to flooding, as dykes are prone to failure when exposed to high river levels for extended periods of time (Environment Canada, 2008a).

The principal flood hazards on the Fraser are caused by the spring freshet. Extreme high tides, localised extreme rainfall on Fraser tributaries and ice jamming also contribute to flood risk (Environment Canada, 2008a). There have been several historical flooding events on the Fraser, the most severe known flood was in 1894, however damages were limited as development was at a very early stage along the river (Environment Canada, 2008a; Lyle & Mclean, 2008).

In 1948, another severe flood affected communities along the Fraser. The flood resulted in the failure of several dyking systems, and a significant portion of the lower Fraser Valley floodplain area was flooded (Environment Canada, 2008a). Damages for this event were estimated at CAD 20 million (CAD 198 million in 2009 dollars) (Bank of Canada, 2009; Environment Canada, 2008a). Though the magnitude of the 1948 flood was lower than the 1894 flood, the damages were much greater due to increased development (Lyle & Mclean, 2008). The 1894 and 1948 flood magnitudes served as standards for the development of structural flood controls throughout the 1960s and 1970s in the Lower Fraser Valley (Lyle & Mclean, 2008).

Major flooding occurred again in the Lower Fraser in 1972, and in this case dyking systems were effective in reducing damages. The 1972 flood event was considerably less severe than flooding in 1894 and 1948 (Lyle & Mclean, 2008), and damages in this case were approximately CAD 10 million (or CAD 53 million in 2009 dollars) (Bank of Canada, 2009; Environment Canada, 2008a).

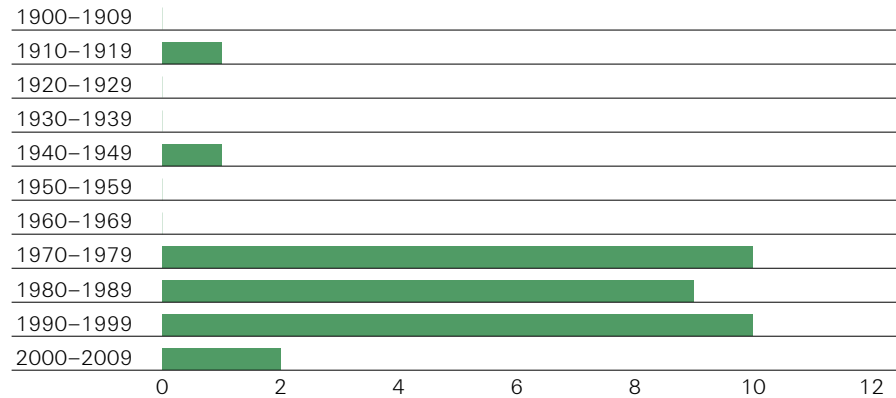
In 1964, a tsunami combined with almost high-tide conditions resulted in flood damages along BC's coastal communities. The most significant damage resulted when the tsunami pushed water 40 km up the Alberni Inlet, and damaged homes and business in the community of Port Alberni. Damages from this event were estimated at CAD 2.5 to CAD 3 million (or CAD 18 to CAD 21 million in 2009 dollars) (Bank of Canada, 2009; Environment Canada, 2008a).

A further significant flooding event in British Columbia was a debris flow caused by a glacial outburst flood. The flood occurred in the largely undeveloped Kicking Horse Pass area in 1978, and resulted in damages to the Trans Canada Highway and rail lines, including the derailing of a passing freight train (Environment Canada, 2008a).

2.4 Flooding in Alberta

The Canadian Disaster Database reports 33 flood disaster events in Alberta between 1900 and 2005 (Public Safety Canada, 2007). Snowmelt and extreme rainfall are the principal causes of flooding in the Prairies (Environment Canada, 2008b). Ice jams also create significant flood risk in Alberta, especially in northern areas (Mahbir *et al.*, 2008). Alberta’s geography is comprised of mountains, foothills and the Great Plains, which affect the province’s flood regime. In terms of costs, the most severe flood events in Alberta occurred in 2005 and 1995.

Figure 5:
Number of Flood Disasters in Alberta, 1900–2005



Data source: Public Safety Canada, 2007

The 2005 flood resulted from heavy rainfall and high water, and affected over 15 communities, including First Nations, and the cities of Calgary and Red Deer (PSC, 2007). Damages from this event were extensive, and included CAD 84 million in payouts through federal disaster assistance, CAD 55 million in provincial relief and CAD 300 million in insurance payouts (2005 dollars) (IBC, 2008; PSC, 2007). A combination of heavy rain and snowmelt resulted in a flood event in 1995 on the Oldman, South Saskatchewan and High Rivers. This flood resulted in 215 flooded basements, as well as damage to 20 bridges and damage to roads, trails and agricultural lands (PSC, 2007). The 1995 flood event resulted in almost CAD 35 million in DFAA payouts, almost CAD 13 million in provincial payouts and CAD 21 million in insurance payouts (1995 dollars) (IBC, 2008; PSC, 2007).

In July 2004, the City of Edmonton was affected by two heavy rainfall events – the first on July 2, resulting in 73 mm of rainfall, and the second on July 11, which resulted in approximately 150 mm of rainfall (Sandink, 2007). As a result of these events, approximately 9,500 insurance claims for sewer backup were made at a value of CAD 143 million (or CAD 157 million in 2008 dollars) (Bank of Canada, 2009; Sandink, 2007).

2.5 Future flood potential

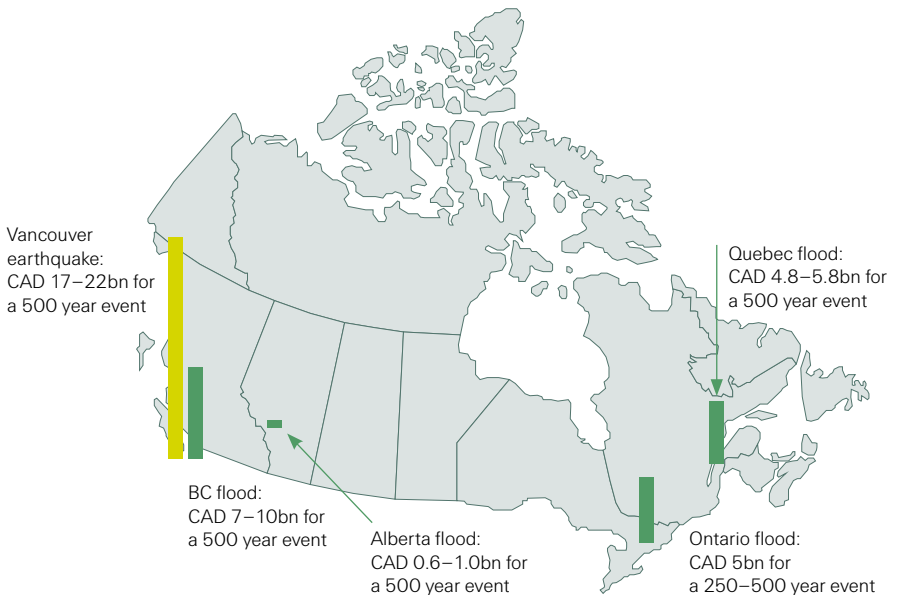
Probable Maximum Loss (PML) estimates for major cities in Canada’s four largest provinces were developed by the risk modeling experts at Swiss Re to give an indication of possible economic risk associated with large flood events (See Figure 6). PML scenarios are an estimate of the maximum damages that could be caused by a natural disaster (Woo, 2002). PMLs were generated using a benchmark historical “as-if” loss for a given province on which a loss distribution (pareto extrapolation) was applied to generate the PML (Collins & Lowe, 2001).

PML scenarios are based on a historical flood event with loss amounts trended to today's dollars, and reflect:

- Today's price level, reflecting the general inflation in price level that occurred during the period. This is measured by the Implicit Price Deflator (IPD) (OECD, nd), and;
- The current stock of properties and contents whose value is reflected by two factors:
 - The increase in the number of structures of various types, which is measured by changes in housing units and/or changes in population over the time period. Data on historical changes in housing units and population were acquired from Statistics Canada (Statistics Canada, 2007a,b; 2004) and;
 - The change in average size or quality of the structures, and the greater amount and value of the typical contents in the structure, which was measured by the Real Net Stock of Fixed Reproducible Tangible Wealth (FRTW) (Statistics Canada, 2009; 2004).

A PML estimate for an earthquake in Vancouver was also included in Figure 6 to provide comparison and context for probable losses caused by large flood events. While not as large as an earthquake in Vancouver, PMLs for large flood events in British Columbia, Ontario and Québec are considerable and could exceed payouts for the 1998 Ice Storm (IBC, 2008).

Figure 6:
Probable Maximum Loss Estimates
for British Columbia, Alberta, Ontario
and Québec



Data source: Public Safety Canada, 2007

3 Overview of Flood Management in Canada

In Canada, as in other developed nations, there has been a historical reliance on structural flood measures, including dams, dykes, levees, and other structures to control the risk of flooding and mitigate flood damages during early efforts at flood control. Table 4 outlines federal government initiatives for flood management in Canada. A coordinated reliance on flood control structures at the federal level in Canada was in place from approximately 1953 and 1970, supported by the *Canada Water Conservation Act*. This focus on structural measures gave way to a mixed structural/non-structural approach during the 1970s, supported by the *Canada Water Act* (Shrubsole, 2007). Non-structural measures included government disaster relief programs, assistance for emergency preparedness and support for floodplain mapping provided to lower levels of government. The main instruments at the national level for these initiatives were the Disaster Financial Assistance Arrangements (DFAA), the Joint Emergency Preparedness Program (JEPP) and the Flood Damage Reduction Program (FDRP).

Though a coordinated national flood mapping program did not exist in Canada before 1975, flood mapping and flood management through land use planning was in place in several provinces, including Ontario, British Columbia and Alberta (Bruce, 1976; Watt, 1995). The pre-FDRP floodplain management program in Ontario has been considered the most comprehensive (Watt, 1995), and was the result of substantial flood damages resulting from Hurricane Hazel, as well as damages associated with high-water levels in the Great Lakes (Giles, 1976). Following Hurricane Hazel, Ontario Conservation Authorities mapped flood lines. These flood maps were then distributed to municipalities, resulting in the passing of several bylaws in 1955 and thereafter, which prohibited construction within the identified flood zone (Giles, 1976).

The province of British Columbia began non-structural management of floodplains following flooding in 1972. These measures included delineation of a 1 in 200 year design flood on flood maps, floodproofing of buildings and management of development in floodplains through zoning by-laws (Doughty-Davies, 1976). Floodplain management efforts also existed in Alberta since 1960 (Watt, 1995).

Despite this early work in non-structural floodplain management in Canada, no national flood mitigation program existed, aside from the provision of funds for structural flood controls and post-disaster relief (Bruce, 1976). Though the federal government was involved in flood management before the implementation of the FDRP, through disaster relief, emergency preparedness and structural measures, the FDRP was considered a substantial shift in flood policy, with its focus on a mix of structural and non-structural measures.

**Table 4:
Federal Government Initiatives related
to Flood Management**

Initiative	Year	Summary of its Role in Flood Management	Current Status
<i>Canada Water Conservation Act</i>	1953	<ul style="list-style-type: none"> ■ Provided cost sharing arrangements between federal government and provinces for structural flood control measures ■ Funding provided only for structural adjustments ■ Clarified roles of all levels of government ■ Ensured higher levels of government became involved in flood management ■ First federal legislation directly concerned with water management 	<ul style="list-style-type: none"> ■ Repealed after enactment of the <i>Canada Water Act</i>
<i>Canada Water Act</i>	1970	<ul style="list-style-type: none"> ■ Supported joint federal-provincial initiatives ■ Allowed for funding of non-structural measures ■ Allowed for implementation of FDRP and JEPP 	<ul style="list-style-type: none"> ■ Currently in place
Disaster Financial Assistance Arrangements (DFAA)	1970	<ul style="list-style-type: none"> ■ Standardizes disaster recovery cost-sharing between the federal government and the provinces ■ Provides partial compensation for disaster recovery to provincial governments, based on DFAA guidelines and criteria 	<ul style="list-style-type: none"> ■ Currently in place ■ Revised in 2008 as part of NDMS to allow for some mitigation funding – DFAA now allows for 15% additional payment for mitigation measures
Flood Damage Reduction Program (FDRP)	1975	<ul style="list-style-type: none"> ■ Enabled resource sharing (financial and expertise) between federal government and provinces for the purpose of creating flood hazard maps ■ Resulted in the mapping of floodplains in hundreds of Canadian communities 	<ul style="list-style-type: none"> ■ No 10-year agreements renewed for provinces or territories ■ Federal government involvement wound-down as of the early 2000s
Joint Emergency Preparedness Program (JEPP)	1980	<ul style="list-style-type: none"> ■ Provides partial financial assistance for emergency preparedness planning ■ Assistance to municipalities is provided through provincial governments 	<ul style="list-style-type: none"> ■ Currently in place
National Disaster Mitigation Strategy (NDMS)	2008	<ul style="list-style-type: none"> ■ Intended to coordinate piece-meal mitigation undertaken by lower levels of government across the country ■ Supports all-hazard mitigation at local, provincial level ■ When implemented, may serve to fill gap left by withdrawal from FDRP 	<ul style="list-style-type: none"> ■ Initial discussions held by PSC (formerly EPC, OCIPEP) and Insurance Bureau of Canada in 1998 and in 2002 ■ Strategy document released in 2008

Sources: Bruce, 1976; de Loë, 2000; Environment Canada, 2008; Hwacha, 2005; Shrubsole, 2007

3.1 The Flood Damage Reduction Program (1975 to early 2000s)

The federal government introduced the FDRP in 1975 in an effort to reduce flood losses across the country. The objective of the FDRP was to reduce flood damage and prevent loss of life by discouraging development in areas vulnerable to floods (Millerd *et al.*, 1994). The FDRP was borne of numerous drivers, including increasing population in urban areas, which had the potential to exacerbate development in flood-prone areas that were as yet unidentified. There were also several large federal disaster relief payouts to provinces, and pressures to manage flooding on limited budgets (Bruce, 1976; Watt, 1995; Shrubsole, 2007).

Further factors that led to the development of the FDRP included (Bruce, 1976; Watt, 1995; Shrubsole, 2007):

- Motivations resulting from an environmental movement, including pressure for environmental agencies to clean up lands and preserve green spaces and agricultural lands rather than investing in structural flood control works. Motivators also resulted from the environmental impacts of flood control structures;
- Considerations of the income transfer that was occurring from the general population to the few who occupied floodplains;
- Evidence that structural works increased the value of floodplain property, and further permitted the development of floodplain lands, and;
- Evidence that government relief encouraged existing development to stay and encouraged new development in floodplains.

The primary aim of the FDRP was to discourage development in flood-prone areas by identifying these areas through extensive flood mapping efforts and using these maps to manage land use development in identified flood prone areas (Bruce, 1976; de Loë, 2000; Shrubsole, 2000; Shrubsole, 2007). Further aims of the program were to increase coordination of federal and provincial flood strategies, promote long term flood damage reduction through reducing flood vulnerable development, increase stakeholder awareness of flooding, policies and programs related to flooding, and increase knowledge of the location of flood-prone areas (Bruce, 1976). The program was also designed to follow-up the identification of flood-prone areas with appropriate measures to reduce the vulnerability of existing development within these areas, including implementation of appropriate structural measures. Financial disaster assistance was also to be refused for flood damages caused to buildings that were built in the floodplain after it had been identified. As well, through the program, provinces were encouraged to reduce their own investments in flood-prone areas (e.g., no longer placing provincial government buildings in these identified areas), and would encourage local authorities to direct flood development away from identified flood-prone areas (Bruce, 1976; de Loë, 2000; Shrubsole, 2000; Shrubsole, 2007).

Further initiatives carried out under the FDRP included (Watt, 1995):

- Flood forecasting studies and programs;
- Regional flood frequency analyses, and;
- Site-specific flood damage reduction planning studies and general application studies.

A major strength of the FDRP was that it leveled the field for local governments by providing standards for mapping and land use regulations, and the funding necessary to achieve this. The FDRP helped to build local capacity for flood management while creating a significant collection of current flood maps that were, and still are, used extensively in development decisions (Bruce, 1976; Environment Canada, 2008e; Watt, 1995).

Public information sessions were held in communities as they were being mapped to ensure greater stakeholder awareness and input (Environment Canada, 2008e). Following development of the flood risk maps, the program suggested development of a brochure to be distributed to the public to communicate flood risk information. Maps were also to be made available to the public, and a technical report was to be made available to professionals involved in engineering, planning and flood management.

General agreements were set up between the federal government and provinces, where the first priority was to create floodplain maps on a 50/50 cost-shared basis (Bruce, 1976, Watt, 1995). Specifications for flood maps developed under the program would be the "design flood event," the magnitude of which should not be lower than a 1 in 100 year magnitude flood event. The program allowed for variation between and within provinces on what design flood magnitude could be applied as long as it equalled or exceeded the 1 in 100 year magnitude (Watt & Paine, 1992; Paine & Watt, 1992). Further, individual provinces could decide on whether to apply a one-zone or two-zone concept (Bruce, 1976).

Under the two-zone concept, both a flood fringe, with a lower risk of flooding, and a floodway, where flood waters are deepest and at a greater velocity, could be defined (Shrubsole *et al.*, 1997). Flood mapping was carried out either by private engineering consultants or government agencies. To ensure a consistent and high quality of the maps, flood mapping guidelines were produced by the federal government (Bruce, 1976).

The federal government entered into agreements with each of the provinces and territories (except Prince Edward Island and Yukon) in subsequent years, basing each agreement on the same three principles: Future development in flood prone areas was to be avoided, financial disaster assistance would be withheld from flood vulnerable developments after designation, and local authorities were to be encouraged to zone on the basis of flood risk (de Loë, 2000).

Hundreds of mapping projects were undertaken under the FDRP, leading to floodplain designation in hundreds of communities across the country. An emphasis of mapping efforts was placed on Ontario and Québec, with several hundred communities attaining designated flood prone areas through the program. As can be seen in Table 5, provinces varied widely in their adoption of regulatory flood standards, ranging from the 1 in 100 year flood magnitude to the 1 in 500 year flood magnitude in Saskatchewan.

There was little effort to define flood risk areas in Prince Edward Island, as it was viewed as having little risk at the time the program was developed. This was also the case in Yukon, where no provincial-federal agreements were signed. Little work was completed in the Northwest Territories, including what is now Nunavut, through the FDRP (Shrubsole *et al.*, 2003). Mapping on Indian lands within provinces was undertaken by the federal government alone (Watt, 1995).

**Table 5:
Mapping Completed under the FDRP
up to the date of June 30, 1995**

Province/Territory	# of Communities	# Mapped	# Designated ¹	Regulatory Flood	Definition of Floodway
Alberta	67	20	11	1:100	Hydraulic ³
British Columbia	143	77	73	1:200	See note ⁴
Manitoba	26	18	17	1:100 ⁵	Hydraulic ³
New Brunswick	15	12	12	1:100	1:20
Newfoundland & Labrador	53	19	16	1:100	1:20
Northwest Territories	9	9	9	1:100	Hydraulic ³
Nova Scotia	6	6	5	1:100	1:20
Nunavut	0	0	0	1:100	Hydraulic ³
Ontario	445	318	200	See note ²	1:100
Québec	510	211	211	1:100	1:20
Saskatchewan	24	22	16	1:500	Hydraulic ³

¹ Designation indicated formal acknowledgement of flood risk areas by provincial and local governments

² Ontario applies three regulatory flood magnitudes: the Hurricane Hazel magnitude in the majority of southern Ontario, the Timmins Storm in parts of southern Ontario and in northern Ontario, and the 1:100 magnitude in south eastern regions.

³ Area of the floodplain with 1m depth, 1m/s velocity and 0.3m water level rise

⁴ Floodway includes the natural channel plus a 30 m (or higher) setback

⁵ The City of Winnipeg applies a 1:160 design flood magnitude

Sources: Choles, 2008; Environment Canada, 2008e; Shrubsole *et al.*, 2003; Watt, 1995

In 1992 and 1993, reviews of the FDRP were performed at two workshops involving federal and provincial civil servants. The workshops found that the FDRP had been exceptionally effective in steering development from flood risk areas, and was a model of federal-provincial cooperation. Civil servants also agreed that there were several side-benefits of accurate flood maps, including assisting local authorities in emergency planning and identification of sensitive ecological functions (Watt, 1995). In a study of costs and benefits associated with the FDRP, de Loë & Wojtanowski (2001) identified various side benefits, including improved decisions in planning at the local level, benefits associated with environmental protection and increased public awareness and acceptance of flooding and floodplain management. During the 1992 and 1993 workshops, civil servants also agreed that the program should be maintained over the long term through continued federal-provincial partnerships, as continued maintenance and implementation of the program was required to ensure that encroachment of development in floodplains did not occur. Further, they agreed that maps produced through the program should be maintained and updated, and there was a need to increase efforts to map flood risk areas in aboriginal lands. However, even at the time of these workshops there was suspicion amongst provincial civil servants that the federal government was beginning to phase out the program (Watt, 1995).

While the mapping portion of the FDRP was considered essentially complete in the 1990s, there was a belief in the need to continually update maps created under the program to ensure accuracy, viability and credibility (de Loë, 2000; Watt, 1995). However, the program began to be phased out in the early 1990s and the last of the agreements expired in 2000 (de Loë, 2000). There is currently no financial support at the federal level for the FDRP (Booth & Quinn, 1995; de Loë, 2000).

3.2 Joint Emergency Preparedness Program (1980 to present)

Since 1980, the federal government has administered the Joint Emergency Preparedness Program (JEPP), which was designed to assist local governments in the development of disaster preparedness projects, through funds provided to provincial and territorial governments (Henstra & McBean, 2005; PSC, 2007b). The JEPP may share costs, up to 75% of a project, not exceeding CAD 3 million for a specific project (PSC, 2007b). JEPP is designed to assist in the funding of projects that have “a clear objective aimed at enhancing national civil preparedness for emergencies or critical infrastructure protection” (PSC, 2007b) and the program has focused specifically on increasing local level emergency response capacity (Shrubsole, 2007).

3.3 National Disaster Mitigation Strategy (2008 to present)

The significant damages caused during the 1996 Saguenay River flood, the 1997 Red River flood, and the 1998 eastern Canada ice storm resulted in an average payout of CAD 366 million in disaster assistance through DFAA for each of the three disasters (Hwacha, 2005). By comparison, before 1996, no one disaster claim paid out by DFAA exceeded CAD 30 million (Hwacha, 2005). Reflecting these spectacular payout events, and recognizing the fact that payouts for such events could increase, in 1998 and in 2002 Public Safety and Emergency Preparedness Canada (now Public Safety Canada) held national consultation meetings to facilitate the development of a National Disaster Mitigation Strategy (NDMS) (Hwacha, 2005; OCIPEP, 2002).

The purpose of the strategy was to support mitigation, to build on the current “modest” investments made in disaster mitigation by governments at all levels (Hwacha, 2005: 521) and to provide a method to enhance the current piecemeal approach to disaster mitigation in Canada. The NDMS was also meant to foster a shared responsibility for disaster prevention amongst all levels of government, and part of the initiative included identification of disaster mitigation efforts taken at regional and local levels (Hwacha, 2005). It was suggested that the NDMS should also be linked with the DFAA, so as to incorporate disaster mitigation into relief funding. Furthermore, the need for the provision of financial incentives, and the lack of resources of local authorities to become involved in disaster mitigation was acknowledged (Hwacha, 2005).

In January 2008, a strategy document, entitled “Canada’s National Disaster Mitigation Strategy” was released by Public Safety Canada (PSC, 2008). As well, a revised set of guidelines for the DFAA were released. The strategy document sets out guidelines for a mitigation strategy at the national level. However, the NDMS does not currently represent a formal policy or arrangement.

3.4 Disaster Financial Assistance Arrangements (1970 to present)

The Disaster Financial Assistance Arrangements (DFAA) are designed to provide disaster recovery assistance to provinces who have sustained disaster damages exceeding CAD 1 per capita. Examples where the DFAA provided assistance include flooding in Alberta in 2005, the Manitoba Red River flood of 1997, and the severe wildfire season in British Columbia in 2003. As recovery costs increase for a province or territory, the federal government, through DFAA, will absorb a proportionately larger share of the costs (Table 6).

**Table 6:
DFAA Funding Shares**

Expenditures Per Capita of Provincial Population	Federal Share	Provincial Share
CAD 0 – CAD 1	0%	100%
CAD 1 – CAD 3	50%	50%
CAD 3 – CAD 5	75%	25%
CAD 5 +	90%	10%

Source: PSC, 2008a

Provinces and territories are responsible for the development and implementation of disaster recovery assistance programs, and decide when disaster payments are provided and the amount that will be provided within their jurisdictions. In the event that federal funding is approved, the DFAA provides funding directly to provinces and territories, and it is the responsibility of the province or territory to allocate DFAA funding for disaster victims and damages as they see fit. As the DFAA is an arrangement rather than a regulation or law, its use is discretionary and may not be applied in all disaster situations.

As of January 2008, the DFAA was revised to allow for a mitigation supplement of 15% of total disaster recovery payouts to be provided to provinces, aimed directly at mitigating the impacts of future hazard events. To qualify for funding, mitigation enhancements must be proposed by the province, and are subject to the approval of the federal government on a case-by-case basis. The revised program will also support “innovative recovery solutions,” which will reduce or prevent the recurrence of damages and can be incorporated or undertaken for the same costs as restoration of damaged property, plus the 15% mitigation supplement (PSC, 2008a).

4 Flood Management in the Case Study Provinces

As discussed above, the federal government in Canada has had a substantial role in the management of flooding, including the provision of funds and technical assistance for mitigation, emergency preparedness and emergency response. Despite the considerable role of the federal government in flood management, flood management in Canada falls largely under provincial jurisdiction, except for aboriginal lands and national parks (Environment Canada, 2008e; Watt, 1995). An overview of flood management approaches in the four case study provinces is provided in this section.

4.1 Overview of Flood Management in Ontario

In Ontario, a complex arrangement of flood mitigation strategies exists that involves all three levels of government. Federal and provincial ministries, Conservation Authorities and municipalities all share responsibility for flood management in the province. Both structural and non-structural flood mitigation measures are used to reduce flood damages in the province over the short and long term (Wianecki & Gazendam, 2004).

As discussed earlier, Ontario was one of the first provinces in Canada to have a progressive approach toward flood mitigation, specifically in the implementation of floodplain management (Giles, 1976). Because of Ontario's long-standing commitment to flood mapping and non-structural flood controls, land use planning that incorporates considerations of flood risk is well entrenched in the province (de Loë, 2000). For this reason, it has been argued that the province is in a good situation to maintain good flood management practices (de Loë, 2000). However, in 2004, Conservation Ontario reported that "much of the current hazard mapping is 15 or more years old, and was financed through MNR and in later years through the Flood Damage Reduction Program (FDRP)" (Conservation Ontario, 2004: 5). Thus, there are opportunities to improve flood management in the province. In particular, flood damage in the province has been trending higher.

Provincial ministries involved in flood mitigation include Natural Resources, Municipal Affairs and Housing, Environment, Energy and Infrastructure, and Community Safety and Correctional Services. There are 36 conservation authorities (mostly in southern Ontario) that govern land use decisions on a watershed basis. Municipalities in Ontario govern local decision-making, including zoning and land use in disaster prone areas (Crabbe & Robin, 2006).

The Ministry of Natural Resources, through the administration of the Conservation Authorities Act, together with the conservation authorities, has traditionally played the foremost role in floodplain management in Ontario (Kowalyk & Moin, 1986). The Ontario Disaster Relief Assistance Program (ODRAP) is administered by the Ministry of Municipal Affairs and Housing, and is the primary disaster relief assistance program for the province (MMAH, 1999). Emergency Management Ontario (EMO), an agency of the Ministry of Community Safety and Correctional Services, has primary responsibility for emergency management within the province, including emergency management legislation and regulations.

The various government ministries, agencies and programs involved in flood management in Ontario are summarized in Table 7.

**Table 7:
Provincial Agency Roles in Flood
Management in Ontario**

Ministry	Description of responsibilities
Ministry of Natural Resources (MNR)	<ul style="list-style-type: none"> ■ MNR has primary responsibility for flood management in the province ■ Manages flood hazard through both structural and non-structural measures ■ Provides an advisory capacity to MMAH and municipalities on land use matters related to flooding ■ The Surface Water Monitoring Centre exists within the MNR. The Centre: <ul style="list-style-type: none"> – Monitors water levels on lakes, rivers and streams and routinely reviews several indicators of flood potential; – Provides flood forecast messages to affected conservation authorities and municipalities, which the municipality or conservation authority will then apply to initiate a flood warning. ■ Various other initiatives, including an urban flooding committee which is reviewing the role of the Province of Ontario in increasing urban flooding vulnerability ■ Has primary responsibility for flood management in areas not under jurisdiction of Conservation Authorities
Ministry of Municipal Affairs and Housing (MMAH)	<ul style="list-style-type: none"> ■ MMAH and municipalities are chiefly responsible for land use planning in the province ■ The MMAH administers the Ontario Disaster Relief Assistance Program (ODRAP)
Emergency Management Ontario (EMO), within the Ministry of Community Safety and Correctional Services	<ul style="list-style-type: none"> ■ Leads the coordination, development and implementation of prevention, mitigation, preparedness, response and recovery strategies in the province ■ Provides information to public about disaster preparedness and emergency management
Conservation Authorities	<ul style="list-style-type: none"> ■ Unique to Ontario, conservation authorities are watershed-based management agencies that deliver services and programs that protect local natural resources in partnership with the provincial and municipal governments ■ There are 36 CAs in the province; most are located in southern Ontario ■ Over 90% of Ontario's population lives within the boundaries of a CA ■ Section 28 of the <i>Conservation Authorities Act</i> is a regulation called <i>Development, Interference with Wetlands and Alterations to Watercourses</i>, which gives CAs the mandate to regulate land use decisions accordingly

Sources: Crabbe&Robin, 2006; EMO, 2008; Kowalyk&Moin, 1986; MMAH, 2008; OMNR, 2008; Shrubsole *et al.*, 1997.

4.1.1 Floodplain Mapping: Regulatory Floodplain Standards, 1-Zone, 2-Zone and SPA

Depending on location in the province, the regulatory flood is determined by the 100-year peak flow, a regional storm (e.g., the Timmins' storm of 1961 in northern Ontario), or the highest observed flood (e.g. the peak flow of a storm with the magnitude of Hurricane Hazel in 1954 in most of southern Ontario). The Timmins Storm flood magnitude serves as regulatory standard for floodplains in northern Ontario and southeastern Ontario. The Hurricane Hazel flood magnitude serves as the regulatory standard for much of southern and southwestern Ontario. The 1 in 100 year magnitude flood serves as the regulatory standard for the remainder of southeastern Ontario (Shrubsole *et al.*, 1997).

In some communities, the two-zone approach is applied, where both a floodway and flood fringe are designated (MNR, 2008). The two-zone concept recognizes that certain areas of the floodplain are less hazardous than others and thus may be better suited to development (Kowalyk and Moin, 1986). The floodway is the portion of the floodplain, usually closest to the watercourse, where development is prohibited or restricted. Development may be permitted in the flood fringe, but is subject to appropriate floodproofing to reach the regulatory flood standard (Kowalyk&Moin, 1986).

In a one-zone flood risk area (or in the floodway in a two-zone community), the following policies are in effect (from Brown *et al.*, 1997):

- No future federal or provincial government buildings or structures that are vulnerable to flood damage will be built in the flood risk area;
- Funds from government sources, such as the Canada Mortgage and Housing Corporation are not available for new buildings or structures placed in the flood risk area and subject to flood damage;
- Any buildings or structures vulnerable to flood damage that are built in the flood risk area after designation will not be eligible for flood disaster assistance, and;
- Federal and provincial governments will encourage local municipalities to adopt Official Plan policies and zoning restrictions on development in the flood risk area.

In communities where a two-zone approach is used, the above policies apply to the floodway zone only. Development is allowed in the flood fringe provided that it is adequately protected from flood damage.

There is also a provision to identify Special Policy Areas (SPA) within a municipality. An SPA is a specific area of a floodplain that was already developed before the floodplain was identified, and where the strict compliance with provincial development policies would have undue negative social and economic effects on the community (Kowalyk & Moin, 1986; Environment Canada, 2008c). These areas may include central business districts within well established cities. The SPA designation allows for some development in the area, provided that buildings have been flood-proofed to a minimum 100-year flood level (Environment Canada, 2008c).

4.1.2 Ministry of Natural Resources

The Ministry of Natural Resources (MNR) is the provincial ministry with primary responsibility for flood management in Ontario. MNR manages flood hazards through both structural and non-structural mitigation measures (OMNR, 2008). MNR is responsible for monitoring water levels on lakes, rivers and streams in the province. The Ministry's Surface Water Monitoring Centre in Peterborough regularly reviews several indicators of flood potential, including detailed current weather conditions, weather satellites, weather radar, stream flow and levels, soil moisture conditions, snowpack information, and ice break-up potential (OMNR, 2008). More than 4,000 sensors gather and send information from approximately 1,200 stations across the province. Regular analysis of these environmental conditions provides reliable and timely information about the potential for flooding to occur, and allows MNR the opportunity to disseminate flood risk information appropriately (OMNR, 2008).

MNR uses the information gathered through monitoring activities to provide flood forecast messages to affected conservation authorities and municipalities, in order to enable them to prepare for, track and manage local flooding. The Ministry makes it clear, however, that flood forecast messages are not flood warnings. It is the responsibility of the local conservation authority or municipality to issue flood warnings to the public (OMNR, 2008).

4.1.3 Ministry of Municipal Affairs and Housing

The Ministry of Municipal Affairs and Housing (MMAH) and municipalities are responsible for land use planning in the province. MMAH is responsible for Ontario's *Planning Act*, which includes stipulations regarding restriction of development in hazard prone lands. As well, MMAH issues the Provincial Policy Statements (PPS) which serve to guide municipal planning matters (MMAH, 2005). Planning decisions made at the municipal level are required to be consistent with policies presented in the PPS, many of which relate to the management of development in flood prone areas (for example, restricting development in floodways unless it is designated as an SPA) (MMAH, 2005). MNR and Conservation Authorities act in an advisory capacity to MMAH and the municipalities on land use matters related to flooding (Kowalyk & Moin, 1986).

The Ministry of Municipal Affairs and Housing administers the Ontario Disaster Relief Assistance Program (ODRAP). ODRAP is intended to cover the costs of returning essential items to pre-disaster condition for people who have suffered damage in designated disaster areas (MMAH, 1999) (See Table 11 for a summary of ODRAP).

4.1.4 Emergency Management Ontario, Ministry of Community Safety and Correctional Services

Emergency Management Ontario (EMO) is a branch of the Ministry of Community Safety and Correctional Services. The mission of EMO is to "lead the coordination, development and implementation of prevention, mitigation, preparedness, response and recovery strategies to maximize the safety and security of Ontarians" (EMO, 2008). EMO produces fact sheets that provide recommended responses to various emergency situations. EMO offers training in emergency management to the general public and emergency management professionals.

4.1.5 Other Ministries

Additional agencies, including the Ministry of Environment (MOE) and the Ministry of Energy and Infrastructure are also involved in flood management in the province. The Ministry of the Environment has an environmental mandate, and thus is focused on environmental aspects of surface water management. One of their important roles is the management of drinking water source protection (de Loë & Berg, 2006). As well, MOE's role in provincial Environmental Assessment legislation provides opportunities for involvement in flood management (OMOE, 2008). The Ministry of Energy and Infrastructure is involved in flooding in some ways, for example, it has a role in the West Don Lands reconstruction project in Toronto, of which flood management is a major component (OMEI, 2009).

4.1.6 Conservation Authorities (CAs)

Conservation Authorities (CAs) are a form of local government based on watershed boundaries, and are unique to the province of Ontario. CAs were established under the Ontario *Conservation Authorities Act* (1946) to facilitate coordination between municipal and provincial governments and to promote a comprehensive approach to resource management on a watershed basis (Boyd, *et al.*, 2004). Over 90% of Ontario's population lives within the boundaries of a conservation authority (Boyd *et al.*, 1999), and CAs are administered under the Ministry of Natural Resources (Shrubsole *et al.*, 1997). CAs carry out several functions to mitigate flooding, including the prediction of flows and water levels in watersheds within their jurisdictions, operate flood control structures, such as dams to prevent or reduce flooding, and work with the province and municipalities to prepare emergency management procedures and integrate flood hazards into municipal planning, including the integration of flood risk mitigation into municipal Official Plans (Conservation Ontario, 2009).

The *Fill, Construction and Alteration to Waterways Regulation*, Section 28 of the *Conservation Authorities Act*, was the primary regulation by which CAs managed flood risk in the past. Section 28 gives CAs the mandate to regulate (from Kowalyk & Moin, 1986):

- The straightening, changing, diverting, or interfering in any way with the existing channel of a river, creek, stream, or watercourse;
- The construction of any building or structure in or on a pond or swamp or in any area susceptible to flooding, and;
- The placing or dumping of fill of any kind which, in the opinion of the conservation authority, might affect the control of flooding, pollution, or the conservation of land.

In May 2004, the provincial government passed a new regulation that replaced the *Fill, Construction and Alteration to Waterways Regulation* under the *Conservation Authorities Act* called *Development, Interference with Wetlands and Alterations to Watercourses*. The new regulation is considered stronger in terms of not permitting development activities that affect riverine flooding, and includes considerations for Great Lakes shoreline flooding and erosion (Boyd *et al.*, 2004).

4.2 Overview of Flood Management in Québec

As in Ontario, the management of flooding in Québec is spread across various government agencies. The majority of responsibility for flood management in the province of Québec lies within two ministries: Ministère de la Sécurité Publique (Ministry of Public Security), and Ministère du Développement durable, de l'Environnement et des Parcs (Ministry of Sustainable Development, Environment and Parks). Table 8 provides an outline of agency responsibilities for flood management in the province.

4.2.1 Ministère de la Sécurité Publique

The Ministère de la Sécurité Publique has jurisdiction for provincial emergency management, and provides public information on flood risk. This agency also provides mitigation and response education to the public (MSP, 2008). The Ministère de la Sécurité Publique monitors the levels and flow rates of waterways in the province, and provides this information to the public through interactive maps and tables on the Ministry's website. The Ministry provides information to the public about the actions citizens should take to prepare for, during and after a flood (MSP, 2008).

The Ministry also provides disaster victims in the province with financial aid through the Disaster Financial Assistance Program (DFAP). In the event of a disaster or imminent disaster within the meaning of the *Civil Protection Act*, the government of Québec may establish a financial assistance program to help restore normal conditions for individuals, businesses, municipalities and organizations that have suffered losses (MSP, 2008). Further detail on DFAP is provided in Table 11.

The Ministry provides a service called Georeference to other ministries within the provincial government. Georeference is a geographic information database tool that allows various ministries to communicate information in an interactive map format. The database is available only to registered users and not to the general public. Ministry of Public Security staff facilitates use of the database by other ministries. Information such as topography, river location and flow rates can be overlaid on the map to discern important information including flood hazards (Personal Communication, D. Fortin, Conseiller aux opérations, Ministère de la Sécurité publique du Québec, May 2008).

**Table 8:
Provincial Agency Roles in
Flood Management in Québec**

Ministry	Programs	Description
Ministère de la Sécurité Publique	Disaster preparedness and emergency management	<ul style="list-style-type: none"> ■ Provides information about what citizens should do in case of flooding (i.e. to prepare for, during, and after a flood)
	Disaster Financial Assistance Program	<ul style="list-style-type: none"> ■ DFAP provides assistance to homeowners, renters ■ Assistance may also be made available to municipalities
Ministère du Développement durable, de l'Environnement et des Parcs	Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains	<ul style="list-style-type: none"> ■ MDDEP administers the policy under the authority of s. 2.1 of the <i>Environment Quality Act</i>; ■ Municipalities apply the policy through municipal regulations; ■ This policy, rather than a provincial regulation, was adopted in order to respect the power of municipalities in making planning decisions; ■ The latest version of the policy was adopted on May 18, 2005 with the latest amendment made in June 2008
	Centre d'expertise hydrique du Québec	<ul style="list-style-type: none"> ■ MDDEP is home to CEHQ, which manages the province's water water regime with a concern for "safety, equity and sustainability" ■ Operates 250 discharge and water level stations in the province's major water streams ■ Operates some 800 public dams and monitors the enforcement of the <i>Dam Safety Act</i> pertaining to the 5,000 dams throughout the province ■ Provides support to municipalities for flood mapping
	Water level watch	<ul style="list-style-type: none"> ■ Monitors the flow rates and levels of many waterways in the province ■ Monitoring location maps and data tables are provided on the ministry's website
	Flood mapping	<ul style="list-style-type: none"> ■ In accordance with provincial planning legislation, municipal/regional governments must identify their own flood-risk areas with the help and support of MDDEP ■ From 1976 to 2004, many flood risk studies and maps were produced under the Canada-Québec FDRP ■ Mapping of flood zones is distributed by CEHQ or Geoboutique Québec ■ Local governments also possess any local flood maps that were produced by the province

Sources: MSP, 2008; MDDEP, 2008a; MDDEP, 2008b; CEHQ, 2008

4.2.2 Ministère du Développement durable, de l'Environnement et des Parcs

The Ministère du Développement durable, de l'Environnement et des Parcs administers the *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains*, which is the key provincial policy related to floodplain development and serves to guide the protection of lands adjacent to water bodies. The goals of this policy are related to both environmental protection and public safety (i.e., mitigation of flood risk), and it was created pursuant to the *Environmental Quality Act* (MDDEP, 2008a; MDDEP, 2008b). The provincial government adopted this policy rather than a provincial regulation in order to respect the power of municipalities in making planning decisions. The latest version of the policy was adopted on May 18, 2005, with the most recent amendment made in June 2008 (MDDEP, 2008a; MDDEP, 2008b).

The Ministère du Développement durable, de l'Environnement et des Parcs is home to the Centre d'expertise hydrique du Québec (CEHQ), the mandate of which is to manage the province's water regime with a concern for "safety, equity and sustainability" (CEHQ, 2008; Vescovi, Baril, Desjarlais, Musy and Roy, 2009). The Centre operates approximately 250 discharge and water level stations in the province's major water streams, operates some 800 public dams and monitors the enforcement of the *Dam Safety Act* pertaining to the 5,000 dams throughout the province. CEHQ further provides the necessary expertise in hydrology and hydraulics to support the operations of the Ministry, helps to regulate Québec's boundary waters, including the St. Lawrence River, Great Lakes and Ottawa River, and provides support to municipalities for flood mapping (CEHQ, 2008). CEHQ also provides close to real-time (every 15 minutes) monitoring of important river flows from stations throughout the province, and publishes this information on a publicly accessible website (CEHQ, 2008).

4.2.3 Other Programs and Ministries Relevant to Flood Management in Québec

The Canada-Québec Flood Damage Reduction Program agreement was in place between 1976 and 2001. Through this program, close to 500 maps were produced, which identified the 1 in 20 and 1 in 100 magnitude riverine flood levels in 245 communities. The designated areas are divided into two zones: the floodway, where new development is discouraged; and the flood fringe, where flood-proofed development is possible. Some exceptions exist however. With Ministerial approval, a "derogation" permits special projects to be undertaken within specified areas of the floodway (Environment Canada, 2008d).

Flood mapping in Québec is ongoing (CEHQ, 2008). In accordance with the *Loi sur l'aménagement et l'urbanisme* (the provincial planning legislation) each regional municipality must identify their own flood-risk areas with the help and support of the provincial government. Mapping of flood zones can be distributed by CEHQ or Geoboutique Québec. Each MRC possesses any local flood maps that were produced by the province.

4.3 Overview of Flood Management in British Columbia

The provincial government is primarily responsible for flood management in British Columbia, though some flood management and mapping activities have been recently downloaded to municipalities (Lyle & McLean, 2008; British Columbia, 2003). Four provincial ministries and several non-governmental organizations have some involvement in flood management. Of these different agencies, the Ministry of Environment and the Ministry of Public Safety are most important. The government programs that relate to flooding can be divided into two categories: Those involved with flood forecasting and flood infrastructure; and those responsible for disaster response and financial compensation. An overview of the roles of various provincial agencies in flood management in the province is provided in Table 9.

4.3.1 Ministry of Environment

The Ministry of Environment is responsible for flood forecasting and flood infrastructure safety. Under the *Emergency Program Act*, the Ministry of Environment provides flood forecasts and bulletins, flood assessment, technical services and planning staff at government operation centres in the case of floods (British Columbia, 1994). The Ministry fulfills its responsibility by operating two programs: The River Forecast Centre and the Flood Protection Program. The River Forecast Centre predicts river levels based on snow pack and river flow information that is collected by the Ministry of Environment. The River Forecast Centre maintains a relationship between the damming authorities to assist in gaining information on water levels and act as a liaison between dam owners and diking authorities (British Columbia, 2008a). One such damming authority is BC Hydro and Power Authority, which has control over significant water resources and works in concert with the provincial government to ensure that flood maps and flood response plans are updated.

Flood infrastructure is addressed most comprehensively by the Ministry of Environment's Water Stewardship Division. The Water Stewardship Division is responsible for preventing injury and loss from flooding through emergency management, dike safety and land use management (British Columbia, 2008b). The *Flood Hazard Management Program* is a program run through the Water Stewardship Division that provides local governments with technical information needed to improve floodplain development, dike management and increase flood preparedness across the province (British Columbia, 2008c).

**Table 9:
Provincial Agency Roles in Flood
Management in British Columbia**

Ministry or Organization	Divisions/Programs	Description
Ministry of Environment	Water Stewardship Division	<ul style="list-style-type: none"> Creates and houses floodplain maps and lower mainland dike inventory maps
	Flood Hazard Management Program	<ul style="list-style-type: none"> Provides local governments with technical information and training needed to improve floodplain development practices, dike management, and increase flood preparedness
	River Forecast Centre	<ul style="list-style-type: none"> Predicts river levels based on snow pack and stream-flow information Provides forecasts and warnings to provincial and local authorities
	Flood Mapping	<ul style="list-style-type: none"> The regulatory flood for maps completed under the Canada-BC FDRP (terminated in 1998) is 1:200
Ministry of Public Safety and Solicitor General	Emergency Management BC	<ul style="list-style-type: none"> Flood protection program provides some funding for floodplain mapping projects and flood protection initiatives
	Provincial Emergency Program (PEP) (Emergency Management BC)	<ul style="list-style-type: none"> Sets disaster response procedures and coordinates multi-ministry responses to flooding Provides information to local governments for an adequate response to flooding from all levels of government Administers the Flood Protection Program, which is a partnership between the federal and provincial governments, receiving funding through the Building Canada Plan. Communities can apply for assistance for flood control structures, of which they will provide 10% of the funding, and the provincial and federal governments will provide 45% each to cover remaining costs.
	Disaster Financial Assistance (DFA)	<ul style="list-style-type: none"> DFA provides financial assistance to homeowners, renters, small businesses and farms Assistance is also available to local governments
Fraser Basin Council (non-government organization)	<ul style="list-style-type: none"> The Fraser Basin Council is a non-government, not-for-profit organization that aims to advance the long term social, economic and environmental well-being of the Fraser Basin The Council acts as the primary facilitator of flood management in the Basin Conducts risk assessments and information dissemination regarding flood risk in the Basin Supports government flood management work 	

Sources: British Columbia, 2009; 2008a; 2008b; 2008c; 2008d; 2008e; 2008f; Day, 1999; FBC, 2004a,b; Lyle & McLean, 2008

4.3.2 Ministry of Public Safety

Emergency flood response and disaster recovery assistance are coordinated by the Ministry of Public Safety. This ministry houses the Provincial Emergency Program (PEP), which sets disaster response procedures and coordinates multi-ministry responses to flooding. The PEP is also responsible for providing information to local governments and local emergency management organizations to allow for adequate response to flooding from all levels of government (British Columbia, 2008d).

The Ministry of Public Safety runs the province's Disaster Financial Assistance Program (DFA). The DFA program provides coverage for uninsured losses including flood damages. The program offers coverage for 80% of the total damage that exceeds CAD 1,000 up to a maximum of CAD 300,000 (see Table 11) (British Columbia, 2008e).

4.3.3 Other Programs and Ministries Relevant to Flood Management in British Columbia

Aside from the Ministry of Public Safety and the Ministry of Environment, there are other ministries that have a peripheral involvement in flood risk management. In unincorporated areas where local government structures do not exist, the Ministry of Transportation and Highways utilizes the *Rural Subdivision Approval* process to determine if areas are flood prone and subsequently whether or not land parcels can be subdivided and developed.

The Fraser Basin Council also has an important role in flood management, and its work focuses on the most populated region in the province. The Fraser Basin Council was formed in 1997 and was based on previous management bodies in the Basin. The Council has a sustainability mandate, including environmental protection in the Basin, and it was created largely out of concern for environmental degradation within the Basin (FBC, 2004a). The Council has conducted or initiated studies on flood potential, including mapping of flood risks and understanding the use of flood-prone areas in the Basin (FBC, 2004b; 2008; Lyle & Mclean, 2008). As well, predecessors of the FBC created flood management plans, and though the FBC has no authority to implement flood management strategies, it provides assistance to governments in their flood control works (FBC, 2004b).

4.4 Overview of Flood Management in Alberta

There are two ministries that share the bulk of the responsibility for flood management in Alberta. Alberta Environment is responsible for flood forecasting and flood damage reduction (Alberta Environment, 2008), and the Ministry of Municipal Affairs is responsible for coordinating the response to flood events and providing cost recovery services (Alberta, 2009). An overview of provincial agency roles in flood management in the province is provided in Table 10.

The provincial government leads flood management efforts by collecting information on flooding and disseminating that information to local governments. The Alberta government emphasizes the role of local government and encourages municipalities to act on the information collected by the province to ensure that development and planning decisions take flood risk into consideration (Choles *et al.*, 2008).

**Table 10:
Provincial Agency roles in Flood
Management in Alberta**

Ministry	Responsibilities	Description
Alberta Environment	Flood mapping	<ul style="list-style-type: none"> ■ Alberta Environment is responsible for flood forecasting and flood damage reduction ■ Flood maps are drawn with a 1:100 regulatory flood return period ■ Within the 1:100 flood risk area there are two zones: the floodway and the flood fringe ■ The floodway is the area with the greatest risk and is defined under the hydraulic criteria of 1 m depth, 1 m/s velocity or 0.3 m water level rise, the flood fringe is the remaining area within the 1:100 area ■ As of March 2008, 46 of 66 communities in the province have been mapped for flood risk ■ Approximately 62% of Alberta's population lives in areas that have been mapped (Personal Communication, J. Choles, Alberta Environment, Nov. 2008)
	Flood Risk Map Information System	<ul style="list-style-type: none"> ■ An online Geographic Information System (GIS) database that displays all available flood risk maps for public viewing ■ Detailed information down to the street/property level based on studies completed under the Canada-Alberta Flood Damage Reduction Program ■ Accessible to the public
	River Forecast Centre	<ul style="list-style-type: none"> ■ Forecasts river levels based on precipitation and river flow data ■ Provides flood forecasts and warnings
	Water Management Operations Division	<ul style="list-style-type: none"> ■ Responsible for operating, inspecting and maintaining provincial water infrastructure including dams and dikes
Ministry of Municipal Affairs	Alberta Emergency Management Agency	<ul style="list-style-type: none"> ■ Responsible for coordinating a comprehensive, cross-government all-hazards approach to managing emergencies in the province
	Disaster Recovery Program	<ul style="list-style-type: none"> ■ DRP provides disaster financial assistance to homeowners, renters, small businesses and farms ■ Assistance is also made available to municipalities ■ A state of local emergency does not have to be declared in order to receive financial assistance under a disaster recovery program

Sources: Alberta Environment, 2008a; Alberta Environment, 2008b; Alberta, 2008; Alberta, 2009; Choles *et al.*, 2008

4.4.1 Alberta Environment

Alberta Environment oversees both non-structural and structural flood management measures. The Ministry undertakes flood forecasts for the province through the *River Forecast Centre*, which is responsible for publishing precipitation data, river flow and water quality information (Alberta Environment, 2008a). In terms of structural flood management practices, the Ministry houses the *Water Management Operations Division*, which is responsible for approximately CAD 5 billion in water management infrastructure. This division undertakes the construction and rehabilitation of water infrastructure and oversees dam safety in the province (Alberta Environment, 2008b).

4.4.2 Ministry of Municipal Affairs and Housing

Some structural aspects of flood risk management are also managed by the Ministry of Municipal Affairs and Housing (MMAH), which sets building and development standards that take flood risk into consideration. The Alberta MMAH also administers emergency management and financial compensation. Emergency planning for the province is conducted by the Alberta Emergency Management Agency, which coordinates the interministerial response to flooding and keeps records of all flood events. Once a flood event has occurred, the MMAH coordinates the Disaster Recovery Program. This program provides relief disaster events that are considered extraordinary and wide spread (Alberta Emergency Management Agency, 2008). More information on the Disaster Recovery Program is provided in Table 11.

4.5 Status of Flood Maps and Implications for Insurance

Flood mapping in Canada presents several challenges for flood insurance. Specifically, maps may pose challenges due to inconsistency related to flood return periods, age and accessibility of maps. Flood mapping in Canada has traditionally been completed for the purposes of land use planning, and may be largely identified as “hazard maps” rather than “risk maps,” which lend themselves better to flood insurance. Thus, the current state of flood maps in Canada is an obstacle for the implementation of a flood insurance program in Canada.

Inconsistency of flood return periods identified in flood maps poses a specific problem for a consistent approach to flood insurance across Canada or within provinces. Risk based insurance rates will require relatively accurate and consistent return periods, so as to allow for equal treatment of all insured homeowners within a specific region. However, as described in Table 5, return periods that have been identified through mapping differ between provinces; for example, a 1 in 100 year return period is applied in Alberta, where a 1 in 200 year return period is applied in British Columbia. As well, return periods differ within provinces in some cases. For example, the province of Ontario has historically applied three different return periods (the Hurricane Hazel, Timmins Storm and 1 in 100 year return periods) over large parts of the province (Shrubsole *et al.*, 2003).

Differing return periods create issues with consistency of risk based rates. For example, the City of London, Ontario applies its historical 1937 as its maximum regulatory flood line, which was approximately a 1 in 250 year flood. As well, a 1 in 100 year flood line is used to delineate the floodway (Hebb & Mortsch, 2007). Thus, an insurer could set risk based rates based on three different risk areas: Areas with a greater than 1 in 100 year probability of flood, areas where flood probability is between 1 in 100 year and 1 in 250 years, and areas where flood probability is lower than 1 in 250 years. However, in some jurisdictions, only one flood line has been defined (e.g., the 1 in 100 year return period), which would allow for only two gradients of risk based rates – either higher than 1 in 100 probability of flooding or lower than a 1 in 100 year probability of flooding. Thus, situations where different return periods are applied in different areas either nationally or provincially will create difficulties related to setting of risk based rates for individual insureds.

Freely available flood maps help both insurers and the public understand and address flood risk, and in most countries where flood is insured, flood maps are readily available for both the public and insurers (Crichton, 2002). However, due to the variety of agencies and levels of government that are involved in flood mapping in Canada, Canadian maps are inconsistent, often difficult to attain, and incomplete. Other countries have developed on-line tools that allow individual property owners to enter their address and receive information regarding their location in floodplains (Martini & Loat, 2007). Some agencies, such as Alberta Environment and the Grand River Conservation Authority in Ontario, have made flood maps freely available on websites (Alberta Environment, 2009; GRCA, 2009). In Alberta, online maps provide property level data and location of properties within the floodway or flood fringe. However, not every community in the province has been mapped. As well, nationally, flood map information is not freely available for all jurisdictions in all provinces. For example, in many cases in Ontario, individuals must make a specific request to their local conservation authority or a provincial agency to gain access to maps. While maps are relatively easily attained once a request has been made, the necessity of making a request stands as an additional barrier to increased public understanding of flooding and flood risk.

Consistency is a mark of the mapping programs in both the US and the UK. In the US, Flood Insurance Rate Maps (FIRMs) are developed by and available from the Federal Emergency Management Agency (FEMA, n.d.). As well, FEMA publishes the “Guidelines and Specifications for Flood Hazard Mapping Partners”, that can be used by stakeholders involved in flood mapping (FEMA, 2009; 2006; 2002). These guidelines assist in promoting accuracy and consistency across the US for flood hazard mapping (FEMA, 2006). In the US, a 1 in 100 year flood hazard area is used for the identification of property owners who should be involved in the US National Flood Insurance Program (NFIP) – a standard that must be met for a community to participate in the NFIP (FEMA, 2006). In the UK, risk based premium pricing for flood insurance has been facilitated by the mapping carried out by the UK government, and maps are provided at no cost on a centralized website (Lamond & Proverb, 2008). As well, insurers can purchase more detailed flood risk classifications from the government (Lamond & Proverb, 2008). UK flood maps use a 1 in 100 year return frequency for riverine flooding and a 1 in 200 year return frequency for coastal flooding. UK flood maps also delineate the 1 in 1000 year return period for both riverine and coastal flooding (Van Alphen & Passchier, 2007). The consistency and availability of flood maps in the US and UK better facilitate flood insurance.

Different users of flood maps require different information (Van Alphen *et al.*, 2009). For example, land use planners may require specific information on the location of flood prone areas and potential depths; emergency managers may be interested in areas with high concentrations of vulnerable individuals; and those charged with structural flood defences may be most interested in prioritizing areas with highest potential for damages and casualties. Insurers are specifically interested in flood risk in terms of probability and possible damages (van Alphen *et al.*, 2009). Sanders *et al.* (2005) argue that for insurers to accurately underwrite flood coverage, the following pieces of information are required:

- Where will flooding occur?
- How frequently will it occur?
- How much damage could result?

As supplementary to these questions, insurers would also be interested in depth and duration of flooding and the degree of flood protection (Sanders *et al.*, 2005). However, the maps used in many Canadian provinces could be considered flood extent and probability maps, rather than risk maps, which are applied for the purposes of land use planning, rather than flood insurance.

Some EU countries have produced both flood risk and flood vulnerability maps. Flood risk maps may show potential for damage in different flood risk areas, and land use practices which may be vulnerable to flooding, including industry and housing. Vulnerability maps provide an indication of the vulnerability of individuals which may be located in flood prone areas, based on characteristics such as elderly populations, and proportion of households without cars or areas that have potentially vulnerable services, such as hospitals (Van Alphen *et al.*, 2009). While risk maps may be preferable to hazard maps, Canadian insurers currently apply existing flood maps to underwrite commercial flood coverage (see Section 5.3). Commercial customers in flood hazard areas may not be offered the commercial flood endorsement, whereas commercial customers who occupy areas outside of identified flood hazard areas may be offered a flood insurance endorsement. Extent and probability maps are the most common type of map created in Europe as well, and flood risk maps that give an indication of potential damage are uncommon (van Alphen *et al.*, 2009). Thus, insurers have demonstrated the capacity to work with maps that give an indication only of location, extent and frequency of flood events, however, risk maps would be preferable.

Through discussion with various stakeholders across Canada, it has become evident to the researchers that many flood maps are likely not up-to-date, and do not reflect changes in land use and other environmental factors such as climate change. Land use changes, including urbanization, can impact flood risk. For example, increasing urbanization between 1974 and 2000 in London, Ontario resulted in significant increased peak flows in the Thames River watershed (Nirupama & Simonovic, 2007). Climate change will also affect flood risk, due to changing characteristics of precipitation patterns (Hebb & Mortsch, 2007). As well, an increasing frequency of extreme rainfall events that have resulted in flooding caused by urban overland flows and infrastructure related flooding has been observed by many stakeholders. These types of flood hazards are not identified in current flood maps, which focus primarily on flooding resulting from overflowing or spilling over of natural water bodies. Incorporation of changing flood hazards and identification of all relevant flood risk would better facilitate a viable flood insurance program.

Accurate assessment of flood risk is essential for a viable flood insurance model, and risk based premiums would be facilitated through the consistent identification of varying flood return periods in each jurisdiction. Accessibility of maps for both insurers and the public will also facilitate a flood insurance program. Risk maps, rather than hazard maps, would be preferable for flood insurance, however, countries have applied only hazard maps for flood insurance, and insurers in Canada currently underwrite commercial flood risk with available flood hazard maps. Accurate, up-dated flood maps will be a necessity for a viable flood insurance model, and it may be necessary to up-date flood maps in Canada so that they better reflect current environmental and land use situations.

5 Current Flood Damage Remittance Measures for Homeowners in Canada

There are various avenues in which homeowners may receive remittances for damages experienced from flooding. As flooding is generally not covered by insurance, governments have filled this gap with government relief programs. While flood coverage is generally excluded from insurance policies, some coverage may be available through endorsements.

5.1 Government Relief

Each of the case study provinces explored in this paper has a government disaster relief assistance program (Table 11). As private insurance is available for most other types of large disaster events (e.g., windstorms, tornadoes, urban fires, wildfire, ice storms, hurricane winds, hail, lightening, etc.), government relief programs are primarily applied for flood losses. Programs vary in each case study province, but generally contain these characteristics:

- Government relief is available only for uninsurable damages;
- Coverage is generally limited either through capping of payouts, deductibles, restriction of coverage to essential items, or by specification of a limited portion of damages that are eligible.
 - For example, caps on the maximum payout are in place in Alberta, British Columbia and Québec's programs. No cap on payouts is specified in Ontario, however, only 90% of the assessed current value of essential items (e.g., refrigerator, one television, essential furnishings) is eligible for coverage (MMAH, 1999).
 - 100% of damages are eligible for damages in Alberta, and there is no deductible, however, there is a payout cap of CAD 100,000.
- Programs are generally available only to homeowners, small businesses, farms and municipal governments.

Generally, provincial government relief is only applied in cases of widespread flooding or when multiple homes have experienced flooding. There have been cases, however, where municipal governments have provided ad-hoc assistance to individual homeowners who have experienced flood losses. Homeowners may also receive emergency disaster relief assistance from municipal governments after flood events. For example, the City of Hamilton, Ontario has discussed providing a small remittance to homeowners affected by uninsured flooding, including damages caused by sewer backup to those who have experienced cancellation of this type of coverage due to previous claims (Macintyre, 2009).

Table 11:
Summary of Cost-Sharing Programs
in Case Study Provinces

Program	Who is eligible?	What type of damage is eligible?	Maximum coverage, Deductible	Criteria for implementation	Administered by	Types of hazards eligible	Funding source	Administration of funds
Federal (DFAA)	Provincial governments	Provinces decide how best to use federal money	0% for first CAD 1 per capita of provincial expenditures; 50% for next CAD 2; 75% for next CAD 2; 90% for 5+ per capita		Public Safety Canada	All types of uninsurable losses	Federal government	Public Safety Canada provides DFAA directly to provincial governments.
Ontario (ODRAP)	Homeowners; Renters; Small businesses; Farm operations; NPO's; Municipalities	90% of the pre-disaster value of essential items of private property owners (principal residences only); Public infrastructure;	No maximum coverage specified	Disaster declaration by province; Municipal council adopts disaster resolution; Citizens may make request in areas that are unincorporated; Province balances damages against financial resources of affected municipality	Ministry of Municipal Affairs and Housing	All types of uninsurable losses	Local Disaster Relief Committee (DRC) must raise a portion of the funds; Province provides CAD 2 for every CAD 1 raised by the DRC	Municipal council must appoint a local Disaster Relief Committee of local citizens to handle claims and conduct fund-raising activities.
Alberta (DRP)	Homeowners; Renters; Small businesses; Farm operations; NPO's; Municipalities	100% of the value of pre-disaster condition of essential items	CAD 100,000 maximum coverage; No (CAD 0) deductible	Local state of emergency does not have to be declared to receive assistance	Alberta Emergency Management Agency, within Ministry of Municipal Affairs	All types of uninsurable losses	The Province of Alberta's Sustainability Fund	Each affected municipality creates a Registration Centre.
BC (DFA)	Homeowners; Renters; Small businesses; Farm operations; NPO's; Municipalities	80% of value of essential items	CAD 300,000 maximum coverage; CAD 1,000 deductible	Local state of emergency does not have to be declared to receive assistance; Does require authorization of Executive Director, PEP	Provincial Emergency Program, with Ministry of Public Safety and Solicitor General	All types of uninsurable losses	Provincial Emergency Program Recovery Office	Local government establishes an Emergency Operations Centre (EOC) with a Finance and Administration section.
Québec (DFAP)	Homeowners; Renters; Small businesses; Farm operations; NPO's; Municipalities	80% of value of essential items	CAD 100,000 maximum coverage; CAD 500 deductible	Local state of emergency is declared	Civil Protection department, within Ministry of Public Security	All types of uninsurable losses	Ministry's Civil Protection Financial Assistance Service	Municipal Organization of Civil Security (OMSC) coordinates and implements response to disaster.

Sources: Ontario Ministry of Municipal Affairs and Housing, 1999; 2008; Sécurité Publique Québec, 2003; 2008; Alberta Emergency Management Agency, 2008; BC Provincial Emergency Program, 2008; Emergency Management BC, 2007; 2008; Public Safety Canada, 2008.

5.2 Homeowner Insurance Coverage for Flooding

The insurance coverage situation for flooding in Canada is complicated and has left homeowners confused about what is and what is not covered (see Section 7.3). Further, endorsements or coverage included in comprehensive policies differ by insurance company, where some include limited coverage in their base home policy and others require an endorsement. The vast majority of insurers do not provide coverage for damages caused by overland flooding (or surface water flooding) or flooding caused by groundwater. Generally, the only type of flood damage that is covered for homeowners in Canada is damage caused by sewer backup.

Although coverage provided by insurance companies across Canada differ, for the purposes of this discussion, flood coverage as prescribed in model wordings provided by IBC are described here (IBC, 2009a,b; 2001; 1994). IBC produces two model policies; one for the Province of Quebec, and one for the rest of Canada.

The model wording for Québec, “Water Damage Endorsement: Ground Water and Sewers,” provides a model optional endorsement for damages from ground water and sewer backup (and other types of flooding caused by infrastructure). This endorsement allows coverage for (IBC, 2009a):

- sudden and accidental entrance or seepage of surface or ground water through basement walls, doors, windows or other openings therein, foundations or basement floors...
- sudden and accidental discharge, backing up or overflow of water from a building sewer, sewer, ditch, sump, septic tank, drainfield or other wastewater treatment system, retention tank or holding pond or French drain; rising of the water table.

This endorsement specifically excludes “flood,” which is defined as including “waves, tides, tidal waves, tsunamis, dam breaks and the rising or overflow of any stream of water or body [of] water, whether natural or man-made” (IBC, 2009a). The model wording “Water Damage Endorsement: Above Ground Water” (IBC, 2009b) allows coverage for “sudden and accidental entrance or seepage of rain or snow through walls or roofs and doors, windows or other similar openings therein...” and “sudden and accidental discharge, backing up or overflow of water from an eavestrough downspout or rainwater leader.”

The model IBC policy wording for the rest of Canada excludes damages caused by groundwater and overland water outright. The model policy states that damages caused by water are not eligible for insurance coverage

- unless the loss or damage resulted from...the sudden and accidental escape of water from a watermain; the sudden and accidental escape of water or steam from within a plumbing, heating, sprinkler or air conditioning system or domestic water container, which is located inside your dwelling; the sudden and accidental escape of water from a domestic water container located outside your dwelling, but such damage is not insured when the escape of water is caused by freezing; or water which enters your dwelling through an opening which has been created suddenly and accidentally by a Specified Peril other than Water Damage;
- ...But we do not insure loss or damage...caused by the backing up or escape of water from a sewer, sump or septic tank; caused by ground water or rising of the water table; caused by surface waters, unless the water escapes from a watermain or from a domestic water container located outside your dwelling (IBC, 2001).

Further, the model policy states: “You are not insured for any claim arising from evacuation resulting from...flood, meaning waves, tides, tidal waves or the rising of, the breaking out or the overflow of, any body of water, whether natural or man made” (IBC, 2009b). As an addendum to the model policy, a model wording endorsement is provided for sewer backup. The endorsement states that “we do not insure...loss or damage caused by water unless the loss or damage resulted from...the backing up or escape of water from a sewer, sump or septic tank” (IBC, 1994).

In Québec insurers who have signed agreements to use the basic IBC model wordings must offer the minimum coverage identified in the IBC basic forms. However, endorsements are not required for signatories, and Québec insurers may also offer more coverage than is stipulated in the IBC basic forms. Insurers in Québec who have not signed agreements with IBC are free to offer any coverage they chose. In the remainder of Canada, there is no obligation for any insurer to adopt the IBC model wordings. Thus, while insurance coverage varies across the country, the IBC model wordings provide a general viewpoint of the insurance industry in regard to the coverage of flood damages.

5.3 Commercial Insurance Coverage for Flooding

While homeowners cannot purchase insurance for overland flooding in Canada, commercial insurance customers may be able to purchase flood insurance from their insurers. As with homeowner insurance coverage, IBC provides model wordings for commercial coverage. There is no obligation for insurers to adopt the IBC model commercial policy wordings, and coverage provided by insurers differs. However, the model wordings provide a general perspective of the insurance industry in regard to commercial coverage for flood damages. In particular, the model wording sets out to exclude flooding and other water damage from a basic insurance policy, then offer coverage as an endorsement that may have an additional fee, and may be offered only in certain circumstances.

The IBC Commercial Property Policy Wording “Commercial Property – Broad Form” provides a model policy wording for commercial property, including building, equipment, stock contents, and all property coverage (IBC, 2008b). The model policy excludes flood perils and states:

This form does not insure against loss or damaged caused directly or indirectly...in whole or in part by flood, including “surface water”, waves, tides, tidal waves, tsunamis, or the breaking out or overflow of any natural or artificial body of water...by seepage, leakage or influx of water derived from natural sources through basement walls, doors, windows or other openings, foundations, basement floors, sidewalks, or sidewalk lights...by the backing up or overflow of water from sewers, sumps, septic tanks or drains, wherever located... (pg. 7).

IBC, however, has created model endorsement wordings for both flooding and sewer backup for commercial property (IBC, 2007a,b). The flood endorsement provides coverage for flooding, defined as “the breaking out or overflow of any natural or artificial body of water and includes “surface water”, waves, tides, tidal waves and tsunamis.” The flood endorsement excludes coverage for sewer backup and groundwater (IBC, 2007a). The sewer backup endorsement, however, provides coverage for “the backing up or overflow of water from within sewers, sumps, septic tanks or drains located inside buildings” (IBC, 2007b).

As an example of application of commercial flood insurance in Canada, senior representatives from two large insurers who insure commercial property in Canada were contacted. Both insurers indicated that flood coverage was excluded from all perils policies, and is offered only as an endorsement. The insurers indicated that commercial flood insurance is heavily underwritten, and that the endorsement is offered only if there is little known flood risk for a particular client.

Both insurers indicated that government flood maps, when available, are used or may be used in underwriting flood coverage for commercial customers across the country. However, one insurer indicated that they relied more on local branch knowledge of past flood events than on government flood maps to underwrite commercial flood coverage. The other insurer, however, indicated that they placed confidence in government flood maps. The insurer indicated that the company did produce their own flood maps based on government elevation data to adjust government flood maps in cases where flooding has occurred outside of areas identified in government flood maps. However, the insurer indicated that government flood maps are rarely adjusted, and that the company generally relies on the government flood maps to underwrite flood coverage.

Both representatives indicated that commercial clients have a good understanding of flood coverage, and because of the heavy underwriting, commercial flood insurance is not a large loss problem, and it is relatively rare to receive a flood claim. One insurer indicated that, in fact, they have only experienced one commercial flood claim in the past 10 years. Further, an insurer indicated that the vast majority of commercial customers do not purchase the flood endorsement, and it is mostly large commercial companies that purchase the endorsement.

While flood insurance is available to commercial insureds in Canada, it is generally offered through an endorsement and high risk customers are not offered coverage.

6 Overview of International Approaches to Flood Insurance

Most Western nations, including the majority of members of the G8, have residential flood insurance programs. Countries including Australia, the United States, Germany, Italy, Japan, Switzerland, France, Spain and the United Kingdom have all instituted insurance programs for flood, though the specifics of each program differ (Paklina, 2003; Swiss Re, 1998). The characteristics of flood insurance programs determine the penetration of this type of insurance, and the prices charged to insureds.

Generally, international insurance models can be placed under four categories: public and bundled (e.g., Spain and France), public and optional (e.g., United States), private and bundled (e.g., United Kingdom and Switzerland), and private and optional (e.g., Germany). This section provides a brief review of some flood insurance approaches that have been adopted in other countries. Before a review of international approaches to flood insurance is provided, the necessary conditions for an insurable peril are discussed, with a focus on optional versus bundled flood insurance coverage.

6.1 What is required for insurance to be in place?

Hausmann (1998) identifies six conditions that must be in place for a peril to be insured, summarized in Table 12.

Table 12:
**Necessary Conditions for a Peril
to be Insured**

Condition	Description
Mutuality	A large number of people must combine to form a risk community
Need	There must be a need for insurance cover when the anticipated event occurs
Assessability	The peril must be assessable in terms of possible losses
Randomness	The event must be independent of the will of the insured, and the time at which the insured event occurs must not be predictable
Economic viability	The risk community must be able to cover flood-loss financial needs
Similarity of threat	The risk community must be exposed to the same threat and the occurrence of anticipated damages must result in the need for funds in the same way for each member of the community.

Source: Hausmann, 1998: 7

Most of the conditions are met for flood insurance so it is not a surprise that flood insurance for homes is available in many countries. A need for coverage of flood damage exists, as flooding often results in serious damages. Randomness is present to a certain extent, however, some flood losses occur very frequently and thus may not be considered as random. Less frequent floods, especially those occurring in undefined flood areas (urban flooding, flooding caused by extreme rainfall, and so on) are less predictable, and may be considered more random. It is clear that flood coverage should not be sought only when a flood is predicted, as this completely eliminates the condition of randomness (Hausmann, 1998). Structural adjustments and changes to channels and streams must be accounted for in flood assessments, as they can alter stream flows and flood levels in foreseeable ways. Environmental changes must also be accounted for, as these factors alter flooding in possibly predictable ways. For example, it has been shown that, as watersheds are urbanized, flood risk can increase (Nirupama & Simonovic, 2007). Insurers must track such changes and ensure that they are factored into insurance pricing and availability (Hausmann, 1998). Thus, if those who have a predictable, frequent exposure to flooding are excluded from coverage, and environmental and structural changes to watercourses are accounted for, the condition of randomness can be met.

Similarity of threat also exists to a certain extent. As policy holders may be exposed to one or several of many different types of flooding (see Table 1), similarity of threat is somewhat limited. However, as the common cause of damages is water, damages are similar in each case, thus, similarity of threat is largely present (Hausmann, 1998).

The frequent occurrence of relatively small-scale flooding allows for statistical assessment of flood magnitude and frequency. However, large-scale flood events are more difficult to assess, and thus reduce the assessability of flood loss. However, catastrophe scenarios can be applied to provide an indication of flood risk (e.g., PML scenarios) and despite some uncertainty, can provide useful risk assessment results (Hausmann, 1998). As well, as with other insured perils such as wind and earthquake, modeling methods do exist to estimate losses associated with large scale flood events.

Mutuality is a challenge for flood insurance, as only a limited population may be formally defined as exposed to flood (Hausmann, 1998). If only those who are exposed to flooding are insured, only a small insurance community would exist, which would be too small to compensate for possible flood losses. Hausmann (1998) argues that this is likely the most important reason why flood insurance is not available in some countries. This concern is most often resolved through bundling of coverage.

Economic viability is another potential challenge for the insurability of flood. Economic viability is threatened when extremely large loss events affect an area with a large concentration of policy holders. If there is only a limited number of policy holders (i.e., a small insurance community) on which to draw (due to limited mutuality), a large loss event can overwhelm the capacity of the small insurance community, and that community will not be able to compensate for losses (Hausmann, 1998). In these cases, if only those at risk are insured, premiums would have to be extremely high to cover potential flood losses, thus rendering the insurance model economically unachievable. Reinsurance, however, can play a role in reducing risks associated with limited economic viability.

Mutuality and economic viability are directly related to the problem of adverse-selection. Adverse-selection occurs when flood insurance is demanded only in areas that have a high occurrence of flooding. Thus, if coverage is available, adverse-selection leads to a situation where coverage is too expensive for homeowners to purchase (Paklina, 2003). However, the problems of mutuality, economic viability and adverse-selection can be overcome through the application of bundled flood insurance coverage.

6.1.1 Optional vs Bundled Flood Insurance Coverage

There are two approaches to offering flood insurance: The option system and the bundle system. Under the option system, insurers offer flood insurance upon payment of an additional premium. This system can be found in Belgium, the United States, Germany and Italy (Crichton, 2007; 2008; Swiss Re, 1998). In the bundle system, flood insurance is made available as part of a “bundle” where flood is included along with other perils, such as fire and theft. This system is used in the UK, Japan, France, Portugal, Israel and Spain (Crichton, 2002; 2008; Paklina, 2003).

One of the primary problems with the optional flood coverage approach is adverse-selection. Adverse-selection occurs in situations where flood insurance is offered as an option on insurance policies, because insurers may “select against” home owners by making the policy available only in areas considered to be safe, and homeowners may “select against” insurers by buying the policy only in areas they consider prone to flooding (Crichton, 2008). Adverse-selection results in reduced economic viability for flood coverage, as the risk community on which to draw is too small to cover flood losses (Crichton, 2008). The result is that flood insurance, when it is available, is very expensive and has a low market penetration. This has been observed in many cases, most notably the National Flood Insurance Program in the US (Anderson, 2000; Burby, 2001; Paklina, 2003).

A paper released by the Organization for Economic Co-operation and Development in 2003 argued for bundled flood insurance over optional coverage. The study reviewed international flood insurance approaches following severe flooding in Europe in 2002, and revealed that countries where bundled flood insurance was in place, including Israel, Japan, Portugal, Spain, Switzerland and the UK, had very high flood insurance penetration rates (Paklina, 2003). This is compared to countries with optional flood insurance coverage, including Austria, Belgium, Germany and Italy where insurance penetration was very low (under 10%) (Paklina, 2003).

The bundled system allows insurers to spread out flood risk over time, across perils and across rating areas (Crichton, 2008). As homeowners who live in areas that are at relatively low risk of flooding will have to purchase flood insurance, a very large insurance community can be created as market penetration will be high, thereby overcoming the problems of mutuality and economic viability.

If risk based insurance coverage is provided, a bundled insurance program can be equitable as those with a lower risk of flood will pay less for flood coverage, whereas those with a higher risk of flood will pay higher prices. Further, under some flooding scenarios, for example extreme rainfall, practically any homeowner can experience flooding, despite their location within or outside of identified floodplains or coastal flood risk areas. Thus, though some cross-subsidization may be required under the proposed insurance model, every homeowner who purchases flood insurance has the potential to benefit from flood coverage.

6.2 United States: National Flood Insurance Program (Public and Optional)

The National Flood Insurance Program (NFIP) is the federal flood insurance program in the United States. Administered through the Federal Insurance Administration (a subsidiary of the Federal Emergency Management Agency or FEMA), the NFIP is a cooperative effort between private insurance companies and the US federal government (Barnett, 1999; Burby, 2001; Pasterick, 1998). The *National Flood Insurance Act* was passed into law in August 1968, on the recommendations contained in studies conducted by two independent federal task forces in 1966. The recommendations were based on the theory that limiting development in flood prone areas and requiring homeowners to purchase flood insurance at actuarial rates would discourage flood vulnerable development (Burby, 2001). Three key objectives of the NFIP include the identification of flood hazard areas and flood risk, mitigation of flood risk through local management of floodplain development, and spread of risk through insurance (Burby, 2001).

The National Flood Insurance Program (NFIP) was undertaken as, and remains, a cooperative venture of all three levels of government and the private insurance industry (Burby, 2001) (See Table 13). The federal government, through FEMA is responsible for setting flood insurance premium rates, identifying flood zones and risk in those areas, and sets the standard for construction in floodplains. State governments oversee regulations set by local governments for development in the floodplain. Local governments must adopt development regulations that meet NFIP standards. Private insurers sell the flood insurance policies on behalf of the government, but do not hold the risk.

FEMA has also developed disaster mitigation programs to support the NFIP, including the Flood Mitigation Assistance (FMA), the Repetitive Flood Claims (RFC), and the Severe Repetitive Loss (SRL) programs (FEMA, 2007). The FMA is designed to promote mitigation measures that reduce or remove long term flood risk to structures insured under the NFIP (FEMA, 2007). Payouts for properties that have sustained repetitive flood damages from 1978 to 2004 were estimated at USD 4.6 billion, thus the two latter programs are designed to target such properties specifically (FEMA, 2007; Walker, 2006).

**Table 13:
Roles/Responsibilities of Each Player
in the NFIP**

Player	Role of Player	
Government	Federal	<ul style="list-style-type: none"> ■ The NFIP is managed under the Federal Emergency Management Agency ■ Identifies flood risk zones ■ Sets flood insurance premium rates ■ Sets standards for construction in floodplains ■ Provides financial backstop – funds can be taken from National Treasury if necessary ■ Operates disaster mitigation grant programs to assist the NFIP, including the Flood Mitigation Assistance (FMA), Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) programs. Eligibility for these programs depends on participation in NFIP. ■ Assumes all financial liability for NFIP
	State	<ul style="list-style-type: none"> ■ Jurisdiction over local governments for land use decisions in floodplains
	Local	<ul style="list-style-type: none"> ■ Local governments choose to participate in the NFIP (must adopt a resolution to participate) ■ Local governments have statutory authority to regulate and enforce floodplain regulations. ■ Responsibilities of local government include <ul style="list-style-type: none"> – Issuing or denying floodplain development permits; – Inspecting development to ensure compliance with building regulations – Maintenance of a record of floodplain development – Provides residents with information of flood hazards, flood maps, flood insurance and construction methods ■ Local governments also participate in flood map revision processes ■ Communities must adopt flood management regulations to participate in the NFIP ■ Communities apply FIRMs to regulate development
Insurance Industry	<ul style="list-style-type: none"> ■ Sell insurance ■ Collect premiums 	
Private Individual	<ul style="list-style-type: none"> ■ Purchases insurance, or chooses to purchase insurance ■ Responsible for losses that exceed insurance coverage (USD 250,000) 	

Sources: Burby, 2001; FEMA, 2007; FEMA, 2009; GAO, 2007

For homeowners to be eligible for the NFIP, the communities in which they live must be approved for the program. Approval requires that the community have occupants in an area subject to a 1 in 100 year flood (Barnett, 1999; Carolan, 2007). Flood Insurance Rate Maps (FIRMs) are used to set insurance premiums and are used to identify eligible communities (Burby, 2001). Maps are also used by communities to regulate floodplain development, and are used by lending institutions to identify where flood insurance will be mandatory for mortgage holders (FEMA, 2009).

Approximately 20,300 communities in the US participated in the NFIP by 2007 (GAO, 2007). Flood management measures applied at the local level generally include zoning, subdivision, or building requirements, and special-purpose floodplain ordinances (Blanchard-Boehm, 2001). Floodplain management requirements within the 1 in 100 year flood risk area, referred to as the Special Flood Hazard Area (SFHA), are designed to prevent new development from increasing the flood threat and to protect new and existing buildings from anticipated flood events (Blanchard-Boehm, 2001). Flood management policies in the US have typically allowed for some non-residential development in the floodplain, provided that it will not increase flood risk and meets flood proofing standards (Brown *et al.*, 1997).

Insurance is offered to flood-prone homeowners on the principle that by purchasing insurance they are taking some responsibility for their own risk, rather than relying completely on structural flood mitigation measures and public relief programs (Blanchard-Boehm *et al.*, 2001; Chivers & Flores, 2002; Krutilla, 1966; Kunreuther, 1985). Homeowners who occupy the SFHA and who have mortgages from federally regulated lenders must purchase flood insurance, at a minimum, for the amount of their outstanding mortgage debt. For those who do not occupy the SFHA, flood insurance can be purchased as an optional coverage. Additional insurance can also be purchased to cover contents (GAO, 2007; Walker, 2006). Flood insurance policies cover direct damages from a range of flood types, including losses caused by erosion and mudslides (Burby, 2001).

The average flood insurance policy costs USD 475 per year (GAO, 2007), and coverage for residential buildings is limited to USD 250,000 (Burby, 2001; Paklina, 2003). Premiums vary on the flood protection buildings are provided (elevation) and date of construction, as well as type of hazard to which the property is exposed, and deductibles may be chosen by the insured (Burby, 2001; FEMA, nd). After October 1, 2009 minimum deductibles were raised from USD 500 to USD 1,000 for pre-FIRM and USD 2,000 for post-FIRM structures (Nebraska, 2009).

Structures built in floodplains before they were identified through FIRMs were allowed to receive subsidized insurance premiums (these are referred to as Pre-FIRM structures). This practice was applied because insurance rates would likely be prohibitive for such buildings, and to encourage communities to participate in the program (GAO, 2007). In April 2007, there were 5.4 million property owners insured under the NFIP (GAO, 2007; Walker, 2006).

The NFIP is an example of a public and optional flood insurance system. Although private insurers are directly involved in the program through selling the coverage and handling premiums, rates are set by the federal government and the program is back-stopped by the federal government when NFIP funds are exhausted after large flood events. For example, the NFIP received funding through the National Treasury after the devastating losses caused by Hurricane Katrina (Crichton, 2008).

It has been reported that, due to the nature of the NFIP, it is not able to handle large loss events. The US Government Accountability Office stated:

The NFIP, by design, is not actuarially sound because Congress authorized subsidized insurance rates to be made available for policies covering certain structures to encourage communities to join the program and premiums are based on the average historical loss year, therefore the NFIP does not build sufficient reserves to cover losses that exceed the historic averages (GAO, 2007: 9).

Homes that were built in SFHA areas before they were identified by FIRMs may be provided insurance at subsidized rates, which may be as low as 35–40% of the true risk premium (Walker, 2006). The premium income generated by the NFIP is roughly USD 2 billion per year, and in most cases, this amount has been adequate to cover its operating expenses (GAO, 2007). However, it has been reported that the program has had routine shortfalls in revenue, including a shortfall of USD 750 million in 2006 due to subsidized premiums (Walker, 2006). The NFIP was heavily burdened by the 2005 hurricane season, especially damages caused by Hurricane Katrina, and the program was forced to borrow as much as USD 20.8 billion from the national treasury in 2006. In May 2007, the NFIP debt to the national treasury was USD 17.5 billion (GAO, 2007).

The task of mapping flood hazard areas and flood risk, and keeping these maps updated to changing local conditions, is a major responsibility. Accuracy of these maps is a crucial element in determining the success of the insurance program (Burby, 2001; Carolan, 2007). As well, it has been discussed that, in order to increase uptake of the program by requiring property owners located outside of the SFHA to purchase insurance through the NFIP, maps that more accurately identify flood risk will be needed (Walker, 2006).

It can be argued that the most significantly detrimental issues of the NFIP are that coverage is optional and that communities must have within their jurisdiction areas that are prone to the 1 in 100 year flood risk to be eligible for the program. This situation leads to inherent adverse-selection, as only those who are exposed to a high risk of flooding are required to buy insurance, and insurance is optional for those with a lower risk. Thus, premiums for each insured in the SFHA are extremely high, and the insurance community from which to draw for large loss events is small. This situation has led to a lack of economic viability, and thus, insurance premiums are frequently subsidized by the government and funds must be borrowed from the Federal Treasury during large loss events.

It can be seen that some of the greatest challenges facing the NFIP are related to mutuality (only those in the SFHA are required to purchase insurance), economic viability (and thus, adverse-selection), and assessability (reflected in the need for improved assessment to increase uptake of the program). These are the conditions identified by Hausmann (1998) as being the greatest challenges to overcome when implementing flood insurance.

6.3 France (Public and Bundled)

In 1982, the French Parliament passed a law that established the Cat.Nat. system – France’s natural disaster insurance system. This law was spurred by significant flooding experienced the previous year in various parts of the country after which assistance provided to victims was poor, and aimed to provide rapid compensation to those affected by natural hazards and promote mitigation and prevention strategies across the country (Michel-Kerjan, 2001; Parisi, 2002). The Cat.Nat. approach combines both private insurance with a government backstop, the Caisse Centrale de Réassurance – a public reinsurer (Paklina, 2003). The Cat.Nat. system applies a bundle approach where natural hazard insurance, which includes flooding, landslides, earthquakes, and other perils difficult to insure, is combined with standard auto, home and business insurance (Paklina, 2003; Parisi, 2002).

An important institutional feature of the system is the existence of a publicly owned reinsurance company, the Caisse Centrale de Réassurance (CCR), which makes natural disaster insurance more feasible for primary insurers. To reduce insurance company solvency fears, private insurers were allowed to purchase reinsurance from the CCR for natural disasters (Michel-Kerjam, 2001). Reinsurance under the CCR is not obligatory, and primary insurers may deal with private reinsurers if they so choose. However, due to guaranteed coverage and relatively low premiums, reinsurance through the CCR is appealing to most primary insurers (de Marcellis-Warin & Michel-Kerjan, 2001; Jametti & von Ungern-Sternberg, 2009).

In France, there also exists a “storm guarantee” for individual properties, in which damages caused by less severe natural events (e.g., hail, frost, wind) are automatically covered through the private insurance industry. Private insurers do not purchase reinsurance for these types of damages through the CCR, and these damages fall outside of the Cat. Nat. system (de Marcellis-Warin & Michel-Kerjan, 2001; Michel-Kerjan, 2001).

Cat.Nat. payouts are only provided during a natural disaster, and payouts for natural disasters are not automatic. A “state of natural catastrophe” must be declared by the Interior Ministry after a disaster, and then each individual mayor must apply for their community to be identified as being in a “state of natural catastrophe” to receive catastrophe assistance (Jametti & von Ungern-Sternberg, 2009; Michel-Kerjan, 2001). A commission comprised of various government departments reviews the mayoral requests, and may either accept or refuse the request. If the request is accepted, it is then up to individual households to make a claim under the Cat.Nat. system within a limited time-period following the approval (Michel-Kerjan, 2001).

There is no risk differentiation in insurance rates, and the premium rate for natural disaster coverage is set by the government and is consistent throughout France (de Marcellis-Warin & Michel-Kerjan, 2001; Parisi, 2002). Cat.Nat. premiums consist of an extra charge on top of existing premiums, and are set as a portion of property insurance premiums and paid to the primary insurers (Michel-Kerjan, 2001). The original portion was set in 1982 at 5.5% of the premium charge for typical insured perils (e.g., fire, explosion) (Jametti & von Ungern-Sternberg, 2009; Parisi, 2002). In 1983 this rate was increased to 9%, and again in 1999 to 12% to reduce the rate of cession to the CCR (Jametti & von Ungern-Sternberg, 2009).

At the inception of the Cat.Nat. system, private insurers were offered cession rates of 40%–90% by the CCR, and there was a very high rate of cession to the CCR – 85% – during the period 1982–1983. The maximum cession rate available to an insurer was reduced to 60% in 1997 to limit the vulnerability of the CCR (Michel-Kerjan, 2001). The rate of insurers ceding business to the CCR dropped to 43% in the period 1988–1999, and it has been argued that the current 12% extra charge has helped the primary insurance industry cover losses themselves without ceding to the CCR (Michel-Kerjan, 2001).

Floodplain maps in France identify three risk zones (Parisi, 2002):

- High Risk (Red Zone);
- Moderate Risk (Orange Zone), and;
- Low Risk (Yellow Zone).

Insurers may refuse insurance coverage for buildings that occupy the highest risk zones, and may require mitigation plans to insure those occupying moderate risk zones. The Cat.Nat. guarantee, however, is extended for those who occupy low risk zones (Michel-Kerjan, 2001). A counterpart of the 1982 law that created the Cat.Nat. system was the development of requirements for local-level risk prevention plans (PPR), which included identification of risk zones (Michel-Kerjan, 2001). However, there has been local-level resistance to risk identification studies, and many local authorities have not adopted risk mitigation plans (Michel-Kerjan, 2001; Morand-Deville, 2008). Implementation of such plans has been enforced more strictly, and a certain flexibility has been allowed regarding building restrictions on hazard lands to ease compliance for local authorities (Morand-Deville, 2008). Expropriation of buildings (building acquisition) may also be applied to reduce risk caused by vulnerable construction, and acquisition is financed through the insurance system (Morand-Deville, 2008).

Deductibles are applied under the natural disaster insurance system, and as of 2001 were:

- USD 380 for property for domestic use, vehicles and other non-professional property;
- For property that is used professionally, the deductible is 10% of the property damage caused by the event, with a minimum deductible of USD 1,150;
- Deductibles for business interruption were equal to three working days at a minimum of USD 1,150 (Michel-Kerjan, 2001).

A sliding scale was introduced in 2001 to vary deductibles to encourage loss prevention measures, and applies to those districts that do not yet have a PPR. When a declared disaster occurs in a particular community, the deductible is increased depending on how many other declarations have been granted for the same peril in the past. One or two disaster declaration(s) results in normal application of deductible; three declarations results in the doubling of the deductible, four declarations results in a tripling, and five results in a quadrupling (Michel-Kerjan, 2001). The sliding scale is discontinued as soon as the hazard mitigation plan is adopted.

The French system of natural disaster insurance has been considered a successful public-private partnership, and some have argued that it may be a good example for altering existing insurance structures to allow for a broader coverage of natural hazards (Jametti & von Ungern-Sternberg, 2006). Indeed, the bundled nature of the program serves to counteract the non-mutual nature of flood risk, and thus this program is not prone to adverse selection. However, there are some criticisms of the French Cat.Nat. system.

Government prescribed rates are a drawback of the Cat.Nat. system. Risk based insurance is preferred to insurance with uniform pricing and deductibles, as it can serve to promote mitigative behaviour and deter risky behaviour by policy holders. Charging the same rate across the country also leads to a situation where those who have no or little risk of sustaining damages are heavily subsidizing those who have a high risk of sustaining damages. Though varying deductible rates are applied, they may be too low to encourage risk-reducing behaviour (Michel-Kerjan, 2001).

It has been argued that low reinsurance rates and guarantees of payouts have increased the rate of cession from primary insurers, and thus have increased burden on the CCR (de Marcellis-Warin & Michel-Kerjan, 2001). Dwindling reserves resulted in substantial changes to reinsurance conditions in the past, including increased retention rates for insurers and increases in premium rates for buildings (e.g., the 1999 increase from 9% to 12%) (Jametti & von Ungern-Sternberg, 2009; Morand-Deville, 2008). The CCR was stressed when floods and storms in 1999 resulted in a triggering of the state guarantee for the CCR, as reserves were wiped out due to high rates of cession (Michel-Kerjan, 2001). The CCR system has required substantial reinvestment in the past, and it has been argued that it will need such reinvestment again in the future (Jametti & von Ungern-Sternberg, 2009).

It has also been argued that the structure of the CCR system has allowed a considerable amount of "risk selection," where private insurers who focus on insuring relatively low risk areas choose only to purchase a low amount of reinsurance from the CCR, and others that focus on insuring high risk areas and purchase a larger amount of reinsurance coverage (Jametti & von Ungern-Sternberg, 2009). This situation also places stress on the CCR.

6.4 Germany (Private and Optional)

In Germany, natural hazards insurance has been offered by private insurance companies as an optional supplement to building and contents insurance since 1991. This supplemental policy is voluntary for property owners and covers losses due to flooding and heavy rainfall, as well as earthquake, land subsidence, avalanche and snow loading. Property damage caused by wind and fire is covered by standard building and contents insurance policies. Storm surge is considered an uninsurable risk and excluded from supplemental policies but sewer and stormwater backup coverage is offered by most insurance companies (Thieken *et al.*, 2006).

The market penetration of standard building insurance is high (estimated by the German Insurance Association to be approximately 90%), as banks generally require it to secure loans (Schwarze & Wagner, 2004). The penetration of supplemental hazards insurance is generally much lower throughout Germany (estimated by the German Insurance Association to be approximately 20% in 2008), although areas in which flood insurance was previously included in policies (in Baden-Wuerttemberg and the former German Democratic Republic) have retained a higher rate of penetration (Thieken *et al.*, 2006; GDV, 2008). German insurers purchase reinsurance on the international market.

A national system of flood hazard mapping does not exist in Germany, so an inundation zoning system known as ZÜRS was created for insurance purposes in 2001. ZÜRS software identifies the flood hazard areas of all significant bodies of water and evaluates the risk of flooding for 90% of all properties in Germany. ZÜRS is based on four hazard zones, shown in Table 14. ZÜRS is managed by the German Insurance Association (GDV) and has been updated from the original 3-zone system as it was originally created.

Table 14:
ZÜRS flood hazard zones

Zone	Hazard	Average statistical flood return period	Current insurability
I	Very low	>200 years	Insurable
II	Low	50–200 years	Insurable provided that enough accumulation cover exists and some mitigation action has been taken by owner
III	Moderate	10–50 years	Insurable provided that enough accumulation cover exists and some mitigation action has been taken by owner
IV	High	<10 years	Uninsurable

Source: Thieken *et al.*, 2006 adapted from Kron, 2003

The August 2002 flooding of the Elbe River at Dresden was the single most expensive flood in German history, with economic losses estimated at €11.6 billion (USD 18.6 billion). While 45% of the losses were sustained in the private sector, only €1.8 billion of this damage was covered by private insurance (Thieken *et al.*, 2006). The flood forced a widespread re-evaluation of the state of flood insurance in Germany, which included a consideration to introduce mandatory natural hazard insurance. The proposal was finally rejected in 2004 (Schwarze & Wagner, 2007) but several other initiatives were pursued.

The German Parliament passed legislation in 2004 that prohibits development on flood prone land. More than 16% of the land adjacent to rivers in Germany is heavily developed (Schwarze & Wagner, 2007). It is estimated that 10% of the land area in Germany is not feasibly insurable (Schwarze & Wagner, 2004). According to the GDV, only 1.5 percent of buildings are uninsurable, however some of these buildings have found an insurance solution by paying higher deductibles or by adopting specific mitigation measures (GDV, 2009).

Insurers in Germany have taken a more cautious approach since the Dresden flood of 2002. Before the flood, premiums were based on maximum flood-related losses of €2.5 billion, whereas after the flood the total is €10 to €15 billion. Flood damages were based on an observation period of 100 years before 2002; after the flood the period is 200 to 300 years (Schwarze & Wagner, 2004).

The deductible for flood-related damages is generally between 1% of the sum insured and 10% of the damage sustained. Premiums for flood insurance provided by one German insurance company, for example, range from €49 to €244 per year depending on the location of the building and previous flood claims (Schwarze & Wagner, 2007).

6.5 United Kingdom (Private and Bundled)

In the UK, a bundle system for flood insurance is applied where flood insurance is available as part of standard or general home insurance policies, and flood insurance is generally included in contents and buildings policies (Lamond & Proverb, 2008). Private insurers, in turn, purchase reinsurance on the international market. While insurance is not compulsory in the UK, building coverage is generally mandatory when homes are financed under a mortgage (Lamond & Proverb, 2008). Under this bundle system, most types of flood risk are covered by flood insurance, and the vast majority of households are covered for flood damages (Paklina, 2003). Approximately 2.2 million homes (10% of the total number of homes in the UK) are at risk from coastal or inland flooding. Approximately 330,000 homes are located in an area with a risk of flooding greater than a 1 in 75 year probability (ABI, 2005).

In 1961, a "Gentleman's Agreement" was established between insurers (now represented by the Association of British Insurers or ABI) and the UK government to loosely define each party's responsibilities in the partnership (Huber, 2004; Lamond & Proverb, 2008). At that time, natural perils, including flood, were bundled with fire in insurance policies, and insurers would not refuse flood coverage for any residential property, regardless of flood risk (Crichton, 2002).

The original agreement set between the UK government and the insurance industry in 1961 guaranteed flood coverage for all residential properties. However, a review of the state of structural flood control measures in some parts of the UK resulted in reluctance of some insurance to continue writing flood coverage in some areas. In 2002 the agreement was altered to restrict guaranteed coverage for those who occupy the 1 in 75 year flood risk areas (Huber, 2004; Crichton, 2002; 2005).

The pricing of policies is differentiated to reflect risk, such that homeowners with a higher flood risk are charged more and those with lower risk pay less. The deductible on the policy however is small, in the range of £50. Deductibles may be higher in cases where insurers have chosen to insure properties with a significant flood risk (Crichton, 2007). Application of excesses are also a means by which insurers account for flood risk for insured properties (Crichton, 2007; Huber *et al.*, 2004; Lamond *et al.*, 2007). A high market penetration of flood insurance, insurance management and investment practices, as well as exclusion of very high risk properties have led to relatively affordable premiums. Premiums have not increased over the past few years, with an average increase of less than 10% over the period 2000–2004. In the years 2003–2004, the average insurance premium for building and contents in the UK, which included coverage for flood, was less than £350 (Crichton, 2007).

The government has an important role to play in making flood insurance feasible in the UK. The three main responsibilities of the government are guaranteeing quality flood maps, adequate flood defence, and effective land use.

The Planning Policy Statement 25: Development and Flood Risk is the most directly relevant policy for land use planning specifically at the regional and local government levels (Communities and Local Government, 2006). The Policy Statement states that

the aims of [the policy] are to ensure that flood risk is taken into account at all states in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of highest risk (Communities and Local Government, 2006: 2).

It is important to note that the UK government does not have statutory authority to manage development in flood-prone areas, and responsibilities passed down to regional and local governments are permissive (Communities and Local Government, 2006). The Policy Statement, however, outlines specific roles of all levels of government and government departments in planning for flood management, as well as the importance of incorporating the concerns of the insurance industry in land use planning decisions that are affected by flooding.

Through the Policy Statement, regional and local governments need to develop strategies to appraise flood risk (e.g., identify riverine/coastal flood risk areas) and prepare relevant documents outlining flood risk, manage flood risk through the development of policies to manage development in identified flood risk zones. Flood zones are identified under three classifications, outlined in Table 15.

Table 15:
UK Flood Zones

Zone	Classification	Return Period/Flood Probability
1	Low probability	Lands that have less than a 1 in 1000 year flood probability (<0.1%)
2	Medium probability	Lands having between a 1 in 100 year and 1 in 1000 year probability of riverine flooding (1%–0.1%) or Lands that have between a 1 in 200 and 1 in 1000 year probability of sea flooding (0.5%–0.1%)
3a	High probability	Lands have a greater than 1 in 100 year probability of riverine flooding (1%) or Lands that have a greater than 1 in 200 year probability of sea flooding (0.5%)
3b	The functional floodplain	Lands where water flows or must be stored during a flood. These lands may have a flood probability greater than 1 in 20 years (5%), or may be designed to convey water during an extreme flood event (e.g., a 1 in 1000 year flood). Local governments may work with higher levels of government to identify these areas.

Source: Communities and Local Government, 2006

Under the policy, development should be steered away from risk Zones 2 and 3, and steered toward areas identified as Zone 1, starting with areas that have the lowest risk of flooding within Zone 1. Zone 1 should be considered for development before Zone 2, and development should only be permitted in Zone 3 when there is no non-flood vulnerable site available, and the benefits of such development outweigh the flood risk. Further development that is located in Zone 3 must meet various criteria, including not impeding water flows and not increasing flood risk in other areas (Communities and Local Government, 2006). As well, the policy identifies risk reducing measures including preservation of natural features that are or could be beneficial for flood control, risk reduction through building practices (location, layout and design), as well as planning in a manner that allows new development to reduce the risk of flooding, including application of sustainable urban drainage techniques (Communities and Local Government, 2006). The Policy Statement specifically addresses possible flood risk changes resulting from climate change, particularly concerns associated with rising sea levels.

Individual property owners have a significant role in the UK flood insurance system; specifically through paying risk based insurance premiums and deductibles. As well, in cases where flood risk may be significant, households may be involved in reducing flood risk to ensure insurability. New homes built after January 1, 2009 will not be guaranteed flood insurance, thus developers and property buyers will have to ensure that properties are eligible for flood insurance before they build or buy them (ABI, 2008). However, the requirements of Planning Policy Statement 25, which include building level flood risk reduction, should ensure that new homes remain insurable (Communities and Local Government, 2006).

6.5.1 Association of British Insurers (ABI) Statement of Principles

The ABI Statement of Principles on the Provision of Flood Insurance outlines the characteristics of flood insurance in the UK, as well as agreed responsibilities of both the government and insurance industry. These characteristics are prescribed to enable the insurance industry in the UK to provide flood insurance to the majority of households and small businesses (ABI, 2008).

Through the Statement of Principles, insurers agree to the following (ABI, 2005; 2008):

- In areas with a flood probability of 1 in 75 years or lower, insurers will provide flood coverage as a standard feature of household (and small business) policies. Flood insurance rates will vary based on flood risk.
- In areas with a 1 in 75 year or higher probability of flood risk, and where improved flood defences are planned to reduce flood risk below a 1 in 75 year probability within five years, flood insurance for households and small businesses will be maintained.
- In areas with a flood risk greater than 1 in 75 year probability, and where no flood defences area planned, insurers will examine insurability on an individual basis, and will not guarantee flood coverage. Insurers may work with high risk property owners to identify methods of reducing flood risk, and with the government to identify flood risk reduction strategies so that individual properties with a significant flood risk may become insurable.

Key government actions are defined in the Statement of Principles, and relate to reducing the number of properties at risk of flooding, sustained flood control investment, and application of land use planning to control development in flood-prone areas. As well, government actions required under the Statement of Principles include commitments to flood risk communication, as current information of flood defences is not largely available in the UK (Department for Environment, Food and Rural Affairs, 2001) and alleviation of urban flooding (ABI, 2005). Government actions as outlined in the Statement are provided in Table 16.

Table 16:
Government Actions for Flood Management under the ABI Statement of Principles on the Provision of Flood Insurance

1. Reducing the annual probability of flooding each year for a substantial number of properties in the UK, a portion of which currently have a significant chance of flooding (greater than the [1 in 75 year] probability).
2. At least maintaining investment in flood management each year, so that the outputs can be sustained in real terms, with a commitment to evidence-based discussions on future funding needs, taking account of climate change and other factors affecting risk.
3. Implementing reforms to the land use planning system to ensure that new developments do not lead to an increase in national or local flood risk.
4. Communicating flood risk effectively, including providing higher quality and more detailed information on flood risk, and on existing, new and upcoming flood protection schemes.
5. Developing an integrated approach to urban drainage that alleviates the risks of sewer flooding and flash-flooding.

Source: ABI, 2005

6.6 Conclusion

Of the many different arrangements found in countries throughout the world, the UK approach to flood insurance provides the best example on which a Canadian model may be based. Specific reasons include:

- A bundled approach to flood insurance, which helps to reduce the problem of adverse-selection;
- The option for exclusion of very high risk homeowners also assists in reducing adverse-selection;
- Risk based flood insurance pricing;
- A partnership approach between the insurance industry, governments and private individuals;
- Specific responsibilities of the insurance industry and the government are defined through an agreement;
- Government responsibilities reflect current measures carried out by Canadian governments, and include land use planning to reduce flood risk, investment in structural flood controls and production of flood maps which identify flood return periods that are relevant for the industry;
- Involvement of individuals in flood management, through carrying a portion of flood damages through deductibles and premiums and by becoming involved in risk mitigation on their own properties, and;
- It is a private insurance program that is supported by government flood risk reduction actions.

The UK model is an active partnership between private insurers and government, and requires significant participation by private property owners. The management of the system, including bundled coverage, has resulted in an extremely high flood insurance penetration rate of 95% (Crichton, 2002). Through this high insurance penetration, coverage has remained relatively affordable, though in cases of recurrent flood claims, private insurers have had flexibility to raise premiums and deductibles. The bundle system also helps the industry avoid adverse-selection (Crichton, 2002).

The insurance industry has also been highly involved in flood management in the UK, including funding or conducting studies on structural flood controls and flood vulnerability (Crichton, 2002). Flood maps are also produced and available through the national government. Further, the UK insurance system relies purely on the private industry, and there is no involvement of the government in terms of setting insurance premium prices, requiring insurance coverage, or paying out claims. This is a favourable scenario for insurance coverage, as it reduces the potential burden on public finances during flood damage events. It also provides the industry flexibility in covering flood on their own terms, which includes application of tried-and-tested methods of assessing policy holder risk and paying out claims.

7 Flood Insurance for Canada

Flood insurance is not only possible, it is a preferred means of providing post-flood financial assistance to homeowners in Canada. Natural hazard management literature has long established that actuarial, risk based insurance coverage can be more effective and equitable than government disaster relief programs. As well, there exists a strong belief in the Canadian public that flooding is already covered under typical home insurance policies – a situation that leads to resentment toward their insurance provider when they attempt to make an insurance claim for flood damages. Thus, provision of flood insurance will provide a business opportunity for insurers, as it will allow insurers to better serve their clients and remove water damage coverage ambiguity. Flood insurance will also provide an opportunity for growth in a mature insurance market.

It has been discussed in the past that a US-style insurance scheme for flooding is not the right approach for Canada. For example, when referring to the creation of the FDRP, Bruce (1976) stated:

One could adopt the United States approach using a combination of flood-risk maps and an insurance scheme. Experience in the United States has shown that this option would likely require heavy government subsidies and complex administration. In addition, in some cases, subsidized insurance schemes have been shown to encourage rather than discourage developments in the floodplain (pg. 10).

The application of flood insurance in Ontario has also been explored in the past. In 1976, and again in 1983, the province reviewed the NFIP in the US and found that the cost of flood insurance at actuarial rates (unsubsidized rates) would be prohibitive. It was found that if flood insurance were to be introduced in Ontario at rates that are acceptable to the individual homeowner, the provincial government would have to heavily subsidize the cost. Furthermore, the studies found that Ontario's practices in floodplain management were effective (Kowalyk & Moin, 1986). However, by applying a number of practices in a Canadian insurance model, such as bundled flood coverage, the difficulties experienced in other flood insurance models can be overcome.

7.1 Government Relief vs Insurance

Shrubsole (2000) stated that "in providing flood relief, we support flood victims...this generosity is often a measure of a caring society" (pg. 17). Indeed, government disaster relief provides much needed assistance after a disaster event, and is an important component in disaster recovery (Barnett, 1999; Tobin & Montz, 1997). However, government relief has been criticized, as it serves to reinforce vulnerabilities and provides little incentive for those who receive it to reduce risky behaviour (Anderson, 2000).

Unlike insurance, individuals who receive government disaster relief often bear no direct costs for remittances. While insurance allows for individuals at risk to sustain a portion of the costs associated with risky behaviour, public relief reduces the direct costs associated with risky behaviour, where costs are shifted to taxpayers (Barnett, 1999; Handmer, 1990). It has been frequently argued that by reducing the direct costs associated with risky behaviour government disaster assistance programs have exacerbated hazard damages, thereby creating perpetual states of damage and recovery (Barnett, 1999; Park & Miller, 1982; Tobin & Montz, 1997). Further, it has been argued that disaster assistance programs may be highly politicized and inefficient (Anderson, 2000).

By providing insurance coverage to occupants of flood-prone areas, individual homeowners become at least partly responsible for their own damages, and thus reduce their reliance on government relief for post-flood recovery (Chivers & Flores, 2002; Krutilla, 1966). Anderson (2000) further argued that individuals seeking to purchase property, or developers seeking to develop land will take into account the cost of insurance before locating there. In this way, actuarial, risk based premiums can assist land use planning approaches that discourage development in flood vulnerable areas.

Risk based premiums and/or deductibles can serve as either incentives to increase mitigative behaviour, or as disincentives to reduce risky behaviour (Burby, 2001; Goddard *et al.*, 1966; Krutilla, 1966). For example, Crichton (2008) stated that

the role of flood insurance is important in that it provides direct economic incentives to individuals to relocate or take their own precautions against flood while at the same time facilitating rapid economic recovery after a flood. In short, it seeks to address the causes of flooding instead of the effects (pg. 129).

7.2 Policy Holders Expect to be Insured for Flood

As discussed in Section 4, the current approach to flood insurance in Canada is inconsistent. This inconsistency, and the fact that insurance policies in Canada cover most damaging perils (e.g., fire, theft), has contributed to substantial misunderstandings related to flood insurance in Canada. For example, a 2004 survey by the Institute for Catastrophic Loss Reduction of 2,100 homeowners across Canada revealed that close to 70% of homeowners believed that they were insured for flood damages (ICLR, 2004). The reaction of a homeowner after suffering severe basement flood damages in a recent urban flooding event in Hamilton, Ontario exemplifies both a lack of understanding of insurable flood losses and anger toward insurance providers:

“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” (interviewee cited in Kernaghan, 2009).

Research following flooding in Peterborough, Ontario has also identified considerable anger toward the insurance industry for a lack of coverage for damages caused by overland flooding (Sandink, 2006; Oulahen, 2008). This situation not only leads to the unfortunate circumstance of uninsured damages for those affected by flooding, but may also present a considerable reputation risk for insurers in the event of large flood events. Further, by simply excluding flood for homeowners, insurance companies are perceived as not customer friendly and innovative.

7.3 Insurance Coverage is a Business Opportunity for Insurers

Providing flood insurance to individual homeowners can serve to increase confidence and satisfaction with insurance companies, and may provide opportunities for modest profits for the insurance industry. The expansion of current coverage to add flood protection is an opportunity for insurers to address a gap in current coverage and better serve their clients. Providing flood insurance coverage will help the many Canadian homeowners who experience flood damage each year, and will bring the peace of mind and security of insurance protection for flood to all Canadian homeowners. As well, provision of flood cover will reduce ambiguity regarding water damage claims, and can also provide an opportunity for growth in Canada’s mature insurance market.

Currently, damage caused by water is only partially covered in the standard homeowners policy. For instance, assuming the proper endorsement is in place, sewer backup is covered, as is water damage caused by a burst pipe. Damage caused by overland water flow, however, is universally excluded. Furthermore, commercial operations can purchase coverage against overland flood, while homeowners cannot. These dichotomies often create much ambiguity and consternation. Consider, for instance, lawsuits that took place in US Gulf Coast states affected by Hurricane Katrina. These so-called “slab” lawsuits (where homes were completely swept away leaving only concrete foundation slabs) triggered millions in legal fees and tied up the courts for many months as homeowners argued that their homes were taken away by wind, thereby affording them full indemnification by insurance companies, while insurance companies argued that the homes were carried off by storm surge, making damage indemnifiable only under the NFIP.

While such a discussion has yet to take place in Canada, it is commonplace after large urban flooding events (such as the August 19, 2005 GTA storm or the 2002 and 2004 Peterborough events) for claims adjusters to make coverage judgments based on the colour and odour of water that has entered a dwelling, with indemnification being afforded if the water is dirty and foul (having entered from the sewer) and coverage being excluded if the water is reasonably clean and odour-free (including overland flooding and ground-water flooding). Providing coverage for all water damage would prevent such discussions from taking place, would simplify claims adjusting, eliminate conflict and disagreements and serve to further narrow the consumer confidence gap.

The Canadian property and casualty insurance market is considered to be mature (rather than emerging, as with many markets in eastern Europe, Asia and Latin America). As such, there is less scope for business growth, as hundreds of insurance companies vie for business in a market which grows very little each year. Reinsurers serving the market find they are competing for business that is often shrinking each year, as large carriers retain more risk and buy less and less reinsurance. One of the only options for growth in such a market is to create new products, either by completely innovating new lines or forms of coverage, or by providing indemnity for a hazard that is currently being excluded in the standard policy. Providing flood insurance to homeowners in this country would do just that.

8 A Proposed Solution for Flood Insurance in Canada

A discussion of a possible flood insurance model for Canada is provided below. This model includes coverage for all types of flooding, flood insurance coverage that is bundled into typical homeowner insurance policies, exclusion of very high risk homeowners from the program, and a partnership between the insurance industry, governments and private homeowners.

Approaches to flood management vary across the country. Important distinctions include the proportion of communities that have been mapped, the various government agencies involved in flood management, which differ from province to province, and the regulatory standards applied to define floodplains in each province. For this reason, it is very likely that any proposed insurance model would have to be adapted to each province, and would be applied at the provincial level, rather than the federal level.

8.1 Types of Flood to be Covered

There are many causes of flooding in Canada (see Table 1), and flood coverage should be extended to as many types of flooding as possible. Currently, Canadian homeowners have no access to overland flood coverage, and sewer backup is the only type of flood coverage that is widely available to homeowners in Canada (see Section 4). There have been many cases where various types of uninsurable flood damages have occurred at the same time as insurable sewer backup damages. Providing coverage for all types of flooding will reduce policyholder confusion, and will reduce discussions about which type of flooding caused what damage following an event. As well, broad water damage coverage may also reduce discussion about the amount (or total cost) of claims after flood events. It will also increase consumer satisfaction with flood insurance, and help to ensure that positive consumer perceptions of the insurance industry are maintained.

8.2 Moral Hazard and Risk Based Pricing

8.2.1 Moral Hazard

Moral hazard has been cited as a potential drawback of the provision of insurance for any peril. Moral hazard may be defined as a “phenomenon whereby the obtaining of insurance tends to alter an individual’s incentives to prevent loss or to take specific actions; for example, to take care” (Parsons, 2003: 451). That is, those who purchase insurance may feel that this action precludes further action to reduce flood risk, as there is an expectation of receiving financial assistance if damages are experienced (Jongejan & Barriue, 2008; Lamond & Proverb, 2008; McLeman & Smit, 2006). This phenomenon has also been cited as a drawback of disaster relief (Barnett, 1999; Handmer, 1990).

For flood insurance, moral hazards may include choosing not to take action to mitigate flood risk on one’s own property, or perhaps purposely taking action during flood events to increase flood damages with the expectation of receiving a higher insurance payout. Such phenomena change the likelihood and severity of damages resulting from insured perils, and make it difficult for insurers to decipher whether damages were caused by random occurrence of perils or the actions of insured individuals (Parsons, 2003). It has been argued that moral hazard can also affect governments, as the provision of insurance for exposed members of the public may reduce governments’ incentives to reduce flood risk through adequate investment in structural and non-structural flood management measures (Lamond & Proverb, 2008).

Price signals through risk based premiums and deductibles can serve to counteract moral hazard (Lenntorp, 2008). Risk based pricing can help to ensure that insured individuals understand their risk, as individuals who have a higher flood risk will experience higher flood insurance rates. Risk based insurance will also incentive positive, risk reducing behaviour through premium discounts for adoption of risk reducing measures. Thus, risk based pricing will be an essential element of flood insurance in Canada.

8.2.2 Risk Based Pricing

Risk based insurance is a necessary condition to attain economic viability of insurance coverage. While an amount of cross-subsidization may be required to ensure economic viability of the program, those who are at a higher risk of damage should pay more for insurance coverage to ensure that cross-subsidization between low risk and high risk individuals is limited. Risk based insurance prices will help to ensure that there is enough capital in the insurance community to cover flood damages. Risk based insurance prices will also serve as an incentive or disincentive for individual homeowners to undertake risk mitigating adjustments or to avoid risky behaviour.

It is likely that a flood insurance model in Canada will require both risk based premiums and risk based deductibles. For homeowners who are at a greater risk of flooding, risk based premiums may result in premiums that are too high, and may increase public resistance to the insurance model. In these cases, risk based deductibles will help keep premiums affordable, but will also ensure that those at greater risk of flooding are carrying a greater flood damage burden.

If risk based premiums and deductibles are applied, they must be clearly communicated to homeowners to ensure that they understand their own risk and are aware that risk reducing behaviour can result in reductions of risk based premiums and/or deductibles. Clear communication of deductibles to homeowners will also ensure that there are no “surprises” when homeowners attempt to make a claim for flood insurance.

8.3 Coverage should be Extended to as Many Low Risk Customers as Possible

Substantial difficulties with flood insurance world-wide have resulted from adverse-selection, and countries where optional flood coverage has been applied have experienced high premium prices and reduced economic viability for flood coverage. Thus, a flood insurance program for Canada should ensure a suitably large insurance community is available for insurers to draw on during a devastating flood event. A strategy that has been commonly applied to ensure a large insurance community is bundling flood coverage into typical homeowner insurance policies. Flood insurance coverage that is bundled with other perils can help to ensure economic viability and mutuality, and thus affordable premiums for consumers and a sustainable flood insurance model. Indeed, the price of flood insurance is likely to be very low for those who have limited flood risk if flood insurance is bundled into typical homeowner policies.

Under the proposed bundled flood insurance approach, some cross-subsidization may be required to ensure that flood coverage remains affordable and that the program remains economically viable. That is, homeowners who are exposed to limited flood risk may still have to pay a small insurance premium if a bundled approach is adopted. However, selection of a higher deductible by low risk homeowners will help to reduce their insurance premiums and application of a risk based pricing approach will control the amount of cross-subsidization that occurs between low risk and high risk insureds.

8.4 Eligible Homeowners

Some homes experience very high flood risk, and might be uninsurable. Excluding high risk property owners from the insurance program could serve three purposes:

1. It could serve as a disincentive for development/location in high flood risk areas;
2. It could reduce the burden on the insurance community after a large flood event, and;
3. It could help to ensure that insurance coverage for low risk property owners remains affordable.

Nevertheless, the insurance industry should strive to cover most homes.

Flood maps in Canada do not normally differentiate between more than one or two levels of flood risk. Currently, the majority of Canadian maps are either 1-Zone, in which only one hazard level is defined, or 2-Zone, in which a floodway (higher risk) and flood fringe (lower risk) are identified. Definition of who will be considered “high risk” property owners will have to occur based on continued discussion between governments and the insurance industry.

To ensure economic viability for a flood insurance model in Canada, it may be necessary to exclude homeowners who are at a very high risk of experiencing damages. Thus, governments (municipal, provincial, federal) will have to clarify means by which those at very high risk will be assisted in flood situations. Preferable strategies may include acquiring properties and removing flood prone buildings, however constructing structural measures to reduce flood risk to an acceptable level may also be appropriate in some situations.

8.5 A Partnership Approach

An effective flood insurance model in Canada will require a partnership between the private insurance industry, governments and homeowners.

8.5.1 The Role of the Insurance Industry

Under the proposed Canadian flood insurance program, the insurance industry (through each provider) should agree to provide flood coverage to homeowners, except for those living in high risk homes (as described above). Insurance providers should also ensure that the price homeowners pay for insurance reflects the risk assumed.

Risk based premiums and deductibles are a necessity for an effective flood insurance program for several reasons:

- Higher risk customers should be subject to a higher deductible and/or be charged a higher rate to ensure that the program is equitable; that is, that those assuming a higher risk are paying a higher price for their insurance coverage;
- Higher insurance deductibles and rates for higher risk property owners will serve as a deterrent to occupy flood risk areas, and an incentive to adopt mitigative adjustments, and;
- Risk based premiums and/or deductibles will help to ensure that the insurance program is sustainable.

Risk based deductibles will be an important means of spreading risk. Deductibles would increase based on the risk of the individual policy holder.

Insurers should also keep track of flood risk changes that occur in areas occupied by their insureds, including factoring updated flood maps into prices, and accounting for environmental or structural changes made to watersheds. These changes should be factored into risk based pricing or deductibles for flood insurance.

The insurance industry should also directly communicate flood risk reduction information to policy holders to help increase flood risk awareness and mitigative behaviour at the private property level. Risk communication should be conducted in partnership with governments to ensure that risk communication messages are consistent.

Insurance companies should also ensure that policy holders are aware of the characteristics of their flood coverage. For example, policy holders should be made aware that they will have to pay a potentially large deductible when claiming for flood damages. Policy holders should also be made aware of changes that would occur to premiums or deductibles. Further, geographic concentration of flood risk areas is a potential liability for insurers if flood insurance were to be introduced. Therefore, insurance companies also need to monitor their accumulation of risk in different flood risk zones and possibly restrict underwriting if certain thresholds are exceeded.

In summary, the role of insurers in a Canadian flood insurance model will be to:

- Provide bundled flood coverage to all homeowners, aside from those occupying very high risk areas;
- Apply risk based insurance premiums or deductibles;
- Keep track of environmental and structural changes to watersheds and streams that have implications for the flood risk of their policy holders;
- Participate in flood risk communications with their policy holders, including possible damages and mitigative options;
- Ensure policy holders are aware of the characteristics of their insurance coverage, and ensure that policy holders are aware of changes in their coverage or premiums, and why their coverage may change over time, and;
- Monitor their accumulation of flood risk.

8.5.2 The Role of Governments

Provincial governments play the leading role in flood management in Canada. Municipalities are encouraged to zone for flood risk and ensure that new development is not located in flood-prone areas, based on flood hazard maps. Cost-sharing structures have allowed several levels of government to invest in flood control works, however provinces often take a lead role in managing flood control structures. All levels of government can be involved in disaster response and recovery assistance.

As part of a flood insurance program in Canada, governments should aim for comprehensive flood hazard identification, which may include working to expand and update flood hazard maps. Governments may also seek to incorporate environmental changes, including the impacts of development and climate change, into flood maps through continued investment in flood mapping and routine flood map updates.

Governments should also work to reduce flood risk for Canadian homeowners. As part of reducing flood risk, governments may continue or increase investment in flood control structures, which may include maintenance of existing structures, alterations of structures to meet changing development and environmental conditions, and building of new structures to reflect changes in flood risk. A flood insurance program will also require that new development does not increase flood vulnerability. Although risk based insurance rates can serve as an additional driver to flood mitigation and may help to prevent individuals from occupying flood vulnerable areas, governments may wish to continue to apply land use planning as the primary method by which new development is discouraged from occupying floodplains. Governments may also wish to ensure that flood risk zoning reflects updated flood risk maps. An effective flood insurance program will also require an aware and engaged public. Specifically, residents of floodplain areas should be made aware of their flood risk and the nature of the damages they could sustain during flood events. Thus, governments may choose to involve themselves in public education programs to increase flood risk awareness. The insurance industry may choose to work together to ensure that flood messages they communicate are consistent.

A viable insurance program will require that government relief programs do not conflict with insurance coverage and payouts. For example, governments may wish to ensure that disaster relief is not provided to those who are eligible for insurance coverage, and may choose to restrict disaster relief payouts to only those who reside in very high risk areas and where homeowners are excluded from insurance coverage. It may also be necessary to ensure that payouts provided to those who receive disaster relief do not exceed the payouts provided by flood insurance.

In summary, if a flood insurance program were to be implemented in Canada, the following actions would be required by governments:

- Comprehensive flood hazard identification;
- Working to reduce flood risk for all Canadian homeowners
- Increasing public awareness of flood risk
- Ensuring that public disaster relief programs do not conflict with the flood insurance program.

8.5.2.1 Flood Insurance Rates Should Not Be Regulated

Experience demonstrates that private insurers can more accurately determine prices that appropriately reflect the risks they assume than governments (Cummins, 2002; Tennyson, 2007). International experience shows that prices set by government typically fail to anticipate large loss events and this leads to taxpayer subsidies for public insurance agencies. Catastrophic under-pricing by private insurance companies can result in insolvency, providing a strong incentive to ensure adequate prices. Extensive and aggressive competition in Canada's insurance markets ensures that prices are not excessive. International experience shows that regulation of insurance practices should focus on solvency supervision and market conduct, while regulation of insurance pricing consistently reduces the effectiveness of coverage (Derrig & Tennyson, 2008; Kovacs & Leadbetter, 2004; Tennyson *et al.*, 2002). Interference in pricing has resulted in some markets with inappropriate subsidies that encourage some homeowners to live in areas of high risk (Derrig & Tennyson, 2008), and has imposed systematic under-pricing of coverage to the extent that some insurance companies were forced to withdraw from markets while others have failed. Insurance regulation in Canada should continue to focus on solvency and market conduct and not interfere with pricing.

8.5.3 The Role of Homeowners

Actions to empower private homeowners to implement appropriate flood damage mitigation measures on their own property should be based on greater awareness of their own flood risks. Private property owners will have to participate in flood losses, through retention of some of the damage costs. Risk based premiums and deductibles will help to ensure that higher risk property owners retain a higher proportion of the costs.

Homeowners should also consistently communicate with insurance providers when improvements are made to buildings or when flood mitigation measures are installed to reduce the risk of underinsurance and ensure fairly priced premiums and deductibles.

8.6 First Steps for Implementation

A flood insurance program in Canada will require a dialogue between the insurance industry and governments, and such a dialogue will likely have to be initiated by the property and casualty insurance industry. The Insurance Bureau of Canada (IBC) has responsibilities to speak with government on behalf of the Canadian property and casualty insurance industry, and thus a first step toward implementation of a flood insurance program for Canada would be a dialogue between IBC and government. A strategy to establish a flood insurance approach for Canada will likely focus on discussing flood insurance with provincial governments, as it is the provinces that hold primary responsibility for flood management in Canada. IBC may choose to first focus its efforts on a particular province, and then spread to other governments over time. It is also possible that governments may approach the insurance industry in the future, as they have done in the past, to discuss an insurance model for flood, thus it will be beneficial for the industry to have a pre-defined and preferred model for the provision of flood insurance if such a situation were to arise.

To ensure a well informed discussion within the insurance industry, development of actuarial costing analyses based on flood scenarios may be required. Following such analyses, an industry forum could be held at an appropriate time to further discuss the basic issues regarding flood insurance in Canada. The analyses and forum could be undertaken jointly by ICLR and IBC.

An industry strategy should highlight the shared role of each stakeholder group (the insurance industry, governments and homeowners), citing the roles of governments and the industry, as suggested in this paper. Specifically, governments should be assured that the purpose of a flood insurance program in Canada will be to support existing flood management efforts, and will not replace effective flood management practices such as land use planning.

9 Conclusion: Flood Insurance in Canada is Possible

Flooding is one of the most significant causes of disasters in Canada, however overland flooding is not presently insurable for private homeowners. Homeowners, however, have come to expect flood insurance, and the current inconsistent approach to flood coverage has left many homeowners confused and unhappy with their insurance coverage.

Criticisms of flood insurance in Canada can be countered by the bundling of flood coverage in typical homeowner policies (spreading insurance premiums across a large community to keep rates low and avoid government subsidies), and through the continued application of land use regulations that discourage development in the floodplain. Indeed, floodplain regulation in Canada has been effective, especially when supported by the FDRP. An insurance program would compliment, not replace current floodplain management practices; in fact, the effective application of insurance would require renewed commitment toward discouraging development in floodplains by all players. As well, an insurance system based on risk based premiums or deductibles can provide greater benefits than the current focus on government relief programs provided by provincial governments in Canada.

Now that a possible solution to flood insurance has been presented, we return to the six insurance principles required for a peril to be insured, as presented by Hausmann (1998).

Table 17:
Meeting the Conditions for Flood Insurance in Canada

Condition	How can this condition be achieved?
Mutuality	While traditional flood definitions do not lend themselves to mutuality (i.e., those occupying floodplains), when more encompassing definition of flood is used, which includes flooding that can occur virtually anywhere, mutuality can be obtained. Mutuality is then addressed through bundled insurance coverage for flood.
Need	There exists a need to cover flood damages.
Assessability	Assessability can be attained through renewed and continued flood mapping efforts. Currently, accurate assessment of flood risk stands as a significant barrier to the provision of flood insurance in Canada.
Randomness	Randomness can be achieved by restricting insurance from those at highest risk (e.g., those who occupy the 1 in 100 year floodplain), and through insurers keeping track of changes in flood hazards.
Economic viability	A large insurance community can result in economic viability through bundled flood insurance coverage. A large insurance community can serve to keep insurance rates low, and will provide capacity for payouts when flood disasters occur.
Similarity of threat	While there are many different types of flooding in Canada, water is the cause of damage in each case.

A partnership between government, the insurance industry and private homeowners will be necessary to sustain a flood insurance system in Canada. While it is possible for flooding to be insured in Canada should the conditions be met, it will not be possible unless appropriate risk assessments are in place.

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