FLOOD MANAGEMENT IN CANADA AT THE CROSSROADS

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The Institute for Catastrophic Loss Reduction (ICLR) was established in 1998 with the mission to reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions to improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters.

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Executive Summary

Decisions to reduce expenditures by all levels of government have come at a time when the economic losses due to flooding are increasing. This situation has raised concerns. During the 1990s, Environment Canada essentially withdrew its support from the Federal Flood Damage Reduction Program, and no other level of government has effectively filled this void. Emergency Preparedness Canada and the Insurance Bureau of Canada have suggested alternative flood management programs be considered by senior levels of governments. These decisions and discussions have occurred in the absence of systematic and rigorous studies that have assessed the full range of existing programs. This paper provides initial steps to address this need.

The Constitutional responsibilities of all levels of government for flood management are described. The major flood management programs sponsored by the federal government are reviewed. The contexts and events associated with two recent and significant floods in the Saguenay and Red River valleys are outlined. The manner in which communities anticipated, responded and recovered from these floods are described. On this basis, the report suggests that significant obstacles to reducing future economic flood losses in Canada are intertwined with current flood management arrangements. There is no requirement or mechanism to effectively integrate structural and non-structural adjustments. Fragmented institutional arrangements continue to permit agricultural drainage, and major reservoirs for hydroelectric and other purposes to be considered without adequate regard for other water issues such as flooding. The construction and operation of dykes and dams have sometimes created a culture of conflict between upstream and downstream communities. A false sense of security is usually promoted by structural adjustments that contribute to increased levels of human settlement. Flood recovery efforts do not effectively support the reduction of future flood losses. After a community has incurred significant losses, senior governments primarily fund disaster relief efforts and the costs for structural adjustments. This arrangement provides little incentive for local landowners and municipalities to adopt effective regulations for floodplain land uses. A narrow range of alternatives is supported through existing programs. A cycle of escalating flood losses due to extreme events should be expected from present arrangements.

An alternative flood management strategy based on the principles of ecosystem management, partnerships and the role of science is described. These principles could serve as a basis to guide the development of future flood management strategies in Canada.

Floods are acts of God; flood losses are the results of acts of humans (White, 1945).

1.0 INTRODUCTION

The statement above suggests that while people cannot do much about floods, they can influence the nature and extent of flood losses. In that regard, Canadians might be a little perplexed about the state of its flood management programs. On the one hand, their flood management approaches have been praised. According to Bruce and Mitchell (1995, 12), "Canada established a world leadership role" in 1975 with the development of the Flood Damage Reduction Program (FDRP). Since that time Environment Canada, the lead federal agency for the FDRP, has assisted many nations in floodplain mapping initiatives. Within Canada, the FDRP saw over 800 communities mapped and designated (Watt, 1995). Handmer and Parker (1992) identified Emergency Preparedness Canada (EPC) as a model that Britain could follow in enhancing its institutional arrangements for emergency planning and management. Despite these accolades, the effectiveness of past approaches must be questioned. Between 1975 and 1999, 63 floods resulted in payments of almost $720 million (1999 dollars) through the federal government's Disaster Recovery Financial Assistance Arrangements program (EPC, 2000). Between 1984 and 1998, insurance claims for flooding, which do not include residential losses, were in excess of $750 million (1999 dollars) (Insurance Council of Canada, 1998). Although the amount of damage varies dramatically on an annual basis, there is concern about the recent and high incidence of catastrophic flood losses – particularly in the Saguenay region (1996) and Red River valley (1997)(Figure 1.1). A trend of increasing damages from floods and other extreme weather-related hazards is expected in the future for three reasons. First, there will be more people living in larger but fewer urban centres. Second, changing climatic patterns with an associated increase in extreme events are expected (Bruce *et al.*, 1999). Third, an aging infrastructure that is more prone to damage will increase loss levels (Kovacs, 1999). Despite our best efforts, Canadian's are and will become more vulnerable to extreme flood hazards.

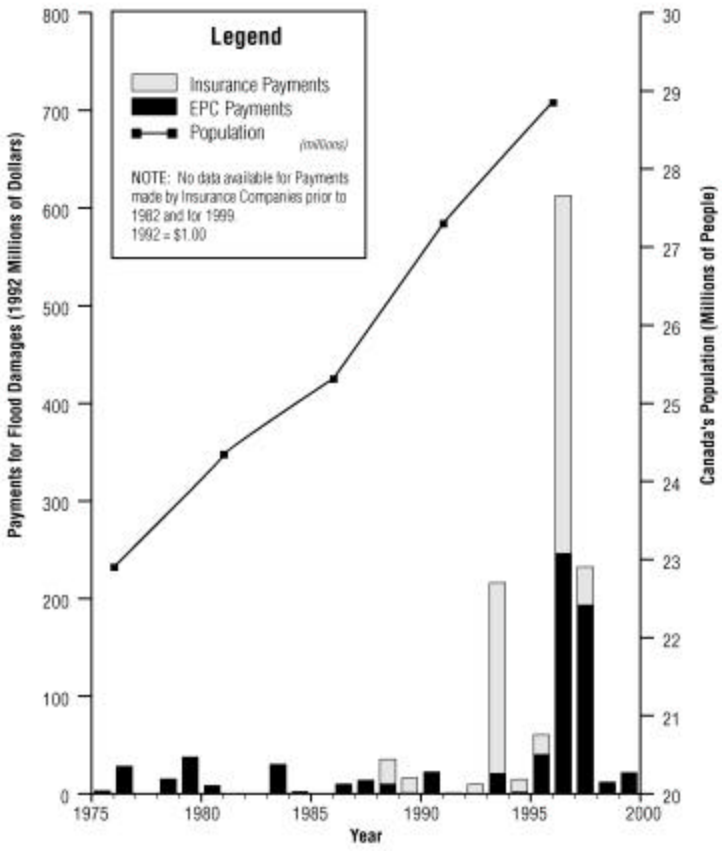

Figure 1.1
Payments for Flood Damages Paid by Emergency Preparedness Canada (EPC) and the Insurance Industry, and Canada's Population Growth (1975-1999)

It is in this context that Canadian flood management is at a crossroads facing choices about whether to address the fundamental challenges confronting it, or to accept a trend of increasing flood damages. Unfortunately, some recent decisions suggest that the latter road will be followed. Environment Canada is not renewing any of the 10-year General Agreements under the FDRP. Budget reductions and administrative changes during the late 1980s and early 1990s led some Canadian water experts to conclude that the federal government was unable "to understand and deal with pressing water issues" (Bruce and Mitchell, 1995, vi). A majority of provincial governments have not effectively filled the void as illustrated by British Columbia's disbanded Floodplain Mapping Branch (Day, 1999). In addition, the hydrometric network which provides the data for mapping initiatives and flood warning systems appears to be in a state of "crisis" (Bruce and Mitchell, 1995, vi). Since the current cost-sharing arrangements under the Disaster Recovery Financial Assistance Arrangements program make it particularly vulnerable for losses due to extreme events, Emergency Preparedness Canada now desires develop a national policy on mitigation (Day, 1999).

Prompted, in part, by increasing weather-related insurance claims, the Insurance Bureau of Canada (1999) is promoting a Natural Disaster Reduction Plan to the federal government. It advocates that federal, provincial and local governments contribute a total of $750 million dollars over five years to create a Natural Disaster Protection Fund. That fund would support infrastructure projects. The plan also advocates augmenting the existing Disaster Recovery Financial Assistance Arrangements by an amount equal to 15% of the post-disaster clean-up cost that would finance preventive measures. The plan identifies the need to create a "culture of preparedness" by informing the public about hazards and requiring future public projects to include an analysis on how they will make Canada's communities more resilient to future natural disasters. The Federation of Canadian Municipalities supports this initiative.

In promoting a culture of preparedness, the IBC is embracing a theme contained within Chapter 7 of *Agenda 21* that advocated "sustainable human settlement development". Its goal is "to mitigate the negative impact of natural and human disasters on human settlements, national economies and the environment" (Grubb *et al*., 1993, 111). Introduced at the Earth Summit in 1992, this goal will be achieved, in part, by promoting a culture of safety. Following the 1997 Red River flood, the International Joint Commission (1997) also embraced this concept. Meeting this and the other challenges raised in *Agenda 21* will require adequate, effective, equitable, and efficient efforts from all levels of government, the private sector, and individuals.

At this time, the role of the federal government in flood management is unclear. No other level of government is effectively filling the vacuum left by Environment Canada's abandonment of the FDRP. In the absence of systematic study and open debate, Canadians face pivotal decisions as to whether and how to pursue future strategies. The objectives of this paper are: (1) to describe the current practice of flood management; and (2) to outline future options. This paper is organized into six parts. Jurisdictional and administrative aspects of the Canadian approach to flood management are noted in the next section. In the third and fourth sections, preventive practices, and flood response, disaster relief and insurance initiatives are described. The fifth section comments on the recent experiences of floods in the Saguenay River and Red River valleys. The last section examines the underlying problems with current flood management initiatives and the crossroads now facing Canadians.

2.0 WHO IS RESPONSIBLE FOR FLOOD MANAGEMENT?

The Canadian Constitution defines the water law. However, rather than treating water as a distinctive entity, responsibilities of the federal and provincial governments are defined under a number of constitutional headings that are either legislative or proprietary in nature. The provinces' ability to legislate in the general area of water management is derived primarily from their exclusive authority to legislate over property and civil rights, over matters of a local and private nature, and over local works. Significant responsibilities are also associated with their ownership of water and other resources. Local governments are formed through provincial statute and are usually delegated responsibility for local services (Wallace, 1997). The federal government has legislative powers over navigation, fisheries, defense, interprovincial and international issues, and can legislate for 'peace, order and good government'. The federal government also holds land in trust for aboriginal people, but whose management is the responsibility of individual Indian Band Councils (Watt, 1995). The federal government can also involve itself in areas of provincial jurisdiction through its spending powers (Doern and Conway, 1994).

It is within this context that all levels of government participate in flood management. In general terms, the federal government often provides research and recommendations concerning aspects of hazard management such as building standards or acceptable levels of risk (Doern and Conway, 1994), and provides training for local emergency officials. Provinces can establish specific regulatory flood levels, set building standards, and advise municipal governments in flood mitigation. Municipal governments must comply with provincial building codes through the passage of local by-laws. If minimum standards are not established by provincial statute, municipal governments have considerable discretion in implementing programs. Harrison (1996) suggested that this arrangement epitomized 'passing the buck' because all levels of government are involved but no one is truly accountable.

Early flood management efforts were the responsibility of individuals and local governments. Senior governments became more involved between 1953 and 1970. During that period, the federal government's involvement in water management was guided by the C*anada Water Conservation Assistance Act*. Senior levels of government could provide up to 75% grants for the capital cost of structural adjustments (Quinn, 1985). Relative to its United States counterpart, the division of responsibilities under the *Constitution Act* provides little political currency to prompt Canada's federal government into leading flood management efforts (Newton, 1997). By the 1970s, however, the shortcomings of existing programs were becoming apparent (Watt, 1995), and a unique set of circumstances facilitated the federal government to assume a leadership role in floodplain management. First, major floods in 1973 and 1974 suggested that the protective works had not curbed the potential for damage (Bruce, 1976). Second, the collective demand for structural adjustments, disaster relief and clean up assistance was straining senior government budgets. Third, there was a belief that the present system was inequitable because it subsidized those residents who occupied flood-prone areas. Fourth, structural measures were seen to promote development in floodplains (Watt, 1995). Fifth, the federal government, rather than fully participating in project planning, simply accepted or rejected proposals submitted by provincial governments. These factors contributed to the development of the FDRP under the provisions of the *Canada Water Act* (1970) that supported cooperative initiatives and extended financial arrangements to embrace both structural and non-structural adjustments (Bruce, 1976). Public education was also an important element of the program. Provinces were enticed to sign 10-year General Agreements with the

federal government, in part, because Environment Canada had a competent core of professionals and available funds. The 10-year agreements could be supplemented by subsidiary agreements on mapping. Flood forecasting, structural adjustments and other planning initiatives could be covered in other sub-agreements.

During this same period, the federal government's Emergency Measures Organization (now Emergency Preparedness Canada) refocused its efforts on peacetime emergencies and mutual aid agreements. This effort culminated in 1988 with the passage of the *Emergencies Act* and the *Emergency Preparedness Act* that identified the federal government as a facilitator for general emergency preparedness (EPC, 1997a).

Thus, the federal approach to flood management has evolved from a constrained cost-sharing arrangement for structural adjustments to a broadening of the range of choice to reduce and respond to flood risks. After 1953, the federal government played a vital role in funding and approving projects. Since 1975, it has funded and led cooperative planning efforts with the provinces. Priority has been placed on reducing the risk to life. Under the FDRP, reducing risks and responding to floods have been two general approaches applied to flood problems. The current intent and practice of each approach are described in the next two sections.

3.0 REDUCING RISK THROUGH THE FDRP: FLOODPLAIN REGULATION, STRUCTURAL ADJUSTMENTS AND PUBLIC INFORMATION

If Canada is to achieve sustainable human settlement development, reducing risk is an essential element. Initially, flood protection was achieved predominantly through the construction of structural adjustments that were favored through the financial arrangements provided by the *Canada Water Conservation Assistance Act*. Although the regulation of floodplain development had long been identified as the single approach most likely to reduce flood losses (White, 1945), it was not until the introduction of the FDRP in 1975 that senior governments actively supported it. The primary and innovative intent of the FDRP was to promote floodplain-mapping studies. It also prohibited federal and provincial governments from engaging in, or providing assistance for undertakings that were in designated high-risk areas. It also restricted federal and provincial disaster assistance only to those structures built before designation and encouraged municipalities to enact zoning regulations based on engineering studies and mapping. At a federal level, Emergency Preparedness Canada would administer these payments. In addition, the FDRP supported other flood adjustments that included flood forecasting and warning, land acquisition, and structural measures (Bruce, 1976). Flood hazard information was also to be communicated to the public, municipalities and industry. Environment Canada has been the lead federal agency in the FDRP and it also operates the national hydrometric network. Formed in 1971, Environment Canada has responsibility for the preservation and enhancement of the quality of the natural environment, including water, air and soil quality, and any matters not assigned to other federal departments related to renewable resources, water and meteorology (Doern and Conway, 1994).

By the late 1980s, the engineering expertise within and the spending powers of Environment Canada that initially supported its leadership role for the FDRP had been eroded significantly (Bruce and Mitchell, 1995). In the early 1990s, a series of administrative changes within Environment Canada saw the disappearance of the Inland Waters Directorate, its flagship for water management activities. In its place, water management responsibilities were distributed among three divisions within the 'new' Environment Canada in order that the goals of sustainable development could be pursued (Mitchell and Shrubsole, 1994). One observer commented that Environment Canada's actions

> smacks of profound superficiality. "Profound" in that it recognizes the importance of the ecosystem approach that emphasizes attention to the entire system and the linkages among its components, but "superficial" in its lack of attention to water in all its dimensions…" (Bruce and Mitchell, 1995, 3).

As noted earlier, Environment Canada (1998a) is not renewing the 10-year General and Mapping Agreements and there has been no effective action by provinces and municipalities to update existing maps and extend the present coverage. It is unclear whether senior levels of government will remain committed to the FDRP principles in the absence renewing the It is unclear whether senior levels of government will remain committed to these principles in the absence renewing the FDRP General Agreements. General Agreements. It appears that Environment Canada redefined its core mandate as water, air and soil quality to the exclusion of flooding. This separation of environmental quality and quantity appears to be inconsistent with the principles of integrated or sustainable water management. However, it apparently reflects the perceived realities of Environment Canada's responsibilities. Between 1995 and 1998, budget allocations for the

hydrometric network were reduced by 35% (Scott *et al.*, 1999). At a time when we need high quality information to meet the challenge of achieving sustainable human settlement development, the level of information to assist decision making is declining (Bruce and Mitchell, 1995).

Despite its turbulent history, the FDRP had many accomplishments. As noted earlier, by 1995, over 800 communities were mapped and designated (Watt, 1995). Studies have concluded that the FDRP was cost-efficient (Ouellette *et al*., 1988; Millerd *et al.* 1994). Where floodplain regulations were implemented, there is a diversity of opinion concerning their effectiveness across the country.

Several studies have concluded that Ontario's approach to floodplain regulation has been generally effective. Boyd (1997) modeled the storm that generated the Saguenay River flood to the Grand River. Results showed that reservoirs reduced flows between 4% and 13%, dykes reduced flood damages by over $120 million, and land use regulations prevented an additional $5 million in damages. Boyd *et al.* (1999) described the mix of structural and non-structural measures operating in the Grand River valley. A mix of structural and non-structural adjustments has long been advocated as a requirement for effective flood management (Shrubsole *et al.*, 1995). In comparing the flood damages for four storms that occurred in Michigan (USA) and Ontario during 1986, Brown *et al.* (1997) concluded that although flood yields for Ontario were higher, the success of its floodplain management policies was reflected in much lower damages. When adjusted for differences in the currency exchange, the $500,000,000 (US) versus the $500,000 (Cdn) damage levels are well over 1,000 times apart. There is little doubt that the combination of structural adjustments, building codes and floodplain regulations have reduced economic losses from what would have occurred without their presence. Since 1975, Ontario has not received payments through the Disaster Recovery Financial Assistance Arrangements Program. This point reflects the success of Ontario's flood management program as well as the nature of the cost-sharing arrangement under that federal program.

Shrubsole *et al.* (1995; 1996; 1997a) concluded that relative to stated goals, conservation authority floodplain regulations have achieved an acceptable level of efficiency, equity and performance. No significant impacts on property values have been associated with their implementation (Schaefer, 1990; Shrubsole and Scherer, 1996; Shrubsole *et al.*, 1997b). The existence of conservation authorities and the establishment of a *Provincial Policy Statement* are the cornerstones that have supported this level of success. Conservation authorities have primary responsibility for flood and erosion control, receive funding from provincial and local governments, and reflect a long-standing cooperative approach to renewable resource management on a watershed basis (Mitchell and Shrubsole, 1992). The *Flood Plain Planning Policy Statement* commits the province to structural adjustments, floodplain regulation, flood warning and disaster relief.

Although these studies suggest Ontario's floodplain policy is effective, it had a tentative and tenuous initiation (Gardner and Mitchell, 1980). Since 1963, conservation authorities had the ability to regulate land uses but these were not pursued, in part, because of the absence of mapping and of clearly defined regulatory flood lines (Mitchell and Shrubsole, 1992). Between the late 1970s and early 1980s, many conservation authorities began enforcing floodplain regulations in areas that were often mapped through FDRP projects. However, some floodplain residents perceived that floodplain standards and regulations had been imposed and resisted their implementation. Some municipalities were also initially reluctant to support floodplain regulations. This view reflected, in part, the development of the FDRP as a partnership between federal and provincial governments. Resistance to floodplain regulations in the 1980s culminated in the formation of an Ontario Flood

Plain Review Committee (1984, 2-8) which characterized the province's efforts as "remote and unclear." The resistance to land use regulations also reflected difficulties from shifting strategies away from ones based on modifying natural processes to those that required people to change the way land was developed, as well as the perception that regulations would reduce property values. The Province adopted many of the Committee's recommendations that included greater flexibility in designating flood-prone areas. While this measure has enhanced municipal and property owner support, it has raised concerns. In Ontario, varying levels of protection are provided without any impact on the level of funding that could be provided from senior government disaster relief funds. Thus, there is a tension in balancing responsiveness, equity and performance.

Other authors have identified difficulties in managing land uses on floodplains in other parts of Canada. Roy *et al.* (1997) commented that the initial floodplain protection provisions within the Canada-Quebec FDRP agreement were relaxed in order to allow development to take place in flood risk areas through policy exemptions. Forget *et al.* (1999) found that designation and mapping failed to prevent inappropriate development on defined floodplain areas in Montreal. They also concluded that dykes, mainly constructed in developed areas, may have promoted a false sense of security and noted a highly variable level of structural integrity, design and maintenance. Cardy (1976) commented on the false sense of security that was associated with structural adjustments in St. John, New Brunswick. Day (1999) maintained that comparatively little mapping occurred in the lower Fraser River basin of British Columbia. Instead, a dyking program there consumed a very large proportion of all funding under the *Canada Water Act*. This imbalance "overshadowed the otherwise innovative and sustainable thrust" of the FDRP (Booth and Quinn, 1995, 72). According to Day (1999), many of the 2.4 million people occupying the lower Fraser River basin are vulnerable to flooding and some lands have yet to be mapped. In 1979, Manitoba established a Red River Designated Flood Area that saw many communities implement floodplain regulations that had been supported through FDRP mapping. Unfortunately, due to a lack of enforcement, only 63% of new homes in the designated flood areas complied with that regulation (IJC, 1997). Lack of enforcement and inadequate sanctions, lack of clear jurisdiction, communication problems, and inadequate financial arrangements have been long-standing shortcomings that have detracted from Ontario's program (Gardner and Mitchell, 1980; Shrubsole *et al*., 1995; 1996; 1997a).

Collectively, these studies suggest that local governments have not always effectively managed floodplain development. This is partly explained by a lack of political will, inadequate capacity, or the absence of mechanisms that promote watershed-based responses. At a practical level, not all existing development and additions/renovations to exiting structures can (re)designed feasibly to make them safe (Shrubsole *et al.*, 1995; 1996; 1997a). There is also a lack of integration between structural adjustments and floodplain regulations. In the Fraser River valley, Montreal and elsewhere, the construction of structural adjustments has sometimes promoted intensive development on floodplains and a false sense of security in their ability to prevent future losses. A related concern pertains to the desired balance between non-structural and structural approaches. The explicit and innovative goal of the FDRP was the mapping of flood-prone areas. Implicitly, it was hoped that once municipalities were made aware of the flood hazard through the maps, they would establish floodplain regulations. However, the traditional focus on structural adjustments consumed over 50% of the all expenditures made under the *Canada Water Act* and were concentrated on relatively few, expensive projects in British Columbia, Manitoba, Ontario and Quebec. In fact between 1975 and 1987, the dyking work in the lower Fraser River basin was pursued without any commitment to damage reduction policies (Booth and Quinn, 1995). Thus, the FDRP did not ensure that structural adjustments and the mapping were pursued in an integrated and balanced

manner. More importantly, these problems can be seen as symptoms that reflect a fundamental flaw with existing strategies that implicitly promotes development in flood-prone areas. Therefore, it might be unfair to lay blame for poor floodplain regulation primarily on the municipal level of government. This idea will be elaborated upon in subsequent sections.

Public information was another important aspect of the FDRP. Handmer (1980) assessed the efficacy of FDRP maps in changing people's attitudes to floods. He concluded that although there was an increase in flood awareness, this change could not be attributed solely to the maps. Kreutzwiser *et al*. (1994), Shrubsole and Scherer (1996), and Shrubsole *et al.* (1997b) surveyed the perceptions of floodplain residents in three Ontario watersheds to the flood hazard and flood adjustments. Generally, residents did not perceive a significant risk of future flooding. There was a poor understanding of floodplain regulations, and structural adjustments were viewed as the most effective approach. Thus, although floodplain regulations are supposed to be the most effective mechanism in reducing future flood damages, residents prefer other measures. Current programs to inform and educate the public about floods have resulted in little change in public behaviour.

Providing information about the likely hazards associated with a particular property during real estate transactions could better inform residents and promote a culture of preparedness. Shrubsole and Scherer (1996) obtained the views of home mortgage lenders, real estate agents and land appraisers in portions of the Grand River watershed (Ontario). They concluded that although formal training pertaining to floods and regulations was limited, the real estate sector was aware of the need to disclose this type of information to prospective buyers. At the time of that study, this was pursued in neither an effective nor consistent manner. Real estate agents most often provided this information to potential purchasers late in the purchase process but prior to an offer to purchase. This timing detracted from effectiveness. In Ontario, conservation authorities had frequently applied a title notice and/or a release as a condition of development in flood-prone areas. A title notice informs the buyer of the flood risk, while a release suggests that a homeowner is unable to bring legal suit against a conservation authority in the event of flooding. These mechanisms provided homebuyers with information about the flood hazard during the title search. However, since the purchaser's lawyer would communicate this information after the offer to purchase had been made, the purchaser may already feel committed to finalize the deal. The mandatory and early disclosure required in the United States could serve as a model in Canada (Platt, 1999).

On a technical front, there is uncertainty in the determination of regulatory floodplains (Paine and Watt, 1992). For instance, most of the storm data in Ontario are relevant for large watersheds of 500 km^2 to 1,000 km^2 in size rather than smaller 25 km^2 catchments (Lorant, 1990). In the absence of data for these smaller areas, the government has circulated reduction curves prepared by the World Meteorological Organization that are applicable to the western United States. Given the recent reductions in the hydrometric network, it is unlikely that curves based on Canadian data will be forthcoming. This information is an important basis for floodplain maps and warning systems. In order to develop longer-term databases, efforts have been made to utilize tree ring, sediment and other proxy data to determine past climate conditions (IJC, 1997). It is unclear the extent to which these data will effectively support the determination of flood-prone areas at a large scale of mapping.

Another shortcoming with the FDRP concerned the varied and limited mapping of aboriginal lands (Watt, 1995). The implementation of structural adjustments was relatively slow in these areas because planning failed to reflect important socio-political differences between aboriginal and non-native communities. For instance, traditional benefit-cost studies that are frequently used to

prioritize mapping projects within provinces were inappropriate for use in aboriginal areas where lands are communally held. On this basis, lands that are held in free title, particularly lands zoned for commercial or industrial use, will show higher benefits and therefore greater need relative to native lands (Bronsro *et al.*, 1999). In addition, insufficient funds were targeted for flood management on native lands. The Federal Departments of Indian and Northern Affairs, and Public Works and Government Services Canada, native communities and provincial governments through initiatives such as Flood Damage and Erosion Mitigation Plan are now addressing this problem. It has seen a revitalized partnership develop among all participants as well as increased funding levels from senior governments.

Floodplain regulations modify the exposure to hazards and structural adjustments modify the hazard itself. Since neither approach eliminates the hazard, it is instructive to examine how Canada responds to floods and distributes the costs of recovery.

4.0 RESPONDING TO FLOODS AND SHARING THE RISKS

Emergency Preparedness Canada (EPC) is the second important federal flood management agency. As part of the Department of National Defense, it coordinates and encourages emergency preparedness activities within the federal government, and between federal and provincial governments (EPC, 1997a). In the context of flood responses, it places initial responsibility for response upon individuals. Based on the extent of the flood and on an individual's capacity to respond, responsibility can move from community, to provincial, and finally to federal levels. Each level of government must request the support of the next one. Emergency preparedness and response is clearly a shared activity among individuals, the private sector, and all levels of government. However, an implicit but fundamental principle of the Canadian emergency response approach places ultimate responsibility for public safety with the municipal level of government (Kuban, 1996). During a disaster response, it should be municipal officials who remain in control, regardless of the level of involvement from other levels of government.

EPC also administers the federal *Disaster Financial Assistance Arrangements* (DFAA) program (EPC, 1999). Under that program, a per-capita cost-sharing formula is used provide disaster relief for eligible expenses (Table 4.1).

Table 4.1
Disaster Financial Assistance Cost-sharing Arrangement

Provincial Expenditures Eligible for Cost Sharing	% Federal Share
First Dollar	0
Second and third dollars	50
Fourth and Fifth Dollars	75
Remainder	90

(EPC, 1999)

This arrangement places a significant financial risk on the federal government for catastrophic losses and has prompted EPC to pursue a broader-based strategy that would better define "the roles for cooperative action to reduce loss of life and damage to properties" (Day, 1999, 59).

Provincial and municipal governments provide various forms of disaster relief. In Manitoba, the Manitoba Emergency Measures Organization provided up to $30,000 compensation for eligible expenses, subject to a 20% deductible from approved costs (IJC, 1997). The $30,000 limit was raised to $100,000 after the 1997 flood on the Red River. In general, cost-sharing arrangements place a heavier burden on senior governments for extreme losses.

The DFAA generally defines eligible costs as those related to restoring public works to pre-disaster conditions, and replacing and repairing basic or essential personal property (EPC, 1999). The intent is to prevent recipients from financing home or building improvements through taxpayers'

contributions. However, this orientation means that the damage potential is maintained rather than reduced.

Insurance is another way of sharing recovery costs. In Canada, residential insurance policies do not cover water damages attributable to overland flooding. However depending on the community, residents may be eligible to be covered for losses due to sewer backup through a standard policy or as an extra provision. Sewer damage can be considerable. In 1993, $185 million (1993 dollars) was paid to residents in Winnipeg as a result of damages due to sewer backups. Afterwards, many insurance companies ceased to offer this provision to residents in Winnipeg. Private insurers will usually provide coverage for commercial losses due to closures and damages. After the 1997 Red River flood, insurance companies paid over $200 million for all damages, with only $2 million associated with sewer back-up (Morris-Oswald *et al.*, 1998). After that event, the few companies that had provided sewer back-up coverage withdrew this clause from residential policies offered to people in Winnipeg. In the future, these individuals will bear these losses. There is mounting concern from the insurance sector about the rising claims for commercial losses (Figure 1.1). The absence of residential flood insurance and selective withdraw of sewer coverage has not seen a recent decline in their flood-damage claims.

It is the federal Department of Indian and Northern Affairs that plays the lead role in emergency preparedness and response management for First Nation communities. In 1985, it entered a flood-risk mapping agreement with Environment Canada. However, risk areas would not be designated unless requested by the Indian Band (Environment Canada, 1993). EPC will assist aboriginal communities in preparing, implementing and maintaining emergency plans (EPC, 1998). There can be difficulties in implementation. For instance, Manitoba has assigned local governments the responsibility of creating emergency preparedness and response plans, and maintaining local emergency response groups. However, Manitoba legislation does not recognize the authority of the chief and the council in governing native lands (Haque, forthcoming). It appears that emergency response on native lands can fall through the cracks of current institutional arrangements.

5.0 THE TALE OF TWO FLOODS: THE RED RIVER AND THE SAGUENAY RIVER

It is instructive to compare the contexts, events and outcomes arising from two of Canada's most recent and significant floods – in the Saguenay River and Red River valleys – in order to better appreciate how well Canada responds to them.

5.1 The Contexts

The source of the Red River is located in the states of North Dakota and Minnesota (U.S.A.), and flows northward to Manitoba. Since this area was the site of a glacial lake, it is relatively flat. Slow moving water and long duration floods characterize its long flood history. While these factors provide the time for evacuation and other emergency responses, they may also increase property damage (Morris-Oswald *et al*., 1998). Winnipeg, Manitoba's largest urban centre with a population of about 662,000, is also located in the watershed. Farming, often assisted by tile and open drains, dominates the land use activities of the watershed. Agricultural drainage in the region contributes to erosion and flooding, particularly overland flooding problems. "Overland flooding in the Red River Basin, under adverse weather conditions, can result in a flooded area of over 1,000 to 2,000 square miles which can last 4 to 6 weeks" (Morris-Oswald *et al*., 1998). With its flat topography, overland flows in the Red River Basin are difficult to monitor and forecast.

In response to past flooding, several measures have been undertaken. Some of the major initiatives include the following:

- The Red River Floodway completed after a serious flood in 1950 at a cost of $63.2 million divided between the federal and provincial government ($37.0 million and $26.2 million respectively). It has an emergency capacity of 2,830m^3/s and provides protection to Winnipeg (Haque, forthcoming).
- With a maximum capacity of 708m^3/s, the Portage Diversion was completed in 1970 at a cost of $17.5 million.
- The Shellmouth Dam on the Assiniboine River was completed in 1972 at a cost of $11.5 million.
- Dyking within Winnipeg was completed after a 1966 flood. After a flood in 1979, these dykes were raised and extended. Dyking was also completed around other flood-prone communities. During this period, about 700 farmsteads were also dyked or the foundations of farm buildings raised.
- In 1979, floodplain regulations were established in the Red River Designated Flood Area.

Large and expensive structural projects, financed primarily by senior governments, dominate the responses of the past.

There has been no significant urban and agricultural development in the Saguenay-Lac St. Jean region. Instead the basin, which is situated within the Canadian Shield, is dotted by small settlements located along watercourses. These communities often rely on the mining and forestry resources of the watershed. During the 20th century, the hydroelectric potential of many rivers was harnessed. By 1996, over 25 public and private agencies had constructed over 2,000 structures

(Grescoe, 1997). Since there had been no significant flood losses prior to 1996, only a very modest level of flood protection was afforded to some communities primarily through dyking projects.

5.2 The Events and Damages

During the 1997 Red River flood, an area in excess of 1,945 km^2 was inundated, sometimes extending over 40 km in width (Rahman, 1998). Over 2,500 homes were flooded, and in excess of $500 million in damages resulted. Flood warnings and evacuation notices ranged from 24 hours in Emerson to 4 days in St. Adolphe (Haque, forthcoming) and permitted 28,000 Canadians in 21 communities to be evacuated. The IJC (1997) commented that emergency measures reduced flood damages but that there were some communication and logistical problems that contributed to some difficulties. In 1997, floodwaters remained in homes for 1 week. About 8,000 livestock within the basin died (Morris-Oswald *et al.*, 1998).

In July 1996, 229 mm of rainfall fell within a 36-hour period on near-saturated soils on the north shore of the St. Lawrence River and caused the most severe flooding in Canadian history. Damage was particularly severe in the area south of the Saguenay-Lake St. Jean Region (Brooks and Lawrence, 1999). In addition to the rainfall event, flood levels were significantly increased by the failure of water structures. For instance, because the dam at Lake Ha!Ha! was overtopped, the reservoir was drained and a nearby dyke eroded (Brooks and Lawrence, 1999). The flood flows were the highest recorded this century and were well above critical discharge levels (Brooks and Lawrence, 1998). A total of 1,718 homes and 900 cottages were destroyed or damaged. Landslides claimed 10 lives (Brooks and Lawrence, 1998). Over 16,000 people were evacuated (EPC, 1997b). In addition, the river channel was widened by up to 280 m, channels were incised (locally up to 20 m) and 2 reaches (6 and 4.5 km long) aggraded by several meters (Brooks and Lawrence, 1999). Thus, flooding and severe geomorphic processes combined to inflict extensive damages and permanent changes to the landscape.

5.3 Implications for Flood Warning and Response

There were positive and negative aspects arising from the Red River flood experience. On a positive note, the Red River Floodway was estimated to have prevented about $0.6 billion in damages (Morris-Oswald *et al*., 1998; Natural Hazards Centre and Disaster Research Institute, 1999). The IJC (1997) reported on the formidable flood fighting efforts led by the Manitoba Water Resources Branch. Over 8,000 military personnel supplemented provincial and local resources. Thousands of volunteers filled sandbags, gave care to children, and provided moral support. In 72 hours, a 24-km long, 3-m high dyke was constructed from clay and other materials. "Of the 800 properties protected by emergency dyking in Winnipeg, only 29 were damaged by floodwaters" (IJC, 1997, 20). Non-government organizations played an active role during all flood phases. For instance, the Red Cross provided $10,000 grants for resident's whose homes were unsalvageable and the Mennonite Disaster Services provided technical advice on rebuilding (Natural Hazards Centre and Disaster Research Institute, 1999; Slmcleod *et al*., 1999).

These strengths must be balanced against shortcomings. In 1997, heavy precipitation in the fall of 1996, exceptional snowpack, a less than ideal temperature pattern, high soil moisture content,

untimely runoff, and an April blizzard combined to cause the highest flood recorded this century (IJC, 1997; Morris-Oswald *et al*., 1998). Although prior knowledge of these conditions and the long flood history promoted a timely flood warning, there were a number of surprises. The IJC (1997) concluded that overland flooding: (i) hampered accurate flood forecasting; (ii) was a major contributor to water flows and flood damage; and (iii) exacerbated damages on numerous farms. Flood crest estimates at the Red River Floodway were underestimated by 1.5 m to 1.7 m (Morris-Oswald *et al.*, 1998). When the community of Ste. Agathe was flooded, it was viewed as 'unexpected' because it had not been flooded previously. For this reason, ring dykes had never been constructed around it and made it vulnerable to overland floodwaters. On the other hand, the eight communities with ring dykes were not flooded (Morris-Oswald *et al.*, 1998). The rapid melt and changes in land use were believed to make the 1997 flood flows sharper and of shorter duration than might otherwise would have been expected (IJC, 1997). These 'surprizes' reflect the uncertainty, complexity and change that are associated in managing human activities, and in understanding and predicting hydrologic and hydraulic processes.

Weaknesses in the institutional arrangements for flood warning also surfaced during the Red River flood. The inadequacy of the flood warning effort was reflected in the employment a single experienced flood forecaster by Manitoba Natural Resources (IJC, 1997). Although about 140 hydrometric stations were operating throughout the entire Red River basin during the flood, the IJC (1997) recommended that more and better ones be established. These could also assist in better predicting flow patterns associated with overland flows and ice jams. For a variety of psychological and other factors, some people ignored flood warnings. For instance, not all farmers accepted offers made in April to have their livestock removed from flood-prone areas (IJC, 1997). These factors suggest that public information programs were inadequate.

Jurisdictional issues sometimes hampered timely emergency responses (Tait and Rahman, 1997). During the Red River flood, some rural municipalities were reluctant to spend their own funds on flood fighting before financial arrangements with the province were finalized because provincial statute precluded them from running operating deficits (IJC, 1997). This reluctance was reinforced in those local officials who had underestimated the flood risk and had concluded that funds spent on emergency preparedness would represent a waste of money (Haque, personal communication). Some municipal flood fighting efforts were criticized because they appeared to be ill prepared (Morris-Oswald *et al*., 1998). The IJC (1997) questioned the capacity of rural municipal response systems because part-time officials, who had relatively less experience with emergency flood systems than their urban counterparts, often staffed them.

Some aboriginal communities in the Red River valley suffered specific difficulties. Although the EPC (1998) had outlined general roles and responsibilities for flood response on Indian Reserves, it was unclear which agencies had a specific role in the development of emergency plans and with their implementation. Some Band Councils did not have official and approved emergency preparedness plans. This problem reflected, in part, their desire to avoid a perception of "favoritism" that might be associated with those members who were identified in the plan (Epp *et al*., 1998). At times, the emergency procedure between some Bands and the provincial government was unclear. In commenting on the experience of the Anishinabe First Nation, Rahman (1998) suggested that the floodplain location of its Emergency Operations Centre as well as inadequate communications with other relevant parties were problematic. With respect to evacuation procedures, some band members perceived that they were not treated fairly because they were re-located to an arena that offered no privacy while non-aboriginal flood victims were offered better temporary shelters. This

choice evidently reflected the poorly communicated preference of the Manitoba Association of Native Fire Fighters which was primarily responsible for aboriginal emergency procedures (Rahman, 1998).

Jurisdictional challenges also surfaced during the Saguenay flood. During that event, the fragmented ownership as well as the unsystematic design and operation of reservoirs posed a very significant obstacle (Canadian Dam Safety Association, 1997). An integrated approval and operating system for water control structures was lacking. These weaknesses were compounded when upstream dams had much larger flow capacities than downstream structures. In addition, design elevations of control structure were different than downstream and nearby dykes. Flood damages were exacerbated when water released from the Ha!Ha! Reservoir overtopped downstream dykes. During the flood, six major water control structures failed and several others were damaged (Canadian Dam Safety Association, 1997). This series of failures made effective flood warning and response even more difficult. In its review on the management of dams in Quebec, the Canadian Dam Safety Association (1997) noted that records about maintenance were often poorly kept or non-existent. Where there was information about dam safety, it was difficult for communities and other interested participants to obtain it.

The operation of structural adjustments in the Red River has created tensions between upstream and downstream communities. Morris-Oswald *et al*. (1998) reported that when the Red River Floodway was first used in 1969, upstream residents perceived that it worsened flooding in their communities. A public inquiry following the 1974 flood confirmed that floodgate operation had increased upstream flooding by 0.65 m. During the 1997 flood, the operation of the floodway increased upstream flood levels in Grande Pointe by 0.64 m. It appears that structural works have contributed to a false sense of security and complacency among the public, fostered conflicts between communities, and distrust of experts and bureaucrats by some people (Morris-Oswald *et al.*, 1998; Caligiuri and Topping, 1999).

5.4 Implications for Flood Recovery Efforts

Claims for disaster financial assistance in the Red River valley were received from 5,100 individuals and 61 municipalities. Since the floodway increased flooding in Grande Pointe, flood victims within that community were permitted to submit claims in excess of the $100,000 limit (Haque, forthcoming). In other areas, the 20% deductible for disaster assistance was waived and grants of up to 75% of costs could be received. Although the FDRP was to limit disaster assistance to those structures built prior to designation, all landowners were compensated (Morris-Oswald *et al.*, 1998). This undermined the credibility of the FDRP and floodplain regulations.

First Nation residents who applied for disaster relief encountered problems because it is the band that owns the buildings and the residents who occupy them (Rahman, 1997; Haque and Epp, 1998). Disaster relief programs are oriented towards private landowners. There was also confusion among federal, provincial and local authorities over how these important socio-political differences could be best overcome.

After the flood, the Manitoba legislature established a new standard for floodplain development. It is now the 1997 flood level plus 0.06 m for dykes and 1.0 m for buildings (IJC, 1997). Primary

responsibility for implementation of the new development standard rests with municipal governments who may use their discretion in applying minimum building elevations into building by-laws (Morris-Oswald *et al.*, 1998). Provincial agencies will not be able to ensure effective implementation of this standard. While new provincial legislation has been introduced to preclude disaster relief to development that fails to comply with the new standard, past experience suggests that this intent will not be followed (Morris-Oswald *et al*., 1998). Traditional public information programs are to be improved. However, there has been no effective action to integrate drainage activities into larger scale watershed management plans.

In Manitoba, a $130 million flood infrastructure enhancement program funded by federal and provincial governments was developed in order to improve flood protection (Caligiuri and Topping, 1999). Funding assistance was provided to homeowners and businesses for dyking or foundation raising. During the first-year of the program, over 2,700 applications were received and about 50% of these completed their projects. However, not all homes were able to meet the new floodproofing standards and there appears to be few fundable options available to them (Natural Hazards Centre and Disaster Research Institute, 1999). A ring dyke around Ste. Agathe and the upgrading of a dyke in Winnipeg are early and major components of the program. By the program's completion in 2003, other communities will be protected through structural measures, some groundwater wells sealed, GIS and topographic data upgraded, the flood forecasting network improved, and geophysical research on the historical pattern of flooding undertaken (Caligiuri and Topping, 1999).

The decision to provide disaster relief funds to all landowners seriously detracted from effective flood management because: (i) it penalized those landowners and municipalities that had implemented floodplain regulations at a cost to themselves; (ii) it continued the tradition of subsidizing floodplain development; and (iii) it implicitly promoted floodplain development. Ideally, disaster assistance should encourage a reduction in future flood losses. The Disaster Financial Assistance Arrangements program did not encourage the removal of structures and it supported a very limited range of reduction measures. Land acquisition is an alternative that is often not pursued by any program. The degree to which the support provided by the NGO community in reducing or increasing future losses is unclear. Thus, while flood responses were prompt, their ability to reduce vulnerability over the long term is uncertain.

6.0 THE PROBLEMS, THE FACTORS AND THE CROSSROADS

6.1 The Underlying Problems

While past flood management efforts have likely reduced the losses of lives and property, they have essentially postponed rather than eliminated damages (Etkin and Brun, 1997; Etkin *et al.*, 1998). As the International Decade for Natural Disaster Reduction comes to an end, many Canadians are concerned about the adequacy of these initiatives to reduce economic impacts and eliminate hazards (Figure 1.1). The crossroads faced by Canadians are characterized by a number of contrasting elements. We can continue down an incremental path and provide bigger structures, more relief and better warning systems, or we can challenge the underlying weaknesses of current approaches and seek a better future.

Prior to 1953, municipalities and individuals were the leaders in flood management. However, over time their efforts became inadequate and uncoordinated. Since 1953, flood management has been predicated on the availability of funding and leadership from senior governments, and in particular from the federal government. In 1975, funding was expanded to embrace structural adjustments, the mapping of flood-prone areas, public education, warning systems and other non-structural adjustments. These approaches have been oriented toward the non-aboriginal population of Canada. During the entire period, flowing water, primarily rivers, rather than the processes within an entire watershed has been the focus of our efforts.

In practice, flood management has fostered a set of cultures that is at the root of the current predicament. When design criteria are not exceeded in those communities that have adopted structural adjustments and floodplain regulations, these measures have, in large part, effectively prevented damages. However, the construction and operation of structural adjustments have fostered conflicts between upstream and downstream communities. This culture of conflict provides a poor foundation for future management innovations. In addition, the emphasis on structural adjustments has nurtured a culture of land development that is based on a false sense of security. Short-term economic gains are more valued than the long-term costs associated with flood damages. When design criteria are exceeded, flood management programs have exacerbated economic losses. The sense of false security and the land development ethic have seriously detracted from effective floodplain regulation and land acquisition programs.

In providing flood relief, we support flood victims. This generosity is often a measure of a caring society. However, an unintentional yet inherent bias in programs has increased the aboriginal community's vulnerability because they have not had the same level of access to flood relief and FDRP funds. In a more general sense, the Natural Hazards Centre and the Disaster Research Institute (1999) concluded that the removal and repair of structures that would reduce future flood damage did not occur systematically after the Red River flood. They also maintained that recovery assistance did not foster strong individual responsibility or self-sufficiency. In their view, communities will not be adequately prepared for a future flood that might exceed design standards. Indeed, their report suggested that some measures might work against the long-term resilience of the residents. A similar situation appears to be developing in British Columbia and other portions of the country (Day, 1999; Forget *et al.*, 1999). Thus, a culture of dependency for future structural adjustments and disaster relief payments continues to be nourished by current recovery programs.

In reconsidering the cost-sharing arrangement with other levels of government under the Disaster Financial Assistance Arrangements program (Table 4.1), the EPC hopes to reduce its liability to large losses. While the American experience with flood insurance (NFIP) could serve as an alternative flood relief model, Platt (1999) concluded that repetitive losses, often without premium increases, is one of its fundamental problems. Like Canadian disaster relief arrangements, that federally supported program has encouraged landowners and local governments to discount future flood losses. Unless a disaster relief program seeks to reduce future flood losses rather merely restore structures and contents to their pre-flood levels, flood damages should be expected to increase.

Hunt (1999) observed that the FDRP encouraged local governments and individuals to rely on senior governments for leadership and financial support. It is noteworthy that the FDRP did not invite direct municipal participation. While this orientation conforms to the traditional practice of Canadian federalism, it often precludes the effective involvement of the municipal level of government. Their participation is crucial because it is the implementation of floodplain zoning regulations, not simply the production of flood-risk maps, that is the key to effective management. This occurs in local communities. The FDRP left it up to provincial governments to encourage the adoption of floodplain zoning by municipalities (Bruce, 1976). Provincial support for floodplain regulations and the capacity of local governments to adopt them was quite varied. Compounding the resolution of this problem is a perplexing characteristic of the practice of Canadian federalism in flood management that encourages a culture of dependency by local governments on senior governments and an associated cycle of escalating flood losses. The cycle begins with significant flood damages being inflicted on a community, perhaps located on a well-known flood-prone area. Relief programs largely funded by senior governments and NGOs immediately respond to this event. Bigger and more structures are built with most of the funding coming from senior governments. Commercial properties and residences are refurbished to pre-flood conditions. Some effort may be devoted to dyking and house raising on individual properties. Flood warning systems are improved. Since these technical solutions are not complemented with effective land use planning, intensive development occurs in flood-prone areas. Primary blame for the latter is often placed upon municipalities. However, it is the previous steps that implicitly support this cycle of escalating economic losses. It also supports "buck passing" among the levels of government who are often blamed by the public when floods occur. Senior governments provide neither consistent nor strong signals on the need to truly integrate structural and non-structural adjustments. In this context, the generally limited support afforded floodplain regulations by many municipalities and property owners is understandable. Finding solutions to break away from the current trend of increasing flood damages is the key management challenge.

6.2 Factors Affecting Flood Damages

The pattern of flood damages is influenced by three factors: population and settlement patterns, the amount and integrity of any infrastructure, and the nature of events. It is the recent incidence of substantial losses (Figure 1.1), the expectation of increasing future flood losses and the lack of leadership for flood management that are causing the current high levels of concern.

Over the last fifty years, Canada's population has doubled and now comprises over 30 million people. Since relatively more Canadians are living in urban centres, particularly the larger cities of

Toronto, Vancouver and Montreal, the potential for significant losses is increased. Due to their high level of economic prosperity, Canadians have acquired more material goods (*e.g.* computers, VCRs) that may be damaged. Generally, these factors have sometimes transformed what were once regional events into national concerns. Along with this shift is a greater level of public pressure and political sensitivity for 'action' that is focused on a relatively small geographic portion of the country (Newton , 1997). It is in this context that land use planning and floodplain zoning can most effectively contribute to preventing future losses. Since there are many communities that already are already flood-prone, a mix of structural and other non-structural measures that cover the breadth of preventive, warning, response and recovery programs will be also be required to solve the problem.

The country's aging infrastructure is also contributing to increased flood losses. During the 1960s, governments in Canada spent 4.5% to 5% of GDP on infrastructure projects, and that amount has now declined to 2% (Kovacs, 1999). These projects include many of the facilities that are integral parts of our urban systems - roads and bridges, water distribution and sewer networks, public buildings, dams and dykes. Many of these water structures are now between 30 and 45 years old, and may require major maintenance in the near and medium term. It is unclear how this activity will be financed. In the absence of required maintenance, all structures become more prone to damage. The flood (and indeed entire concrete and earthen) infrastructure that now supports human settlements was often developed at the cost of nature's infrastructure – wetlands, floodplains and other natural areas (Hunt, 1999). Given the current trend in damages, it is unclear if the economic benefits associated with tradition settlements will outweigh the costs over the long term.

The nature of weather events is the third factor that influences damages. In a Canadian context, Hoffman *et al*. (1998) noted that precipitation over the Great Lakes was relatively higher and more variable for the period 1940-1990 compared to the 1900-1940. They also suggested that there is no apparent spatial pattern to precipitation trends across Canada. In the global context of climate change and severe weather events, Bruce *et al*. (1999) suggested that long-term reliable data identified an increase in the frequency of extreme rainfall events in the United States, Japan, northern Australia and the northwest coast of India. However, shorter period records in China and the former Soviet Union failed to support this trend. Thus, there is considerable variability in the pattern of recent changes and it is uncertain what changes will occur in the future. If changing weather patterns due to human activities are found to be a major cause of increased damages levels, Canadians must increase their efforts to reduce greenhouse gas emissions. With about 0.5% of the world's population, Canada contributes about 2% of global emissions of greenhouse gases and is the second highest per capita emitters of greenhouse gases in the world (Bruce *et al.,* 1999). In 1997, Canada was one of 160 nations that signed the Kyoto Protocol to the Framework Convention on Climate Change. It extends previous voluntary emission controls initiatives by establishing legally binding reduction targets for six greenhouse gases, by providing a timetable and by defining a process to determine compliance measures. Under the protocol, Canada has agreed to reduce emissions by 6%, of its 1990 emissions (Climate Change Program, 1998). Through the Federation of Canadian Municipalities, 37 municipalities belong to a '20% Club' that have committed to a 20% reduction target in green house gases from 1990 levels.

The relative contribution of these three factors in the pattern of flood losses Canada is experiencing is unclear. The success of future flood management initiatives will be affected by the interaction of these three factors. Since there is concern about the need, cost-effectiveness and adequacy of measures aimed at reducing greenhouse gas emissions, it is pragmatic to focus flood management efforts on issues related to the location of people and land uses, and the nature of the human

settlement infrastructure. The management challenge is to define management principles that reduce our vulnerability in order to achieve sustainable human settlement development.

6.3 The Crossroads and Guiding Principles

The recent actions by government have often been grounded in a desire to address fiscal problems. While this is an urgent issue, it must not be solved at the cost of important issues. Reducing the vulnerability of communities to flooding and other hazards has been a very low priority recently. The federal government does not perceive itself as gaining much political capital in this area and believes it is largely a provincial responsibility. Within the federal government, any political capital is divided unevenly between Environment Canada and Emergency Preparedness Canada. Since the Environment Canada's mandate focuses on environmental quality, eliminating the FDRP spending was relatively easy to justify. The
program restricted senior governments to provide disaster assistance to those structures built before an area had been designated. However, the key federal agency that implements that requirement, EPC, was not effectively involved in the FDRP. Traditionally, EPC has focused on disaster preparedness, response and recovery measures, and not flood prevention. Provincial disaster relief agencies were also not effectively incorporated into the FDRP. Future discussions about flood management must involve not only all levels of government, but all of their relevant agencies that embrace the full set of management strategies – prevention, preparedness, response and recovery. The effective participation of insurance and NGO sectors are also keys to enhancing future efforts.

Provincial commitment to the issue is reflected in the relatively few people it employs in flood management. Provinces perceive that flood management should primarily be seen as a municipal responsibility. In the absence of a strong provincial commitment and appropriate mechanisms that foster watershed-based solutions, it is unlikely that municipal governments have the capacity and appropriate geographic scale to manage floods effectively. "Passing the buck" appears to be an active activity by all levels of government. However, it does not solve the problem. The implicit messages local governments and landowners receive from current management programs often encourage floodplain development and establish a context for future increased economic losses.

The recent set of actions and proposals emanating from Environment Canada (1998a; Pearce and Quinn, 1998), Emergency Preparedness Canada (Day, 1999) and the Insurance Bureau of Canada (1999) underscore the current management crisis. While there is some comfort in knowing an awareness of the problem exists, there has been neither a systematic assessment of the past strategies, nor a rigorous assessment of proposed alternatives. On this basis, Bruce and Mitchell (1995) suggested that Environment Canada reconsider its decision to abandon the FDRP. In responding to this criticism, Environment Canada (1998a) indicated a willingness to review the effectiveness of past mitigation programs and clarify the flooding component of a national mitigation policy. However, it will not fund future mapping initiatives. Since these statements address neither the need for an adequate technical support group within any level of government nor funding for mapping, the federal role in flood mitigation activities has devolved from that of a leader to, at best, an impotent facilitator or observer. In general, it appears that individual agencies working from restricted mandates will continue to do their best in a difficult and constantly changing context. Individually and collectively, these initiatives largely address the urgent issue of funding without confronting the long-standing and underlying problems that underpin Canadian

flood management strategies. If the current void in leadership is not filled, a provider of disaster assistance could become a more frequent role of all levels of government in future flood management activities. It was this set of circumstances that prompted the development of the FDRP in 1975.

If we are going to solve current problems, a fundamentally new direction in flood management should be considered. In that regard, there is an emerging consensus that sustainable development should be the core around which all resources and hazards should be managed (Berke, 1995; Mileti *et al*., 1999). It is also a concept that was endorsed by Environment Canada (1998b) in a discussion paper entitled *Canada and Freshwater: Experience and Practices*. It suggested that three principles support sustainable management – ecosystem, partnerships and the role of science. It is most appropriate to consider applying these principles as the foundation for future flood management initiatives.

6.3.1 The Ecosystem Approach

The ecosystem approach appreciates the complexity of relationships among and within environmental, social and economic systems. Rather than focusing attention on one element of the environment, attention is often turned to considering how human health, vulnerability or other broad measures of quality affect the natural and social environment. There are at least three important components of the ecosystem approach to be considered in flood management.

First, to implement this approach, attention is often given to watersheds. Past approaches have reflected a 'rivercentric' rather than a 'basincentric' orientation. Paying attention to the river and its flood-prone valley has impaired our ability to consider the impacts and appropriate mitigative measures that are associated with agricultural drainage and other land use developments. A preoccupation with the river has also contributed to the exclusion of mapping floods caused by ice jams and overland flow. The contribution of drainage projects to the generation of flood flows is not considered during application review. The 'rivercentric' focus has also promoted a relatively narrow set of responses to address flood problems. The synergistic effects of natural processes such as flood waters and erosion rates have been overlooked. A 'basincentric' approach would increase the range of choice and promote the consideration of a broader set of flood sources and hazard types. Thus, the 'basincentric' approach emphasizes how human activities can be best accommodated through a better understanding of a watershed's processes. In focusing on watersheds, both inland and coastal areas deserve attention.

Although the 'basincentric' approach represents an improvement over present practice, an overly human-oriented focus of a watershed could be perceived as one potential shortcoming. An 'ecocentric' approach might address this weakness. This second element of the ecosystem approach aims to manage and restore floodplain, river channels and watershed biodiversity in a manner that enhances the quality of the natural and human environment. The natural flood control functions and other beneficial attributes of watersheds are considered and valued in a systematic manner. In the United States, the focus of flood management has recently shifted in this direction (Mileti, 1999). There have also been selective efforts to remove structures from flood-prone areas in the United States (Burby, 1998; Hunt, 1999). In Canada, consideration could be given to enhancing floodplain management through floodplain and wetland acquisition, as well as river and wetland restoration with funds available through the IBC (1999) proposal. Funds could also be obtained from water supply and pollution control agencies in order to support this type of initiative. In this manner, the

use of the term 'infrastructure' to embrace both human and natural features. The 'ecocentric' approach strives to "cooperate with nature" rather than work against it (Burby, 1998).

A third aspect of the ecosystem approach focuses attention on integrated institutional arrangements. The fragmented approach to the approval of permits for reservoirs in the Saguenay contributed to flood damages. Permit approvals for water structures, agricultural drainage and land development have been granted on a case-by-case, rather than a watershed basis. While these shortcomings highlight the need for institutional reform, there will be resistance to the required changes. For instance, water operators in the Saguenay basin generally supported existing administrative arrangements because they were familiar with them and they adequately served their specific needs. However, the Canadian Dam Safety Association (1997) advocated the development of new institutional arrangements based on a greater sharing of responsibilities, particularly between the provincial government and municipalities. Among other duties, municipalities would be required to prepare an emergency plan that was integrated with similar plans prepared by dam owners and operators. In the lower Fraser River, this aspect of the ecosystem approach would address the present gap among dyking, mapping, urban development and land use planning. The apparent barriers between agencies that have responsibilities for flood prevention (*e.g.* Environmental Canada under the FDRP) and those that focus on preparedness, response and recovery (*e.g.* Emergency Preparedness Canada) would be reduced, or ideally eliminated.

In the context of urban centres, Berke (1998) advocated the use of growth management techniques to supplement traditional land use planning. These would establish standards to guide the density, type, construction and rate of development in order that development in hazardous areas is prevented. Structures would be designed to withstand multiple hazards. Public facilities that are crucial to responding to a hazard would also be accessible (Berke, 1998). This level of institutional integration has infrequently been considered in a Canadian context. Thus, the application of the total ecosystem approach considers multiple hazards as well as the linkages within and between both natural and human systems.

6.3.2 Partnerships

There are several themes associated with partnerships. First, there is a sense that those who occupy floodplains must become more responsible for their actions, and less dependent on current relief and rehabilitation initiatives (Morris-Oswald *et al.*, 1998). However, this attribute can only be fostered if senior governments place greater commitment on land use planning, and there is a significant departure from current approaches that foster the culture of dependency. Indeed, Canadian municipalities have been generally excluded as a meaningful partner in previous flood management programs.

Although the partnerships of the past were adequate at the time of their development, new forms of partnership are required to address present and future challenges. In this regard, all relevant agencies from all levels of government, and the insurance and NGO sectors should collaborate in the development of any national flood/disaster management policy.

In considering new forms of partnerships, a more appropriate balance must be found between responding to the immediate needs of flood victims and the need to reduce long-term vulnerability. The most effective long-term adjustment, land use regulation, has been generally resisted because of

conflicts between social and individual property rights. Cost-sharing arrangements have biased the selection of solutions towards structural adjustments. There is often a false sense of security generated by structural projects. In hindsight, a shortcoming with the FDRP was the lack of attention devoted to the implementing regulations after the mapping exercises had been completed. While Ontario's approach has been an evolving one and is not perfect (Shrubsole, 1995; 1996; 1997a), several qualities have contributed to its success. Floodplain regulations appear to have been effective when they: (i) are practiced on a watershed basis; (ii) are one part of an integrated set of adjustments; (iii) are supported by a firm policy; and (iv) provide for a reasonable level of local discretion.

Another aspect of the partnerships would promote the development of a culture of flood preparedness (IJC, 1997). To achieve this goal, we must go beyond traditional information and education programs based on pamphlets, open houses, audio-visual productions, and school programs. While these are valuable, they are inadequate. Newton (1997) concluded that a flood preparedness culture required a shift in basic human values and social-environment interactions. While this is a formidable challenge, it can be fostered by both private and public sectors. For instance, provincial governments could require real estate agents to disclose timely and effective hazard information to purchasers during real estate transactions. This is a requirement of the United States National Flood Insurance Program and can serve as a model for similar approaches in Canada (Platt, 1999).

6.3.3 The Role of Science

The role of science accepts that managing any aspect of water requires knowledge on the biophysical, economic and social systems and their interaction. This is a formidable task and reflects a knowledge base that we have not yet developed. According to Hunt (1999), monitoring must be increased and the principles of adaptive management applied. While complete knowledge is likely not achievable, floodplain management efforts should be well-informed about precipitation patterns, water flows on historical and real-time levels, risks, warnings, preparedness levels, remedial measures, and lessons from previous floods (Handmer and Parker, 1992). In this manner, all flood management efforts should be based on the best information available.

The use of Geographic Information Systems (GIS) can be one way of improving current knowledge levels. According to Haque (personal communication), it and related technologies have been applied through a series of pilot projects at the local and regional levels in North Carolina (NCDEM, 1998). If successful, both preventive and response programs could be improved. Local governments could make more informed decisions and increase current levels of self-reliance. This development would also have positive impacts on the nature of partnerships required to enhance flood management.

Between 1990 and 1998, federal and provincial budget reductions resulted in the termination of 724 hydrometric stations. "Although stations with limited informational value or redundant information should be considered for network reduction, clearly 21% of the former national network did not fall into these categories" (Scott *et al*., 1999, 51). At a time when the need for information is more crucial than ever, recent decisions have dismantled important elements of the hydrometric network. There is little doubt that we can better utilize the remaining database. For instance, data collected from water control projects has not been used often to re-evaluate management actions or change the

operations of structures. However, the recent budget reductions are in stark contrast to the current need. Perhaps some funds could be made available through the IBC (1999) proposal to enhance the current level of support for the hydrometric network. Operating funds should also be expected from water supply and wastewater treatment agencies as part of the user-pay philosophy. Part of the development charges that are assessed by municipalities could also be targeted on the hydrometric network.

In short, the dilemma concerning which crossroad to choose reflects, in large part, the choice of framing flood problems as being primarily technical or institutional in nature. The road well traveled essentially extends a 50-year tradition in flood management that appears to make communities more vulnerable to higher magnitude floods. A relatively narrow set of alternatives is used to solve flood problems. The construction of more, larger and better structures encourages more floodplain development and increases the loss potential. The road less traveled applies a wider range of the best structural and non-structural solutions in an institutional environment that promotes sustainable human settlement development. It utilizes the concepts of growth management (Berkes, 1998). A difference in the outcomes associated between the two roads pertains to what proportion of funds will be spent on disaster relief versus reducing long-term vulnerability. Hopefully, a forum will be available that allows all levels of government and relevant stakeholders to debate the merits of these and other roads.

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