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The Role of Government in Services for Natural Disaster Mitigation

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Executive Summary

Losses from natural disasters in Canada are increasing and evidence suggests that natural disasters will occur with greater frequency and intensity in the years to come. Despite this, disaster mitigation remains a low-priority issue for many, which raises a number of questions. Should disaster mitigation be primarily a government responsibility? What is the appropriate role for government in this endeavour? What are the services for disaster mitigation that a government can provide and what form should they take?

In answering these questions, we can take several points of view, including an economic perspective (i.e., which services should be provided by government?); a legal perspective (i.e., is the government legally liable if a citizen is harmed by a natural disaster?); and a moral perspective (i.e., what is the moral responsibility of a government to its people?). In light of these various viewpoints, it is suggested herein that disaster mitigation is an important and appropriate responsibility for government and resources should be made available to facilitate its implementation.

This paper identifies four tools that contribute to disaster mitigation (Planning, Hazard Assessment and Monitoring, Prediction and Warning Systems and Public Education and Research) and explores various government services that exist within these areas. Though there are many effective programs in Canada which contribute individually to disaster mitigation, a more coordinated and better supported effort is required to entrench a national mitigation strategy and reduce Canadian vulnerability to natural hazards over the long-term.

Over the past few decades, there has been a marked increase in the frequency and cost of extreme natural hazards around the world. Global losses from these events have risen significantly, averaging approximately US\$40 billion annually over the past decade, with costs in 1999 reaching US\$100 billion (Munich Reinsurance, 1999). While major non-weather events such as the 1995 Kobe earthquake contributed to these figures, 80 per cent of the costs are attributable to weather (e.g., hurricane, tornado, ice storm) and weather-related (e.g., flood, drought) events. Canadians have experienced the upward trend in natural disaster losses firsthand; for example, the ice storm which struck eastern Canada in January 1998 caused at least 28 deaths and is now estimated to have cost over CDN\$5 billion (OCIPEP, 2002a).

The escalating toll of disaster losses has prompted investigations into the characteristics of natural hazards and the human response to them. Research in this area suggests that, while hazards may not be preventable, the damage inflicted by extreme events can be significantly reduced. Disaster mitigation is defined as “sustained action taken to reduce or eliminate the long-term risk to people and property from hazards and their effects (FEMA, 1999)”. It can be structural (i.e., mitigating hazards to prevent a disaster), as well as non-structural (i.e., mitigating the vulnerability of a community to reduce the impacts of a disaster). Specific examples of mitigation include: better design and construction of structures, enforced through enhanced building codes; more advanced systems for gathering information on hazards, their characteristics and frequency of occurrence; improved warning mechanisms to alert people about impending hazards (e.g., weather warnings); and modification of socioeconomic activities to reduce vulnerability of at-risk populations.

Interest in mitigation tends to be highest immediately following a disaster, where community vulnerability has been highlighted through disruption, loss of life and property damage (Solecki and Michaels, 1994). The post-disaster atmosphere offers a great opportunity for mitigation and policies are often built into the reconstruction process to reduce a community’s vulnerability to future events (Rubin and Popkin, 1990; Berke et al, 1993). Recent studies have shown that, even in the absence of a disaster, some people voluntarily devote resources to activities and practices that mitigate their personal vulnerability. For example, a 2002 study by Simmons and Kruse (2002) found that homebuyers in a hurricane-prone region in the United States would be willing to pay extra for a home that had wind-resistant features such as storm shutters to protect .

Despite these examples, under normal circumstances, mitigation is generally a low priority for governments and individuals. Because the benefits of mitigation activities are not immediately tangible, the costs and sacrifices that are often required to reduce personal and community vulnerability are difficult to justify in the absence of an imminent threat. Moreover, citizen demand for mitigation is often artificially low, as people have a natural psychological inclination to underestimate risk and tend to minimize the danger they perceive from hazards in their environment (Drabek, 1991).

Because of this unwillingness or inability on the part of individuals, it seems increasingly clear that government intervention is required to protect lives and reduce property damage from natural disasters. But what is the appropriate role for government in this endeavour? What are the services for disaster mitigation that a government can provide and what form should they take? The objective of this paper is to discuss the role of government in services for disaster

mitigation, identify different services that can be employed for this purpose and assess their strengths and deficiencies in the Canadian context.

The Role of Government

Assessment of the appropriate role of government in services for mitigation can be contextualized within the wider debate over its role in society, a point of dispute that may be as old as the institution itself. In Western countries, this debate has become particularly acute since the mid-1970s, when serious reassessments of the public sector began to change the face of government. Critics who observed through the economic philosophy of the free market claimed that the size of government had become problematic, questioning the degree to which government should be involved in regulation and subsidization and which goods and services it should provide (Hughes, 1998). Into the 1980s and 1990s, these arguments were fuelled by financial crises, as government spending was reduced and emphasis was placed on privatization.

In assessing the role of government in society, we can draw on a variety of different perspectives. The most prominent arguments in this debate seem to emanate from the economic realm, but there are legal and moral dimensions that may also be relevant.

Economic Perspective

The role of government is often debated in the context of economics, where private firms seek to limit or eliminate government involvement in the provision of goods and services that they argue should be produced by the private sector (Committee on Partnerships, 2003). Within this argument, a relatively consistent general principle emerges: government should intervene only in areas where markets fail; that is, where private firms are unable or unwilling to produce a particular good or service (Hughes, 1998).

One area where government compensates for market failure is in the provision of *public goods*. From an economic perspective, a public good exhibits one or both of the following characteristics: (1) jointness of consumption - the good can be consumed by more than one individual without deteriorating its usability and (2) non-excludability - once the good is produced, people cannot be prevented from consuming the good (Holcombe, 2000). A good is considered a public good if, by its nature, it cannot be sold exclusively to a select group while excluding "free riders". Lacking control over use and redistribution of the good, private firms will choose not to produce it, leaving an opportunity for public production, where a government can tax *all* the citizens to pay for the service. An example of a public good is a lighthouse; its light-emitting qualities are not reduced if more or fewer ships use it, and once implemented, its light cannot be restricted to certain users. The economic value of a lighthouse can be measured through a reduction in marine vessel collisions, which in turn saves lives, improves economic efficiency and protects the environment from spills.

Government intervention can also be required where there is a problem of *imperfect information*; where people are unwilling or unable to become familiar with information about risk, regulations can provide protection externally (Hughes, 1998). An example of this is the setting and enforcement of land-use regulations in hazardous areas like floodplains. If people are unaware of

hazards that threaten a particular property (e.g., because Canadians are not required to disclose hazards at the point of sale), then in order to protect the safety of its citizens, a government must take on the responsibility of warning them before a hazard becomes a disaster. For example, floodplain mapping provides information for consumers to make informed decisions and better gauge the level of risk associated with them. Furthermore, armed with this information, governments may invoke legislation to forbid people from taking such a risk.

Remaining in the economic realm, another responsibility of government is to practice fiscal prudence, to use scarce tax resources collected from citizens in an effective and efficient manner. A commitment to fiscal responsibility would demand that governments pursue pre-disaster mitigation policies, which are almost always less expensive than post-disaster relief and recovery (FEMA, 1999). In Canada, rapidly escalating post-disaster relief costs are making the cycle of damage and repair unsustainable; “[s]ince 1994, government disaster finance assistance payments are averaging \$300 million per year, compared to an annual average of only \$25 million for the period 1970-1993. This is money that had to be diverted from other public policy and spending priorities (ICLR and EPC, 1998)”.

The value of government investment in mitigation is illustrated through the economic benefits of weather forecasting in the United States; for example, accurate hurricane monitoring and warning systems save an estimated \$US 2.5 billion in coastal damage costs annually (Committee on Partnerships, 2003).

Legal Perspective: The Duty of Care

Are governments in Canada legally obligated to mitigate hazards? To put it another way, can a government be found legally liable for injury or property loss caused by a disaster? Very little is written in Canada to connect disaster management with the legal liability of governments, but it seems plausible that a government could be found negligent in the event that an *operational decision* breaches a *duty of care* owed to citizens.

Under Canadian tort law, a distinction is made between policy decisions and operational decisions. If policy is adopted that negatively affects the interests of individuals or corporations, it cannot be used as a basis for claims of negligence, but if a public official or agency makes an operational decision in the implementation of the policy, which has an adverse effect on an individual or corporation, the government may be found liable for negligence (Rosenberg, 1999). The Ontario Law Reform Commission (1989) calls this the *operational/planning distinction*:

...at the planning level of government, where policy decisions are made as to the allocation of scarce governmental resources, there is no liability in the Crown for negligence. At the operational level of government, where significant policy choices are not usually involved, the Crown can be held liable in negligence unless that decision involved a considered policy decision.

Andrew J. Roman (2002) suggests that:

The distinction between “Policy” decision and “Operational” decision is basically a legal rationalization. The key issue is duty of care, and when there is “proximity”. The court will determine that there is enough proximity, and that a government action was an operational decision, if the court believes that transferring the cost of the losses incurred from the plaintiff to the defendant is just.

The distinction is based on a *duty of care*, which Rosenberg (1999) explains:

The duty of care is the duty to take care; every person has the legal obligation, or duty, to be careful in what he or she does, or chooses not to do, so as not to cause harm to his or her neighbor...It was originally a duty between private individuals but, with the evolution of case law, it came to apply as well to the Crown, both for the actions of its servants in the conduct of their duties and for the decisions taken in the course of their day-to-day work.

Investigating this issue in the context of Canadian municipal government, Roman (2002) suggests that there are “two broad areas in which a municipality can potentially be held liable in negligence: inadequate preparedness to prevent or limit a preventable emergency; and inadequate preparedness in response to an emergency, causing more severe harm”.

According to Roman, “courts hold municipalities to a very high standard of care” and “the scope of persons to whom a duty of care is owed is unclear: the courts exercise a broad discretion, subject to principles articulated with neither clarity nor consistency (Roman, 2002).”

In assessing whether or not a government has contravened a duty of care, courts will determine if the conduct “falls below the standard reasonably expected to be met”, based on “such factors as the nature and extent of the risk and the ease with which it could have been reduced or eliminated (Roman, 2002).”

Because there is no legal precedent in Canada regarding the liability of governments for disaster losses, the preceding information can only provoke further thought about the responsibility of government to the protection of citizens. For example, since increasingly detailed information regarding hazards, risk and vulnerability is becoming available to governments, should citizens be able to reasonably expect a higher standard of care? Moreover, detailed research, success stories and recommended practices for mitigation continue to emerge, making it much easier for governments to design strategies which reduce disaster risk, so is it reasonable to expect that governments should make greater efforts in this area? Finally, does a changing climate and increasingly hazardous natural environment demand a stricter duty of care, obligating governments to do more *before* a disaster occurs in order to protect the health and safety of citizens?

Using the operational/planning distinction referenced above, choosing to create and implement mitigation strategies is a policy decision that is not subject to legal liability. However, to be effective, mitigation requires a sustained effort, with adequate resources and facilities; if these are not maintained, and agencies are expected to “do more with less”, services to citizens may suffer. The Government of Canada is currently engaged in consultations with interested parties to

formulate a National Disaster Mitigation Strategy, a policy that defines disaster mitigation as “sustained actions taken to reduce or eliminate the long-term impacts and risks associated with natural and human-induced disasters” (OCIPEP, 2002b). In order for this policy to be effective, adequate resources must also be made available to strengthen Canadian resistance to natural hazards and reduce vulnerability to disaster losses.

Moral Perspective: Government as Protector

Since Roman times, public safety has been a primary responsibility of governments, illustrated in the Latin phrase *salus populi suprema lex esto*, or *the welfare (safety) of the people is the supreme law*. Today, the protection of citizens remains one of the primary responsibilities of public officials. Where people are unwilling or unable to protect themselves from the hazards in their environment, governments have an obligation to take appropriate action in the public interest to reduce the risk of injury or property damage. Governments in Canada have largely accepted this responsibility, illustrated through non-structural and structural examples that can be seen every day. For example, concrete barriers separate oncoming traffic to prevent serious head-on accidents (prevention), speed limits reduce the risk of accidents (reduction) and seatbelts reduce injury in the event of an accident (mitigation).

Governments in Canada have also accepted this responsibility in the area of hazard management, illustrated through Canada’s outstanding response capability. Across the country, quick and well-organized response personnel help to minimize the impact of disasters by responding promptly and providing care to affected populations. A reasonable extension of this responsibility would be to include mitigative actions, designed to reduce loss of life and damage to property *before* a disaster.

A related concept is *perceptions of fairness*. Where the government has delivered a number of services or provided certain information in the past, there is a sense of “status quo property rights” and “perceived contracts”, felt by citizens in terms of what their government should do for them (Committee on Partnerships, 2003).

Services for Disaster Mitigation

Services for disaster mitigation can be broadly grouped into four categories, including:

- Hazard assessment and monitoring;
- Planning;
- Prediction and warning systems;
- Public education and research.

Hazard Assessment and Monitoring

One of the first steps to mitigating natural disasters is to identify and assess hazards that threaten a community. Once hazards have been identified, the vulnerability of the community can be assessed and policy can be made accordingly.

According to Deyle et al. (1998), there are three forms of hazard assessment, each involving a different degree of sophistication. The authors identify these elements as:

- *hazard identification*, which involves a survey of an area to identify various hazards and estimate their magnitude and probability of occurrence;
- *vulnerability assessment*, which develops the relationships between identified hazards and existing and future populations and property who are or will be exposed to the hazards to “estimate damage and casualties that will result from various intensities of the hazard”; and
- *risk analysis*, which “involves making quantitative estimates of the damage, injuries, and costs likely to be experienced within a specified geographic area over a specific period of time (Deyle et al, 1998).”

A detailed and comprehensive hazard assessment, particularly if it incorporates risk analysis, provides the information necessary for decision-makers to identify policy options and determine the appropriate strategy for mitigating natural hazards that threaten communities. Once vulnerabilities have been identified, actions can be taken to reduce risk.

Individual communities may lack the resources or technical expertise to undertake a comprehensive hazard assessment, so intergovernmental cooperation in this area is very important. Encouraging examples of this can be found in several Canadian provinces; for example, the British Columbia Ministry of Energy and Mines has conducted detailed assessments of the earthquake and landslide hazards in the province, which have been incorporated into regional and local planning (Government of British Columbia, 2002).

New technologies are evolving to permit more sophisticated assessments of hazards. Advanced remote sensing techniques and improvements in geographic information systems (GIS) allow hazards to be digitally mapped and modelled to determine the present and future risk associated with them (Boyle et al, 1998).

The first step in Hazard Assessment and Monitoring is to identify hazards, which requires observation and monitoring, including the collection, quality control and analysis of information on the occurrence of hazardous events. Within the federal government, the main organizations involved in these activities are the:

- Meteorological Service of Canada (part of Environment Canada) - weather, climate, water levels, sea ice (mainly through arrangements with the Canadian Coast Guard);
- Geological Survey of Canada (part of Natural Resources Canada) – earthquake and volcanic activities and ground water; and
- Hydrographic and Ocean Science and Canadian Coast Guard activities (parts of the Department of Fisheries and Oceans Canada) – tides, ocean surges, sea ice (with MSC).

Each of these organizations conducts vulnerability assessments and risk analyses concerning the hazards within their fields of responsibility. Other organizations at both federal and provincial levels also have monitoring responsibilities; for example, the MSC cooperates with the provinces in water survey measures that provide the basis for flood hazard mapping and flood prediction.

The Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) is the primary agency tasked with the coordination of government efforts for disaster mitigation. It serves as a resource point for information on natural and human-induced hazards and provides information on services available for disaster mitigation. One program of OCIPEP is the National Hazards Electronic Map and Assessment Tools Information System (NHEMATIS), a hazard database created through a public/private partnership which identifies and assesses facilities and individuals at risk from natural hazards in Canada. The information contained in the database also identifies potential future disasters, providing a basis for preparedness and mitigation activities (OCIPEP, 2001).

Another notable project is the Canadian Natural Hazards Assessment Project, a joint effort among the MSC, OCIPEP and the Institute for Catastrophic Loss Reduction which was undertaken to identify natural hazards in Canada and assess Canadian vulnerability as a basis for policy-making in the areas of preparedness and mitigation (Environment Canada, 2002).

Planning

The identification of at-risk areas through a comprehensive hazard assessment is an important step in disaster mitigation but, in order to deter future losses in the event of a disaster, this information must also be incorporated into the community planning process, both in determining long-term development strategies and regulating existing land uses (Boyle et al, 1998). A land-use plan considers the projected needs of a community and marks out a strategy to designate land for future development, provide services and facilities for future populations and preserve environmental resources (Godschalk and Brower, 1985). A land-use plan can enhance mitigation by guiding development away from at-risk areas.

In Canada, municipal governments have the delegated authority to develop and maintain a community's Official Plan, a strategy document that assesses local resources and future community needs and sets guidelines for development to ensure long-term sustainability. Incorporating a community hazard assessment into an Official Plan would help to get municipal officials thinking about how to deal with hazardous areas. Future uses of at-risk parcels of land could be mapped out in advance to ensure that development in these areas is appropriate and does not create an unnecessary level of risk for citizens (e.g., locating a high-density residential neighborhood in a floodplain). Management of flood risk is still an issue in Canada (Shrubsole et al, 2003).

The planning process can be used to build disaster mitigation into future community development, which can then be enforced through zoning bylaws. Building codes also provide a tool for enforcement of disaster mitigation principles and can be used to ensure construction techniques contribute to the resilience of structures to environmental hazards. To avoid flooding, for example, design criteria for public works infrastructure like sanitary and storm sewers can

incorporate higher tolerances to account for unexpected events. Building codes can be used by governments to protect the interests of citizens; for example, by requiring a minimum standard for construction materials and techniques used in new home construction, governments are able to ensure a measure of safety for consumers who may not be fully informed of risk upon purchase.

While building codes offer the potential for disaster mitigation, they must be consistently enforced in order to be effective. Problems with enforcement have been strikingly illustrated in the United States; after Hurricane Andrew in 1992, insurance investigators estimated that building code violations were to blame for approximately one quarter of the insured losses from the event (Insurance Institute for Property Loss Reduction, 1995).

The creation of building codes in Canada is a provincial responsibility, but provincial building codes are largely modeled after the National Building Code of Canada (NBC). Although enforcement of building codes is a provincial responsibility, it is delegated, in most cases, to municipal governments. As such, municipal officials are in a unique position to utilize building code enforcement as a method of disaster mitigation. Usually located within the same building, officials from the community's building department have an opportunity to work together with those in the planning department to initiate a cooperative effort to improve community resilience. Where the planning department could locate and designate hazardous areas in the community, building code enforcement officers can take greater care in ensuring strict construction standards. Getting municipal officials thinking about disaster mitigation in their daily roles will help to promote it as a community priority.

Prediction and Warning Systems

An important component of a national mitigation strategy is an effective Prediction and Warning System that provides information concerning the likely occurrence of future events and warns the public about impending hazardous events. The prediction component of this service involves collection of information on the past and present occurrences of hazardous events and scientific analysis to provide information on the past (up to the present) frequency of occurrence and characteristics of events.

Weather and climate forecasting are common tools of prediction that are valuable in the mitigation of natural disasters. Credible scientific analysis of long-term climate trends can encourage policies designed to increase community disaster resilience and reduce losses, such as building restrictions and land-use planning. Short-term prediction and advance warning of specific extreme weather events can enable communities to take necessary precautions to reduce their impact (Dore, 2000). Short-term prediction is highly valuable for reducing business losses as well; for example, airlines are able to use weather information to decide on the feasibility of continuing or canceling flights based on an assessment of conditions (Sowden, 2002).

New technologies have made prediction more accurate and comprehensive, permitting longer-range predictions, but further investment in this area is needed to ensure greater resolution and precision (Sarewitz and Pielke Jr., 1999). For example, though improvements in monitoring and forecasting technology over the last few decades have significantly improved the ability of

scientists to predict the onset of El Niño (a phenomenon historically responsible for a number of extreme weather events that have resulted in natural disasters), the damage caused by extreme weather attributable to El Niño remains high, because current technology is only able to predict broad characteristics that will accompany the phenomenon, such as increased rainfall or higher temperatures in certain regions; more sophisticated modeling capabilities are required to predict specific effects of El Niño after it has begun (Nicholls, 2001).

Once predictions have been made, an effective warning system allows people to take appropriate action to protect themselves before a disaster, which helps to reduce injury and loss. In order to be effective, components of the disaster warning process must be integrated and maintained, including sensing and observation equipment, processing and modeling facilities and appropriate communications systems for delivery and dissemination (FEMA, 2000). Governments play a major role in this process because much of the infrastructure is owned and operated by public departments and agencies; funding or lack of funding for any of the components in the process can affect the accuracy and effectiveness of disaster warnings and hence the vulnerability of people in an at-risk area.

There are a number of technical areas where improvement is needed to enhance the effectiveness of warning systems. In order to provide accurate and specific disaster warnings, greater investment is required in monitoring and prediction systems and in supporting research. With existing technology, for example, there is major uncertainty in predicting the path of hurricanes, mid-latitude cyclones and tornadoes, so forecasters will generally issue a warning covering a wider area than will actually be affected by the event. Because evacuation of a community or other response actions are very expensive and difficult to coordinate, emergency officials often base the decision on the predicted heading and severity of a storm. If this information is inaccurate, an expensive decision could be made in vain (Pielke Jr. and Carbone, 2002). Moreover, when people are issued a disaster warning and then are not affected by an event, there is a tendency to ignore future warnings, so it is essential to improve disaster warnings and ensure that they are distributed only to people who are at risk (FEMA, 2000).

A major administrative detail in this area is who should be the official authority to issue disaster warnings. On one hand, disaster warnings exhibit the properties of a public good, suggesting that authority for their distribution should be reserved for public control. On the other hand, private meteorological companies argue that they should have the right to issue disaster warnings as well, or risk losing credibility in the eyes of the public. The importance of this issue should not be understated, as problems arise when there are no defined rules for the issuance of disaster warnings. Without clear parameters, duplication and discrepancies between the advice given by public agencies and private firms can cause confusion, alarm and panic among emergency personnel and vulnerable populations. An example of this occurred in the United States before the 1988 Hurricane Gilbert, when an evacuation advisory issued by a private meteorology firm was contradicted by the US National Weather Service, causing confusion and panic among Texas residents along the coast of the Gulf of Mexico (Kerr, 1990).

In Canada, the Meteorological Service of Canada (MSC) is responsible for providing information on weather, climate, water and ice state within Canada. On an annual basis, the MSC issues approximately 14,000 severe weather warnings and 3,500 ice hazard warnings, as well as

about 500,000 public weather forecasts, 200,000 marine weather forecasts and 400,000 aviation forecasts. Warnings are only issued when extreme events are expected (Environment Canada, 2001). MSC polls show that about 94 per cent of Canadians listen to at least one weather forecast daily, making it one of the most frequently used federal government services. Despite the important role that the MSC plays in prediction and warning, federal spending cuts reduced its total budget by roughly 38 per cent between 1995 and 1999. Even with slight increases in recent years, the total budget of the MSC in 2000-2001 was only about 75 per cent of what it was 10 years earlier.

Public Education and Research

In many cases, mitigation strategies are not adopted because of a lack of public support. Though potentially devastating, disasters are relatively rare, while the costs and sacrifices associated with land-use regulation and building code enforcement can be seen every day. As a result, people are apt to resist mitigation strategies in the absence of a perceived threat (Burby, 1998). Public education can help people become aware of vulnerability, introduce them to alternative strategies for coping with hazards and stimulate public interest in disaster mitigation as a community priority. In order for people to make informed decisions and take mitigative actions at an individual level, they must have access to information not only about the hazards that they face, but also the potential damages that could result in the event of a disaster.

Individuals and local governments are the primary agents of disaster mitigation, yet resistance to disaster mitigation efforts is often strongest at this level. To overcome this problem and to stimulate a greater interest in disaster mitigation among Canadians, further effort must be made to share information with people and inform them about ways in which they can protect themselves and contribute to the resilience of their community.

In the United States, there is a large body of literature focused on natural hazards and disaster mitigation, mainly published within the last thirty years. This research has helped to raise awareness among policy-makers and guide disaster mitigation policy at all levels of government. While the Canadian equivalent of this literature is growing, much more research is needed to fully assess the hazards Canadians face and identify strategies to address them that are appropriate within the Canadian context.

In order to facilitate a wider research network in Canada, closer partnerships must be developed among government agencies, academic institutions and private organizations, modeled on successful collaborative efforts that have developed to date. Moreover, interdisciplinary information-sharing should be a priority for organizations and agencies committed to disaster mitigation.

Recommendations

There are many government programs, services, agencies and organizations that individually contribute to disaster mitigation in Canada. The foundations for a truly effective national mitigation network are largely in place, but further investment and development is required to seal holes and repair weaknesses that have resulted from restructuring and budget cuts over the last ten years.

Hazard Assessment and Monitoring - In order for targeted mitigation programs to be employed, it is first necessary to identify and assess natural hazards that threaten Canadian communities. Because local governments often lack the resources or technical expertise to conduct comprehensive hazard assessments, intergovernmental cooperation is required to ensure that hazards are identified and mapped.

Planning - Incorporating principles of disaster mitigation at the planning stage can help to ensure that hazardous parcels of land are identified and designated for non-residential uses. Communities should be encouraged to use a regional hazard assessment as a guide when deciding zoning and land-use regulations in order to prevent unsuitable use of hazardous areas. Building codes can be improved by incorporating location-specific hazard information, which can be addressed at the design stage. Greater interdepartmental collaboration at the municipal level, particularly between the planning and building departments of a community, could help to raise awareness of disaster mitigation and ensure that it is implemented at each stage of the development process, from land acquisition and zoning to construction.

Prediction and Warning Systems - In order to accurately predict weather and climate systems, improvements must be made to prediction systems. Investment must be made in meteorological infrastructure to take advantage of new technology for accurately detecting and monitoring hazardous weather conditions. Existing warning dissemination methods must be further developed; warning distribution should be targeted specifically to at-risk population and in a way that will ensure a wide reception.

Public Education and Research - In order to embed disaster mitigation as a national priority, a greater effort is necessary to convey the importance of this task to the public. Through public information and awareness campaigns, a wider constituency can be built for action at the local level, as citizens who are engaged in the topic are more likely to promote these ideas within their community.

Scientists predict that the number and severity of extreme weather-related events will continue to rise in the decades to come. This fact, coupled with a rising population, greater urbanization and aging infrastructure, amplifies the need to focus on mitigating natural hazards. In order to avoid increasing property losses and personal injury, it is essential for Canada to develop proactive mitigation strategies prior to disasters. Governments have an essential role as the facilitators of these changes and the pursuit of disaster mitigation policies is an appropriate undertaking for governments as a protector and service-provider. In Canada, existing structures offer a foundation on which a well-coordinated national program of disaster mitigation could be built,

but greater investment and sustained commitment from governments at all levels is necessary to make this idea a reality.

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